Evaluating the Economic Impact of Special Economic Zones in Colombia: Employment, Export Performance, and Spillover Effects (2008-2017)

Daan Dumont

SolisID: 5754062

Utrecht University

Master of Science Human Geography

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Professor: Nicola Cortinovis

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I. Abstract

Implementing special economic zones (SEZs) as place-based policy has gained great interest in both developed and developing countries. However, since governments provide economic incentives to companies that establish themselves in SEZs, public funds are utilized. The justification for this expenditure depends on whether the (economic) benefits generated by SEZs exceed the associated costs.

This study focuses on the influence of SEZs on employment, exports and spillover effects in Colombia in the time frame from 2008 to 2017. The aim is to determine whether the intended goals of the Colombian government with regard to SEZs are achieved. The research question that is central to this study is: To what extent do special economic zones in Colombian municipalities affect employment and export between 2008 and 2017? SEZs refer to designated and contained geographic regions within a country characterized by more liberal laws.

In order to answer the research question, a quantitative approach and a longitudinal research design were used. The hypotheses were tested by means of fixed effects regression analyses to control for both time-invariant characteristics and time changing effects. Based on various analyses it was found that SEZs have no statistically significant effect on employment, exports, or spillover effects. Interestingly, terrorist attacks have a positive statistically significant effect on exports, while the number of graduates has a negative effect.

Based on the results, future research should investigate why no statistically significant relationships were found by adding new variables. In addition, the striking results regarding terrorist attacks and number of graduates on exports should be further investigated.

II. Preface

In front of you lies my Master Thesis 'Evaluating the Economic Impact of Special Economic Zones in Colombia: Employment, Export Performance, and Spillover Effects (2008-2017)'. This thesis was written as the last part of my Master Urban and Economic Geography at Utrecht University.

Since I was twelve I have been fascinated by Latin culture, especially Colombia. It was always my dream to go there and I succeeded. In total I have been in this beautiful, diverse, and versatile country for almost 1 year. When it was time to come up with a research topic, I initially had no idea. A list was presented with topics that different teachers were working on and that you as a student could write your thesis about. Then I saw a topic about Colombia and I knew immediately that this could not be a coincidence. Even though the focus was economic and quantitative in nature which is outside my comfort zone, I still decided to do it. This has taught me a lot of new things in the field of statistical analysis that I didn't know I had in me.

Writing my thesis did not go as hoped and expected. Normally I should have been finished in July 2023, but due to huge setbacks in my private life, writing it was not my top priority. After I had recovered a bit from these drastic events, it was hard work to get to this result.

Finally, I would like to thank my supervisor Nicola Cortinovis for the pleasant cooperation, his time and patience. I would also like to thank the study advisor Aukje de Graaf for the pleasant guidance so that I have been given some delay to be able to write my thesis in peace. Last but not least, I would like to thank my girl friend and fellow student Lisanne van Damme for all her support during the hard times I have been through.

I sincerely hope that my thesis contributes to science and that you as readers learn something from it.

Daan Dumont

Utrecht, 12th of September 2024

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1. Introduction

In 1547 the first special economic zone (SEZ) was founded in the port of Leghorn in the Bay of Genoa in the north-west of Italy (Meng, 2005). During the early 17th century, several European cities witnessed the emergence of more free ports (forerunner of nowadays SEZs), which eventually transformed into free trade zones (FTZs). Aggarwal (2010, p. 4) defines these FTZs as compact, duty-free regions with well-defined boundaries, providing warehousing, storage, and distribution facilities for trade, transshipment, and re-export operations in numerous entry ports worldwide. Like the FTZs in the 17th century, today's SEZs are designated and contained geographic regions within a country characterized by more liberal laws, such as tax reductions, and economic policies aimed at stimulating foreign-invested manufacturing and export-oriented services (Shah, 2009).

The last 50 years, the implementation of SEZs as a place-based policy has gained great interest in both developed and developing countries. In 1975 only 79 zones were registered in 29 countries (Aggarwal, 2010, p. 1), whereas in 2008 approximately 3.000 zones in 135 countries were established (World Bank, 2008, p. 7). Within SEZs, the direct impact includes a significant contribution of over 68 million direct jobs and more than 500 billion US dollars in value added related to trade. By 2016, the number of zones had increased even further to around 3,500 in 138 different countries, employing a total of around 70 million people (Herrera, 2016).

At first glance, these seem to be positive results, which speaks in favor of implementing SEZs, yet the existence of economic activities in SEZs does not imply a net positive outcome to the economy of a country by rule (Moberg, 2015, p. 168). Firms can relocate within a country from a non-SEZ area to an SEZ area, whereby employment and exports may shift from area A to B (Lu et al., 2019). On the whole, the literature on the impact of SEZs on employment and exports is inconclusive, with some asserting that SEZs have substantial effects on exports, investment, employment, and welfare, while others argue the contrary (Davies & Mazhikeyev, 2019). For instance, Nazarczuk and Uminski (2018) found a positive relation between SEZs and exports in Poland, whereas Steenbergen and Javorcik (2017) found no effect on the same matter in the context of Rwanda. In addition, Jensen and Winiarczyk (2014) found, in the case of Poland, that SEZs have managed to attract 'foreign direct investments' (FDI), yet the contribution to employment or wage improvements has been relatively limited. These conflicting voices from the literature are the reason for this study, which looks at the impact of SEZs on economic activities in the context of Colombia.

This study's country of interest, Colombia, has experienced a similar trend. In 1958 the first SEZ was established in the city of Barranquilla in the Atlántico department (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 161; Ministerio de Comercio, Industria y Turismo [MINCIT], 2022). Colombia established 102 SEZs across 20 departments in 2016 (Arévalo-Luna & Arévalo-Lizarazo, 2019), and by March 2022, the number had increased to 121 SEZs (MINCIT, 2022). Colombia has also exhibited a comparable trend in the creation of direct employment opportunities. In 2009, SEZs facilitated 28,954 direct jobs in Colombia, while this number increased to 174,058 direct jobs in 2016 (Asociación de Zonas Francas de América Latina [AZFA], 2017).

The five departments of the utmost importance and with the most SEZs are:

Antioquia, Bolívar, Valle del Cauca, Atlántico, and Cundinamarca (Asociación Nacional de Empresarios de Colombia [ANDI], 2017; Fontalvo-Hererra et al., 2019; MINCIT, 2022). The reason for this is that in these departments the five largest cities of Colombia are located: Bogotá (Cundinamarca), Cali (Valle del Cauca), Medellín (Antioquia), Atlántico (Barranquilla), and Cartagena (Bolívar). Figure 1 is a map of Colombia at the department level, with the aforementioned five cities highlighted. The map indicates that the departments in Colombia are relatively large, while SEZs are established with the aim of improving the economy locally (Aggarwal, 2006; Ambroziak & Hartwell, 2018; World Bank Group, 2017). As a consequence, the geographical unit of analysis in this study will be Colombian municipalities, because this is the smallest administrative unit in Colombia (Datlas, n.d.).

Figure 1. Political and administrative map of Colombia including its major cities

(Mapsland, n.d.)

Based on the wide range of literature regarding the economic impact of SEZs, it appears that two variables often emerge: employment and export (Aggarwal, 2006; Moberg, 2015; Lu et al., 2019; Wang, 2013;). In fact, according to Davies and Mazhikeyev (2019, p. 146), promoting exports is the main purpose of an SEZ. In addition, the creation of employment opportunities stands as one of the primary objectives of SEZs, yet in the Colombian context it appears that SEZs are not major sources of employment (Arévalo-Luna & Arévalo-Lizarazo,

2019, p. 170). Since significant improvements can be realized in employment and exports, both of which are among the primary objectives of SEZs, these factors are designated as the two main dependent variables in this study.

Additionally, this study specifically targets a defined time period, encompassing the years from 2008 through 2017. The justification for this selection is straightforward, as the Colombian government's data pertaining to export and employment is exclusively accessible for these particular years (Datlas, n.d.). Given the importance of these variables in this study, the aforementioned period has been chosen as the time frame for analysis.

Furthermore, with place-based policies, like SEZs, it is important to include the possible presence of so-called spillover effects as well. According to Fischer and Getis (1997), spillover effects refer to the interconnectedness of (economic) activities between one geographical area and those in surrounding areas. Specifically, in the context of SEZs, spillover effects look at the (economic) impact of an SEZ on surrounding regions without an SEZ (Ying, 2000). These can be both positive and negative spillover effects. For instance, a municipality in Colombia has an SEZ, but surrounding municipalities do not have one. Non-SEZ-based firms may relocate to the municipality with an SEZ (Lu et al., 2019). This is an instance of a negative spillover effect, because the presence of an SEZ has adverse economic consequences for its surroundings. Conversely, firms in non-SEZ municipalities can benefit through observing and learning from their competitors in SEZ municipalities, serving as an example of a positive spillover (Lu et al., 2019). Because spillover effects could play a vital role around the concept of SEZs, it is important to include this in the analysis of this research.

Finally, it is important to briefly outline what is meant by the term SEZ in this study, because this concept has evolved into various forms and often is called by different names in different countries (World Bank Group, 2017). For instance, SEZs are called maquiladoras in Mexico, Costa Rica, and El Salvador, industrial free zones in Ghana, special export processing zones in the Philippines, special economic zones in China and India, and free economic zones in Russia (De Armas & Jallab, 2002).

In the case of Colombia a distinction can be made between two types of SEZs: zonas francas permanentes (ZFP) and zonas francas permanentes especiales (ZFPE) (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 163). In short, ZFPs are zones where several companies can establish themselves, while within the boundaries of a ZFPE only one company is allowed to establish itself (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 163). In June 2016, Colombia had 38 ZFPs and 62 ZFPEs, respectively (AZFA, 2017). This number increased to 42 ZFPs and 79 ZFPEs in March 2022 (MINCIT, 2022). All of the above names for SEZs are used interchangeably in the academic world, as they carry nearly identical meanings (Aggarwal, 2007). In order to avoid confusion, the term special economic zone, or SEZ, is used throughout the rest of this study. The terms ZFP and ZFPE are only utilized when it is pertinent to differentiate between them.

1.1 Relevance

1.1.1 Academic relevance

Despite the increasingly sophisticated work on place-based policies, like SEZs, most research is focused on such programs in the United States and Europe (Lu et al., 2019; Wang, 2013),

whereas in developing countries the majority of SEZs are situated (Carter & Harding, 2011, p. 8). Research in the context of developing countries is limited in numbers. Attempts have been made, for example, for India (Aggarwal, 2006; Aggarwal, 2010) and China (Lu et al., 2019; Wang, 2013). This research provides insights into the role and impacts of SEZs in Colombia in order to contribute to the lack of academic work in the context of developing countries.

Furthermore, in many cases, the main goal of an SEZ is the promotion of exports. However, within the academic world there is little rigorous evidence on its economic impact, particularly in relation to the promotion of exports (Davies & Mazhikeyev, 2019, p. 146). In this study, export is one of the key dependent variables. This study specifically examines the impact on exports when an SEZ is present in a municipality. This knowledge contributes to the lack of evidence surrounding the relationship between an SEZ and exports.

1.1.2 Societal relevance

Many place-based policies, such as SEZs, aim to encourage agglomeration economies to stimulate local economic development by creating jobs, attracting investments and capital, and promoting trade and exports. SEZs facilitate interactions among firms, which can lead to increased productivity in concentrated regions. This is often achieved through the formation of clusters or the attraction of technologically advanced industrial facilities (Combes et al., 2011).

Despite their significant potential, some SEZs have not demonstrated substantial impact and, in certain countries, have even become economic burdens (Moberg, 2015, p. 167). For instance, Philippine authorities invested heavily in infrastructure development for an SEZ in Bataan, undertaking projects such as port upgrades, the construction of a new dam for energy supply, and the erection of modern office buildings. However, despite these substantial investments, the zone struggled to attract enough businesses, resulting in a costly failure for the government (Warr, 1987).

In the context of Colombia, the national government has formulated a clear goal with the implementation of SEZs: to reduce regional disparities in employment, innovation, exports, and investment (MINCIT, 2011). The national government accomplishes this by designating specific areas as SEZs, where incentives play a crucial role. For instance, firms based in SEZs enjoy a 10% tax reduction and exemption from value-added taxes (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 163). Reducing taxes inevitably leads to a loss of revenue, which must be offset through alternative taxes (Zee et al., 2002, p. 1501). As a result, the Colombian people are essentially paying for the financial benefits of the (foreign) companies they have attracted. This could be acceptable in the event that attracting (foreign) companies results in sufficient positive externalities, like an increase in exports and employment (World Bank Group, 2017, p. 17).

If this is not the case, it is suggested that primarily SEZ-based firms benefit from this. After all, SEZ-based companies pay lower taxes and may also experience other financial advantages (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 163). This is an undesirable situation because the aforementioned intended goals of the Colombian government are not being achieved. As a result, the question of whether SEZs have meaningful effects on the local economy, given that they are funded by public money, holds significant social relevance for

both Colombian policymakers and citizens. If unmet goals exist, it is prudent to allocate public funds in a way that effectively benefits the Colombian people.

1.2 Research question

Built upon the introduction and the relevancies, the following research question has been drawn up:

''To what extent do special economic zones in Colombian municipalities affect employment and export between 2008 and 2017?''

Based on this central question, the following sub-questions have been formulated:

1) To what level do zonas francas permanentes perform better (stronger effect) than zonas francas permanentes especiales in terms of employment and export in Colombian municipalities between 2008 and 2017?
2) To what extent do special economic zones in Colombian municipalities foster employment between 2008 and 2017?
3) What is the impact of special economic zones on export in Colombian municipalities between 2008 and 2017?
4) To what extent do special economic zones in Colombian municipalities facilitate employment and export spillover effects between 2008 and 2017?

In response to the main question and sub-questions, the following objective has been outlined for this study: to gain insights into whether the intended goals of the Colombian government regarding the implementation of SEZs are being achieved. In order to measure the success of SEZs in Colombia, the two dependent variables 'employment' and 'export' have been included. In addition, 'spillover effects' have also been included as a mediating variable. This study examines the potential positive or negative influence of SEZs on either of these variables within the Colombian context.

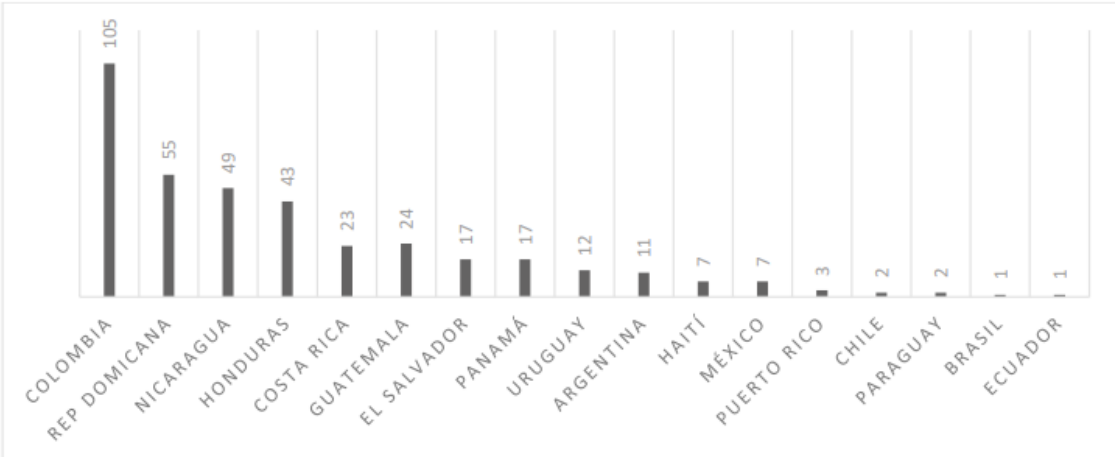
1.3 Reading guide

The next section delves deeper into the history of SEZs in Colombia and provide an overview of the main laws and regulations related to SEZs. This provides insights into Colombia's policy direction and the evolution of its policies. Section 3 presents the theoretical framework, detailing the concepts relevant to this study. It reviews existing knowledge on SEZs, business clustering, employment, export, and spillover effects, and introduce the conceptual model. Furthermore, the hypotheses for this study are formulated within this theoretical framework. Chapter 4 discusses the methodology of this study, covering both the research and analysis methods. Section 5 presents and interprets the main results and findings. Section 6 provides the conclusion of the study and addresses the research question. Finally, the study concludes with a discussion, including interpretations of the results, identification of limitations, and suggestions for further research.

2. Context: history of special economic zones in Colombia

Colombia is the leader in Latin America when it comes to the number of SEZs (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 161). Figure 2 illustrates the number of SEZs in Latin America and the Caribbean as of 2015. Colombia surpasses the combined total of SEZs in the Dominican Republic (55) and Nicaragua (49). This prompts an inquiry into the specific laws and regulations that have contributed to Colombia's prominence in establishing SEZs within the region. This chapter provides a comprehensive analysis of the primary legislative and regulatory measures implemented in Colombia since the inception of its first SEZ.

Figure 2. Special economic zones in Latin America and the Caribbean in 2015



(AZFA, 2017)

Until December 2005, Colombia had 11 SEZs, but these were not yet covered by a legal basis (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 162). On December 30, 2005, this changed when Act 1004 was introduced (Alcaldía Mayor de Bogotá D.C., 2005; ANDI, 2020). This was the first step of the creation of a free trade regime, which enabled the first private free trade zones (ANDI, 2020). This Act contains provisions regarding the creation of SEZs, what an SEZ is, the purpose of SEZs, and who the users of SEZs are (Alcaldía Mayor de Bogotá D.C., 2005). In short, this Act encompasses the essential elements, requirements, and procedures necessary to access the free trade zone regime in Colombia (ProColombia, 2022).

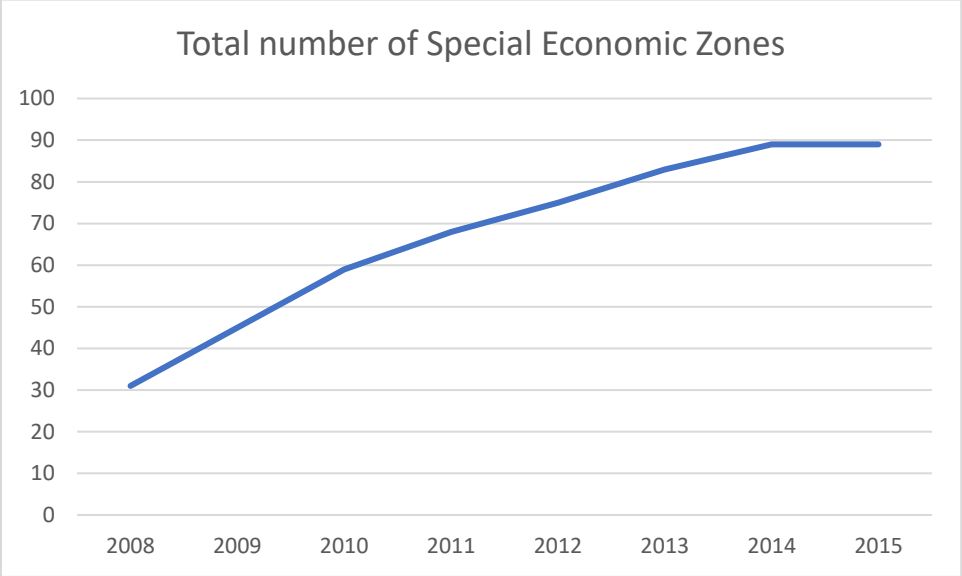
In Colombia the Ministry of Commerce, Industry and Tourism is in charge with respect to the Free Trade Zone Regime and all related laws, acts, and decrees (ANDI, 2020). With the introduction of Act 1004, 5 purposes were formulated by the Ministry of Commerce, Industry and Tourism that an SEZ would have to comply with (ANDI, 2020):

1. To be an instrument for creating jobs and attracting new capital.
2. To be a development pole that fosters competitiveness in the regions in which it operates.
3. Simplify procedures for trading goods and services to accelerate sales.
4. Promote economies of scale.
5. Develop industrial processes that are highly productive and competitive, under the concepts of clean production, technology, security, good business practices, and transparency.

Since the implementation of Act 1004 in 2005, the number of SEZs in Colombia has increased

almost tenfold (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 161). Figure 3 shows an increase of almost 50 SEZs between 2008 (31) and 2012 (75). Furthermore the graph indicates that between 2013 and 2015 the number of SEZs was quite stable. However, this graph suggests that since the establishment of Act 1004, which is the legal foundation of SEZs in Colombia, the number of SEZs has risen rapidly. This can be an explanation for the high number of SEZs in Colombia compared to other countries in the region.

Figure 3. Total amount of special economic zones in Colombia between 2008 - 2015



(MINCIT, 2022)

On December 23, 2016, Act 1004 was extended by Decree 2147 (ANDI, 2020; Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 162; ProColombia, 2022, p. 31). The Colombian government, through Decree 2147, implemented a series of stimuli and benefits for firms settling down, including those already established in SEZs, to achieve the aforementioned purposes (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 163). Specifically, companies within an SEZ pay 10% less tax than companies outside it. In addition, export goods enjoy exemption from value-added taxes and tariffs (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 163). Finally, firms, companies, and other SEZ users must comply with the five purposes outlined in Act 1004 to create jobs and attract investment, in order to obtain the benefits and opportunities associated with operating within an SEZ (ProColombia, 2022, p. 28).

On March 15, 2021, the Ministry of Commerce, Industry and Tourism issued Decree 278 of 2021, which is a continuation and extension of Decree 2147 (Dentons, 2021; ProColombia, 2022). Decree 278 makes a number of changes that are meant to expand the traditional boundaries of SEZs and encourage business projects that show value chain integration, technological investment, job creation, and the progress of goods and services (Dentons, 2021). There are four main changes: (i) the approval and extension processes for SEZs are made easier; (ii) if certain annual export goals are expected, the required employment and/or investment commitments are lowered; (iii) a Technical Committee of Free Trade Zones is set up to make the zone more competitive; and (iv) some SEZ employees could work from outside the free trade zone (Dentons, 2021; ProColombia, 2022). The primary goal of the most significant changes is to facilitate the establishment of SEZs, thereby fostering the local economy, competitiveness, employment, exports, and investments.

3. Theoretical framework

From the central question and sub-questions that have been formulated, two dependent variables (employment and export) and one mediating variable (spillover effects) are distinguished. These variables may be influenced by the presence of an SEZ, which is the independent variable in this study. The theoretical framework first elaborates on the term SEZ. Subsequently, it is discussed which variables are used to measure the impact of SEZs and whether SEZs are effective according to the existing literature. Followed by a detailed explanation of the phenomenon of company clustering. Next, the dependent variables and the mediating variable are expanded upon in separate paragraphs. Finally, this chapter formulates the hypotheses associated with the sub-questions in various paragraphs and concludes with the presentation of the conceptual model.

3.1 Defining special economic zones

According to the World Bank (2008, p. 9), SEZs all around the world share some basic principles:

1. Geographically delimited area, usually physically secured (fenced in).
2. Single management/administration
3. Eligibility for benefits based upon physical location within the zone.
4. Separate customs area (duty-free benefits) and streamlined procedures.

The four principles lead to the aforementioned definition of Shah (2009): SEZs are designated and contained geographic regions within a country characterized by more liberal laws, such as tax reductions, and economic policies aimed at stimulating foreign-invested manufacturing and export-oriented services. The aim of these more liberal laws is to draw in businesses and investments, as well as to create jobs. This is usually done by means of tax incentives, (partially) free import and export, or the cheaper purchase of land (Aggarwal, 2010; Wang, 2013). In the context of Colombia, SEZ-based firms pay 10% less tax than companies outside it. In addition, value-added taxes and tariffs do not apply to exported goods (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 163).

However, the definition of SEZs does not stop there. The SEZ concept has evolved over the years. This has led to a variety of zones, each with different goals, markets, and activities, but they all fall under the umbrella of SEZs (World Bank, 2008). The World Bank (2008, pp. 9-10) distinguishes the following zones: free trade zones, export processing zones, freeports, enterprise zones, and single factory export processing zones. Aggarwal (2010) adds a few more: hybrid export processing zones, country specific zones, high tech parks, cross border SEZs, regional integration agreements, and sector specific zones. However, as mentioned in the introduction, these different concepts are used interchangeably in the academic literature (Aggarwal, 2007). An export processing zone, for example, is a type of SEZ, yet both names refer more or less to the same thing. Therefore, for convenience, the overarching term SEZ is often used in academia as well as in this study (Aggarwal, 2007).

In Colombia you have roughly two types of SEZs: zonas francas permanentes (ZFP) and zonas francas permanentes especiales (ZFPE) (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 163). A

ZFP is an area where several companies are located that enjoy special tax and customs treatment. In short, various companies can establish themselves in ZFPs. ZFPEs, on the other hand, are zones within which only a single company is located. The company must have a significant economic and social impact on the country and meet the government's established investment and employment requirements (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 163; Legis Writing Team, 2021).

3.2 Are SEZs effective?

An important question for policymakers is whether or not the implementation of SEZs is effective or not. In order to answer this question it is necessary to take into account the policy objective(s) when establishing an SEZ. SEZs are typically established to achieve one or more of several policy objectives: (i) attracting foreign direct investment and promoting exports and industrialization; (ii) mitigating high unemployment rates; (iii) supporting comprehensive economic reform strategies; and (iv) serving as testing grounds for new policies and approaches (Akinci & Crittle, 2008; Farole & Akinci, 2011; Zeng, 2010).

These are the overarching objectives for SEZs, yet there is no universally accepted formula to quantify their success. Generally, the 'success' of a particular program is primarily determined by its ability to fulfill the initially defined objectives set during its establishment (typically spanning a time frame of 10 to 15 years) and its commercial viability relative to the overall investments made in the initiative (Zeng, 2016a). In general, the intended objectives of SEZs are measured by using economic quantitative variables, such as foreign exchange, export generation, employment, and investment (Zeng, 2016a). Wang (2013) conducted research that examined the overall impact of SEZs on the local economy in China. Rather than concentrating on specific objectives of SEZs, the study encompasses a broader perspective. Wang (2013) distinguishes various variables to gauge the effects on the local economy, including FDI, exports, domestic investment, total factor productivity growth, wages, consumer price index, and house prices. In contrast, the study by Lu et al. (2019) investigated the same phenomenon (in China) as Wang (2013), but used other variables: output, capital, number of firms, productivity, wage rate, and employment. This demonstrates that there is no fixed formula for measuring the success of SEZs. It relies on the specific intentions behind the introduction of SEZs in a country or region, as well as the research interests of scholars investigating the subject. This research, for example, focuses primarily on the variables employment and export, but other variables could also be studied.

However, there is a general principle that holds significance for all studies related to measuring the success of place-based policies, such as SEZs. It is crucial to establish a system for monitoring and evaluating the progress of an SEZ to ensure it is moving in the right direction. This enables timely interventions and adjustments when necessary. In cases where the implementation of an SEZ proves to be unsuccessful, the availability of appropriate exit mechanisms becomes critical to terminate poorly designed programs in a timely manner. Nevertheless, it is essential to avoid premature conclusions, as it often takes several years before (positive) outcomes are realized. Practicing caution is vital to avoid prematurely categorizing something as either a success or a failure, thus prematurely terminating an SEZ (Zeng, 2016a).

Now the question remains whether SEZs are indeed effective and successful or not. According to Lu et al. (2019), establishing SEZs has a positive effect on capital investment, employment, output, productivity, wages, and firm growth. Wang's (2013) study also has found a positive relationship between SEZs and an increase in FDI and wage of workers. Furthermore, Ebenstein (2012) used a random effect approach to examine the impact of SEZ policy in China. The study's findings indicated that profits, FDI, and labor productivity exhibited significant positive responses to the SEZ policy. Despite the positive relationships identified by Ebenstein (2012), it is worth noting that the study also found limited or no impact between SEZs and employees' salaries. In addition, the study has found that life is more expensive in coastal areas (where many SEZs are located in China) and SEZ regions, and, therefore, SEZ policies have had a negative impact on the welfare of Chinese workers working within an SEZ. Hence, it is not a policy example that can be broadly beneficial for development in Asia (Ebenstein, 2012).

Conversely, multiple studies highlight the success of SEZs, particularly in achieving one of their primary objectives: attracting investment (Cheng and Kwan, 2000; Crozet et al., 2004; Ledyaeva, 2009). These studies demonstrated a strong association between foreign investors and SEZs. However, it is important to note that the success of SEZs in attracting foreign capital does not guarantee their overall effectiveness. The clusters formed within SEZs may not experience the same level of economic development as pre-existing clusters (De Propris & Driffield, 2006).

Drawing definitive conclusions regarding the effectiveness and success of SEZs proves challenging, primarily due to the varying methodologies employed in case studies and the absence of consistent approaches (Jensen & Winiarczyk, 2014, p. 7). While informative, these case studies do not offer conclusive evidence on whether SEZs, as a policy, enhance welfare. Nonetheless, the literature generally agrees on the positive correlation between SEZs and attracting foreign investors (Cheng and Kwan, 2000; Crozet et al., 2004; Ledyaeva, 2009).

However, when it comes to long-term objectives such as reducing regional inequality by generating higher incomes for workers, the results are mixed at best (Jensen & Winiarczyk, 2014, p. 10). Furthermore, the success of regional policies, including SEZ policies, is heavily influenced by the national institutional context of a country (Farole, 2013; Rodríguez-Pose, 2012). Hence, conducting research on a broader scale between countries could be valuable in providing definitive insights into the circumstances under which certain policies are effective or not.

3.3 Clustering

SEZs are a prominent development strategy implemented worldwide (Akinci & Crittle, 2008). They attempt to foster agglomeration economies by building clusters, increasing employment, and attracting technologically advanced industrial facilities (Combes et al., 2011; Lu et al., 2019). Firms exhibit a tendency to congregate in close proximity to one another due to industrial agglomeration, which in turn reduces transportation costs, leading to the realization of agglomeration economies (Marshall, 1920).

Moreover, the clustering of firms within and around SEZs can generate ample pools of skilled labor, ultimately advantageous for the firms operating within the SEZs (Neumark & Simpson, 2014). The significance of this concentrated labor becomes particularly evident in SEZs that specialize in a specific industry or supply chain (World Bank Group, 2017, p. 16),

which is the case of many SEZs in Colombia (MINCIT, 2022). Labor pooling enhances the matching process between firms and the workforce (Combes & Duranton, 2006). SEZs can generate a substantial skilled labor pool through both natural forces, where workers are attracted by higher wages and job opportunities, and intended forces, which include SEZ-specific policies or strategies designed to attract workers (World Bank Group, 2017).

Potential benefits that firms can gain from labor pooling are: higher labor productivity, reduced search costs, and improved labor matches for jobs (Combes & Duranton 2006; Rodríguez-Pose & Crescenzi, 2008). Moreover, employees can capitalize on a broader range of employment opportunities. These conclusions stem from the fact that employees have the ability to move between firms and industries within an SEZ (World Bank Group, 2017). In addition, employers face a tradeoff, as easy job mobility can result in fierce competition for skilled employees (Combes & Duranton, 2006). As a result, employers tend to raise wages for these employees to retain or attract them (World Bank Group, 2017, p. 17). Although SEZs in Colombia are mainly focused on industries that require less highly skilled workers, such as fruit, palm oil, and sugar (MINCIT, 2022). The theory of generating a labor pool due to the presence of an SEZ also sounds plausible when it comes to less highly skilled employees.

Several studies have aimed to investigate the correlation between regional clusters and companies' export performance (Diez-Vial & Fernández-Olmos, 2014; Fernhaber et al., 2008). While some studies have reported a positive and statistically significant relationship (Antonio Belso-Martínez, 2006; Fernhaber et al., 2008; Tambunan, 2009), others have yielded conflicting results and identified negative effects (Diez-Vial & Fernández-Olmos, 2014).

However, this study assumes that firm clustering and the associated potential for agglomeration benefits (e.g., reduced transport costs) can significantly improve international competitiveness, potentially encouraging firms to develop dedicated growth strategies based on international markets (Marshall, 1920). In Colombia, companies are more likely to cluster within the borders of ZFPs than in ZFPEs, as multiple companies are allowed to establish themselves here, whereas in ZFPEs only one company is allowed to settle. Taking all these elements into account, the following two null hypotheses and alternative hypotheses are formulated:

> **H0:** There is no difference in employment performance between Colombian municipalities with a ZFP and those with a ZFPE between 2008 and 2017.
>
> **H1a:** Colombian municipalities with a ZFP have a better employment performance than those with a ZFPE between 2008 and 2017.
>
> and
>
> **H0:** There is no difference in export performance between Colombian municipalities with a ZFP and those with a ZFPE between 2008 and 2017.
>
> **H1b:** Colombian municipalities with a ZFP have a better export performance than those with a ZFPE between 2008 and 2017.

3.4 Employment

One of the previously mentioned goals of an SEZ is to create employment in areas with high unemployment (Akinci & Crittle, 2008; Farole & Akinci, 2011; Zeng, 2010). Nevertheless, SEZs are not significant drivers of employment in Colombia (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 170). The fact that SEZs aim to create employment, while this is not the case in Colombia, makes the (potential) correlation between SEZs and employment a central focus of this research.

Aggarwal (2007, p. 2) identifies three channels through which the impact of SEZs on employment can be analyzed: (i) the direct job creation within SEZs for both skilled and unskilled workers; (ii) the indirect employment generated by SEZ activities; and (iii) specific employment opportunities for women within SEZs. It is believed that increased employment leads to higher incomes, improved living standards and higher labor productivity. Therefore, job creation is considered an important means of alleviating poverty (Aggarwal, 2007, p. 2).

The establishment of SEZs is often associated with direct employment, as labor-intensive industries seeking cheap labor often set up in these zones, creating new jobs (Aggarwal, 2007). In developing countries, where cheap labor is readily available, SEZs often attract foreign investors in labor-intensive industries, resulting in a growing demand for low-skilled workers. As SEZs develop and focus on higher value-added activities, the demand for skilled labor also increases (Aggarwal, 2007, p. 3). Therefore, SEZ policies can have a positive effect on attracting new businesses, which can have a significant impact on employment. It is expected that as more companies locate in an SEZ, more employment opportunities will also arise (Farole & Akinci, 2011; Zeng, 2010; Zeng, 2021, p. 265).

However, the impact of SEZs goes beyond direct employment and creates additional opportunities in sectors that are affected by an SEZ. These sectors include transportation, communications, automotive, civil aviation, shipping, tourism, hospitality, packaging, banking and insurance, and provide employment for both unskilled and skilled workers (Aggarwal, 2007, p. 3). For example, an SEZ located near a port can increase the demand for export services, which creates indirect employment in the transportation and container manufacturing industries through the increased demand for these services.

Furthermore, the impact that SEZs have on improving the position of women through employment opportunities is substantial. This is emphasized by Madani (1999), who argues that SEZs play an important role in women empowerment, especially young and single women from rural and economically disadvantaged backgrounds. These women often experience limited opportunities for formal employment, making SEZs a valuable place for these women, as they can increase their chances of employment and thus income and independence. The demand for low-skilled workers in SEZs increases the chances of employment for these women. Employers perceive female workers as industrious and disciplined, making them preferable for some jobs partly due to the lower wages that women receive. The combination of the demand for low-skilled female workers and the presence of these women, offers the opportunity to improve the living standards and quality of life for women (Madani, 1999). Nevertheless, Farole (2011) concludes that in some SEZs women are still underrepresented and, when employed, overrepresented in low-paid positions.

In addition to the three channels discussed, there are other factors that determine the influence of SEZs on employment generation (Aggarwal, 2007, p. 2). Two significant factors identified in the literature are education (Papadopoulou, 2019; Spencer & Cooper, 2006) and wage (Kim & Lim, 2018; Apergis, 2008).

Spencer and Cooper (2006) argue that education is the pathway to the labor market, with successful completion of educational programs having a positive effect on labor force participation. Prokou (2008) and Sulkowski and Zawadzki (2016) add that completing a tertiary education is particularly important for obtaining a job. This is supported by the Organization for Economic Co-operation and Development [OECD] (1998), who argue that individuals who have completed higher education experience lower unemployment and earn higher wages. The theory that supports this positive relationship between education and employment is the 'human capital theory' (Papadopoulou, 2019, p. 8). According to this theory, individuals invest in education and training based on rationality and deliberate decisions (Becker, 1994). These decisions are based on a cost-benefit analysis and anticipated benefits, such as higher future income and greater job security (Papadopoulou, 2019, p. 8). Human capital theorists, including Mincer (1991) and Brewer et al. (2010), conclude that the benefits of education outweigh the costs, leading to higher wages, greater job security, and increased labor market participation. From this it can be concluded that education and in particular the completion of tertiary education have a positive effect on employment.

In contrast, the relationship between wages and employment is less straightforward. On the one hand, Card (1992) and Card and Krueger (1994) identify a positive relationship between minimum wage increases and employment. On the other hand, studies by Arestis and Mariscal (1994), Kim and Lim (2018), and Neumark and Wascher (2007) show a negative relationship between wage increases and employment. These contradictory findings can be attributed to the dual effects of wage changes: an increase in wages can enhance the labor supply by encouraging more individuals to seek employment, while simultaneously raising employers' costs. The latter can lead to a decrease in the demand for labor, which can eventually lower wages (Apergis, 2008). This dynamic agrees with the neo-classical economic theory, which assumes that the relationship between wages and employment is influenced by market mechanisms, whereby both the demand for labor influences wages, but also that wages in turn influence the demand for labor (Apergis, 2008). The continuous interaction between wages and employment illustrates their strong interconnection and mutual influence.

The findings regarding the relationship between employment generation and the presence of SEZs in the literature lack consistency. For instance, Sanders and Brown (2012) conducted a study on SEZs in the Philippines and found that their primary objective of job creation was only achieved in a limited number of regions. Notably, regions experiencing the most significant job growth also had the highest rates of migration. This led to a situation where the overall number of jobs did not increase significantly, resulting in persistently high unemployment rates in the Philippines. Similarly, Amirahmadi and Wu (1995) concluded, within the Asian context, that the impact of SEZs on employment generation is characterized by mixed results. In contrast, the Dominican Republic has seen a positive increase in employment since the introduction of SEZs. In 1970 only 500 people worked in such zones, while this grew to 200,000 in 2007 (Facility for Investment Climate Advisory Services [FIAS], 2008). In addition, the Jebel Ali SEZ in Dubai employed 170,000 individuals in 2016,

accounting for approximately 13 percent of Dubai's labor force. Additionally, in Bangladesh, eight SEZs created employment opportunities for a total of 350,000 people (International Finance Corporation [IFC], 2016).

Moreover, there is a favorable trend regarding advancements in skills and labor productivity. Governments and SEZ investors collaborate to assess the workforce's needs and jointly provide training programs aimed at acquiring and improving the critical skills required to increase labor productivity. Noteworthy examples of successful collaborations include the Polytechnic University of Honduras and the Malaysia Penang Skills Development Center (Farole, 2011; Kingombe & Te Velde, 2013). Based on the above information, the following null hypothesis and alternative hypothesis have been formulated:

> **H0:** There is no difference in employment performance between Colombian municipalities with an SEZ and those without one between 2008 and 2017.
>
> **H2:** Colombian municipalities with an SEZ perform better on employment than municipalities without one between 2008 and 2017.

3.5 Export

In addition to generating employment, promoting and increasing exports is also one of the intended objectives with the establishment of an SEZ (Akinci & Crittle, 2008; Farole & Akinci, 2011; Zeng, 2010). Nevertheless, there is little hard evidence in the literature that finds a significant positive relationship between SEZs and the promotion of exports (Davies & Mazhikeyev, 2019, p. 146). This is evidenced by the inconsistent results from the limited literature available on this topic, for instance, Nazarczuk and Uminski's (2018) study revealed a positive correlation between SEZs and exports in Poland, whereas Steenbergen and Javorcik (2017) discovered no discernible effect on this aspect in Rwanda.

The Asian Development Bank [ADB] (2015) conducted a large-scale study that analyzed the share of exports from SEZs relative to total exports in several Asian countries. The results show that SEZs are responsible for a significant share of total exports: in the case of the Philippines, SEZs accounted for 49 percent of total exports in 2011, while in China, this figure stood at 44 percent in 2012, Bangladesh observed a contribution of 13 percent in 2013, whereas Sri Lanka showcased an impressive 67 percent in 2007. These substantial numbers support the existence of a positive relationship between SEZs and exports.

Additionally, Schminke and Van Biesebroeck (2013) investigated the impact of economic and technological development zones (ETDZs) and science and technology industrial parks (STIPs) on exports in China. The findings revealed that firms operating within these specific types of SEZs not only demonstrated significantly higher export levels, but also had a greater likelihood of exporting to developed countries than firms operating outside these zones. Equally, Amirahmadi and Wu (1995) concluded that SEZs in Asia perform significantly better in terms of exports than their non-SEZ counterparts.

Besides the aforementioned studies highlighting a positive correlation between SEZs and exports, there are also studies that present less optimistic findings. Johansson and Nilsson (1997) argue that the positive impact of SEZs on exports is contingent upon governments effectively eliminating trade restrictions and implementing export-oriented strategies. In

essence, for SEZs to fully leverage their potential in driving exports, it is crucial to have well-established institutional frameworks and regulations in place within a country. For instance, the Dominican Republic has succeeded in increasing employment and labor productivity in SEZs (Rhee et al., 1990). Despite these achievements, SEZs in the Dominican Republic fail to make a significant positive contribution to the country's exports. This can be attributed to the persistence of trade barriers and import substitution policies in the Dominican Republic, which impede the potential impact of SEZs on export growth (Rhee et al., 1990). Moreover, Carneiro et al. (2015) conducted research on the same subject and their findings corroborate the notion that SEZs in the Dominican Republic function in isolation from the broader economy. This example supports the theory of Johansson and Nilsson (1997).

In addition, the studies by Aggarwal (2006) and Aggarwal et al. (2008) looked at the relationship between SEZs and exports in India. Both studies came to a similar conclusion, highlighting that SEZs in India account for only 5 percent of total exports despite the establishment of the first SEZ in 1965. This suggests that the contribution of SEZs to total exports has not grown substantially in a period of more than 40 years.

Furthermore, not only the presence of SEZs can affect exports, but other factors can also play an important role. These factors include the clustering of firms (Diez-Vial & Fernández-Olmos, 2014; Fernhaber et al., 2008), human capital (Mulliqi et al., 2019; Wagner, 2012), and the prevalence of crime and violence (Gorrín et al., 2023). The last paragraph of section 3.3 already addressed the possible relationship between cluster formation and exports, with the number of firms increasing the likelihood of cluster formation (Diez-Vial & Fernández-Olmos, 2013).

Secondly, the role of human capital in influencing exports is substantial and cannot be overlooked. Becker (1994) defines human capital as the skills, knowledge and experience that individuals possess, which can be improved through education and training. The positive relationship between human capital and exports is mainly explained by the mechanism of labor productivity (Mulliqi et al., 2019). Workers with high levels of human capital—characterized by advanced skills, competences and experiences—tend to perform better at work, leading to higher productivity within firms and, consequently, improved export performance (Eickelpasch & Vogel, 2011; Wagner, 2012).

Finally, violence and crime affect exports at both local and regional levels. Gorrín et al. (2023) argue that crime and violence are critical factors that limit productivity and welfare in developing countries, thereby affecting exports. Their study concludes that increasing crime and violence, partly as a result of the war on drugs in Mexico, leads to significantly lower export levels compared to comparable countries such as Colombia, Peru, and Chile. According to Melitz (2003), this is because increased violence increases the marginal cost of exporting, which in turn reduces a country's international competitiveness and results in a decline in exports.

Given the available literature, it is clear that the question of whether SEZs contribute substantially to a country's exports has no definitive answer. However, it is clear that the institutional framework and associated laws and regulations within which SEZs operate can have a positive or negative influence on their impact on exports (Johansson & Nilsson, 1997). Since SEZs are designed with the aim of promoting export growth, this study assumes a significant and positive effect of SEZs on exports. Building on this assumption, the following null hypothesis and alternative hypothesis have been formulated:

H0: There is no difference in export performance between Colombian municipalities with an SEZ and those without one between 2008 and 2017.

H3: Colombian municipalities with an SEZ perform better on export than municipalities without one between 2008 and 2017.

3.6 Spillover effects

Policymakers see SEZs as a tool within broader development strategies aimed at enhancing not only the designated areas but also disadvantaged regions' economies. By enticing new businesses with favorable conditions and economic incentives, governments expect long-term economic growth in surrounding areas through spillover effects (World Bank Group, 2017, p. 22). For instance, in China, policymakers believe that prioritizing the development of coastal regions by establishing SEZs is in the national interest (Yang, 1990). Although this initially creates an economic disparity between the coastal areas and the remainder of the country, it is deemed necessary for modernization and to catch up with the economic progress of neighboring nations (National Center for Development and Research [NCDR], 1994). The policymakers expect that as the coastal regions with SEZs progressed, they would catalyze economic growth throughout the country via spillover effects (NCDR, 1994).

According to the literature, spillover effects refer to the interaction of economic activities between a specific geographical area and its surrounding areas (Fischer & Getis, 1997; Getis, 1997). In the context of SEZs, spillover effects examine the economic ramifications of an SEZ on adjacent regions lacking such zones (Ying, 2000). Spillover effects can manifest as either positive or negative outcomes. Ciżkowicz et al. (2017, p. 574) argue that (foreign) companies attracted to SEZs generally possess superior technology, knowledge, and managerial skills compared to domestic corporations. The economic discrepancy, coupled with potential interactions between SEZ-based and non-SEZ-based firms, creates the prospect of positive spillover effects. For example, local employees may interact with employees of SEZ-based firms, which can lead to demonstration effects, learning by doing and the exchange of knowledge. Consequently, this can contribute to improving the technology and human capital of domestic corporations (Ciżkowicz et al., 2017, p. 574). This aligns with the aforementioned vision of Chinese policymakers, who prioritized the designation of coastal areas as SEZs, anticipating that subsequent economic growth would extend to the rest of the country (Yang, 1990).

On the other hand, the economic gap between SEZ-based and non-SEZ-based firms can actually be a catalyst that widens the differences. For instance, non-SEZ-based firms may relocate to SEZs. In addition, SEZ-based firms may rely on low-cost labor attracted by migration from poorer (surrounding) areas (Myrdal, 1957; Lu et al., 2019). Furthermore, small and traditional companies within non-SEZ-based firms may face bankruptcy because they cannot compete with their SEZ-based counterparts (Myrdal, 1957). These conflicting views on spillover effects pose challenges in drawing definitive conclusions, but they demonstrate that the importance of spillover effects should not be overlooked.

In addition to the dual nature of spillover effects—both positive and negative—there exists a differentiation in how these effects are defined and measured. Scholars distinguish between

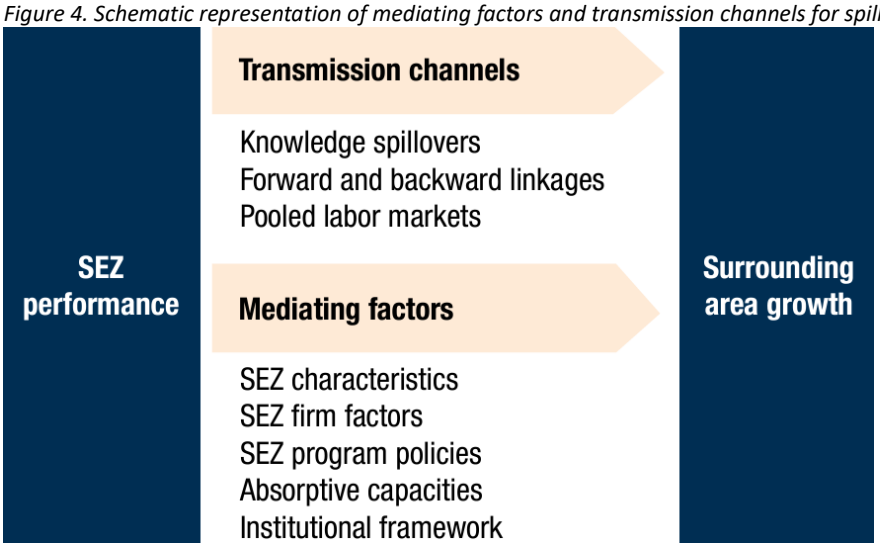
static, dynamic, and socioeconomic outcomes when analyzing spillovers (Farole, 2011). Static spillovers emanating from SEZs toward local economies are primarily economic in nature and tend to materialize in the short term (Frick & Rodríguez-Pose, 2019, p. 77). For instance, SEZs attract (foreign) companies that invest money and require (low-skilled) personnel, thereby creating jobs that locals can fill. Furthermore, the increase of companies in SEZs correlates with a rise in government revenues and short-term export growth (Farole 2011; Zeng, 2016b). These examples illustrate that the effects extend beyond the confines of SEZs.

Dynamic spillovers constitute the second type and are oriented toward achieving long-term structural developments (Frick & Rodríguez-Pose, 2019, p. 77). Over time, the interaction between SEZ-based firms and non-SEZ-based firms facilitates knowledge exchange, leading to advancements in local knowledge among employees and employers, technological progress, the fostering of a more open economy through collaboration, and economic diversification (Farole, 2011). These dynamic spillovers are pivotal for enhancing regional firms productivity and fostering sustained economic growth (Frick & Rodríguez-Pose, 2019, p. 77).

The third and final type of spillovers pertains to the socioeconomic implications of SEZ policies, encompassing issues such as land acquisition challenges, employment quality, compensation and resettlement practices, and gender-related impacts (Frick & Rodríguez-Pose, 2019, p. 77). All three types of spillovers stem from the interactions between SEZ-based firms, non-SEZ-based firms, and employees. Furthermore, the degree of migration of employees between companies, backward and forward linkages, the institutional framework of host countries, and the size and quality of the labor supply are equally important (Frick & Rodríguez-Pose, 2019, p. 77; World Bank Group, 2017, p. 23). Thus, it can be asserted that the intensity of these interactions correlates with the likelihood of spillover effects occurring.

In short, spillovers can be static, dynamic, or socioeconomic in nature, but how do they transfer to local economies? Whether and to what extent spillovers are transmitted depends on various mediating factors and transmission channels (Frick & Rodríguez-Pose, 2019, p. 77; World Bank Group, 2017, p. 23). Figure 4 shows the most important transmission channels and mediating factors that are important in the context of SEZs to generate spillovers.

Figure 4. Schematic representation of mediating factors and transmission channels for spillovers



(World Bank Group, 2017, p.23)

One of the transmission channels, namely knowledge spillovers, is closely linked with the mediating factor 'absorptive capacity'. The effective transfer of new knowledge and skills from firms and workers within an SEZ to their counterparts outside it (knowledge spillovers) predominantly hinges upon the extent to which the newfound knowledge is absorbed by local enterprises and workforce entities (Audretsch & Feldman, 2004; Boschma, 2005). In this context, it is imperative for local enterprises and workforce entities to possess a certain level of learning competencies and absorptive capacity, enabling them to discern, comprehend, and subsequently apply these newfound knowledge, skills, and technologies within their own production processes (World Bank Group, 2017, p. 23). As with all other transmission channels, the potency of knowledge spillovers is augmented through increased interaction between firms located within SEZs and those situated beyond their confines (Farole & Winkler, 2014).

Backward and forward linkages form another important transmission channel for spillover effects. Backward linkages entail the procurement of components from domestic subcontractors to facilitate the production process (Ciżkowicz et al., 2017, p. 574). Conversely, forward linkages refer to the fact that SEZ-based firms sell part of their production on the local market (Ciżkowicz et al., 2017, p. 574). Both backward and forward linkages facilitate direct engagement between local firms and SEZ-based firms, which can enable the transfer of knowledge and technology (Duarte et al., 2014; Farole & Winkler, 2014). For instance, backward linkages may afford local enterprises opportunities to enhance the skills of their workforce to align with the demands of SEZ-based firms (Frick & Rodríguez-Pose, 2019, p. 78; World Bank Group, 2017, p. 23). In short, backward and forward linkages have the potential to generate multiplier effects concerning local employment, innovation, and growth (Farole 2011; Zeng, 2016b).

The characteristics of SEZ-based firms intricately link to the potential for spillovers. The quality and magnitude of spillover effects is determined by the motivations of SEZ-based firms to invest, their intended duration of operation within the zone, and their sourcing strategies (Farole & Winkler, 2014). As an example, if a company decides to establish itself in an SEZ with a short-term view and plans to focus on the international market, this is less likely to lead to spillover effects (Frick & Rodríguez-Pose, 2019, p. 78; World Bank Group, 2017, p. 24).

Furthermore, the institutional framework of the country where an SEZ is located constitutes another important mediating factor. Consider the arrangement of financial support, such as tax reduction, for incoming companies, the regulation of the labor market (such as the free movement of workers from SEZ-based firms to non-SEZ-based firms), and the handling of intellectual property rights (World Bank Group, 2017, p. 24). In addition, local governments possess the authority to determine what industries and companies are allowed to establish in an SEZ, as is the case in Colombia, where only one company is allowed to establish within the boundaries of a ZFPE (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 163; Legis Writing Team, 2021). In conclusion, a combination of various transmission channels, mediating factors, and the degree of interactions between SEZ-based firms, non-SEZ-based firms, and employees determine the transmission of spillovers.

Finally, now that there is clarity on the concept of spillovers and their mechanisms of transmission to local economies, it becomes pertinent to examine the scholarly literature regarding the association between SEZs and spillover effects. The literature addressing the

relationship between SEZs and spillover effects is relatively scarce, although studies investigating the connection between FDI and spillover effects are more prevalent (Frick & Rodríguez-Pose, 2019, p. 78; World Bank Group, 2017, p. 24). One of the primary goals of SEZ policies is to attract FDI, which is considered a catalyst for generating spillover effects (Frick & Rodrguez-Pose, 2019, p. 78; World Bank Group, 2017). Therefore, scholarly studies exploring the correlation between FDI and spillover effects can serve as a benchmark for the relationship between SEZs and spillovers.

In general, developed countries show that FDI engender positive spillover effects. In some cases, governmental intervention becomes imperative to facilitate the establishment of transmission mechanisms. In contrast, the situation for developing countries appears less optimistic. Frequently, these countries exhibit insufficient absorptive capacity to generate spillover effects (Frick & Rodríguez-Pose, 2019, pp. 78-79; World Bank Group, 2017, pp. 24-25). This notion finds support in the research conducted by Duarte et al. (2014), which examined the influence of FDI on spillovers within Mozambique. Their findings indicate that the nation's limited absorptive capacity and skill base led to constrained spillover effects. In addition, the authors conclude that countries sharing similar characteristics with Mozambique are unable to capitalize on FDI as a viable economic development strategy.

Further, Vahter (2011) conducted research on the impact of FDI on knowledge-sourcing activities, innovation, and productivity growth of domestic firms in Estonia's manufacturing sector. The author concludes that FDI inflows do not lead to knowledge transfer to domestic firms or foster growth in innovative activities. In other words, FDI does not lead to spillover effects in the field of innovation and knowledge.

Additionally, proximity and location to larger markets and firms within the same sector are deemed as significant determinants influencing spillover effects (Frick & Rodríguez-Pose, 2019, p. 79; World Bank Group, 2017, p. 26). For instance, Barrios et al. (2006) contend that foreign companies in Ireland from the same sector clustering together generate positive employment and productivity spillovers. This assertion is corroborated by Thompson's (2002) research, which similarly concludes that the concentration of firms yields positive effects on spillovers.

Lastly, in the context of China and India, it is concluded that the establishment of SEZs has minimal or negligible impact on the expansion of exports from local industries (Leong, 2013). Additionally, Amirahmadi and Wu (1995) assert that across Asia, spillovers to local economies are scarce, occurring primarily in the most developed regions of countries.

Given the lack of research on the relationship between SEZs and spillover effects, as well as the inconclusive findings regarding the link between FDI and spillover effects, drawing definitive conclusions proves challenging. However, in light of the positive correlation observed between FDI and employment spillovers in the studies by Barrios et al. (2006) and Thompson (2002), the following null hypothesis and alternative hypothesis are formulated:

> **H0:** Colombian municipalities with an SEZ do not generate employment spillover effects between 2008 and 2017.
>
> **H4a:** Colombian municipalities with an SEZ generate positive employment spillover effects between 2008 and 2017.

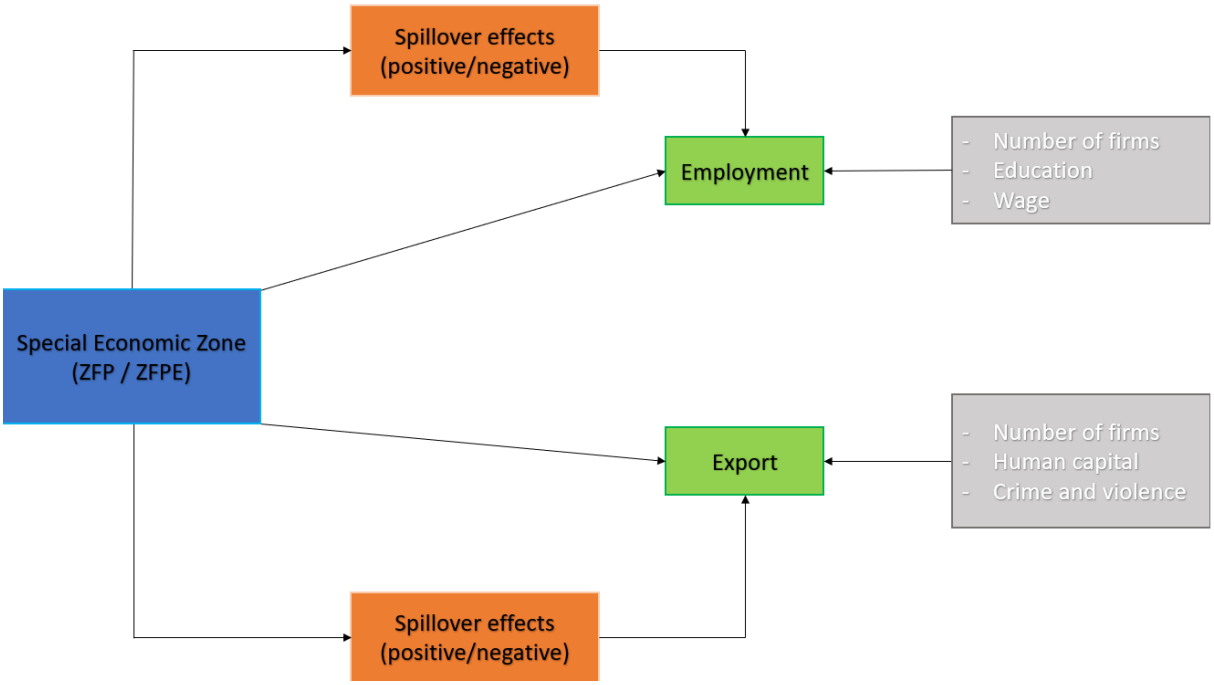
Even less research has been done into the relationship between SEZs and export spillover effects, so the following null hypothesis and alternative hypothesis have been formulated based on the research of Leong (2013):

> **H0:** Colombian municipalities with an SEZ do not generate export spillover effects between 2008 and 2017.
>
> **H4b:** Colombian municipalities with an SEZ generate negative export spillover effects between 2008 and 2017.

3.7 Conceptual model

Based on the research question(s), the study's purpose, theoretical framework, and hypotheses, Figure 5 depicts the conceptual model. The model portrays the presence of an SEZ as the independent variable, with employment and exports serving as the dependent variables. Additionally, the potential existence of both positive and negative spillover effects acts as a mediating variable on both employment and exports. Finally, a number of control variables have been identified for both dependent variables. These control variables are based on existing literature and are further operationalized in the methodology chapter.

Figure 5. Conceptual model



4. Methodology

This chapter provides a detailed discussion and justification of the various methods employed in this research. First, the research design is discussed, followed by an explanation of the data collection methods and the characteristics of the data. Next, the research population and area are addressed, along with the operationalization of the variables from the conceptual model. Subsequently, for each hypothesis, it is justified which analysis tool is used, and the equations are formulated and explained. Finally, the validity and reliability of the research are discussed.

4.1 Research design

The literature review indicates that the intended goals of SEZs are commonly measured using quantitative variables, such as foreign exchange, export generation, employment, and investment (Zeng, 2016a). The quantitative nature of these variables allows for statistical testing to prove or disprove hypotheses (Litosseliti, 2018). Numerous studies have examined the relationship between SEZs and various economic elements using this approach (Ambroziak & Hartwell, 2018; Lu et al., 2019; Wang, 2013). This type of research is classified as quantitative research, which emphasizes numerical data and statistical analyses (Creswell & Creswell, 2018; Litosseliti, 2018; Scheepers et al., 2016). This study examines the possible relationship between SEZs in Colombian municipalities and employment and exports. Given that all variables (SEZs, employment, and exports) are quantitative in nature, a quantitative research approach is deemed most appropriate (Creswell & Creswell, 2018; Litosseliti, 2018; Scheepers et al., 2016).

The choice of a quantitative approach rather than a qualitative or mixed methods approach, is the first crucial step in determining the appropriate research design (Creswell & Creswell, 2018). The next step is to identify a specific type of inquiry (i.e. research design) within one of these three categories. Each type of inquiry offers specific procedural guidance for conducting the research and is referred to as 'strategies of inquiry' (Denzin & Lincoln, 2011).

Over the years, the number of research designs has increased significantly due to advancements in computer technology, which enable the analysis of complex models and data. In quantitative research, Creswell and Creswell (2018) differentiate between experimental, non-experimental, and longitudinal research designs. Before determining which of these three designs is most suitable, it is important to restate the main question, sub-questions, and aim of this study, as this clarifies the intended outcomes of the research. The main research question is: *To what extent do special economic zones in Colombian municipalities affect employment and export between 2008 and 2017?* In order to answer this main question, the following sub-questions have been formulated:

1) To what level do zonas francas permanentes perform better (stronger effect) than zonas francas permanentes especiales in terms of employment and export in Colombian municipalities between 2008 and 2017?
2) To what extent do special economic zones in Colombian municipalities foster employment between 2008 and 2017?
3) What is the impact of special economic zones on export in Colombian municipalities between 2008 and 2017?

4) To what extent do special economic zones in Colombian municipalities facilitate employment and export spillover effects between 2008 and 2017?

In response to the main question and sub-questions, the objective of this research is to determine whether the Colombian government's intended goals with the implementation of SEZs are being achieved. In order to measure the success of SEZs in Colombia, the study includes two dependent variables: employment and export, along with a set of control variables. Additionally, spillover effects are included as a mediating variable. This study investigates whether SEZs have a positive or negative influence on these variables in the Colombian context. Hypotheses are formulated for these sub-questions based on the literature review, and these are tested in the next chapter. The specific data analyses used to test the hypotheses are detailed in Section 4.6. Overall, the use of a quantitative research method is further justified as the hypotheses are analyzed statistically (Creswell & Creswell, 2018; Litosseliti, 2018; Scheepers et al., 2016).

The main question and sub-questions share a common characteristic: a time component. This research focuses on the period from 2008 to 2017. This shared characteristic makes using a longitudinal research design most suitable for this study. Longitudinal studies involve the repeated collection of data over an extended period from the same research units, allowing for the observation of changes in variables over time (Litosseliti, 2018, p. 57). This contrasts with cross-sectional research designs, where data are only observed at a single point in time (Creswell & Creswell, 2018; Litosseliti, 2018, p. 57).

The major advantage of longitudinal designs is their ability to observe changes over time. However, this is also their biggest disadvantage: if research is conducted over 10 years, the research subjects must remain available for that period. In scientific terms, this is known as the difficulty of sample retention (Litosseliti, 2018, p. 58). Another disadvantage is that longitudinal research over several years is time-consuming and costly, whereas resources are often scarce in scientific research (Litosseliti, 2018, p. 58). The potential problems of sample retention difficulty and the frequent lack of time and funding are discussed in more detail in the next section, along with how these issues are addressed in this study.

In summary, based on the aforementioned considerations, a quantitative approach, specifically a longitudinal research design, is most suitable for this research. This choice is supported by previous studies on this topic (Ambroziak & Hartwell, 2018; Lu et al., 2019; Wang, 2013) and aligns well with the objectives and research questions of this study.

4.2 Data collection

Within quantitative research, various data collection methods, such as surveys and questionnaires, are used (Creswell & Creswell, 2018; Litosseliti, 2018; Sadan, 2017). These data collection methods can be classified as primary data collection, where data are collected directly by the researcher (Sadan, 2017). However, primary data collection is not suitable for this study for two main reasons. First, the country of interest, Colombia, is located thousands of kilometers from the Netherlands, making the process both expensive and time-consuming. Second, the study covers a period that started more than 15 years ago

and lasted 10 years. Obtaining reliable information about this period through methods such as questionnaires would be difficult, if not impossible.

On the other hand, secondary data collection methods involve the use of data that the researcher has not collected themselves, but instead has obtained from pre-existing sources, such as government databases, national statistics, and organizational reports (Greenhoot & Dowsett, 2012; Johnston, 2014; Sadan, 2017; Scheepers et al., 2016). Secondary data offer researchers the significant advantage of not having to spend time on data collection, allowing them to devote more time to other aspects of the research process. However, the time required to familiarize themselves with the datasets should not be underestimated. Datasets often contain extensive information, much of which may not be relevant to the study. Selecting the right information can be time-consuming, depending on the quality of the dataset. Nevertheless, using secondary data is generally less time-consuming than collecting primary data, which is why many researchers consider it advantageous (Greenhoot & Dowsett, 2012, pp. 3–6).

Another advantage of secondary datasets, especially public-use datasets, is that they often consist of large samples and longitudinal designs. This allows researchers to answer questions that would otherwise be impossible due to a lack of resources and time. Particularly when the research questions are longitudinal in nature, the use of secondary datasets is an appropriate method (Chase-Lansdale et al., 1991; McArdle et al., 2009). Furthermore, public-use datasets often employ complex sampling procedures, resulting in large representative samples and highly generalizable findings (Greenhoot & Dowsett, 2012, p. 4). These advantages, combined with the study's research design, justify the choice to use secondary data. This approach addresses potential issues with sample retention and the time- and cost-intensive data collection process.

This study used existing data representing all 1,122 Colombian municipalities from 2008 to 2017. However, not all municipalities – see section 4.3 'Data characteristics: inclusion and exclusion criteria' for more information – are included in the analysis. Data on which municipalities have an SEZ and how many are obtained from MINCIT (2022), which provides the date of establishment and location for each SEZ (see Appendix A for more detailed information per SEZ). Data on employment, export, number of firms, and wages were obtained from Datlas (n.d.), which provides information on the number of persons employed, total export value (in US dollars), total number of firms, and total annual wage (in Colombian pesos) per municipality. Lastly, data on human capital, education, and crime and violence were sourced from the Centro de Estudios sobre Desarrollo Económico [CEDE] (n.d.), which includes information on the number of students who have completed tertiary education and the number of criminal and violent incidents, such as homicides and terrorist attacks, per municipality.

Because the data originates from different datasets, it is necessary to merge them into a new, workable dataset. In Colombia, each municipality has a unique municipal code. Since all the data is at the municipal level, these unique municipal codes can be used to link the data. This made it relatively easy with the programs RStudio, ArcGIS Pro, and Excel to create a new dataset from all the separate datasets (see section 4.6.2 for further details on the dataset creation process).

Yet, the use of secondary data also entails limitations. Since the data has already been collected, the researcher has no control over who, what, or how the data is measured (Greenhoot & Dowsett, 2012, pp. 5-6). In particular, the available constructs that were measured posed a limitation in this study. Not all desired data could be obtained, such as the number of people employed per sector or the number of individuals who had completed secondary education. Additionally, if some data are available, they may not be at the municipality level (OECD, 2024) or over the time frame of this study (Departamento Administrativo Nacional de Estadística [DANE], n.d.). This limitation means that the most appropriate data are not always available to measure the variables. Nevertheless, it is still possible to measure the variables accurately based on previous studies using the available data. Section 4.5 delves deeper into the justification and operationalization of the collected data.

4.3 Data characteristics: inclusion and exclusion criteria

The use of secondary data makes a substantial volume of data available for this study. As discussed earlier, data for all 1122 municipalities in Colombia are accessible for the independent, dependent and control variables during the specified study period. However, the availability of data does not inherently guarantee their usability or reliability. The Datlas (n.d.) dataset, which contains information on the dependent variables of employment and export, is particularly crucial for this study. If these data are found to be inaccurate or inappropriate, they should be excluded from the dataset to avoid potential biases in the study results. Ensuring the integrity and relevance of the data is crucial for producing valid and reliable findings (De Vocht, 2016).

The employment dataset contains information for each municipality for consecutive years, with some municipalities having a zero value. The presence of zero-valued items in the dataset warrants investigation, as it is unlikely that entire municipalities record no employment activity. Plausible explanations for such occurrences could include differences in data collection practices across municipalities in Colombia or shortcomings in the measurement instruments used. In particular, regions such as the Amazon rainforest, which covers 44% of Colombia's land area with a population of only 1.4 million, pose logistical challenges for data collection due to limited internet access, minimal presence of national government influence, and frequent instances of violent conflict (Bandura et al., 2020; Grantham et al., 2022). Consequently, obtaining clean data accurately and consistently in such regions becomes a challenge. As a result of these challenges, certain study units are excluded from the dataset used for employment-related analyses. Table 1 outlines the count of included and excluded municipalities over several years, with those that recorded a zero value excluded from the dataset. The table shows that the exclusion of such municipalities does not cover a substantial portion of the dataset and shows a downward trend over time.

Table 1. Colombian municipalities that are in- and excluded from the employment dataset between 2008-2017

Municipality	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Included	1107	1108	1109	1113	1116	1116	1118	1120	1121	1121
Excluded	15	14	13	9	6	6	4	2	1	1
Total	1122	1122	1122	1122	1122	1122	1122	1122	1122	1122

(Datlas, n.d.)

The situation regarding the dependent variable export parallels that of employment. Although there are examples, notably municipalities in the Amazon region, where export activities are absent, Table 2 reveals a remarkably higher prevalence of zero values for municipalities in the context of exports compared to employment. Consequently, municipalities that register a value of zero in the export variable are not considered for inclusion in the dataset and subsequent analyses, a precautionary measure aimed at avoiding potential biases in findings (De Vocht, 2016). Despite the exclusion of a significant number of municipalities, more than half are still included in the analysis each year. Such robust sample representation facilitates the extrapolation of findings to the broader population due to the large number of cases available for analysis (Greenhoot & Dowsett, 2012, p. 4).

Table 2. Colombian municipalities that are in- and excluded from the export dataset between 2008-2017

Municipality	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Included	635	630	634	684	703	699	662	654	676	675
Excluded	487	492	488	438	419	423	460	468	446	447
Total	1122	1122	1122	1122	1122	1122	1122	1122	1122	1122

(Datlas, n.d.)

4.4 Research population and research area

The central research question and sub-questions outline Colombian municipalities with an SEZ as the study population for this study. These municipalities with an SEZ are categorized as the treatment group, while municipalities without an SEZ are designated as the control group. As shown in Chapter 2, after the entry into force of Law 1004 in 2005, there has been a substantial increase in the number of SEZs in Colombia (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 161). Table 3 presents the total number of ZFPs, ZFPEs, and their combined totals

(total SEZs) between 2008 and 2017. Notably, the number of ZFPEs has experienced a significantly higher growth rate, almost fivefold over this period, compared to the almost doubling of the number of ZFPs. This trend is further substantiated by the consistent upward trend in the number of ZFPEs, in contrast to the stagnant trend observed for ZFPs.

Furthermore, the number of municipalities with an SEZ also shows a stable upward trend, while the number of municipalities with a ZFP has shown minimal growth, from only 22 in 2011 to 27 in 2017. This indicates that the majority of new municipalities with an SEZ are mainly due to the creation of new ZFPEs. Moreover, Table 3 shows that there are more SEZs than municipalities with SEZs, implying that some municipalities host multiple SEZs (see Appendix A for more detailed information per SEZ).

Table 3. Total number of ZFPs, ZFPEs, and SEZs in Colombia between 2008-2017

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Total ZFPs	18 (12)*	21 (15)	27 (20)	29 (22)	30 (23)	33 (25)	34 (26)	34 (26)	34 (26)	35 (27)
Total ZFPEs	13 (10)	24 (18)	32 (25)	39 (30)	45 (33)	50 (36)	55 (38)	55 (38)	61 (42)	63 (42)
Total SEZs	31 (19)	45 (28)	59 (38)	68 (42)	75 (45)	83 (50)	89 (52)	89 (52)	95 (56)	98 (57)

(MINCIT, 2022)

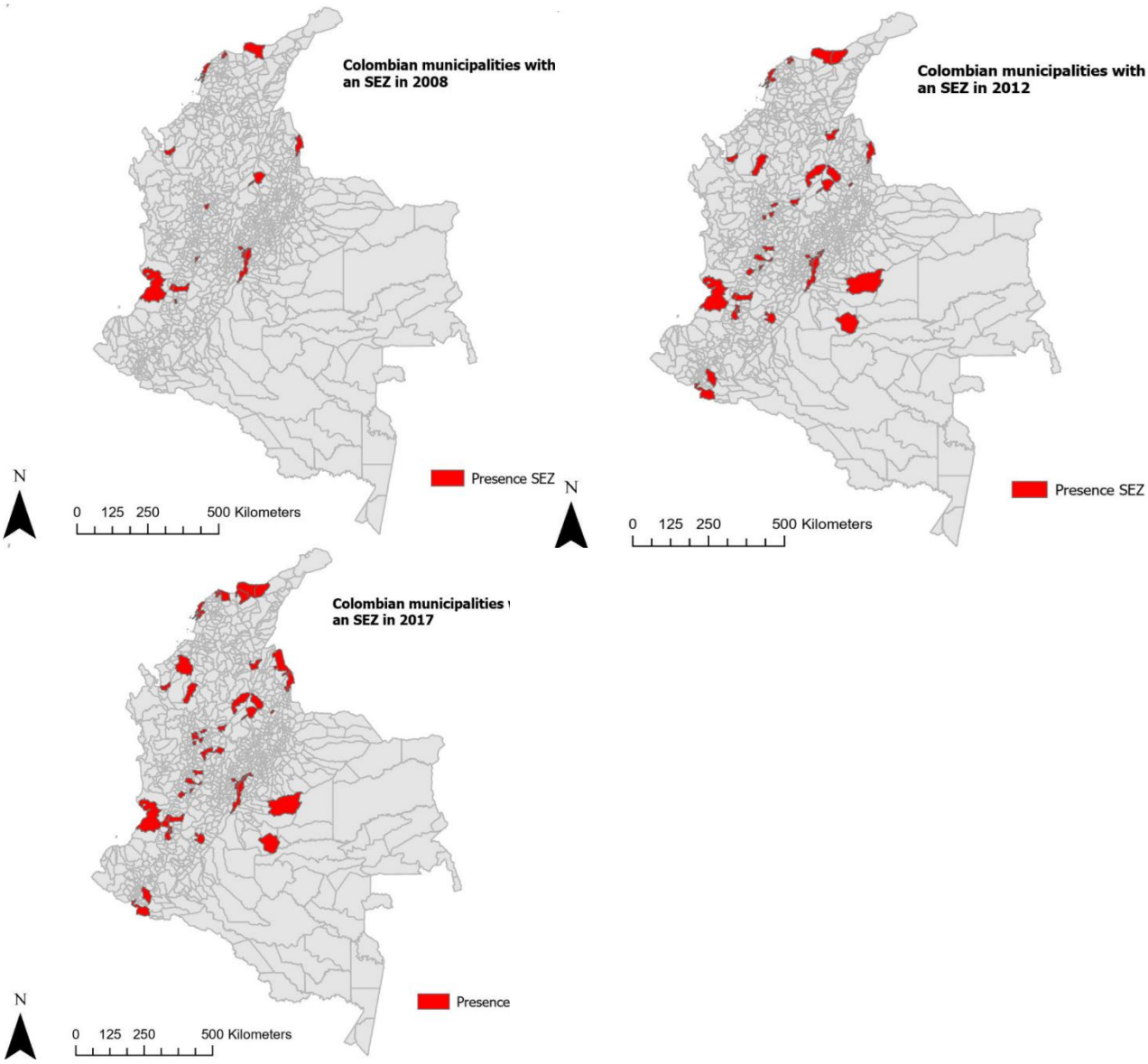
** The number in brackets represents the number of Colombian municipalities with a(n) ZFP, ZFPE, or SEZ.*

Chapters 1 and 2 also refer to various figures regarding the number of SEZs in Colombia. For example, AZFA (2017) reports that Colombia had 105 SEZs in 2015, while Arévalo-Luna and Arévalo-Lizarazo (2019) list 102 SEZs for 2016. Both figures are derived from scientific articles or reports, which indicates their credibility. However, this study uses data from MINCIT (2022), as it specifies the municipality in which each SEZ is located. Furthermore, since these data come from an official Colombian government institution, they are considered a reliable source.

Since Colombian municipalities are the study population for this study, Colombia itself serves as the study area. Figure 6 illustrates the distribution of SEZs among Colombian municipalities for the years 2008, 2012, and 2017. In particular, municipalities with an SEZ are often located near other municipalities with an SEZ. Furthermore, in 2008, the majority of SEZs were concentrated in coastal and metropolitan areas (see Figure 1 for more details). In 2012 and 2017, the distribution of municipalities with SEZs was more dispersed across the country, although they remained mainly in the northern, western and central regions.

Large parts of Colombia are not represented by an SEZ. These areas are mainly rural municipalities or those with a sparse population, such as the southern and eastern regions where the Amazon rainforest is located. In summary, the Colombian government tends to establish SEZs mainly in economically important areas, especially urban and coastal areas.

Figure 6. The presence of SEZs in Colombian municipalities in 2008, 2012, and 2017



(MINCIT, 2022)

4.5 Operationalization

Various variables are distinguished in the conceptual model, including independent, dependent, mediating, and control variables. To ensure these abstract variables are suitable for analysis, they must be operationalized (Scheepers et al., 2016). The following outlines the measurement approach for each variable:

***SEZ**:* This variable is defined as a dummy variable, where a municipality with an SEZ is assigned a value of 1, and a municipality without an SEZ is assigned a value of 0. This measurement approach is consistent with methodologies used in other studies on this topic (Lu et al., 2019; Wang, 2013).

***Employment**:* This variable is measured by the total number of individuals employed within a municipality. This measurement approach aligns with the methodology used in the study by Lu et al. (2019, p. 338), thereby affirming its validity as an appropriate measurement instrument.

***Export**:* This variable is measured by summing the total value of exports (in US dollars) from all companies operating within a municipality. This method of measuring exports has been employed in previous studies (Lu et al., 2019; Wang, 2013; Wagner, 2012), thereby validating its use in this context.

***Spillover effects**:* Measuring abstract variables, such as spillover effects, poses a significant challenge. Analyses pertaining to spillover effects are situated within the realm of spatial econometrics (Anselin & Rey, 1991). A foundational concept in this discipline is 'spatial dependence' (Anselin, 2001). Spatial dependence implies that the value of a variable at a specific location is influenced by the values of the same and other variables at neighboring locations (Elhorst, 2017, pp. 1-2). The standard methodological toolkit of spatial econometricians includes the 'spatial lag variable' (Anselin, 2001, p. 5). The spatial lag variable captures the influence exerted by neighboring locations on a variable's value at a specific location. Essentially, it is a weighted average of the values of a variable from nearby or adjacent areas, embodying the concept of spatial dependence (Anselin, 1988; Anselin, 2001).

This study investigates whether municipalities with an SEZ impact the dependent variables of employment and export in surrounding municipalities through spillover effects. Municipalities hosting an SEZ are thus pivotal to this analysis. Constructing a spatial lag variable for the independent variable 'presence of SEZ' is crucial to quantify spillover effects. In summary, the variable 'spillover effects' is operationalized via the spatial lag variable of 'presence of SEZ' (designated as 'WSez'). This provides a succinct overview of spatial econometrics; a more detailed discussion and justification of this concept and its operationalization can be found in Section 4.6.1.

***Number of firms**:* This variable requires minimal operationalization due to its straightforward nature. It is measured by the total number of firms operating within a municipality. This measurement approach is consistent with the methodology used by Lu et al. (2019).

***Human capital**:* This variable related to exports is measured using different proxies. The studies by Mulliqi et al. (2019, p. 778) and Wagner (2012) use the percentage of highly educated individuals as a proxy for measuring human capital. Highly educated individuals include those who have successfully completed a tertiary education, such as a university degree (Mulliqi et al., 2019, p. 778; Wagner, 2012).

In the context of Colombia, tertiary education includes three streams: Técnico Profesional, Tecnológico and Profesional (university) (Colombia Potencia de la Vida, 2024). The Técnico Profesional stream is comparable to an MBO level 2, 3 or 4 diploma in the Netherlands. Moreover, Tecnológico is equivalent to an MBO level 4 diploma and Profesional is comparable to a bachelor's degree in the Netherlands (Nuffic, n.d.).

In this study, the proxy 'education' for human capital is measured by the total number of students who complete tertiary education each year. Instead of the total number of

people who have completed tertiary education, the focus is on the annual number of graduates (i.e., the sum of all three studies together). This approach is used because of the lack of suitable data on the total number of graduates, while data on annual graduates are accessible. This method aims to measure the proxy 'education' as accurately as possible.

Additionally, Wagner (2012) uses the average annual wage per worker as a secondary proxy to measure human capital. However, this study uses the total amount of wages (in Colombian pesos) earned per year. This decision is based on the availability of relevant data. Despite the difference in specific measurement, both approaches involve quantifying the size of wages as a proxy for assessing human capital, and thus serve as suitable measurement instruments. In summary, human capital is measured by both education and wages.

The control variable 'human capital' is not specifically delineated for the dependent variable employment. However, the different control variables 'education' and 'wage' are specified. These variables are measured using the same methodology as for human capital. Papadopoulou (2019) investigated the relationship between education and employment, measuring education as the number of persons with a tertiary degree. This reasoning justifies using the same measurement approach for education as for the proxy 'education' in assessing human capital.

Further, the control variable 'wage' is measured differently in this study than the approach of Apergis (2008), who used hourly wages to study the relationship between real wages and employment. Due to the lack of hourly wage data in this study, the total wages earned by all workers are used to measure this variable, similar to the measurement approach for the control variable 'human capital'. This method ensures that wage data remain a useful proxy for investigating the relevant economic dynamics.

***Crime and violence**:* A commonly used proxy to measure crime and violence is the number of homicides per year, as shown by Gorrín et al. (2023) in their study on the relationship between crime and export performance. In addition, Krug et al. (2002) have identified other indicators to measure the level of crime and violence, including the number of terrorist attacks and robberies per year. Therefore, in this study, the control variable 'crime and violence' is measured using the following proxies: the number of homicides, the number of terrorist attacks and the number of robberies per year.

4.6 Data analysis methods and equations

Before discussing the specific equations for each hypothesis, it is essential to outline some general considerations that apply to all hypotheses and their analyses. These general considerations ensure a consistent approach across hypotheses and facilitate a coherent analytical framework. In this study, the dependent variables, employment and export, are measured on a ratio scale. The independent variable is a dummy variable, while all control variables are also on a ratio scale. These measurement scales meet the requirements for conducting multiple regression analyses (De Vocht, 2014; De Vocht, 2016, p. 181).

However, this study uses 'fixed effects linear regression analyses' rather than basic multiple regression analyses. Fixed effects methods allow researchers to account for potential observable or unobservable confounding variables in non-experimental research by including them in linear regression models (Allison, 2009, p. 1). Without measurement, there

is no control. Vogt (1993) defines confounding variables as variables that obscure the effects of another variable. These variables can confound and obscure both the findings of the data and the conclusions of the study, making it unclear whether the observed effect is due to the actual treatment or to the influence of the confounding variable. This ambiguity undermines the validity of the study's conclusions and complicates the determination of true causal relationships.

Using a fixed effects linear regression model makes it possible to control for confounding variables (Allison, 2009; Mummolo & Peterson, 2018, p. 829). Furthermore, this approach addresses omitted variable bias by eliminating much of the variation caused by potential confounding variables, as variables that were not initially included in the analysis are taken into account in this way (Mummolo & Peterson, 2018, p. 829; Torres-Reyna, 2007, p. 16).

Two basic principles must be observed to use a fixed effects linear regression model: first, the dependent variable must be measured at least twice, for example in different years; second, the values of these measurements must differ significantly in order to observe the potential effect of the independent variable (Allison, 2009, p. 1). In addition, there are roughly two types of fixed effects: entity fixed effects and time fixed effects (Torres-Reyna, 2007, p. 16). Variables that remain constant over time but vary across entities, such as geographic location, can be controlled by entity fixed effects. Conversely, time fixed effects can control variables that change over time but remain consistent across entities, such as international agreements and national policies (Torres-Reyna, 2007, p. 16).

Both conditions are met in this study, which legitimizes the use of a fixed effects linear regression model. In complex topics, such as this study, numerous observable and unobservable confounding variables may not be included as control variables due to unavailable data or the inability to measure the variable (Torres-Reyna, 2007, p. 16). However, these variables must be taken into account to obtain accurate results.

Incorporating both entity fixed effects and time fixed effects in the analysis provides a solution to address this issue. For example, the research units in this study are Colombian municipalities with an SEZ, each unique in terms of climate, geographical location, presence of a port or airport, or status as a departmental capital. These factors can influence the results and must be included in the analysis. By adding a municipality fixed effects term, time-invariant characteristics of municipalities can be controlled for (Allison, 2009).

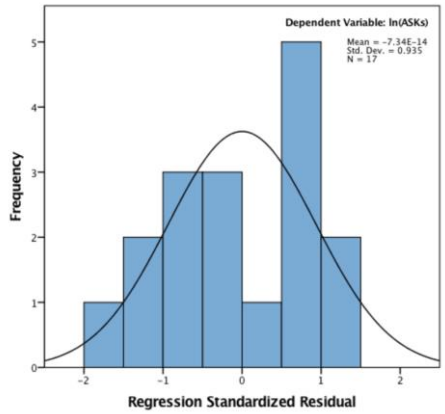
Additionally, controlling for time fixed effects is a commonly employed technique in longitudinal studies to primarily account for macro (economic) shocks (Gösser & Moshgbar, 2020, p. 2). This study spans a period of 10 years, during which significant changes can occur, such as policy shifts or macroeconomic shocks like the international banking crisis in 2008. Incorporating time fixed effects is essential to control for these factors. The combined use of entity fixed effects and time fixed effects on the same subject has also been applied by Lu et al. (2019, pp. 333-334).

Furthermore, in practice, independent variables are never perfect predictors of dependent variables. Instead, the regression line estimates outcomes based on the available data (Gallo, 2015, p. 5). The quality of this regression line is partly determined by the 'error term', which is present in every regression. The error term equals the standard deviation of the population divided by the square root of the sample size (De Vocht, 2016, p. 74). A larger error term indicates a less reliable regression line (De Vocht, 2016, p. 74; Gallo, 2015, p. 5).

Because the error term is indispensable in any regression analysis, it has also been included in this study. In practice, all error terms associated with each independent or control variable for each research object were clustered into a single error term.

Moreover, multiple regression analyses require the satisfaction of several assumptions, which are also applicable to alternative multiple regression techniques, such as fixed effects linear regression analyses (De Vocht, 2014, p. 202; De Vocht, 2016, p. 184). The primary assumption pertains to the distribution of the residuals of the regression model, which must follow a normal distribution (De Vocht, 2014, pp. 202-203; De Vocht, 2016). A normal distribution, also known as a Gaussian curve, is a symmetric probability distribution where the arithmetic mean is centrally located and represents the most likely outcome. As values diverge from the mean, the probability density decreases but never reaches zero (De Vocht, 2016, p. 66). In practice, distributions are rarely perfectly normal, but a histogram or Normal Probability Plot (NPP) can be utilized to assess the normality of the regression model's residuals. In a normal distribution, the values of the residuals are centered around the arithmetic mean in a histogram (De Vocht, 2014, pp. 202-203; De Vocht, 2016, p. 192). Figure 7 presents a histogram, illustrating a normally distributed regression model, because the residuals are centered around the arithmetic mean.

Figure 7. Example of a histrogram to check for a normal distribution



(Miyoshi et al., 2017)

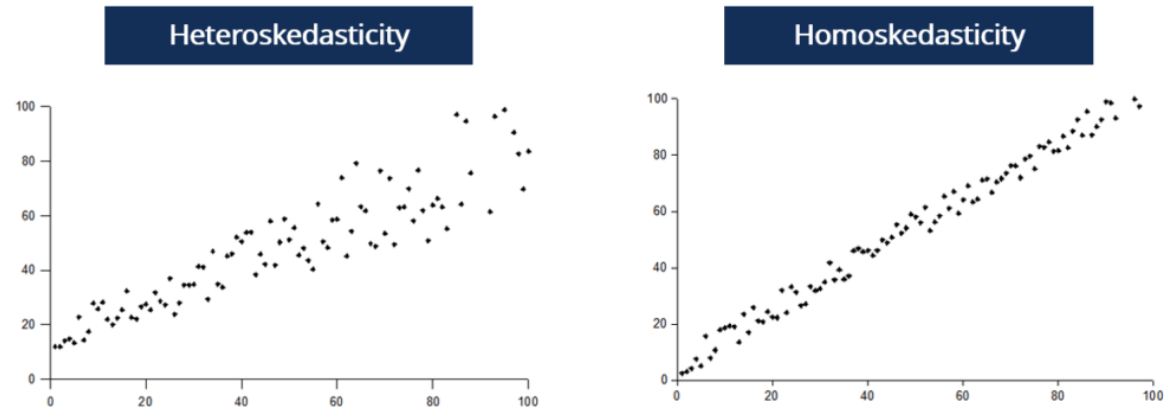
The second criterion that must be satisfied is the absence of multicollinearity (De Vocht, 2016, p. 184). Multicollinearity occurs when two independent or control variables exhibit a high degree of correlation. This issue arises because the two regressors effectively measure the same phenomenon, making it technically infeasible to ascertain the distinct effect of each regressor on the dependent variable. According to De Vocht (2016, p. 192), multicollinearity is typically indicated by a mutual correlation coefficient, *r*, greater than |0.9|. The Pearson Correlation Coefficient, *r*, quantifies the relationship between two interval or ratio variables, where $r = 0$ signifies no relationship and $r = 1$ indicates a perfect relationship (De Vocht, 2016, pp. 172-173). To detect multicollinearity, one can construct a bivariate correlation matrix for all independent and control variables. If any correlations are found to be $r > |0.9|$, one of the variables involved must be excluded from the model (De Vocht, 2016, p. 192).

The third assumption pertains to the model being both linear and homoscedastic (De Vocht, 2016, p. 184). The linearity assumption is fulfilled if the residuals align approximately along a

straight line. Homoscedasticity refers to the condition where the variance remains constant for every value of *X* (De Vocht, 2016, p. 164). This indicates that the residuals are independent of the observations, resulting in a balanced distribution around the regression plane (De Vocht, 2016, p. 184). In contrast, if the variance is not constant and the residuals increase with the predicted Y-value, the model exhibits heteroscedasticity, often represented graphically by a 'horn' shape, indicating that the residuals are not independent (De Vocht, 2016, p. 176).

Both linearity and homoscedasticity can be assessed by plotting a scatter plot of the (standardized) residuals against the (standardized) predicted Y-values. Figure 8 illustrates both a homoscedastic and a heteroskedastic regression model. In the homoscedastic model, the residuals are closely aligned, maintaining a constant variance, thereby also fulfilling the linearity assumption. Conversely, in the heteroskedastic model, the residuals diverge increasingly, indicating a violation of both homoscedasticity and linearity (De Vocht, 2016, p. 176).

Figure 8. Scatterplot of both a heteroscedastic and a homoscedastic regression model



(CFI Team, n.d.)

Prior to the regression analysis, the assumption of multicollinearity must be checked for. The other assumptions must be checked afterwards (De Vocht, 2016, p. 192).

4.6.1 Spatial econometrics

The hypotheses related to spillover effects necessitate further elaboration beyond what has already been discussed. The analysis of spillover effects is a central theme within the discipline of spatial econometrics (Anselin & Rey, 1991). Spatial econometrics is defined as "the collection of techniques that deal with the peculiarities caused by space in the statistical analysis of regional science models" (Anselin, 1988, p. 7). Essentially, spatial econometrics involves the integration of spatial effects into statistical analyses (Anselin, 2001).

In the context of regression analysis, spatial effects pertain to spatial dependence, or its less pronounced form, spatial autocorrelation, and spatial heterogeneity (Anselin, 2001, p. 3). Spatial dependence is described by Legendre and Legendre (1998) as "the property of random variables taking values, at pairs of locations a certain distance apart, that are more similar (positive autocorrelation) or less similar (negative autocorrelation) than expected for randomly associated pairs of observations" (p. 8). In other words, the value of a variable at a given location is influenced by the values of the same variable at neighboring locations. This

is consistent with numerous theories that predict a change in explanatory variables in a specific unit *i* will affect the dependent variable not only within unit *i* itself but also in other units *j* (≠ *i*) (Elhorst, 2017, pp. 1-2).

Furthermore, the quotation from Legendre and Legendre (1998, p. 8) effectively illustrates the relationship between spatial dependence and spatial autocorrelation. Specifically, when there is a clustering of similar values—either high or low—this is referred to as positive spatial autocorrelation, while a situation where a high value is surrounded by low values, or vice versa, is known as negative spatial autocorrelation (Griffith & Arbia, 2010).

The distinction between the two lies in their focus: spatial dependence examines the interaction or influence between spatial units, whereas spatial autocorrelation describes the pattern and clustering of similar or dissimilar values across space. Moreover, spatial dependence refers to the degree of spatial autocorrelation among independently measured values observed in a geographical context (Crawford, 2009). In scientific research, spatial dependence is frequently employed to indicate the extent of spatial interactions between spatial units (Janatabadi & Ermagun, 2024; Kostov, 2010; Mur et al., 2012). Therefore, in this study, the concept of spatial dependence is used instead of spatial autocorrelation.

In addition, spatial heterogeneity refers to local variations of spatial dependence within a given area (Jiang, 2015, p. 5). Anselin (2001) further explains that spatial heterogeneity manifests as structural instability, which can take the form of non-constant error variances (heteroskedasticity) or varying model coefficients (variable coefficients). Practically speaking, this means that certain geographic events, such as spillovers, are more likely to occur in some locations than in others (Jiang, 2015, p. 5). For instance, in economic studies, the impact of Silicon Valley on the Californian economy differs significantly across the state due to the high concentration of multinational corporations like Apple and Microsoft in that region compared to other areas within the state (Storper, 2013).

Having established the nature of spatial effects in the context of regression analyses, it is crucial to concretize spatial dependence in order to effectively incorporate it into fixed effects linear regression models. The challenge lies in making an abstract concept like spatial dependence measurable. Spatial econometricians have a standard set of tools to address this, with one of the most essential being the spatial weight matrix. This matrix is pivotal for modeling spatial data, including phenomena such as spillover effects (Anselin, 2001, p. 5; Getis & Aldstadt, 2004; Janatabadi & Ermagun, 2024; Kostov, 2010; Mur et al., 2012).

The spatial weight matrix (*W*) is an *N* x *N* positive matrix, where *N* denotes the number of spatial units, such as regions or locations. Each element of the matrix W_{ij}, represents the spatial relationship between unit *i* and unit *j* (Janatabadi & Ermagun, 2024; Mur et al., 2012, p. 1). The spatial weights W_{ij} are non-zero when units *i* and *j* are considered to be neighbors, and zero otherwise. By convention, self-neighbor relations are excluded, resulting in diagonal elements of *W* being set to zero, $W_{ij} = 0$. Figure 9 illustrates a schematic representation of a spatial weight matrix, where the self-neighbor relation is excluded by the 0-diagonal.

Figure 9. Schematic representation of a regular spatial weight matrix

$$W = \begin{bmatrix} 0 & w_{1,2} & \cdots & w_{1,j} & \cdots & w_{1,N} \\ w_{2,1} & 0 & \cdots & w_{2,j} & \cdots & w_{2,N} \\ \vdots & \vdots & \ddots & \cdots & \cdots & \cdots \\ w_{i,1} & w_{i,2} & \vdots & 0 & \cdots & w_{i,N} \\ \vdots & \vdots & \vdots & \vdots & \ddots & \cdots \\ w_{N,1} & w_{N,2} & \vdots & w_{N,j} & \vdots & 0 \end{bmatrix}$$

(Mur et al., 2012)

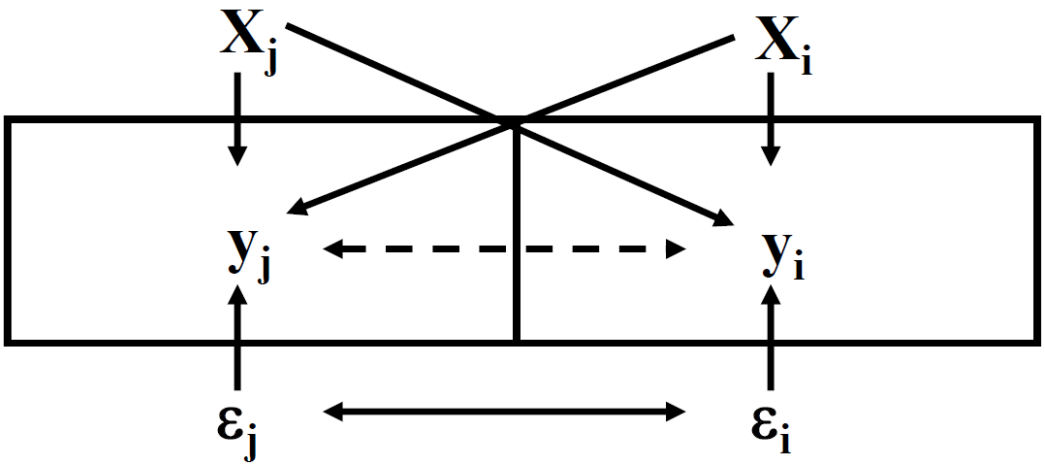
The value of W_{ij} indicates the degree to which two spatial units are considered neighbors, with higher values signifying a stronger spatial connection or influence between units *i* and *j*. The specific value of W_{ij} is partially determined by the type of spatial weight matrix employed (Janatabadi & Ermagun, 2024). For instance, fixed distance matrices use a predetermined distance threshold to define the spatial relationship between two units; once this threshold is exceeded, the units are no longer considered neighbors (Marmion et al., 2009). Alternatively, *K*-nearest neighbor matrices define neighborhood relationships based on a specified number of closest neighbors, denoted by *K*. For example, if *K* is set to 3, each geographic unit considers its three nearest neighbors as its neighbors (Wheeler & Tiefelsdorf, 2005). Contiguity spatial weight matrices take a different approach, defining all geographic units that share a common border as neighbors (Janatabadi & Ermagun, 2024, p. 5; Kostov, 2010, p. 15). Lastly, the inverse distance or distance decay matrix assigns greater weight to nearby observations, with the weight decreasing as the distance between units increases (Janatabadi & Ermagun, 2024, p. 5; Lu & Wong, 2008, p. 1044).

Lu (2022) implemented a row-standardized inverse distance weight matrix, with a threshold of 150 km, to analyze human capital spillovers in China. Given the similarities in studying spillovers, this study has also used a row-standardized inverse distance weight matrix. However, a threshold of 50 km is used due to the smaller area of Colombia (1,140,619 km²) compared to China (9,562,910 km²) (World Bank Group, 2021).

Using the values of W_{ij}, the abstract concept of 'spatial dependence' can be quantified. By applying the formula W_{ij} x Y_j (dependent variable) or W_{ij} x X_j (independent variable), a new variable is created: the spatial lag variable (Anselin, 2001, p. 5). The spatial lag variable captures the influence of a variable from neighboring locations on the value of the same variable at a given location. It is essentially a weighted average of the values of a variable from nearby or adjacent areas, which reflects the concept of spatial dependence (Anselin, 1988; Anselin, 2001).

Figure 10 illustrates the mechanism of a spatial lag variable, showing how the value of an independent variable in location X_j affects both the dependent variable in location Y_i and the dependent variable in location Y_j. Moreover, Figure 10 also shows that the values of the dependent variables Y_i and Y_j affect each other. This indicates that a spatial lag variable can be derived from both an independent and a dependent variable.

Figure 10. Schematic representation of the function of a spatial lag variable



Matthews (2006)

The hypotheses related to spillover effects concern municipalities with an SEZ experiencing positive employment spillovers and negative export spillovers. The central focus is on the dummy independent variable 'presence of SEZ'. Consequently, this study has used a spatial lag variable of this independent variable, called 'WSez'. This spatial lag variable is used in the analyses to test for spillover effects, allowing for the investigation of spatial dependence and the quantification of the abstract concept of spillover effects.

4.6.2 Data procedure

In this study, various programs were employed to process the data and conduct the analyses. The original data on employment and export from Datlas (n.d.) were initially loaded into RStudio. The relevant data in both datasets were grouped in RStudio, ensuring each municipality per year had a single row instead of hundreds. The datasets were then merged into a joint dataset using Excel and ArcGIS Pro, based on the unique location codes of each municipality. Subsequently, data on SEZs from MINCIT (2022) were incorporated into the dataset using ArcGIS Pro. Additional control variable data from CEDE (n.d.) were similarly added. This comprehensive dataset was exported from ArcGIS Pro as an Excel file, which was then re-imported into RStudio. Thereafter, an inverse spatial weight matrix was created for each year in RStudio, based on a shapefile for the relevant year generated with ArcGIS Pro. Using this matrix, the spatial lag variable 'WSEZ' was calculated for each year. These spatial lag variables were then integrated into the complete dataset in ArcGIS Pro as a new column.
Finally, a separate dataset for employment and export was created in ArcGIS Pro, excluding all zero values from each dataset (see section 4.3). Both datasets were exported from ArcGIS Pro as Excel files and subsequently added to RStudio.

With the datasets now complete, fixed effects linear regressions could be executed. Before conducting these regressions, the descriptive statistics of the datasets were examined using SPSS Statistics 29, which provides relatively simple and clear descriptive statistics. The assumptions (i.e. multicollinearity, homoscedasticity, linearity, and normal distribution) were

also verified with SPSS Statistics 29. Following these preparations, the fixed effects linear regressions were performed in RStudio. The results were then formatted into readable tables using various packages (e.g., pandoc and modelsummary). The data procedure is summarized here; a detailed description can be found in the online Appendix (RScript). In the final sections of this chapter, the equations for each hypothesis are presented.

4.6.3 ZFP vs. ZFPE

The first hypothesis in this study is split into H1a and H1b but follows the same structure. Hypothesis H1a examines whether ZFPs perform better in terms of employment compared to ZFPEs, while Hypothesis H1b focuses on exports. The only differences between the two are the dependent variables and the associated control variables. Each hypothesis has a single equation, as the equations for ZFP and ZFPE are structurally identical, differing only in the names of the independent and dependent variables. The following equations have been formulated:

$$\textbf{\textit{Employment ZFP(E)}}_{my} = \beta_1 \text{ZFP(E)}_{my} + \beta_2 \text{Number of firms}_{my} + \beta_3 \text{Education}_{my} + \beta_4 \text{Wage}_{my} + \lambda_m + \lambda_y + \varepsilon_{my}$$

Employment ZFP(E)$_{my}$ is the employment outcome of municipality m in year y; β_1ZFP(E)$_{my}$ is a dummy variable where it has the value 1 if municipality m has a ZFP(E) in year y and the value 0 otherwise; β2Number of firms$_{my}$ is a control variable with a certain value of municipality m in year y. The other control variables function in the same way; λ_m is a municipality fixed effects term capturing time-invariant village characteristics such as geographic location; λ_y is a year fixed effect; and ε_{my} is the error term in municipality m in year y. However, in practice the error term is a clustered error term of all individual error terms together.

$$\textbf{\textit{Export ZFP(E)}}_{my} = \beta_1 \text{ZFP(E)}_{my} + \beta_2 \text{Number of firms}_{my} + \beta_3 \text{Human capital}_{my} + \beta_4 \text{Crime and violence}_{my} + \lambda_m + \lambda_y + \varepsilon_{my}$$

The aforementioned elucidation pertaining to employment extends equivalently to the equation concerning exports, albeit with alterations in the dependent variable and adjustments in certain control variables.

4.6.4 Employment

The second hypothesis under investigation in this study pertains to the association between SEZs and employment. The corresponding equation is delineated as follows:

$$\textbf{\textit{Employment}}_{my} = \beta_1 \text{SEZ}_{my} + \beta_2 \text{Number of firms}_{my} + \beta_3 \text{Education}_{my} + \beta_4 \text{Wage}_{my} + \lambda_m + \lambda_y + \varepsilon_{my}$$

The only difference from the previous employment-related equation is the independent variable. In this context, β_1SEZ$_{my}$ is a dummy variable that takes the value 1 if municipality m has an SEZ in year y and 0 otherwise. The rest of the equation remains as previously explained.

4.6.5 Export

The third hypothesis examines the relationship between SEZs and exports. The corresponding equation is presented as follows:

$$\boldsymbol{Export_{my}} = \beta_1 \text{SEZ}_{my} + \beta_2 \text{Number of firms}_{my} + \beta_3 \text{Human capital}_{my} + \beta_4 \text{Crime and violence}_{my} + \lambda_m + \lambda_y + \varepsilon_{my}$$

This equation follows the same structure as that of ZFP vs. ZFPE. The only difference is the same as in the employment equation, where $\beta_1 \text{ZFP(E)}_{my}$ has been changed to $\beta_1 \text{SEZ}_{my}$.

4.6.6 Spillover effects

The fourth hypothesis is split into H4a and H4b. Hypothesis H4a pertains to employment spillovers, while H4b addresses export spillovers. The equations are formulated as follows:

$$\boldsymbol{Employment_{my}} = \beta_1 \text{SEZ}_{my} + \beta_2 \text{Number of firms}_{my} + \beta_3 \text{Education}_{my} + \beta_4 \text{Wage}_{my} + \text{WSEZ}_{my} + \lambda_m + \lambda_y + \varepsilon_{my}$$

$$\boldsymbol{Export_{my}} = \beta_1 \text{SEZ}_{my} + \beta_2 \text{Number of firms}_{my} + \beta_3 \text{Human capital}_{my} + \beta_4 \text{Crime and violence}_{my} + \text{WSEZ}_{my} + \lambda_m + \lambda_y + \varepsilon_{my}$$

The equations follow the same structure as those for employment and export, with the addition of one variable: WSEZ_{my}. WSEZ_{my} is the spatial lag variable of the independent variable $\beta_1 \text{SEZ}_{my}$. WSEZ_{my} captures the influence of an SEZ in municipality m in year y on the dependent variables employment or export of neighboring municipalities m in year y.

4.7 Validity and reliability

Validity, as outlined in the literature, refers to the extent to which a concept or variable is measured accurately (Heale & Twycross, 2015; Scheepers et al., 2016). Different forms of validity focus on different aspects of measurement accuracy (see Oluwatayo, 2012 for a detailed discussion). This study focuses on three specific types: internal validity (Onwuegbuzie, 2000; Shadish et al., 2002), external validity (Onwuegbuzie, 2000; Scheepers et al., 2016; Shadish et al., 2002), and content validity (Heale & Twycross, 2015; Scheepers et al., 2016).

A study is considered internally valid if the results obtained can be attributed solely to the independent variable(s) (Onwuegbuzie, 2000; Shadish et al., 2002). In this study, the use of a fixed effects linear regression model allows for control over both observable and unobservable confounding variables, thus addressing the problem of omitted variable bias (Mummolo & Peterson, 2018, p. 829; Torres-Reyna, 2007, p. 16). This approach improves the internal validity of the study. While it does not imply that the results are entirely due to the independent variable (e.g., the presence of an SEZ), it limits the influence of confounding variables on the results.

Conversely, external validity refers to the extent to which research results can be generalized to populations, settings, and circumstances outside the experimental context (Onwuegbuzie, 2000; Scheepers et al., 2016; Shadish et al., 2002). This study aimed to include all Colombian municipalities, but due to limitations in secondary data, some municipalities were excluded (see Section 4.3). Specifically, up to 15 municipalities were omitted from the employment analysis, while the majority were included in the export analysis. Despite these exclusions, a sufficient number of municipalities were analyzed, ensuring that the findings remained generalizable to the broader population, supporting external validity (Greenhoot & Dowsett, 2012, p. 4).

Finally, content validity refers to whether all necessary proxies to measure a variable are included, ensuring comprehensive coverage of the variable's domain (Heale & Twycross, 2015; Scheepers et al., 2016). The use of secondary data in this study affects content validity, as not all desired data for measuring a variable are accessible (Greenhoot & Dowsett, 2012, pp. 5-6). For example, in the case of the control variable 'human capital', proxies such as 'education' and 'wage' are used, while Mulliqi et al. (2019) also include proxies such as the share of skilled workers, average labor costs, and top manager experience. Due to limitations in available and usable data, these additional proxies are excluded from the analyses, which negatively affects content validity. Nevertheless, this study maintains internal and external validity, thus supporting the overall validity.

Additionally, reliability pertains to the consistency and accuracy of the measurement (De Vocht, 2016, p. 10; Scheepers et al., 2016; Sürücü & Maslakçi, 2020). It addresses the question of whether the same results would be obtained if the study were replicated under similar conditions. If consistent results are achieved upon repetition, the research can be considered reliable (De Vocht, 2016, p. 10). This study utilizes secondary data, which ensures that the same data is accessible to all researchers. Therefore, if the same research methods are applied to this data by another researcher, it is expected that the results will be virtually identical (De Vocht, 2016; Scheepers et al., 2016; Sürücü & Maslakçi, 2020). Consequently, in addition to validity, reliability is also ensured in this research.

5. Results

This chapter presents the results of this study. The first section deals with the descriptive statistics of the two datasets, Employment and Export. Subsequently, the hypotheses in the sections are tested by means of fixed effects linear regression analyses, which are performed after checking for multicollinearity. Based on the results, the hypotheses are proven or disproven. After the analyses, the remaining assumptions are examined.

5.1 Descriptive statistics

This study used two datasets: employment and export. For both datasets, an independent table was created to present the main descriptive statistics. Table 4 presents the descriptive statistics for the employment dataset, it provides insights into the characteristics of different economic zones (i.e. ZFP, ZFPE and SEZ), employment, establishments, wages and education level in different municipalities.

Table 4. Descriptive statistics of the employment dataset

	N	Mean	Std. Deviation	Minimum	Maximum
Presence_ZFP	11149	.02	.140	0	1
Presence_ZFPE	11149	.03	.164	0	1
Presence_SEZ	11149	.04	.194	0	1
WSEZ	11149	.03649194566	.07533785972	.00000000000	1.0000000000
Total_Employment	11149	6037.19	73397.051	1	2604659
Total_Establishments	11149	608.74	6210.614	0	233155
Total_grad_univ	11149	138.69	1933.640	0	90621
Total_Grad	11149	226.86	3698.649	0	211018

The presence of a ZFP or ZFPE is relatively rare, with an average of 0.02 and 0.03 respectively. These values indicate that only 2% of municipalities in Colombia had a ZFP and 3% had a ZFPE between 2008 and 2017. An average value of 1 would imply that 100% of municipalities had a ZFP(E), so a value of 0.02 corresponds to 2%. Likewise, the presence of an SEZ is the sum of the number of ZFPs and ZFPEs, so it is not surprising that the average is also only 0.07. This implies that only 7% of the Colombian municipalities have an SEZ. Moreover, the spatial lag variable 'WSEZ' has an average value of 0.036, which implies that the influence of municipalities with an SEZ has a limited effect on the employment of surrounding municipalities. Nevertheless, it is worth mentioning that the maximum value is 1, which implies that in at least one case there are strong spillover effects between a municipality with an SEZ on the employment of a surrounding municipality.

The average employment in municipalities is 6,037.19 with a relatively high standard deviation of 73,397.051, suggesting a significant variation in employment levels across municipalities. Additionally, the municipality with the highest recorded employment level has 2,604,659 workers, reflecting a significantly higher employment rate in comparison to the average across municipalities. Furthermore, the number of establishments shows a similar trend, with an average of 608.74 accompanied by a high standard deviation of 6,210.614. This indicates substantial variation between municipalities in the number of establishments, with some municipalities having as few as 1 establishment, while others accommodate as

many as 233,155 establishments. Wage levels across municipalities also exhibit significant variability, with an average wage of approximately 859 billion Colombian pesos and a standard deviation of 1.232 trillion Colombian pesos. The minimum value of 4,284,800 Colombian pesos and a maximum value of approximately 50.7 trillion Colombian pesos support the idea of considerable variability in the area of wages. Finally, the number of graduates exhibits considerable variability across municipalities as well. On average, there are approximately 227 graduates per municipality with a relatively high standard deviation of 3,698.649. This, coupled with a minimum of 0 graduates and a maximum of 211,018 graduates, highlights the substantial disparities in educational attainment between municipalities.

The descriptive statistics of the export dataset are presented in Table 5. The table consists of the same variables as those of the employment dataset. The only difference is that the variables belonging to 'crime and violence' have been added.

Table 5. Descriptive statistics of the export dataset

	N	Mean	Std. Deviation	Minimum	Maximum
Presence_ZFP	6652	.03	.175	0	1
Presence_ZFPE	6652	.04	.202	0	1
Presence_SEZ	6652	.06	.238	0	1
WSEZ	6652	.05110548547	.08206158063	.00000000000	.71943534359
Total_Establishments	6652	990.07	8017.660	1	233155
Total_Wages (in Colombian pesos)	6652	1.412967E+11	1.592659E+12	22976200.000	5.071959E+13
Total_Export_Value (in US dollars)	6652	67969215.917	374307490.53	.51000000000	7788578696.0
Total_Grad	6652	374.29	4781.680	0	211018
Total_Homicides	6652	19.73	94.841	0	1972
Total_Terrorist_Attacks	6652	.63	2.519	0	51
Total_Thefts	6652	249.46	2071.964	0	96215

The descriptive statistics for ZFPs, ZFPEs, and SEZs are comparable to those of the employment dataset. However, the means and standard deviations are slightly larger in the export dataset, partly due to the inclusion of 6,652 cases compared to the 11,149 cases in the employment dataset. Specifically, 3% of municipalities have a ZFP, 4% have a ZFPE, and 6% have an SEZ. Furthermore, the spatial lag variable 'WSEZ' again has a relatively small mean of 0.051, suggesting a limited impact of municipalities with an SEZ on the export of surrounding municipalities.

On average, municipalities have approximately 990 establishments. However, the large standard deviation of 8,017.66 illustrates a considerable variability. Certain municipalities have a notably high number of establishments, with a maximum of 233,155, while others report as few as a single establishment, highlighting the considerable variation in business density across regions. Similar to the employment data, there is significant variability across municipalities in terms of wages and export values, with standard deviations of 1.593 trillion Colombian pesos for wages and 374 million US dollars for exports. This underscores the wide disparities in economic indicators between different municipalities. Likewise, the number of graduates also shows significant differences between municipalities, with an average of approximately 374 graduates and a standard deviation of 4,781.68. This is comparable to the

employment dataset, which again illustrates that there are considerable differences between municipalities in the area of educational attainment. The averages of the number of homicides and thefts are 19.73 and 249.46 per municipality, respectively. This indicates that these forms of crime occur relatively frequently. However, there is again substantial variability between municipalities in terms of crime. In some municipalities, these types of crimes are absent, while others report up to 1,972 homicides and 96,215 thefts. This together with high standard deviations of 94.8 for homicides and 2,071.9 for thefts, respectively, highlighting the variability between municipalities. In contrast, terrorist attacks occur less frequently with an average of 0.63. However, the standard deviation of 2.519 and a maximum of 51 indicate that terrorist attacks occur relatively frequently in some municipalities.

In summary, the data in Table 4 and 5 highlight significant differences in the presence of economic zones, business activities, employment, wages, export values, educational outcomes and crime rates in different municipalities. Although the descriptive statistics of the export dataset are largely similar to those of the employment dataset, the differences lie mainly in the values of the means and standard deviations, which can be attributed to variations in the number of observations between the two datasets.

5.2 ZFP vs. ZFPE

The first hypotheses tested address the differences in employment and export performance between ZFP and ZFPE. The alternative hypotheses are formulated as follows:

> **H1a:** Colombian municipalities with a ZFP have a better employment performance than those with a ZFPE between 2008 and 2017.
>
> and
>
> **H1b:** Colombian municipalities with a ZFP have a better export performance than those with a ZFPE between 2008 and 2017.

The equations formulated in Section 4.6.3 detail the inclusion of specific independent and control variables for each analysis. Before conducting the fixed effects linear regression analyses, it is essential to first check for multicollinearity (De Vocht, 2016, p. 184). Table 6 presents the results of the bivariate correlation matrix for the employment dataset, with relevant data highlighted in red. The results indicate that the variable 'Total Wages' exhibits correlations of $r > |0.9|$ with the variables 'Total Establishments' and 'Total Grad', signaling the presence of multicollinearity. Consequently, the 'Total Wages' variable are excluded from the employment analysis.

Furthermore, the correlation between 'Total Establishments' and 'Total Grad' is $r = 0.902$. After rounding, this value is $r = 0.90$, which is at the threshold for multicollinearity (De Vocht, 2016, p. 192). In this study, it was decided that multicollinearity between these variables would not be assumed, as excluding one of them would result in the loss of too many control variables.

Table 6. Checking for multicollinearity in the employment dataset

		Presence_ZFP	Presence_ZFPE	Total_Establishments	Total_Wages (in Colombian pesos)	Total_Grad
Presence_ZFP	Pearson Correlation	1	.347**	.304**	.265**	.243**
	Sig. (2-tailed)		<.001	<.001	<.001	<.001
	N	11149	11149	11149	11149	11149
Presence_ZFPE	Pearson Correlation	.347**	1	.264**	.229**	.211**
	Sig. (2-tailed)	<.001		<.001	<.001	<.001
	N	11149	11149	11149	11149	11149
Total_Establishments	Pearson Correlation	.304**	.264**	1	**.967****	**.902****
	Sig. (2-tailed)	<.001	<.001		<.001	<.001
	N	11149	11149	11149	11149	11149
Total_Wages (in Colombian pesos)	Pearson Correlation	.265**	.229**	**.967****	1	**.951****
	Sig. (2-tailed)	<.001	<.001	<.001		<.001
	N	11149	11149	11149	11149	11149
Total_Grad	Pearson Correlation	.243**	.211**	**.902****	**.951****	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	
	N	11149	11149	11149	11149	11149

**. Correlation is significant at the 0.01 level (2-tailed).

Table 7 presents the results of the bivariate correlation matrix for the export dataset. The observed correlations are similar to those found in the employment dataset. Multicollinearity is reported between the variable 'Total Wages' and the variable 'Total Establishments' (r = 0.967) and 'Total Graduates' (r = 0.951). Furthermore, multicollinearity is reported between the variable 'Total Thefts' and the variable 'Total Establishments' (r = 0.922), 'Total Wages' (r = 0.939), and 'Total Graduates' (r = 0.935). Consequently, the variable 'Total Wages' and 'Total Thefts' are omitted from the model.

Regarding the correlation between 'Total Establishments' and 'Total Graduates' the r-value (r = 0.902) is equal to that of the employment dataset. Based on the same argumentation both variables are included in the model, because otherwise too many control variables are lost.

Table 7. Checking for multicollinearity in the export dataset

		Presence_ZFP	Presence_ZFPE	Total_Establishments	Total_Wages (in Colombian pesos)	Total_Grad	Total_Homicides	Total_Terrorist_Attacks	Total_Thefts
Presence_ZFP	Pearson Correlation	1	.350**	.308**	.268**	.246**	.292**	.045**	.281**
	Sig. (2-tailed)		<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
Presence_ZFPE	Pearson Correlation	.350**	1	.270**	.236**	.217**	.234**	.069**	.256**
	Sig. (2-tailed)	<.001		<.001	<.001	<.001	<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
Total_Establishments	Pearson Correlation	.308**	.270**	1	**.967****	**.902****	.760**	.261**	**.922****
	Sig. (2-tailed)	<.001	<.001		<.001	<.001	<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
Total_Wages (in Colombian pesos)	Pearson Correlation	.268**	.236**	**.967****	1	**.951****	.722**	.241**	**.939****
	Sig. (2-tailed)	<.001	<.001	<.001		<.001	<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
Total_Grad	Pearson Correlation	.246**	.217**	**.902****	**.951****	1	.625**	.208**	**.935****
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
Total_Homicides	Pearson Correlation	.292**	.234**	.760**	.722**	.625**	1	.279**	.741**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001		<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
Total_Terrorist_Attacks	Pearson Correlation	.045**	.069**	.261**	.241**	.208**	.279**	1	.241**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001		<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
Total_Thefts	Pearson Correlation	.281**	.256**	**.922****	**.939****	**.935****	.741**	.241**	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	
	N	6652	6652	6652	6652	6652	6652	6652	6652

**. Correlation is significant at the 0.01 level (2-tailed).

Now that the variables to be included in the fixed effects linear regression analyses have been clearly defined, the analyses can be executed. The results for hypothesis H1A are presented in Table 8. The first column shows the results for municipalities with or without a ZFP, while the second column shows the results for municipalities with or without a ZFPE. The regression coefficients are 12,387.941 for ZFPs and 6,174.282 for ZFPEs, respectively. However, these values are not statistically significant, which is supported by the large standard errors of 11,300.785 for ZFPs and 3,659.381 for ZFPEs.

Table 8. Results of the fixed effects linear regressions of hypothesis H1a

	Employment (ZFP)	Employment (ZFPE)
Presence ZFP	12387.941	-
	(11300.785)	
Presence ZFPE	-	6174.282
		(3659.381)
Total Establishments	2.760***	2.762***
	(0.184)	(0.187)
Total Graduates	3.359***	3.358***
	(0.137)	(0.136)
Num.Obs.	11149	11149
R2 Adj.	0.989	0.989
R2 Within Adj.	0.545	0.544
Dependent Variable	Total Employment	Total Employment
Municipality FE	X	X
Year FE	X	X
Clustered SE	Municipality	Municipality

- p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

In contrast, the control variables 'Total Establishments' and 'Total Graduates' are both statistically significant with p-values less than 0.001. This implies that each additional graduate is associated with an increase in total employment of approximately 3.36 employees for both municipalities with or without a ZFP and those with or without a ZFPE. Likewise, each additional establishment in a municipality corresponds to an increase in total employment of approximately 2.76 employees in both contexts. The statistical significance and positive regression coefficients of these variables suggest a strong positive impact on total employment.

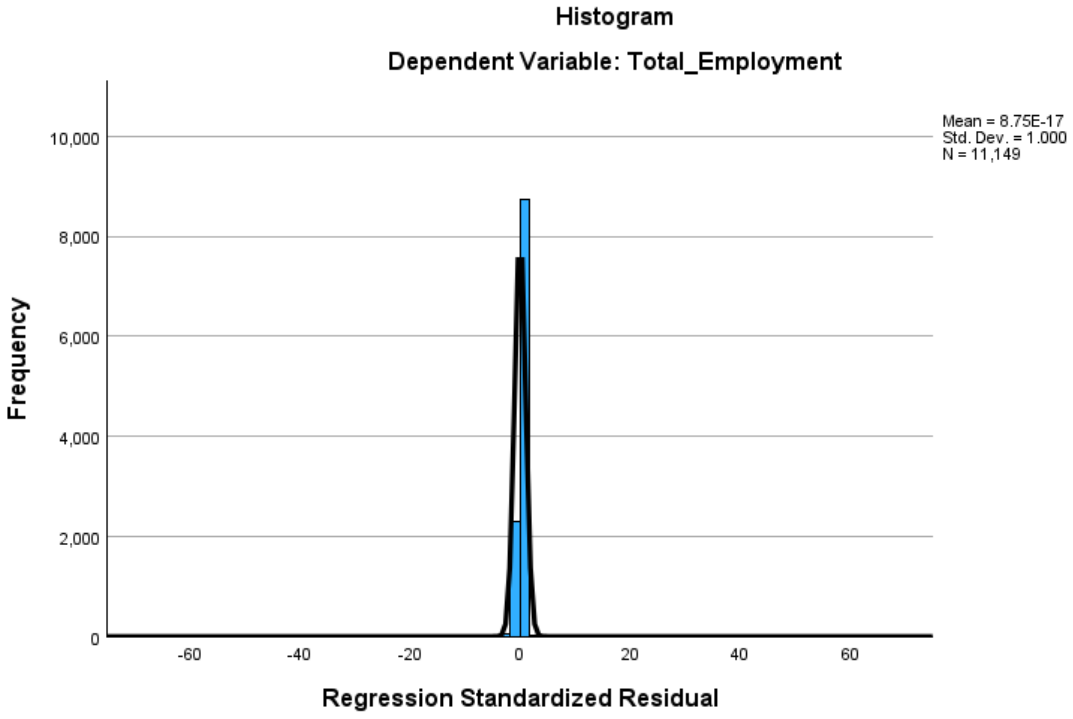
Furthermore, the adjusted R-squared (R^2 Adj.) value for both models is 0.989, indicating that the models account for a very high proportion of the variance in total employment. The within adjusted R-squared (R^2 Within Adj.) values of 0.545 and 0.544 suggest that the models explain 54.5% and 54.4% of the variance within municipalities over time. Additionally, both models include fixed effects for municipalities (municipality FE) and years (year FE), taking into account unobserved factors that vary between municipalities and over time.

Furthermore, the standard errors are clustered (clustered SE) at the municipality level, which takes into account potential intra-municipal correlation over time.

In conclusion, due to the insignificant coefficients for both ZFP and ZFPE, it cannot be concluded that ZFPs show better employment performance than ZFPEs in the period from 2008 to 2017. This indicates that there is insufficient evidence to reject the null hypothesis (i.e., no effect) and, therefore, to support the alternative hypothesis H1a. However, this does not imply that the null hypothesis is true; rather, it means that the data and analysis do not provide enough evidence to demonstrate a difference in employment performance between ZFPs and ZFPEs.

Finally, it is essential to assess the normality of the residuals, the homoscedasticity of the residuals and the linearity of the model (De Vocht, 2016, p. 184). The normality of the residuals is evaluated using a histogram, as illustrated in Figure 11. In this figure, the distribution is noticeably peaked around the center (i.e., the arithmetic mean), with a narrow spread and extended tails on both sides. The presence of long tails indicates the existence of extreme outliers, which can significantly affect the results. However, the dataset includes 11,149 study subjects, with approximately 11,000 cases (represented by the two tall blue bars) concentrated around the arithmetic mean, indicating a normal distribution. Moreover, these outliers come mostly from municipalities that include the largest cities in Colombia (i.e., Bogotá, Medellín, Cali, Barranquilla, and Cartagena). Excluding these values from the analysis would result in incomplete and imprecise findings. Since the outliers represent only a few dozen cases out of 11,149, while the majority of cases conform to the normality trend, the distribution is considered normal and therefore meets the normality assumption (De Vocht, 2016, p. 193).

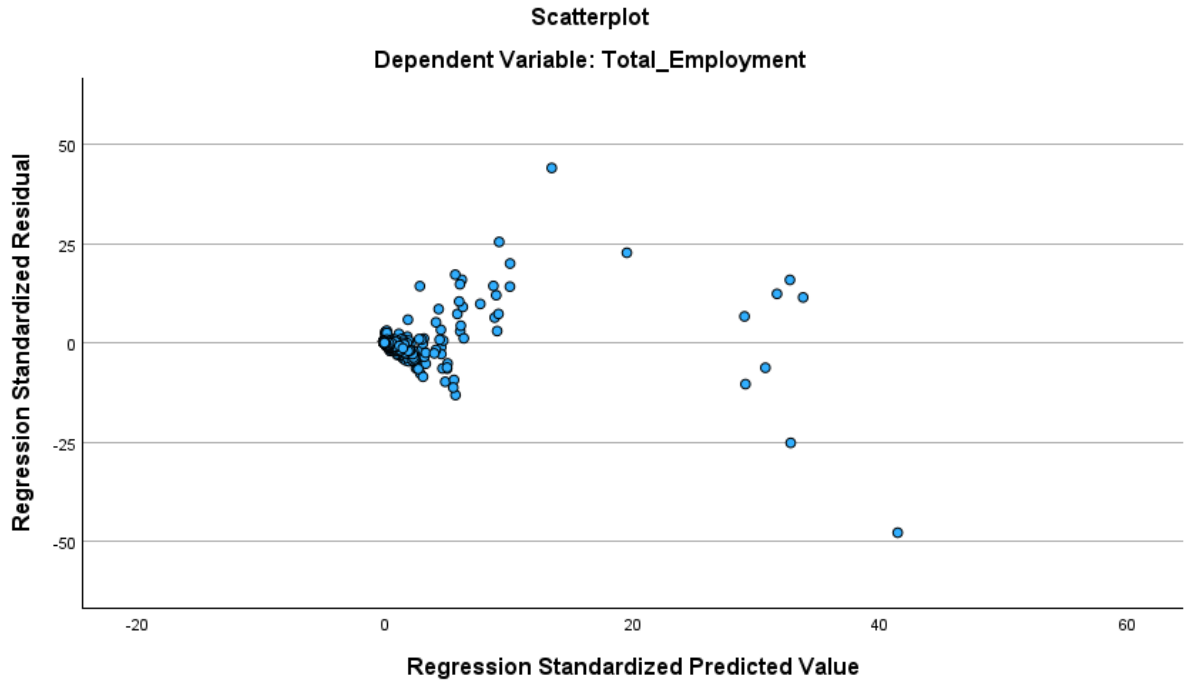
Figure 11. Checking for normality of the residuals of the dependent variable employment



Both of the remaining assumptions can be evaluated using a scatterplot, where the expected standardized values are plotted on the y-axis and the standardized residuals on the x-axis (De Vocht, 2014; De Vocht, 2016). As illustrated in Figure 12, the majority of the values are concentrated around the zero-point. However, approximately 100 residuals (similar to Figure 11) can be identified as outliers, with the most extreme outlier located at the bottom right representing the capital, Bogotá. The presence of these outliers in a dataset comprising 11,149 cases suggests that the assumptions of linearity and homoscedasticity are not fully satisfied. Nevertheless, excluding these outliers would result in most values aligning closely with the zero line, supporting both a linear and homoscedastic model.

On the contrary, it is not advisable to remove these outliers from the dataset, as they represent cities with the highest numbers of ZFPs, ZFPEs, and SEZs (see Appendix A). Removing these cases could lead to a distorted interpretation of the results relevant to this study. Furthermore, De Vocht (2016, p. 194) suggests that minor deviations from assumptions are not a cause for concern, which applies in this case. Therefore, it can be concluded that the model meets both the homoscedasticity and linearity assumptions.

FIgure 12. Checking for the requirement of homoscedasticity and the linearity assumption of the dependent variable employment



The results of the fixed effects linear regression analysis of hypothesis H1b are shown in Table 9. Table 9 examines the impact of various factors on total exports in Colombian municipalities, specifically focusing on the presence of ZFPs and ZFPEs. The table provides results for two separate models: one assessing the effect of ZFP presence and another for ZFPE presence.

The coefficient for the presence of a ZFP has a value of -7,457,226.161, which means that when a municipality has a ZFP, exports decrease by approximately 7.46 million US dollars compared to those without a ZFP. However, this result is not statistically significant, which is supported by the large standard error of 25,728,154.72. Similarly, the presence of a ZFPE is associated with a decrease in total exports by approximately 36.54 million US dollars.

Nevertheless, this result is also not statistically significant, which can be (partly) explained by the large standard error of 26,328,306.105.

Table 9. Results of the fixed effects linear regressions of hypothesis H1b

	Export (ZFP)	Export (ZFPE)
Presence ZFP	-7457226.161	-
	(25728154.717)	
Presence ZFPE	-	-36542926.644
		(26328306.105)
Total Establishments	2529.810	2593.582
	(2317.447)	(2357.226)
Total Graduates	-5731.327***	-5758.407***
	(952.218)	(938.458)
Total Homicides	474783.054	461564.590*
	(244512.105)	(232518.070)
Total Terrorist Attacks	5271629.011**	5250790.449**
	(1930646.798)	(1934807.885)
Num.Obs.	6652	6652
R2 Adj.	0.771	0.771
R2 Within Adj.	0.012	0.012
Dependent Variable	Total Export (in US dollars)	Total Export (in US dollars)
Municipality FE	X	X
Year FE	X	X
Clustered SE	Municipality	Municipality

- $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The control variable 'Total Establishments' is positive in both models, but statistically insignificant. This suggests that the number of establishments has a minimal influence on exports. Conversely, the control variable 'Total Graduates' is statistically significant in both models with p-values less than 0.001. The negative coefficients of -5,731.327 and -5,758.407, respectively, imply that an increase in the number of graduates is associated with a decline in total exports. Additionally, the control variable 'Total Homicides' has a positive and statistically significant effect, with a p-value less than 0.05, on export in the ZFPE model. In concrete terms, this means that for every homicide there is an increase of 461,564.590 US dollars in export. In addition, the control variable 'Total Terrorist Attacks' also has a positive and statistically significant effect, with p-values less than 0.001, on export in both models. This suggests that municipalities that experience more terrorist attacks score better on export than municipalities that experience less terrorist attacks.

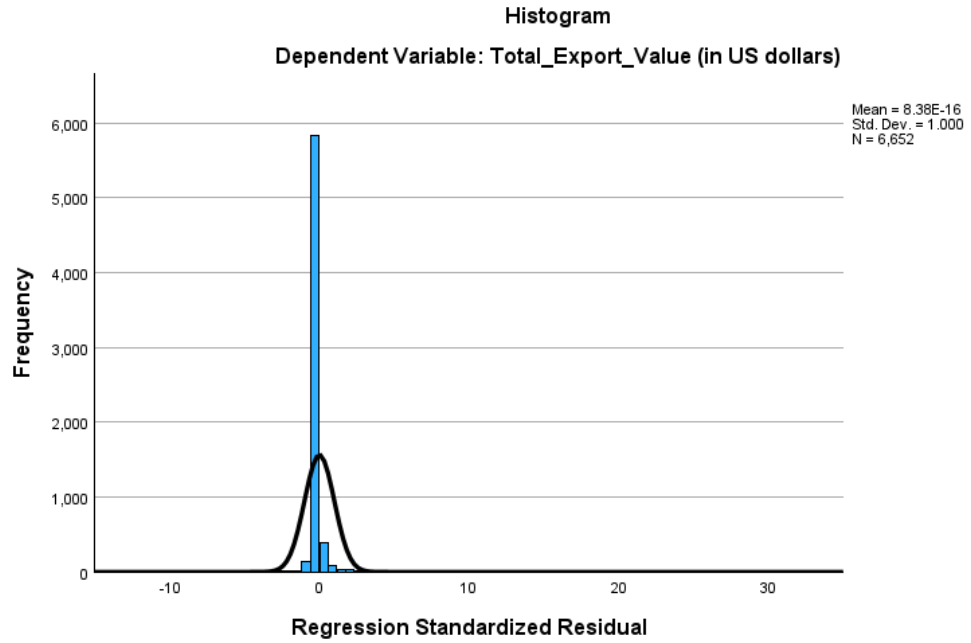
Lastly, the adjusted R-squared value is 0.771 in both models, which means that the models explain approximately 77.1% of the variance in export. So, the models have a significant explanatory power. However, the within-group adjusted R-squared has a value of 0.012 in

both models. This means that very little of the variance between municipalities over time is explained by the models.

In summary, the fixed effects linear regression results show that the presence of both ZFPs and ZFPEs has no statistically significant effect on exports. Interestingly, the control variable 'Total Graduates' has a statistically significant negative impact, while the number of homicides (i.e. in the case of ZFPE) and number of terrorist attacks have a statistically significant positive impact on exports. In conclusion, as neither the effect of ZFPs nor ZFPEs on export performance is statistically significant, the data do not provide sufficient evidence to reject the null hypothesis. This means that the alternative hypothesis H1b is not supported. However, as with hypothesis H1a, this does not automatically mean that the null hypothesis is true. The results mean that there is insufficient evidence that there are statistically significant differences with regard to export between municipalities with a ZFP and those with a ZFPE.

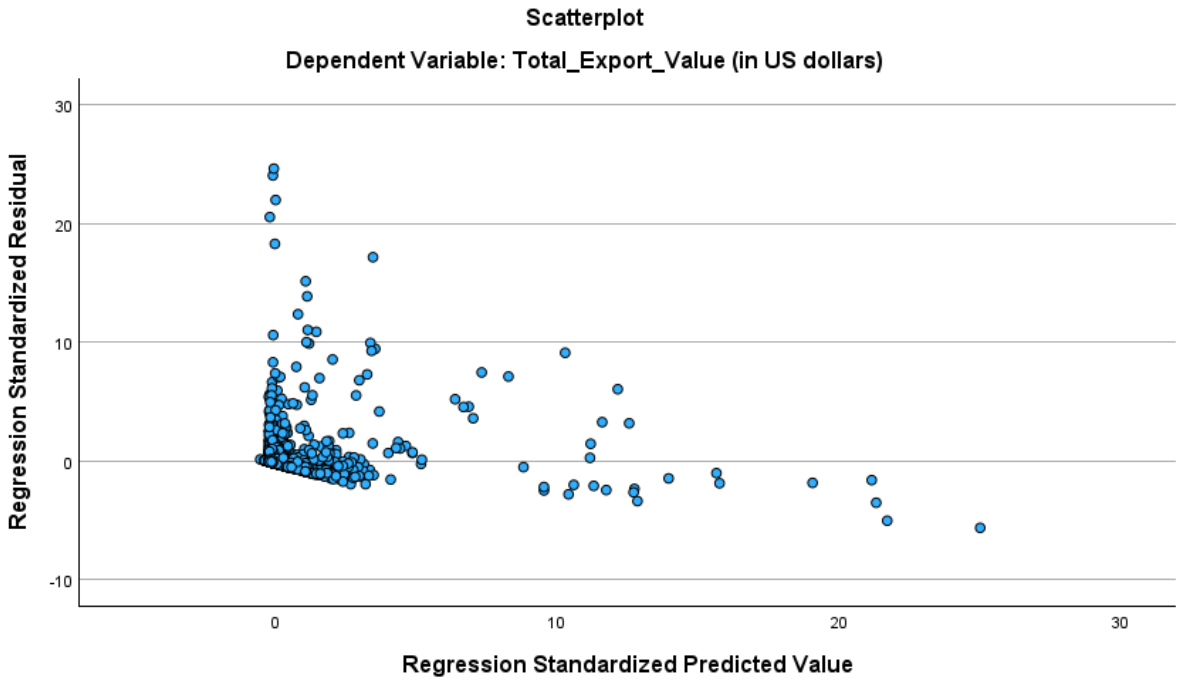
As with the previous hypothesis, it is essential to evaluate the assumptions of normality, homoscedasticity, and linearity of the model (De Vocht, 2016, p. 184). The normality of residuals is assessed through a histogram, as shown in Figure 13. The histogram reveals a narrow, highly peaked distribution around the arithmetic mean (0), indicating that most residuals are closely clustered around the center. However, there are a few notable observations with larger residual values (outliers) on the right, which extend the distribution. These outliers may be influencing the overall results, as seen in Figure 11. Notably, these extreme residuals largely originate from municipalities containing Colombia's largest cities. Excluding these values from the analysis would lead to incomplete and incorrect results. Given that the outliers represent only a few dozen cases out of 6,652, while the majority of cases align with the trend of normality, the distribution is deemed normal and thus satisfies the assumption of normality (De Vocht, 2016, p. 193).

FIgure 13. Checking for normality of the residuals of the dependent variable export



The assumptions of homoscedasticity and linearity can be evaluated using a scatterplot, as previously described (De Vocht, 2014; De Vocht, 2016). Figure 14 presents the scatterplot corresponding to hypothesis H1b. The plot demonstrates that most values are concentrated around the zero line, with the dispersion becoming less dense as the predicted values increase, primarily due to the previously mentioned outliers. However, as with the prior hypothesis, these outliers are significant for the validity of the research and should not be excluded from the analysis. In line with De Vocht's (2016, p. 194) assertion that minor deviations are not a cause for concern, it is concluded that the model for hypothesis H1b satisfies the assumptions of both homoscedasticity and linearity.

FIgure 14. Checking for the requirement of homoscedasticity and the linearity assumption of the dependent variable export



5.3 Employment

The second hypothesis examined concerns the relationship between SEZs and employment. The alternative hypothesis is formulated as follows:

> **H2:** Colombian municipalities with an SEZ perform better on employment than municipalities without one between 2008 and 2017.

This hypothesis shows many similarities with hypothesis H1a; therefore, the underlying assumptions do not require detailed discussion here. The results of the assumption checks are given in Appendix B, which shows that the results are almost identical. Therefore, the variable 'Total Wages' is also excluded from this model, due to multicollinearity issues. Furthermore, the model satisfies the assumptions of normality of residuals, homoscedasticity and linearity, as described in the previous section.

The results of the fixed effects linear regression analysis for hypothesis H2 are presented in Table 10. Similarities can also be observed with the results in Table 8. The coefficient for the independent variable 'Presence of SEZ' indicates that the presence of an SEZ in a municipality

is associated with an increase in total employment of 9,009.283 employees. However, this variable is not statistically significant, probably due to the relatively large standard error (5,501.326), which indicates considerable variability.

Table 10. Results of the fixed effects linear regression of hypothesis H2

	Employment
Presence SEZ	9009.283
	(5501.326)
Total Establishments	2.761***
	(0.184)
Total Graduates	3.358***
	(0.135)
Num.Obs.	11149
R2 Adj.	0.989
R2 Within Adj.	0.546
Dependent Variable	Total Employment
Municipality FE	X
Year FE	X
Clustered SE	Municipality

- $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Both control variables, 'Total number of establishments' and 'Total number of graduates', are statistically significant, with $p < 0.001$. This indicates that for each additional establishment or graduate, the number of employees increases by 2.76 and 3.36 respectively, which reflects the results in Table 8.

Furthermore, the adjusted R-squared and adjusted R-squared within-group values are also almost identical to those in Table 8, at 98.9% and 54.6%, respectively, indicating a very strong model fit.

In conclusion, since the relationship between the presence of an SEZ and employment is not statistically significant, it is not possible to state with certainty that Colombian municipalities with an SEZ experienced better employment outcomes compared to those without an SEZ in the period from 2008 to 2017. Therefore, the data do not support the alternative hypothesis H2, which means that the null hypothesis cannot be rejected. As discussed earlier, this does not necessarily mean that the null hypothesis is true; the data and analysis do not provide sufficient evidence to demonstrate that municipalities with an SEZ score better on employment performance.

5.4 Export

The third hypothesis in this study concerns the relationship between SEZ and export. The alternative hypothesis is formulated as follows:

> **H3:** Colombian municipalities with an SEZ perform better on export than municipalities without one between 2008 and 2017.

Similar to hypotheses H1a and H2 on employment, there are notable parallels between hypotheses H1b and H3, therefore the assumption checks are not discussed in detail here. The detailed results of these checks are available in Appendix C. The findings are identical to those of hypothesis H1b, which leads to the exclusion of the control variables 'Total Wages' and 'Total Thefts' from the analysis due to multicollinearity. Furthermore, both the histogram and the scatterplot are very similar to those of hypothesis H1b. Therefore, based on the aforementioned explanation, it is assumed that the model satisfies the assumptions of both homoscedasticity and linearity.

Table 11 presents the results of the fixed effects linear regression analysis consistent with hypothesis H3. Similar to hypothesis H1b, the results for hypothesis H3 are largely similar, although some minor differences are observed. For example, the control variable 'Total Homicides' is both positive and statistically significant for ZFPEs, while for SEZs it remains positive but not statistically significant.

Table 11. Results of the fixed effects linear regression of hypothesis H3

	Export (SEZ)
Presence SEZ	-22019030.975
	(14611860.403)
Total Establishments	2555.981
	(2337.439)
Total Graduates	-5752.230***
	(944.270)
Total Homicides	462301.799
	(236483.875)
Total Terrorist Attacks	5254151.660**
	(1931926.602)
Num.Obs.	6652
R2 Adj.	0.771
R2 Within Adj.	0.012
Dependent Variable	Total Export (in US dollars)
Municipality FE	X
Year FE	X
Clustered SE	Municipality

- $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The presence of an SEZ is associated with a decrease of approximately 22 million US dollars in total export value. However, this result is not statistically significant, which is also supported by the large standard error (14,611,860.403). Furthermore, each additional establishment is associated with an increase of approximately 2,556 US dollars in total export value, yet this result is also not statistically significant. Conversely, the number of graduates has a negative and statistically significant impact on export, with a p-value less than 0.001. For each additional graduate, the total export value decreases by approximately 5,752 US

dollars. Moreover, the number of terrorist attacks is positive and statistically significant ($p < 0.01$). In concrete terms, each additional terrorist attack results in an increase of approximately 5.25 million US dollars in export.

Furthermore, the adjusted R-squared value has a value of 0.771, which means that 77.1% of the variance in export is explained by this model. This indicates a relatively high level of explanatory power. In contrast, the value of the within-group adjusted R-squared is 0.012, which is very low. This means that the independent and control variables explain only a small part of the variance within municipalities. So the explanatory power of the model is much stronger between municipalities than within municipalities.

In conclusion, the relationship between export and the presence of an SEZ is not statistically significant. Consequently, the alternative hypothesis H3 is not supported by the data, which means that the null hypothesis cannot be refuted. In short, based on the results from the model, it cannot be concluded that SEZs improve export performance.

5.5 Spillover effects

Concerning the spillover effects, two distinct hypotheses have been proposed: one concerning the employment spillover effects and the other focusing on the export spillover effects. The alternative hypotheses are articulated as follows:

> **H4a:** Colombian municipalities with an SEZ generate positive employment spillover effects between 2008 and 2017.

and

> **H4b:** Colombian municipalities with an SEZ generate negative export spillover effects between 2008 and 2017.

The equations presented in Section 6.3.3 are nearly identical to those corresponding to hypotheses H2 and H3, with the sole distinction being the inclusion of the spatial lag variable ‘WSEZ’. Consequently, the results previously discussed for hypotheses H2 and H3 are not elaborated further, as they are largely similar. The primary focus is on the spatial lag variable, as it is critical for testing the presence of employment or export spillover effects, which is necessary for the acceptance or rejection of the hypotheses.

Additionally, the detailed assumption checks are not repeated because of the overlap with the previous hypotheses. The relevant results are provided in Appendix D, where it is evident that, once again, for the employment analysis, the control variable ‘Total Wages’ has been excluded, while for the export analysis, both ‘Total Wages’ and ‘Total Thefts’ have been omitted due to multicollinearity. Both models satisfy the remaining assumptions, including normality of residuals, homoscedasticity, and linearity, as discussed in prior sections.

The results of the analyses are presented in Table 12. The spatial lag variable 'WSEZ’, associated with employment spillover effects, has a coefficient of 9,443.699, indicating a positive but statistically insignificant effect. This suggests that while the presence of SEZs in neighboring areas may have a positive influence on employment within the municipality, the effect is not substantial enough to achieve statistical significance.

Table 12. Results of the fixed effects linear regressions of hypotheses H4a and H4b

	Employment spillover effects	Export spillover effects
Presence SEZ	8901.197	-21995477.244
	(5470.453)	(1.459046e+07)
Total Establishments	2.756***	2556.933
	(0.180)	(2.342682e+03)
Total Graduates	3.358***	-5752.636***
	(0.135)	(9.519640e+02)
Total Homicides	-	462165.147
		(2.378554e+05)
Total Terrorist Attacks	-	5254017.802**
		(1.932552e+06)
WSEZ	9443.699	-2341462.863
	(5077.131)	(1.056034e+08)
Num.Obs.	11149	6652
R2 Adj.	0.989	0.771
R2 Within Adj.	0.547	0.012
Dependent Variable	Total Employment	Total Export (in US dollars)
Municipality FE	X	X
Year FE	X	X
Clustered SE	Municipality	Municipality

- $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In contrast, the spatial lag variable 'WSEZ', representing export spillover effects, is negative but also not statistically significant. This suggests that the presence of an SEZ in a Colombian municipality may have a negative impact on the exports of surrounding Colombian municipalities; however, this result is not statistically significant.

In summary, the spatial lag variable 'WSEZ' has a positive coefficient in the case of employment and a negative one in the case of export. These findings suggest that the influence of SEZs extends beyond the municipal boundaries. However, in both cases the results are not statistically significant, so there is no evidence to support either of the alternative hypotheses. In short, the null hypotheses cannot be refuted based on these data and analyses. So, it cannot be said that SEZs generate either employment or export spillovers.

6. Conclusion

This study examined the effects of SEZs on employment and export performance in Colombian municipalities between 2008 and 2017. The study used a spatial econometric model, including fixed effects, to analyze the impact of SEZs, taking into account spillover effects in neighboring municipalities. The aim of this research is to answer the following research question:

''To what extent do special economic zones in Colombian municipalities affect employment and export between 2008 and 2017?''

To address the research question, four sub-questions were formulated and converted into measurable hypotheses based on the literature review. These hypotheses were tested using fixed effects linear regression models, with key findings and sub-conclusions drawn for each hypothesis. The sub-conclusions are briefly summarized here to provide a comprehensive response to the research question.

A comparison between ZFPs (zones with multiple firms) and ZFPEs (zones with a single firm) indicated no statistically significant differences in economic outcomes. Both types of SEZs demonstrated similar performance in terms of employment and exports. As a result, there is no evidence to suggest that ZFPs outperform ZFPEs in these areas due to clustering effects. Conversely, the number of graduates and the number of establishments have a strong positive and statistically significant impact on employment in both ZFPs and ZFPEs. This shows that factors related to educational attainment and the density of businesses in a municipality have a greater impact on employment creation than the establishment of an SEZ.

Also with respect to exports, there are control variables that are statistically significant. For both ZFPs and ZFPEs, it is found that the number of graduates has a negative impact on exports, with each new graduate resulting in approximately a decrease of 5,700 US dollars in exports. In contrast, the occurrence of terrorist attacks has a positive impact on exports in both cases, with an increase of approximately 5.3 million US dollars per additional terrorist attack. Finally, the number of homicides in the case of ZFPEs is also positive and statistically significant, with each additional homicide resulting in an increase of approximately 460,000 US dollars in exports. In summary, a complex issue like export involves more than just the implementation of place-based policies like the implementation of SEZs. Other factors have a more direct and greater influence on export than the presence of an SEZ.

Secondly, with regard to employment, the results show that the presence of an SEZ is associated with an increase in employment. However, this result is not statistically significant, so it cannot be concluded that the presence of an SEZ results in an increase of employment. On the contrary, as with ZFPs and ZFPEs, the number of graduates and the number of establishments do have a positive and statically significant effect on employment.

Thirdly, the presence of an SEZ is associated with a negative relationship with exports. However, this relationship is not statistically significant, so it cannot be concluded that an SEZ has a negative or positive influence on exports. In this case, the number of graduates and the

number of terrorist attacks are again statistically significant, with the former showing a negative relationship and the latter showing a positive relationship. However, the number of homicides is not statistically significant, while this is the case for ZFPEs. From this, it can be concluded that when only one company is active in an SEZ, there is a positive relationship between the number of homicides and export; if this is not the case, there is no significant relationship.

Finally, based on this research it can be concluded that there are no significant employment or export spillover effects. Although the spatial lag variable 'WSEZ' is positive with regard to employment spillover effects and negative with regard to export spillover effects, the results are not statistically significant. It can therefore not be concluded from this that municipalities with an SEZ have a positive or negative influence on surrounding municipalities.

In conclusion, the findings of this study indicate that, based on the data and analyses conducted, it cannot be determined whether the presence of an SEZ in a Colombian municipality had a positive or negative impact on employment, export performance, or spillover effects during the period from 2008 to 2017.

7. Discussion

The last two chapters present the results and the main conclusions. In this last chapter, a bridge is built between the results and conclusions with the scientific literature. In other words, are the results and conclusions supported by the literature or are they contradicted? Furthermore, the limitations of this research are discussed, while also reflecting on (better) alternatives. Then, the implications of this research are discussed, after which it is concluded with suggestions for further research.

7.1 Interpretations of the results

SEZs are usually established to achieve one of the following policy objectives: (i) attracting foreign direct investment and promoting exports and industrialization; (ii) mitigating high unemployment rates; (iii) supporting comprehensive economic reform strategies; and (iv) serving as testing grounds for new policies and approaches (Akinci & Crittle, 2008; Farole & Akinci, 2011; Zeng, 2010). This is in line with the goals set by the Colombian government regarding the implementation of SEZs: reducing regional inequality in employment, exports, innovation, and investment (MINCIT, 2011). However, the literature shows that the impact of SEZs on employment and exports is inconclusive, with some asserting that SEZs have substantial effects on employment and exports, while others argue the contrary (Davies & Mazhikeyev, 2019). For example, Nazarczuk and Uminski (2018) conclude that SEZs have a positive effect on exports in Poland, whereas Steenbergen and Javorcik (2017) found a negative relationship in Rwanda. These contradictions make it interesting to place the results and conclusions in this study within the scientific literature.

Based on the literature, expectations were formulated in the form of hypotheses. These hypotheses were tested using fixed effects linear regression analyses. The first hypotheses in this study include the difference between ZFPs and ZFPEs on employment and exports. The results showed that both ZFPs and ZFPEs have no statistically significant effect on both employment and exports. In particular, the fact that the presence of ZFPs has no statistically significant effect on employment is striking. Several companies can establish themselves in ZFPs, which can promote the possibility of cluster formation. The formation of clusters should result in an increase in employment (Combes et al., 2011; Lu et al., 2019). Neumark and Simpson (2014) support this idea, they claim that the formation of clusters within and around SEZs can generate ample pools of (skilled) labor. Especially if a ZFP is specialized in a specific industry or supply chain (World Bank Group, 2017, p. 16), which is the case of many ZFPs in Colombia (MINCIT, 2022). Based on the literature, it is expected that ZFPs would have a positive influence on employment through the creation of clusters, but this idea is not supported in this study.

That the presence of a ZFP is not statistically significant on exports is partly in line with the literature. Some studies have reported a positive and statistically significant relationship (Antonio Belso-Martínez, 2006; Fernhaber et al., 2008; Tambunan, 2009), while others have found a negative and statistically significant effect (Diez-Vial & Fernández-Olmos, 2014). In short, there is no clarity on this topic, which means that the result of this study neither agrees with the literature nor contradicts it.

With regard to employment, there are conflicting voices, for example, Arévalo-Luna and Arévalo-Lizarazo (2019, p. 170) claim that in Colombia SEZs are not major sources of employment, while the number of direct jobs in Colombia grew from 28,954 in 2009 to 174,058 in 2016 (AZFA, 2017). The latter fully covers the time span of this study, which suggests that SEZs have a positive relationship on employment. However, in this study the relationship between SEZs and employment is not statistically significant, which does not support this. This result is in contrast to several studies, for example, FIAS (2008) and Lu et al. (2019) found a positive and statistically significant relationship between SEZs and employment. In contrast, the study by Sanders and Brown (2012) found that job creation in the Philippines as a result of the implementation of SEZs was only achieved in a limited number of regions. This shows that the result of this research lies somewhere in the middle within the literature, because the result is not significant, while this is the case in various studies. Nevertheless, the result is also not negative, which means that the result does not fall under this either.

Conversely, the number of establishments and the number of graduates are positive and statistically significant on employment performance. That the number of establishments contributes positively to employment should not come as a surprise, after all, the more companies, the more jobs (Farole & Akinci, 2011; Zeng, 2010; Zeng, 2021, p. 265). The positive and statistically significant relationship between total graduates and employment is also widely supported in the literature. Spencer and Cooper (2006) argue that education is the gateway to the labor market, with completing an education having a positive effect on labor force participation. Prokou (2008) and Sulkowski and Zawadzki (2016) add that completing a tertiary education in particular contributes significantly to obtaining a job. In short, the result found in this study fits perfectly within the human capital theory (Papadopoulou, 2019, p. 8). This theory assumes that the benefits of education exceed the costs, which results in a positive relationship between education and employment (Mincer, 1991; Brewer et al. 2010). Both results found are therefore consistent with the literature.

In this study, the relationship between SEZs and exports is negative but not statistically significant. Academic evidence shows that there is little rigorous evidence between the relationship of SEZs and exports (Davies & Mazhikeyev, 2019, p. 146). This confirms that the result found in this study is not entirely surprising. However, despite the fact that the result found is not statistically significant, it is striking that the coefficient is negative. The study by Johansson and Nilsson (1997) offers a possible explanation for this. They argue that the impact of SEZs on exports depends on whether governments are able to effectively eliminate trade restrictions and implement export-oriented strategies. In other words, the presence of well-established institutional frameworks and regulations in a country is vital in driving exports through SEZs. This is supported by the study by Rhee et al. (1990). In this study, it is argued that the Dominican Republic has failed to make a significant positive impact on exports as a result of trade barriers and import substitution policies.

However, in Colombia there are several laws and regulations including Act 1004 of 2005 that form the basis for a well-established institutional framework and regulations. One of the points of Act 1004 is to simplify the procedures regarding trading goods and services in order to accelerate sales (ANDI, 2020). This would imply that the conditions for a positive relationship between SEZs and exports should be present. Nevertheless, the relationship is negative but not statically significant, which could imply that despite an institutional framework and regulations these are insufficient to achieve a positive effect.

On the contrary, the number of graduates is negative and strongly statistically significant. This is an interesting result, because completing an education is generally seen as something positive. Eickelpasch and Vogel (2011) and Wagner (2012) conclude for example that employees with high levels of human capital, obtained through education among other things, perform better at work, which increases the productivity of a company and thus export performance. The result of this research is at odds with the literature and is therefore an interesting new finding that contributes to the academic world.

Finally, with regard to crime and violence, it is striking that the number of homicides, in the case of ZFPEs, and terrorist attacks are positive and statistically significant. This is counterintuitive, because crime and violence is not associated with anything positive. For example, Gorrín et al. (2023) argue that crime and violence limit productivity in developing countries, such as Colombia, and thus have a negative impact on exports. A possible explanation for this result is that crime and violence are more prevalent in metropolitan areas, such as Bogotá and Medellín (see Figure 13). These large and important cities in Colombia have a disproportionate export performance compared to the rest of the country. It is plausible that there is more crime and violence there than in a municipality in the middle of the Amazon, which can explain the paradoxical result. In summary, there is more business activity in metropolitan areas and thus also exports, but at the same time, due to the large population, there are also more criminal activities such as homicides and terrorist attacks.

Finally, based on this research, it can be concluded that SEZs in Colombia do not generate employment or export spillover effects because the results are not statistically significant in both cases. A possible explanation for the statistically insignificant results may lie in shortcomings of mediating factors and transmission channels (Frick & Rodríguez-Pose, 2019, p. 77; World Bank Group, 2017, p. 23). In the context of developing countries, such as Colombia, the insufficient development of 'absorptive capacity' as a mediating factor seems to be a key determinant in the limited generation of spillover effects (Frick & Rodríguez-Pose, 2019, pp. 78-79; World Bank Group, 2017, pp. 24-25). In short, it could be that employees in Colombia are insufficiently able to absorb and subsequently use newfound knowledge. The explanation could also be found in other transmission channels or mediating factors, but absorptive capacity is specifically mentioned in the literature as an important shortcoming in developing countries that prevents spillover effects from occurring. (Frick & Rodríguez-Pose, 2019, pp. 78-79; World Bank Group, 2017, pp. 24-25).

7.2 Limitations and reflection

The primary limitation of this study is related to the data collection method. By using secondary data, no influence could be exerted on who, what, or how the data was measured (Greenhoot & Dowsett, 2012, pp. 5-6). These limitations are made clear by means of a number of examples.

First, the period that is central to this study (2008-2017) was chosen because a large part of the relevant data comes from Datlas (n.d.) which only has data for this specific time frame. Consequently, the choice for this period was not made on the basis of a well-considered consideration, but rather dictated by the availability of data, leading to a reliance on finding relevant information within this period. In practice this turned out to be a challenge, because when relevant information was found, it did not fall within the time frame of this study

(DANE, n.d.). Additionally, the 10-year time frame posed challenges for sample retention, as maintaining consistency and continuity over such an extended period proved difficult (Litosseliti, 2018, p. 58). This is evident, for example, from Table 2, which shows that in 2012, 419 cases were excluded from the dataset, while this was 468 for 2015 due to unsuitable data. This means that the same research objects are not present in every year, which means that the results obtained are incomplete.

Secondly, the use of secondary data appeared to affect the content validity of this study, because not all desired data were available or usable to measure some variables. For example, in the case of human capital, the proxy 'education' is used. To measure this proxy, the studies by Mulliqi et al. (2019, p. 778) and Wagner (2012) use the percentage of highly educated individuals, while in this study the number of graduates per year is used as a proxy, because other data is not available. This illustrates once again the shortcomings of secondary data.

Lastly, following on from the previous point, the use of secondary data is a limitation when using control variables. The available data determines which control variables can be included in the analyses, after all, if no data is available, it is impossible to add them to a dataset. This resulted in a reverse approach, where the available data was examined to determine its alignment with the literature, rather than allowing the literature to dictate which variables should be included in the dataset. Ideally, the literature should guide the selection of variables. This has significantly affected the content validity in this study, which leads to the conclusion that secondary data has advantages, but also leads to considerable limitations.

The second limitation concerns the results of this study, which follows from the last point of the previous limitation. Because only variables that are available can be included, not all desired variables are included in the analyses, such as the share of employees active per sector and/or the share of women who are employed. As a result, there is a large overlap between the employment and export dataset in this study, with the only difference being the addition of crime and violence in the export dataset. As a result, the results in various analyses are very similar.

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Also, the fact that in no model does a statistically significant effect exist between ZFPs, ZFPEs, or SEZs and employment or export calls for adding and/or omitting variables in order to demonstrate a statistically significant effect. However, as mentioned earlier, this is only possible to a limited extent due to the use of secondary data.

An alternative data collection method could counteract the described limitations of secondary data. Using primary data collection could be a solution, because the researcher then has influence on what kind of data is collected, which tackles the limitations of secondary data (Sadan, 2017). However, this also has limitations, because it is time-consuming and expensive to collect data for 10 years with the possibility of difficulties with sample retention (Litosseliti, 2018, p. 58). An intermediate solution could be a way out, to address the limitations of both data collection methods as much as possible. By using a

primary data collection method, such as a survey or questionnaire, you as a researcher keep control. However, it is then wise to shorten both the time frame of 10 years and the number of research units to make the research feasible and affordable. By utilizing a primary data collection method, such as surveys or questionnaires, the researcher maintains control over the variables and data collection process. However, to ensure the study remains feasible and cost-effective, it would be advisable to shorten the 10-year time frame and reduce the number of research units.

7.3 Implications

As previously mentioned, the Colombian national government has set a clear objective with the implementation of SEZs: to reduce regional disparities, in employment and exports (MINCIT, 2011). Although this study found no statistically significant relationship between ZFPs, ZFPEs, or SEZs and employment or exports, the negative coefficient observed in the analyses concerning exports is noteworthy. A more comprehensive study, incorporating additional variables, could potentially reveal a statistically significant negative relationship.

This is important for both Colombian policymakers and citizens, because if it turns out that there is a negative statistically significant effect between SEZs and exports, the set objectives have not been achieved in the period 2008-2017. This is detrimental to policymakers in Colombia, as the goals have not been achieved and public money is involved in implementing SEZs and attracting companies through tax incentives of 10% and an exemption from value-added taxes (Arévalo-Luna & Arévalo-Lizarazo, 2019, p. 163).

In addition, this is important for the people of Colombia, because the financial incentives that the government provides to (foreign) companies that establish themselves in an SEZ lead to a decrease in revenues for the government that must be compensated by another means such as increasing taxes (Zee et al., 2002, p. 1501). This means that the Colombian people essentially pay for the financial benefits of (foreign) companies. This is considered acceptable if the benefits outweigh the costs, meaning that SEZs generate greater financial or economic gains, like an increase in employment and/or exports, than the expenses incurred in their establishment and operation (World Bank Group, 2017, p. 17).

In summary, despite the fact that the result in this study is not statistically significant, the negative export coefficient gives food for thought. If nothing happens or changes, this could mean that the policies related to the implementation of SEZs in Colombia could become an economic burden instead of a catalyst (Moberg, 2015, p. 167).

7.4 Suggestions for further research

Based on this research, a number of issues have come to light that require further investigation. The first suggestion relates to what was described in the previous paragraph. Although the relationship between ZFPs, ZFPEs, and SEZs with respect to exports is statistically insignificant in this study, the presence of a negative coefficient suggests the need for a more in-depth follow-up investigation. Incorporating additional variables and utilizing more comprehensive data could potentially reveal a statistically significant effect.

A second suggestion for further research concerns the surprising result that terrorist attacks and homicides in the case of ZFPEs have a positive statistically significant effect on export, while the number of graduates has a negative effect. These counterintuitive findings require deeper investigation. A follow-up study could explore the underlying causes of these

results. Conducting a comparative study across different countries would be valuable in determining whether the findings of this study are unique to Colombia or if similar patterns occur in other developing countries or even in developed nations.

8. Literature

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9. Appendices

Appendix A: Detailed information per SEZ

(MINCIT, 2022)

SEZ Name	Department	Municipality	ZFP or ZFPE	Establishment year
NTERNACIONAL VALLE DE ABURRÀ "ZOFIVA S.A.S"	Antioquia	Caldas	ZFP	2012
RIONEGRO	Antioquia	Rionegro	ZFP	1993
ZONA FRANCA PERMANENTE DE URABA S.A.S	Antioquia	Apartadó	ZFP	2008
HOSPITAL SAN VICENTE DE PAUL	Antioquia	Rionegro	ZFPE	2009
ZONA FRANCA ESPECIAL CEMENTERA DEL MAGDALENA MEDIO S.A.S "ZOMAN"	Antioquia	Maceo	ZFPE	2011
DEXCO ZONA FRANCA (TABLEMAC MDF S.A.S.)	Antioquia	Barbosa	ZFPE	2011
GETCOM COLOMBIA S.AS.	Antioquia	Bello	ZFPE	2013
EMPRESA COLOMBIANA DE CEMENTOS S.A.S. ''ECOCEMENTOS S.A.S''	Antioquia	Sonsón	ZFPE	2016
ONELINK COLOMBIA S.A.S.	Antioquia	Medellín	ZFPE	2016
BARRANQUILLA	Atlántico	Barranquilla	ZFP	1994
LA CAYENA	Atlántico	Barranquilla	ZFP	2007
INTERNACIONAL DEL ATLANTICO	Atlántico	Galapa	ZFP	2007
CELSIA S.A. E.S.P	Atlántico	Barranquilla	ZFPE	2009
CLINICA PORTOAZUL S.A.	Atlántico	Puerto Colombia	ZFPE	2009
SOCIEDAD PORTUARIA REGIONAL DE BARRAQUILLA S.A.	Atlántico	Barranquilla	ZFPE	2010
SYKES COLOMBIA	Atlántico	Barranquilla	ZFPE	2013

S.A.S.				
BARRANQUILLA INTERNACIONAL TERMINAL COMPANY S.A "BITCO S.A"	Atlántico	Barranquilla	ZFPE	2013
CANDELARIA	Bolívar	Cartagena	ZFP	1993
CARTAGENA	Bolívar	Cartagena	ZFP	1994
PARQUE INDUSTRIAL ZONA FRANCA DEXTON S.A.S.	Bolívar	Cartagena	ZFP	2007
PARQUE CENTRAL S.A.S.	Bolívar	Turbaco	ZFP	2010
SANTELCA INTERPRISE S.A.S	Bolívar	Turbaná	ZFP	2013
ARGOS S.A.	Bolívar	Cartagena	ZFPE	2008
GYPLAC S.A.	Bolívar	Cartagena	ZFPE	2008
REFINERÍA DE CARTAGENA S.A. REFICAR	Bolívar	Cartagena	ZFPE	2008
CONTECAR S.A	Bolívar	Cartagena	ZFPE	2009
EXTRACTORA LOMA FRESCA SUR DE BOLIVAR S.A.	Bolívar	San Pablo	ZFPE	2010
SOCIEDAD PORTUARIA REGIONAL DE CARTAGENA	Bolívar	Cartagena	ZFPE	2011
PUERTO BAHIA	Bolívar	Cartagena	ZFPE	2012
CENTRO HOSPITALARIO SERENA DEL MAR S.A.	Bolívar	Cartagena	ZFPE	2014
SOCIEDAD PORTUARIA MARDIQUE S.A.	Bolívar	Cartagena	ZFPE	2014
PUERTO MAMONAL S.A. SOCIEDAD PORTUARIA	Bolívar	Cartagena	ZFPE	2014
SOCIEDAD PORTUARIA EL CAYAO S.A. E.S.P.	Bolívar	Cartagena	ZFPE	2016
ECONTACT COL S.A.S.	Caldas	Manizales	ZFPE	2009
CORPORACION	Cauca	Puerto Tejada	ZFP	2009

EMPRESARIAL DEL NORTE DEL CAUCA - CENCAUCA - ZONA FRANCA DEL CAUCA				
CONJUNTO INDUSTRIAL PARQUE SUR	Cauca	Villa Rica	ZFP	2010
AGROINDUSTRIAS DEL CAUCA S.A.	Cauca	Guachené	ZFPE	2007
COLOMBINA DEL CAUCA S.A	Cauca	Santander de Quilichao	ZFPE	2009
CARVAJAL PULPA Y PAPEL S.A.S	Cauca	Guachené	ZFPE	2009
EXTRACTORA LA GLORIA S.A.S	Cesar	La Gloria	ZFPE	2011
GECELCA 3 S.A.S. ESP	Córdoba	Puerto Libertador	ZFPE	2011
CLÍNICA UNIVERSITARIA MEDICINA INTEGRAL S.A.S.	Córdoba	Montería	ZFPE	2016
BOGOTÁ	Cundinamarca	Bogotá	ZFP	1993
INTEXZONA S.A.	Cundinamarca	Cota	ZFP	2008
OCCIDENTE	Cundinamarca	Mosquera	ZFP	2008
TOCANCIPÁ	Cundinamarca	Tocancipá	ZFP	2009
ZONA FRANCA METROPOLITANA S.A.S	Cundinamarca	Cota	ZFP	2010
EXXENTA ZONA FRANCA GACHANCIPÁ	Cundinamarca	Gachancipá	ZFP	2011
FEMSA	Cundinamarca	Tocancipá	ZFP	2013
ZFB EL DORADO S.A.S. USUARIO OPERADOR DE ZONA FRANCA	Cundinamarca	Sesquilé	ZFP	2017
BIO D S.A.	Cundinamarca	Facatativá	ZFPE	2007
CORFERIAS S.A.	Cundinamarca	Bogotá	ZFPE	2008
PEPSICO ALIMENTOS LTDA.	Cundinamarca	Funza	ZFPE	2008
VIDRIO ANDINO S.A..	Cundinamarca	Soacha	ZFPE	2008
CERAMICA SAN LORENZO INDUSTRIAL DE COLOMBIA	Cundinamarca	Sopó	ZFPE	2009

PROTISA COLOMBIA S.A.	Cundinamarca	Gachancipá	ZFPE	2009
CLINICA LOS NOGALES SAS	Cundinamarca	Bogotá	ZFPE	2009
PRODUCTOS FAMILIA CAJICA S.A.	Cundinamarca	Cajicá	ZFPE	2010
ZONA FRANCA INDUSTRIAL COLMOTORES S.A.S. "ZOFICOL S.A.S."	Cundinamarca	Bogotá	ZFPE	2011
CLÍNICA DE MARLY JORGE CAVELIER GAVIRIA	Cundinamarca	Chía	ZFPE	2016
FUNDACIÓN CTIC - CENTRO DE TRATAMIENTO E INVESTIGACIÓN SOBRE CANCER LUIS CARLOS SARMIENTO ANGULO	Cundinamarca	Bogotá	ZFPE	2017
DIACOR SOACHA ZONA FRANCA SAS.	Cundinamarca	Soacha	ZFPE	2016
BRISA S.A.	La Guajira	Dibulla	ZFP	2010
PUERTO BRISA	La Guajira	Dibulla	ZFPE	2014
SURCOLOMBIANA S.A.S.	Huila	Palermo	ZFP	2010
Santa Marta	Magdalena	Santa Marta	ZFP	1994
TAYRONA S.A.	Magdalena	Santa Marta	ZFP	2008
LAS AMÉRICAS S.A.S. UOZF	Magdalena	Santa Marta	ZFP	2008
PALERMO USUARIO OPERADOR DE ZONA FRANCA S.A.S.	Magdalena	Sitionuevo	ZFP	2013
BIOCOMBUSTIBLES SOSTENIBLES DEL CARIBE S.A.	Magdalena	Santa Marta	ZFPE	2007
SOCIEDAD PORTUARIA DE SANTA MARTA – SPSM	Magdalena	Santa Marta	ZFPE	2008
SOCIEDAD PORTUARIA PUERTO NUEVO S.A.	Magdalena	Ciénaga	ZFPE	2013
BIONERGY ZF S.A.S	Meta	Puerto López	ZFPE	2010

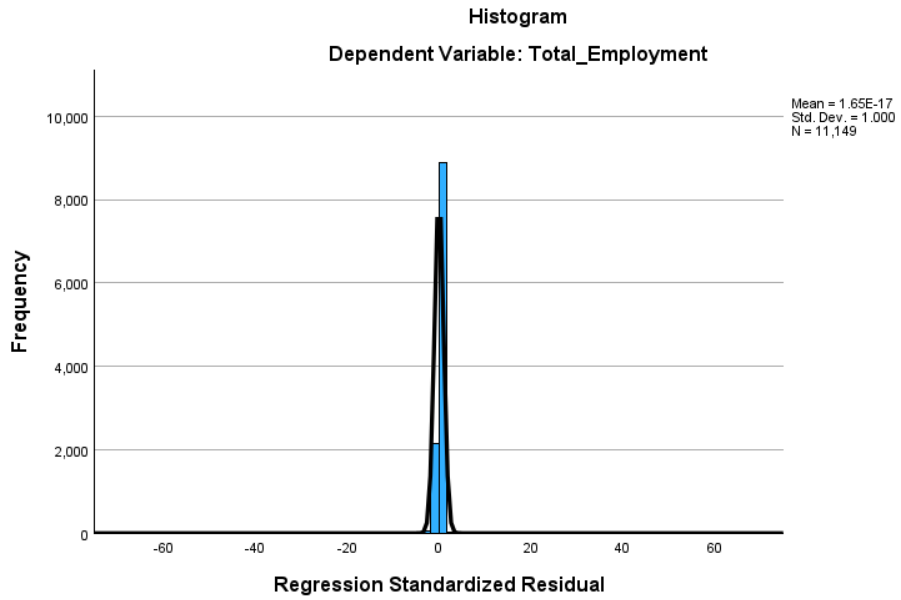
ACEITES CIMARRONES SAS	Meta	Puerto Rico	ZFPE	2012
ALIMENTOS NARIÑO S.A	Nariño	Ipiales	ZFPE	2010
CLINICA HISPANOAMERICA S.AS	Nariño	Pasto	ZFPE	2010
Cúcuta	Norte de Santander	Cúcuta	ZFP	1994
MEDICAL DUARTE ZF S.A.S.	Norte de Santander	Cúcuta	ZFPE	2012
TERMOTASAJERO DOS S.A. E.S.P.	Norte de Santander	San Cayetano	ZFPE	2013
ACEITES Y GRASAS DEL CATATUMBO S.A.S.	Norte de Santander	Tibú	ZFPE	2014
Eje Cafetero	Quindío	Armenia	ZFP	1996
INTERNACIONAL DE PEREIRA	Risaralda	Pereira	ZFP	2010
TELEMARK SPAIN S.L. SUCURSAL COLOMBIA	Risaralda	Pereira	ZFPE	2009
SANTANDER S.A.	Santander	Floridablanca	ZFP	2009
ECODIESEL COLOMBIA S.A..	Santander	Barrancabermeja	ZFPE	2008
FUNDACION FOSUNAB	Santander	Floridablanca	ZFPE	2010
PROCEDADORA DE ACEITE ORO ROJO LTDA	Santander	Sabana de Torres	ZFPE	2010
PUERTO IMPALA BARRANCABERMEJA S.A.S.	Santander	Barrancabermeja	ZFPE	2017
PACIFICO	Valle del Cauca	Palmira	ZFP	1993
PALMASECA	Valle del Cauca	Palmira	ZFP	1994
CELPA S.A.	Valle del Cauca	Buenaventura	ZFP	2011
ZONAMERICA S.A.S.	Valle del Cauca	Cali	ZFP	2014
CERVECERÍA DEL VALLE S.A.	Valle del Cauca	Yumbo	ZFPE	2007
TERMINAL DE CONTENEDORES DE BUENAVENTURA – MARINILLA	Valle del Cauca	Buenaventura	ZFPE	2008
PROTERRA FOODS S.A.S.	Valle del Cauca	Palmira	ZFPE	2011
SOCIEDAD PUERTO	Valle del Cauca	Buenaventura	ZFPE	2012

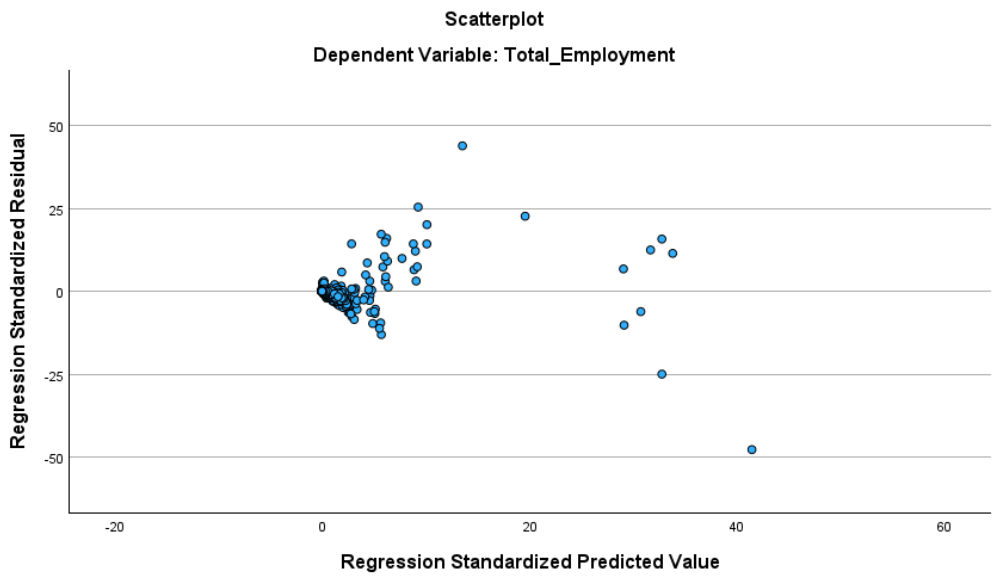
INDUSTRIAL AGUADULCE S.A.				
SOCIEDAD PORTUARIA REGIONAL DE BUENAVENTURA S.A.	Valle del Cauca	Buenaventura	ZFPE	2012
DESTILERIA RIOPAILA S.A.S.	Valle del Cauca	Zarzal	ZFPE	2012

Appendix B: Assumption checks for hypothesis H2

		Total_SEZs	Total_Establishments	Total_Wages (in Colombian pesos)	Total_Grad
Total_SEZs	Pearson Correlation	1	.377**	.330**	.314**
	Sig. (2-tailed)		<.001	<.001	<.001
	N	11149	11149	11149	11149
Total_Establishments	Pearson Correlation	.377**	1	.967**	.902**
	Sig. (2-tailed)	<.001		<.001	<.001
	N	11149	11149	11149	11149
Total_Wages (in Colombian pesos)	Pearson Correlation	.330**	.967**	1	.951**
	Sig. (2-tailed)	<.001	<.001		<.001
	N	11149	11149	11149	11149
Total_Grad	Pearson Correlation	.314**	.902**	.951**	1
	Sig. (2-tailed)	<.001	<.001	<.001	
	N	11149	11149	11149	11149

**. Correlation is significant at the 0.01 level (2-tailed).

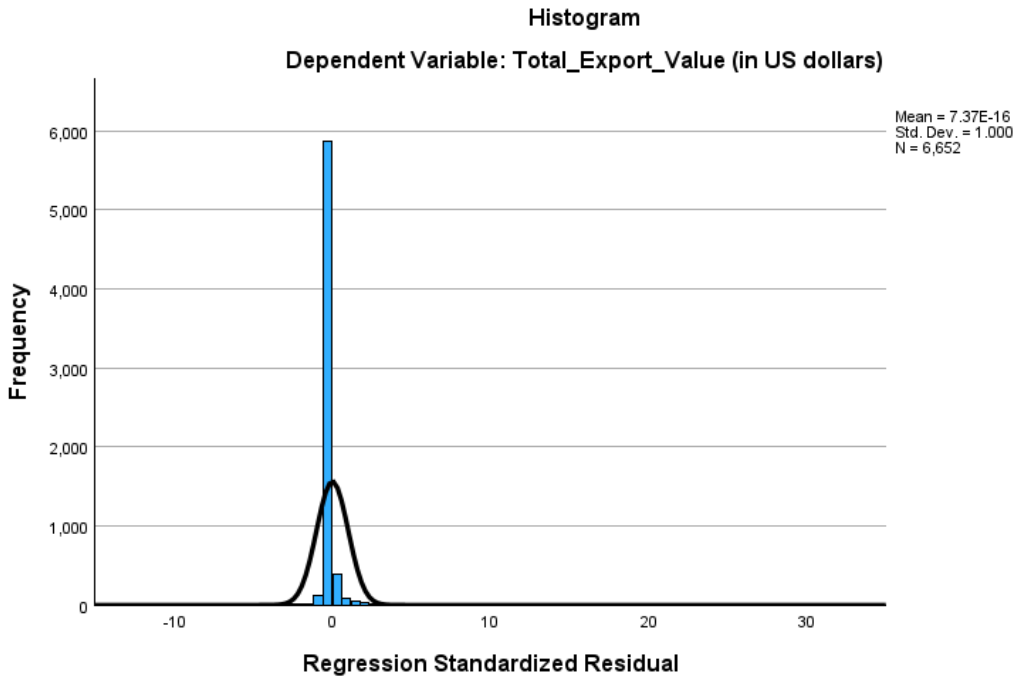


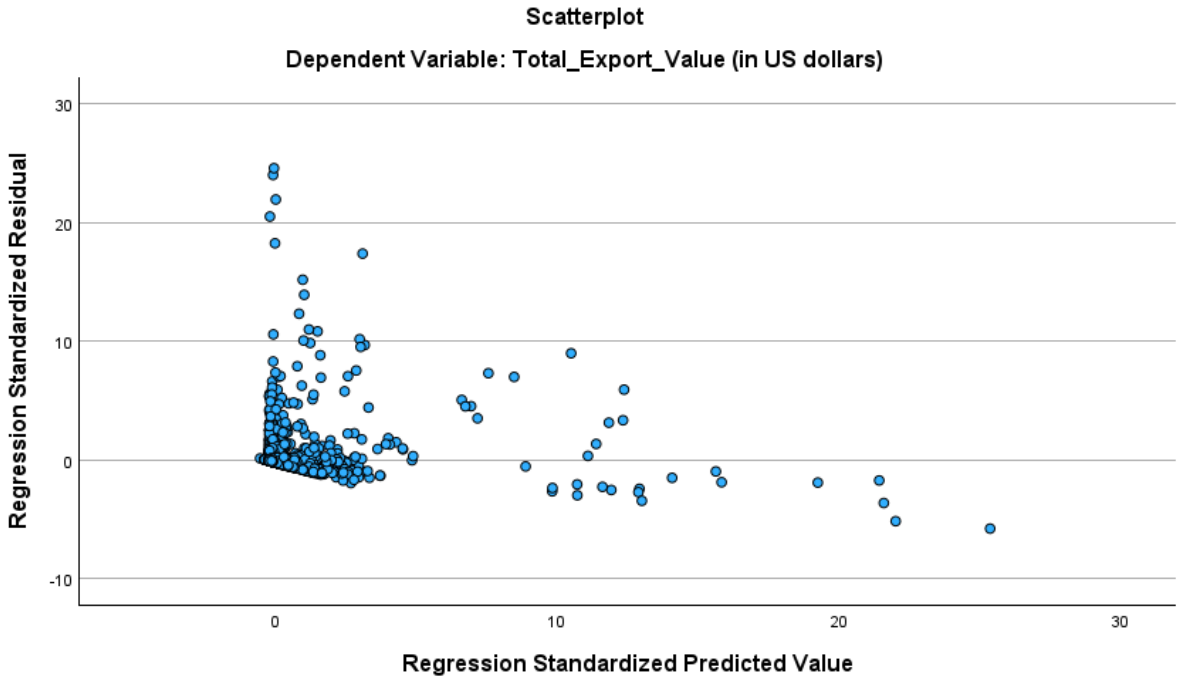


Appendix C: Assumption checks for hypothesis H3

		Presence_SEZ	Total_Establishments	Total_Wages (in Colombian pesos)	Total_Grad	Total_Homicides	Total_Terrorist_Attacks	Total_Thefts
Presence_SEZ	Pearson Correlation	1	.249**	.215**	.193**	.251**	.049**	.242**
	Sig. (2-tailed)		<.001	<.001	<.001	<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652
Total_Establishments	Pearson Correlation	.249**	1	**.967****	**.902****	.760**	.261**	**.922****
	Sig. (2-tailed)	<.001		<.001	<.001	<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652
Total_Wages (in Colombian pesos)	Pearson Correlation	.215**	**.967****	1	**.951****	.722**	.241**	**.939****
	Sig. (2-tailed)	<.001	<.001		<.001	<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652
Total_Grad	Pearson Correlation	.193**	**.902****	**.951****	1	.625**	.208**	**.935****
	Sig. (2-tailed)	<.001	<.001	<.001		<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652
Total_Homicides	Pearson Correlation	.251**	.760**	.722**	.625**	1	.279**	.741**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652
Total_Terrorist_Attacks	Pearson Correlation	.049**	.261**	.241**	.208**	.279**	1	.241**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001		<.001
	N	6652	6652	6652	6652	6652	6652	6652
Total_Thefts	Pearson Correlation	.242**	**.922****	**.939****	**.935****	.741**	.241**	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	
	N	6652	6652	6652	6652	6652	6652	6652

**. Correlation is significant at the 0.01 level (2-tailed).

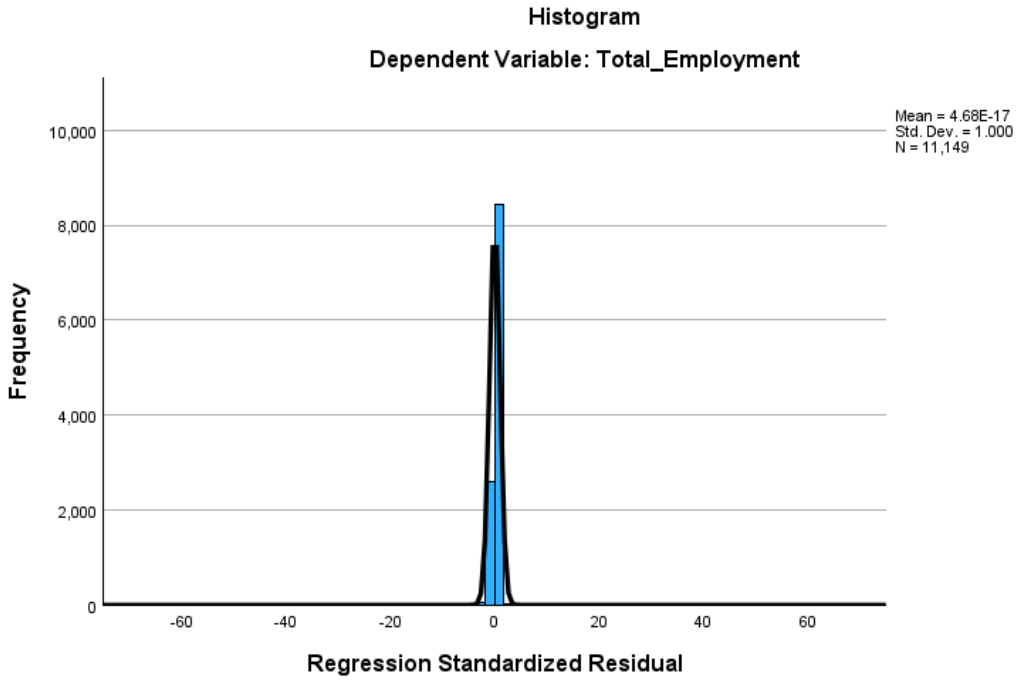

Histogram
Dependent Variable: Total_Export_Value (in US dollars)
Mean = 7.37E-16
Std. Dev. = 1.000
N = 6,652
Frequency
6,000
5,000
4,000
3,000
2,000
1,000
0
-10
0
10
20
30
Regression Standardized Residual

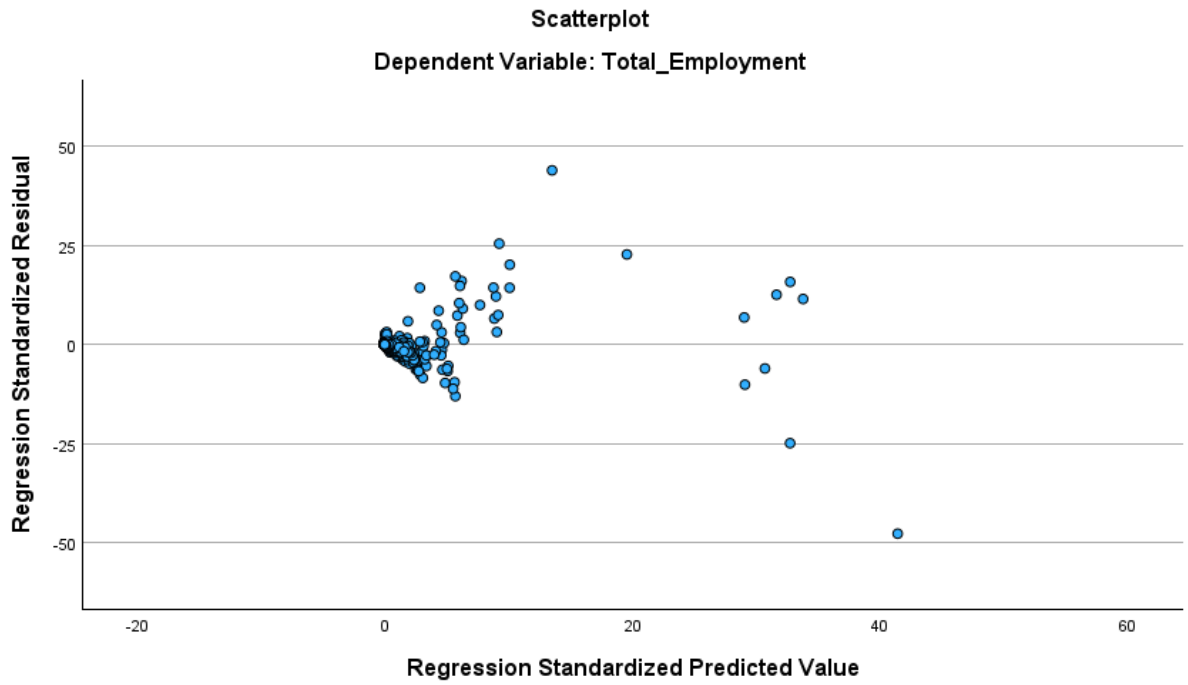

Scatterplot
Dependent Variable: Total_Export_Value (in US dollars)
Regression Standardized Residual
30
20
10
0
-10
0
10
20
30
Regression Standardized Predicted Value

Appendix D: Assumption checks for hypotheses H4a and H4b

		Presence_SEZ	Total_Establishments	Total_Wages (in Colombian pesos)	Total_Grad	WSEZ
Presence_SEZ	Pearson Correlation	1	.245**	.211**	.190**	.237**
	Sig. (2-tailed)		<.001	<.001	<.001	<.001
	N	11149	11149	11149	11149	11149
Total_Establishments	Pearson Correlation	.245**	1	**.967****	**.902****	.075**
	Sig. (2-tailed)	<.001		<.001	<.001	<.001
	N	11149	11149	11149	11149	11149
Total_Wages (in Colombian pesos)	Pearson Correlation	.211**	**.967****	1	**.951****	.062**
	Sig. (2-tailed)	<.001	<.001		<.001	<.001
	N	11149	11149	11149	11149	11149
Total_Grad	Pearson Correlation	.190**	**.902****	**.951****	1	.048**
	Sig. (2-tailed)	<.001	<.001	<.001		<.001
	N	11149	11149	11149	11149	11149
WSEZ	Pearson Correlation	.237**	.075**	.062**	.048**	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	
	N	11149	11149	11149	11149	11149

**. Correlation is significant at the 0.01 level (2-tailed).

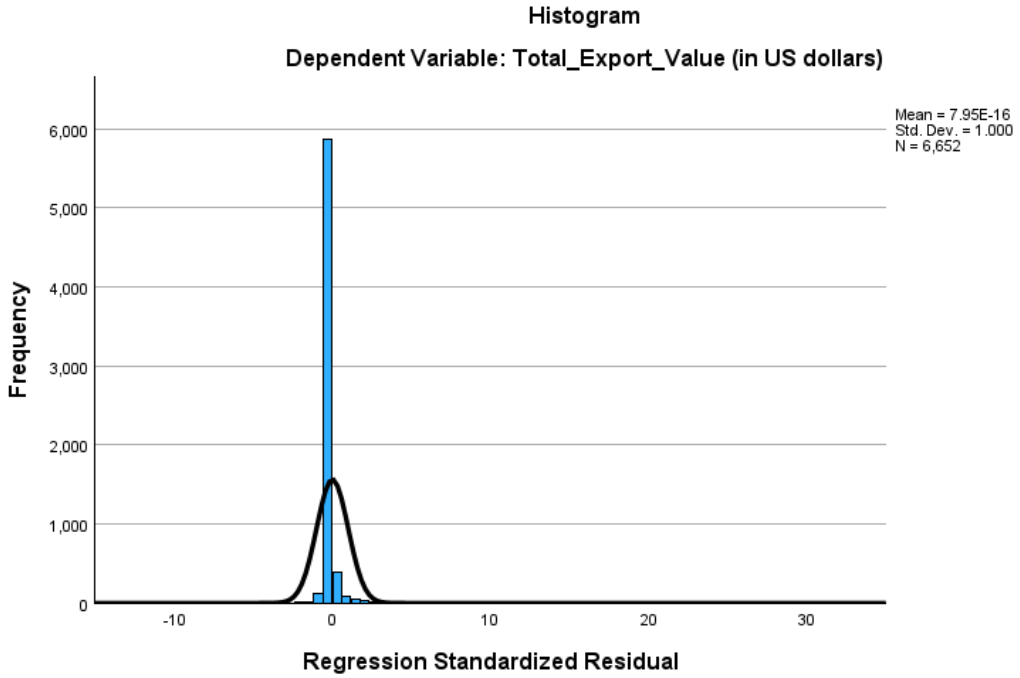


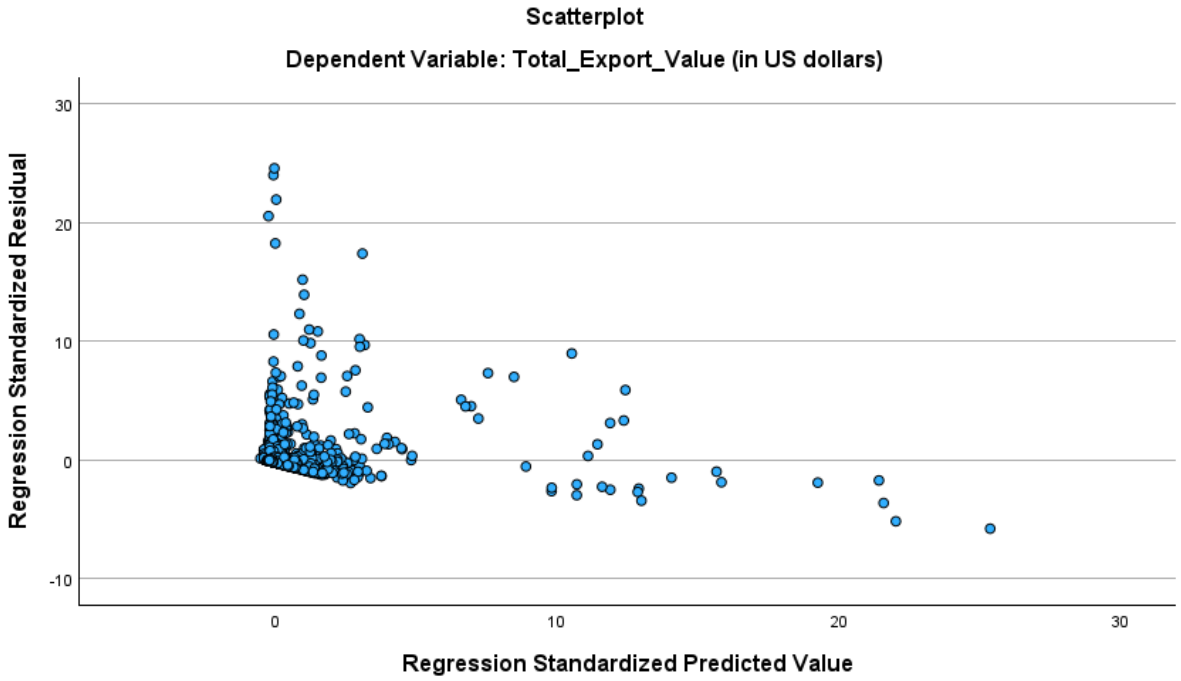


		Presence_SEZ	Total_Establishments	Total_Wages (in Colombian pesos)	Total_Grad	Total_Homicides	Total_Terrorist_Attacks	Total_Thefts	WSEZ
Presence_SEZ	Pearson Correlation	1	.249**	.215**	.193**	.251**	.049**	.242**	.237**
	Sig. (2-tailed)		<.001	<.001	<.001	<.001	<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
Total_Establishments	Pearson Correlation	.249**	1	.967**	.902**	.760**	.261**	.922**	.069**
	Sig. (2-tailed)	<.001		<.001	<.001	<.001	<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
Total_Wages (in Colombian pesos)	Pearson Correlation	.215**	.967**	1	.951**	.722**	.241**	.939**	.059**
	Sig. (2-tailed)	<.001	<.001		<.001	<.001	<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
Total_Grad	Pearson Correlation	.193**	.902**	.951**	1	.625**	.208**	.935**	.043**
	Sig. (2-tailed)	<.001	<.001	<.001		<.001	<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
Total_Homicides	Pearson Correlation	.251**	.760**	.722**	.625**	1	.279**	.741**	.137**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001		<.001	<.001	<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
Total_Terrorist_Attacks	Pearson Correlation	.049**	.261**	.241**	.208**	.279**	1	.241**	-.025*
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001		<.001	.039
	N	6652	6652	6652	6652	6652	6652	6652	6652
Total_Thefts	Pearson Correlation	.242**	.922**	.939**	.935**	.741**	.241**	1	.079**
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001		<.001
	N	6652	6652	6652	6652	6652	6652	6652	6652
WSEZ	Pearson Correlation	.237**	.069**	.059**	.043**	.137**	-.025*	.079**	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	.039	<.001	
	N	6652	6652	6652	6652	6652	6652	6652	6652

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).


Histogram
Dependent Variable: Total_Export_Value (in US dollars)
Mean = 7.95E-16
Std. Dev. = 1.000
N = 6,652
Frequency
6,000
5,000
4,000
3,000
2,000
1,000
0
-10
0
10
20
30
Regression Standardized Residual


Scatterplot
Dependent Variable: Total_Export_Value (in US dollars)
Regression Standardized Residual
30
20
10
0
-10
0
10
20
30
Regression Standardized Predicted Value