WAGE EQUATIONS AND THE REGIONAL ECONOMICS IN GUATEMALA

BY

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DISSERTATION

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ABSTRACT

Guatemala is one of only three countries in America which urban population is smaller than the rural one. United Nations estimates that in the coming years the economic structure of the country will change to an urban country. This situation triggers the need of an enhanced understanding of the role of market size, income distribution, regional disparities, and regional economic growth with respect to the ways in which they condition the economic growth of a nation. Given such framework, the study pretends to explore some economic conditions of the regions of Guatemala that may influence decision making of workers and firms when moving between regions. The theoretical topics in the research involve the utilization of wage equations and the endogenous growth theory. In the first case, the purpose is to evaluate two issues: the spatial distribution of the wages in Guatemala through the potential market of new economic geography (NEG), and the influence of the local labor conditions on the determination of the wage rates in the regions through the wage curve. Regarding the endogenous growth theory, it is presented an analysis of the influence of public capital on productivity and production of non-agricultural firms located in different municipalities of the country. The research includes an analysis of the influence of neighboring effects of their economic conditions as regards labor market and public investment, a situation that very few papers have explored (Palombi and Fingleton, 2013). In order to accomplishing such tasks, the research is divided in two parts. The first part, which is concentrated on the analysis of wage equations, uses spatial pooled cross sectional data for 2006 and 2011 including information at individual and regional level for the estimation of both wage equations. Thus, about the NEG wage equation, there are two outputs to underline. One is that the model demonstrates not only that the metropolitan area has the higher market access, but as time passes such market is enlarged further; and second, the estimates of market access are statistically significant and too small, meaning that market access is not enough to explain the spatial distribution of wages, and hence the economic regional imbalances of the country. As regard the wage curve, the results reveal that both local and neighboring labor market conditions (unemployment and underemployment) exert important and negative influence on the wage determination in each region in Guatemala. Thus, differences in wages across the regions can be explained by labor condition of their locales. With respect to the second part of the research, the endogenous growth theory, the purpose is to

analyze the relationship between public investment and economic performance of municipalities in Guatemala. In order to accomplish such a task, the paper uses a panel data in two econometric models based on the endogenous growth model. The first model uses a Cobb-Douglas production function which is a widely accepted by the academia and researchers to calculate productivity. The second model uses the multilevel analysis to estimate the effects of public investment on production. Since the estimations follow the endogenous growth model, the methodology includes the variables of human capital, research and development and weighted neighbor public investment to test the positive spillover effects. The results show that there is some evidence that public investment have positive influence on the economic performance in the municipalities under study. These results assert that productivity and production are positively influenced by the public investment. Also, it shows that a locale is positively influenced by neighbor public investment when it belongs to the metropolitan area, and negatively influenced when it belongs to the non-metropolitan area. Finally, the research shows that the economic inequality between economic agents and places are responsible of the migratory process within the country, which is pursued by people with the motivation of reducing their economic gap related to the difference between their own economic and social position and that of people in other wealthier places. However, it is happening that as a consequence, economic conditions are getting worse in all regions of the country, including in the metropolitan area, while authorities are not weighting such issue.

To Maria Mercedes (Meches) and Angela-

your support, sacrifice and love are an essential part of this success.

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I would like to express my special appreciation and thanks to my advisor Professor Geoffrey Hewings for the continuous support of my Ph.D study, for his patience and guidance, for the motivation and enthusiasm that he transmitted continuously while encouraging me to go beyond the frontier of the knowledge. His words, which I still have in mind, were wise not only for the development of this dissertation, but for life.

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Chapter 1: Introduction

Developing countries are characterized by high, and increasing, rates of urbanization that are result of domestic rural-to-urban migration. The urbanization process presents enormous planning challenges because it has been accompanied by changes in the social and economic structure of these countries. In a general sense, the high rate of urbanization has triggered the need to undertake regional studies. There is a particular need for an enhanced understanding of the role of market size, income distribution, regional disparities, and regional economic growth with respect to the ways in which they condition the economic growth of a nation. In most countries, regions are differentiated from each other in terms of their natural, social and economic resources that, combined with migration, provide a source of increasing regional disparities (Armstrong and Taylor, 2000). The focus of this dissertation is rooted in attempts to assess how regional disparities come into being and persist in Guatemala as it is one of only three countries in America which urban population is smaller than the one from rural area, and it is projected that in the coming years the population in the urban area of Guatemala will reach the 50% of the total population (United Nations, 2012). This can be achieved by understanding the different economic conditions that economic agents, particularly workers and firms, face in various regions of the country.

The study pretends to explore some economic conditions of the regions of Guatemala that may influence decision making of workers and firms when moving between regions. It is presumed that people involved in internal migration search for places where the economic development is highest, meaning that people will move to locales where the opportunity for doing business and obtaining better jobs is greater. In fact, the survey of living standard conditions of Guatemala (ENCOVI, 2006) reveals that the metropolitan area is absorbing large flows of internal migration at a high rate; however, as shown later, people in the metropolitan area are suffering from a process of impoverishing. Consequently, in this research it is assumed that internal migration is involved in a circular cumulative causation of impoverishment in which the regional economic inequality pushes economic agents out of less advantaged regions to search for better living standards within the country. The destination target is usually the metropolitan area, and based on the information of ENCOVI 2006 and 2011, one can deduce

that such an area is not able to absorb the increasing labor force fed by the flows of internal migration because the level of production are relative low to the levels of labor supply, leading into underemployment and low wages. As a result, the crowded metropolitan area begins to suffer from deteriorating economic conditions attached to a systematic impoverishment that further deepens the economic inequality in the country. The former argument is true, but it is not the complete picture by any means. It is important to recognize that the information is very limited to two years of analysis, and the phenomena described above may represent only short term process of adjustment. Brechling (1973) argues that the interregional migration of labor force may have an important role in stabilizing the aggregated economy as regions that experience higher economic growth tend to pull labor, creating a very tight local labor markets. However, this is testable only for long term equilibrium.

A question to address here is which incentives or factors do economic agents pursue when contemplating moving between regions or markets? Clearly the question aims to study the decision of location and investment of household and firms. As a household, one would search for better labor market conditions including better wages, and hence better living standards. As a firm, one would search for better conditions that favor the production and selling of their goods and services. This encompasses market size, infrastructure for adequate economy of scales, and network externalities. Accordingly, this research has as objective the analysis of labor market and public investment in infrastructure as they represent important economic conditions of the country that contribute to an understanding of the dynamics and trajectories of regional economies.

First, labor market conditions play an important role in conducting the process of location decision of economic agents; for instance, wage rates may incentive neighboring population to move into the local market, or they would discourage local workers, inducing them to find new jobs in other labor markets that may enhance their economic living standards. Thus, it is important to consider regional interdependence because a single regional labor market does not react independently, often regional labor markets depend on the economic behavior of other markets. The new economic geography of Krugman (1991) provides an example of how the economic conditions of neighbors can influence the decision to move between regions when comparing trade costs, prices and incomes from different regions, and how they can shape business opportunities and wages. Hence, when analyzing labor markets,

attention should not be focused only the local level. Influences on local market conditions can originate in other regions, with the implication that economic agents may base their decisions (for example, to move or to stay) on both local conditions and conditions in neighboring regions.

Inevitably internal migration creates impact at origin and destination locales. ENCOVI (2006) reveals that the second most important reason for moving from one region to another within Guatemala is due to labor opportunities; therefore, people leaving their locales would induce structural changes in the labor market where they belong originally as well as in the new one where they will be settling. These structural changes are reflected in changes of unemployment, underemployment and wages. For instance, the metropolitan area is the most developed one, and it is receiving the 42% of the immigrants (ENCOVI, 2006) which creates economic and social pressure to the status quo of the region by overcrowding it and increasing the labor supply, which may end with decreases of wages, or unemployment. The neoclassical explanation to such situation is represented by Harris and Todaro (1970), who argues that internal migration tend to decrease as much as wages tend to equilibrate across the regions. As described in chapter 2 of this research, wages in Guatemala are indeed adjusting, and they are doing it with substantial decreases in real terms. This is because the markets in the regions are not capable of matching production and consumption, and hence decent jobs and labor supply.

Thus, internal migration triggers a chain of economic effects that initially can be manifested in the labor market, and then extended, via classical general equilibrium mechanisms, to the entire economy. In order to capture such a decision-making process, the research focus of this analysis concerns the role of wages as an incentive factor to the migration process. In that sense, in this research is proposed to use wage equations to provide two sources of analysis. The first, represented by the new economic geography (NEG), seeks to evaluate and discuss the conditions that drive people to migrate between regions. This aims to evaluate if a geographic pattern of economic development influences the spatial distribution of wages that justifies the internal migration. The second mechanism, the Blanchflower and Oswald wage curve, focuses on providing an evaluation and description of given local labor market conditions. This aims to analyze a possible monopolistic power pattern in the process of wage determination due to changes in the labor supply of the regions. As mentioned before, it is important to recognize the interregional linkages of the economic conditions, so both

mechanisms offer the opportunity of analyzing the influence of the labor conditions of neighboring regions on local economic agents.

Second, public infrastructure is part of the economic conditions that characterize the regions of Guatemala. It covers market failures that the private sector is unwilling or unable to correct, for instance, sewers, roads, water, etc. Thus, public investment in infrastructure generates positive externalities to the private sector, enhancing the productivity of the firms as well as the well-being of households. Aschauer (1989) shows evidence that public capital is highly correlated to the economic growth of the locales, meaning that public infrastructure is a key factor in the regional disparities. Locales benefited with more public capital stock present better conditions to firms for producing their goods and services. This is because public capital provides positive external economies that complement the production costs through the provision of proper roads, water, sewers, which firms may use for their commercial benefits. In addition, there is a discussion in literature about the correlation between public capital and economic growth. Some authors (Boarnet, 1998; Holtz, 1994) underline that such correlation exists because prosperous places tend to demand more public capital because they are in the disposition of afford it, while poorer places don't have such economic capacity. In spite of this efforts, empirical evidence (for a list of papers see Romp and de Haan, 2007) shows that public capital enhances productivity of the firms, and hence the economic growth of the places.

In Guatemala, public capital is assigned through governmental transfers, in which central government provides a budgetary assignment to the municipalities of the country, while population is not charged for any additional tax. Therefore, it is expected that public capital improves in part their economic development. Given such context, this research seeks to analyze the relationship between public investment and economic performance of firms in the different municipalities of Guatemala, in which economic performance is measured through productivity and production at the firm level. This budgetary assignment has been criticized by the civil society of Guatemala because the decision of where to invest has been based on political conventions, and hence the impact on the economic performance is likely to be inefficient leading to aggravate economic disparities in terms of public infrastructure. Some of the implications are that people is pushed from the regions where the public capital stock is scarce, and tend to search for new places that provide better opportunities for establishing a business, creating in this way another form of regional disparity.

Moreover, adopting the two above objectives in the Guatemalan case provides a different perspective than traditional research done there that extends beyond the national and dualist delimitations found in previous research (Alejos, 2003; Adams, 2005; Vasquez, 2011). The application of wage equations for Guatemala is relevant because they reveal how differential wages represent opportunities to move towards economic prosperity on the countrywide, regional and individual levels. Consequently, the results of this type of research may contribute to the set of information policy makers might wish to review when elaborating policy instruments addressing issues such as regional disparities. In addition, this type of research helps bridge the gap in the literature regarding applications of empirical research between developed and developing countries.

In 2001 the congress of the Republic of Guatemala approved the law of social development (Article 42-2001) that contemplates the creation of the social development policy for Guatemala. It aims to strength the access to health, education, employment & migration, disaster risk, and social communication, which are considered as key to the development of the country. In spite if this effort, the issue of internal migration is not considered as a part of a public agenda. "[In Guatemala], the situation of internal migration is still a pending issue on the public agenda, this must be strengthened, as currently there is limited information about its characteristics and development [process]" (SEGEPLAN, 2012). Therefore, this research is relevant for planners because it allows for the mapping of a social or economic system that linking structures and agents. It provides an overview of the conditions and performance of the society as a whole, in which regional disparities are in increasing rate. (World Bank, 2009) Since no public policy has been elaborated and executed to deal with the internal migration, the study would aid in the consideration of the options for influencing a public policy agenda. The results presented below in this paper will provide of planners with the ability to understand that changes in the economic conditions across regions may result in movements of agents and how these movements may contribute both positively and negatively to national development goals. Davidoff and Reiner (1962) believe that understanding the status quo of society should be of central interest for planners who desire to propose meaningful policy recommendations. This includes comprehension of efficiency, rational action, market orientation, and the allocation of resources. Therefore, the research provides a pragmatic view of such elements that

are represented by the economic situation of Guatemala, including labor markets and their economic drivers.

The structure of this dissertation proposal is as follows. In addition to the current chapter, this paper contains four additional chapters, and the conclusion. Guatemala is used as case study because there is little research regarding Guatemala's regional economies. Thus, Chapter 2 presents a description of the economic background of the country. It provides a synopsis of national and regional economic context, in which is exposed that in spite of enjoying a healthy macroeconomic stability in the country, the economic growth is not enough to provide decent living standards conditions of the people.

Chapter 3 presents the theoretical framework of wage equations. It describes four models that have featured prominently in the study of labor migration and wages. The discussion begins with a description of the Harris and Todaro model, whose objective is to explain rural-urban migration. One mainstay of this model involves the positive relationship between income expectations and unemployment levels. Harris and Todaro (1970) construct a labor supply model where wages and unemployment rate have a positive relationship. They assume that skilled workers are scarce, and hence have power when negotiating their wages. If labor market conditions deteriorate, workers tend to migrate to urban areas. For this reason, firms tend to keep workers by increasing their wages.

The second model discussed is the New Economic Geography wage equation. This wage equation is derived from the "core-periphery model" proposed by Krugman (1989). This model will be used for the purpose of study the spatial distribution of wages in Guatemala through the market access, where market access represents, in Harris' spirit (1954), the summation of markets accessible to a point. The fundamental assumption is that all external markets have a substantial effect on local wages. The evidence has revealed that wages will be higher at the economic center and lower at the periphery.

The third model refers to the notion of a *wage curve*. This is referred as an empirical law of economics where the objective is to study the relationship between wages and unemployment levels. Contrary to the argument made by the Harris and Todaro model, this theory explains that unemployment has a negative effect on wages, i.e., the higher the unemployment in a local market, the lower the wages become. Firms use such labor conditions

to create a threat against workers in order to reduce their salaries. Also, this section briefly discusses the significance of the wage curve in a developing country, where unemployment is not a relevant indicator as underemployment to describe the labor conditions that shape the wage curve.

Finally, the fourth model is the Mortensen and Pissarides model. It explains that in any labor market, firms and workers will face search frictions. Firms and workers will incur costs in attempting to match a job position with the labor resources that are available. The cost can be represented in monetary terms or time; when referring to time, the amount of time in an unemployment status is affected by the reservation wage and labor market tightness. It is not their objective to analyze the relationship between the unemployment rate and wages; however, it is expected that lower wages will be observed when the unemployment rate is high as will be discussed later.

Chapter 4 includes the research questions, methodology, and estimates the wage equations in Guatemala. In this chapter I only include the NEG wage equation and the wage curve, while the Mortensen and Pissarides model is left for future research due to limitations on the available data. About the NEG wage equation, there are two outputs to underline. One is that the model demonstrates not only that the metropolitan area has the higher market access, but as time passes such market is enlarged further; and second, the estimates of market access are statistically significant and too small, meaning that market access is not enough to explain the spatial distribution of wages, and hence the economic regional imbalances of the country. As regard the wage curve, the results reveal that both local and neighboring labor market conditions (unemployment and underemployment) exert important and negative influence on the wage determination in each region in Guatemala. Thus, differences in wages across the regions can be explained by labor condition of their locales.

In addition, chapter 5 presents a study of the economic performance of the regions in Guatemala. The objective of this chapter is to provide an empirical evaluation of the regional economic conditions of the country. The intention of it is to provide a benchmark study in which the results of the wage equations can be associated with the economic performance of the country as a whole. The chapter includes an analysis of the relationship between public investment and economic performance of firms in 72 municipalities in Guatemala. It also

includes the influence of the spatial spillovers produced by public investments in neighboring municipalities. The results show that there is evidence that public investment exerts a positive influence on economic performance in the municipalities by stimulating productivity and production of the firms in the regions. It also shows that a locale is positively influenced by neighboring municipalities' public capital when it is invested in a metropolitan area, and is negatively influenced when it is invested in a non-metropolitan area.

Finally, chapter 6 contains the final discussion and conclusion of the research.

Chapter 2: Economic background of Guatemala

The current chapter describes the economic background of Guatemala. In order to better understand the present economic situation of the country, it is appropriate to provide a brief synopsis of the issues that have led the current Guatemalan context.

The most influential event on the social and economic development of the country was the civil war that occurred from 1960-1996. Although the current project does not intend to discuss this event at length, the war has had a profound impact on the process of economic and social development of Guatemala. The war divided the economic history of the country in three stages: the period before the civil war (1960), the period during the civil war (1960-1996), and the period after the civil war.

Pre-war, Guatemala was known as an agricultural country—one in which Spaniard descendants and US companies created a system of forced labor (Galeano, 1978). This situation produced, in part, the first civil revolution that included a series of social movements that led to the creation of the agrarian and labor reforms of the country in 1952. During this period, many US companies were expelled from the country, causing international complaints that motivated, through international pressure, the annulment of the agrarian reforms (Palma, 2008). This action became one of the factors that led to the outbreak of the civil war in 1960.

During the period of war, due to a lack of certainty and absent the security necessary for private investment in the rural areas, Guatemala was essentially divided into two great regions according to the economic interests of that time: the metropolitan area and the rest of the country; in was in the latter area where the war took place. This division resulted in an economic and social polarization of the country's resources that produced entrenched poverty in non-urban regions that can be traced to three primary causes. First, the non-metropolitan areas, with very few exceptions such as Quetzaltenango (the second important city), were dedicated exclusively to the production of agriculture products, and basically this was the unique interregional linkage with the metropolitan area as there was no internal free mobility of workers due to the political pressure of the moment. Secondly, the investment of public capital in infrastructure greatly benefited metropolitan area. It left most of the remaining municipalities without adequate infrastructure for encouraging the allocation of private investment in their locales. This includes the lack of roads for internal trade, that furthermore continues to restrict

some remote rural communities from access to the rest of the country (IFAD, 2012). Finally, human capital deteriorated steeply in regions where the war took place: the non-metropolitan areas. Chamarbagwala and Morán (2011) argue that the Guatemalan civil war had a long-term and strongly negative impact on the education of children in the rural areas. As a result, the current accumulated human capital of the country lacks adequate preparation for the adoption of either the high or medium technology that could drive efficiency and efficacy in the methods of production employed, especially in the non-metropolitan area.

The aftermath of the civil war created a new economic and social structure in which spatial differences in terms of development and economic growth become more apparent (as will be shown later); however, the regions of the country are more interconnected than they were during the war with greater market access and far fewer restrictions. The following sections describe the post-war economic situation since the beginning of the 2000's as a period after which social and economic statistics began to be more readily available (INE, 2006).

2.1 The present economic context of Guatemala

In the Central American context, when comparing the GDP in constant prices of 2005, Guatemala is the country with the largest economy in 2011 (SECMCA, 2014)[1]. It is 1.3 times larger than Costa Rica—the next largest economy (see figure 1). Guatemala's population is about 15 million people, also the largest among Central American countries (ECLAC, 2012). Accordingly, its GDP per capita ranks third after Costa Rica and El Salvador (ECLAC, 2014). In terms of income inequality, Guatemala is also the most unequal country in Central America, reflecting in part a lack of social inclusion in the population. UNDP (2013) ranks Guatemala in the position 119 in the world in terms of income inequality. When combined with the human development index, the country drops to rank 133 in terms of human capital, based on factors such a comparative measure of life expectancy, literacy, education and standards of living for countries worldwide (UNDP, 2013).

[1] Executive Secretariat of Central American Monetary Council.

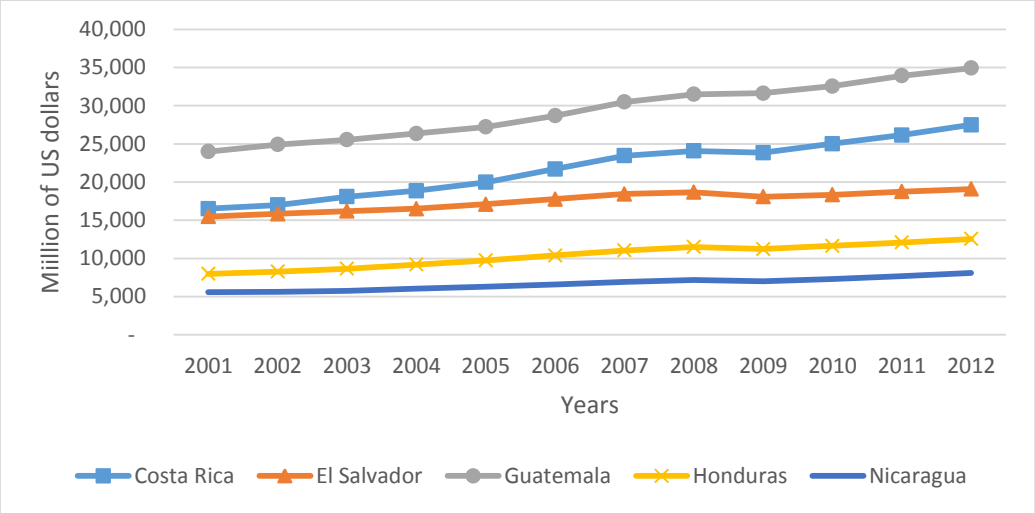

Figure 1. Central America: Total Annual Gross Domestic Product (GDP) Constant prices in millions of US Dollars
Source: ECLAC

In the national context, over the last thirty years the real gross domestic product of Guatemala increased at an average annual rate of 3.1%. Also, since 1996 Guatemala has enjoyed of macroeconomic stability that is characterized by a stable GDP growth, low inflation, stable exchange rate, and a small fiscal deficit. (See table 1) After 2001, BANGUAT (2014) data indicates that this behavior is driven mostly by the economic growth of the services industry that includes commerce, banking, and transportation. The same data indicate stagnation in the agriculture and manufacturing industries over the last decade. The final consumption in the country grew at an annual average rate of 3.7% in the period of 2001 to 2012, representing also the 96% of the total real GDP in the same period. Gross fixed capital in Guatemala, which represents 15% of the GDP, grew on average 1.8% annually over the same period. Imports and exports each grew at an average annual rate of 2.5% during the 2001-2012 period; in this regard, international trade of Guatemala is characterized by having negative net exports, which represent 11.8% of the total real GDP. The country relies heavily on the export of agricultural goods—such as coffee, sugar, bananas, and cardamom—and also on the export of manufacturing goods—like textile fibers, textiles, and clothing (maquila). The most commonly imported goods are fabricated metal products and machinery, oil derivatives, and chemical products. Overall, the economic growth of Guatemala strongly depends on international markets (BANGUAT, 2012). Two key factors influenced the economy during this period: the

expansion of the international market of Guatemala in 2006 as a result of entering fully into the CAFTA-DR (Dominican Republic-Central America free trade agreement); and the collapse of the US and European financial markets in 2007-2008 that by 2009 had extended to rest of the world. (BANGUAT, 2008 and 2009)

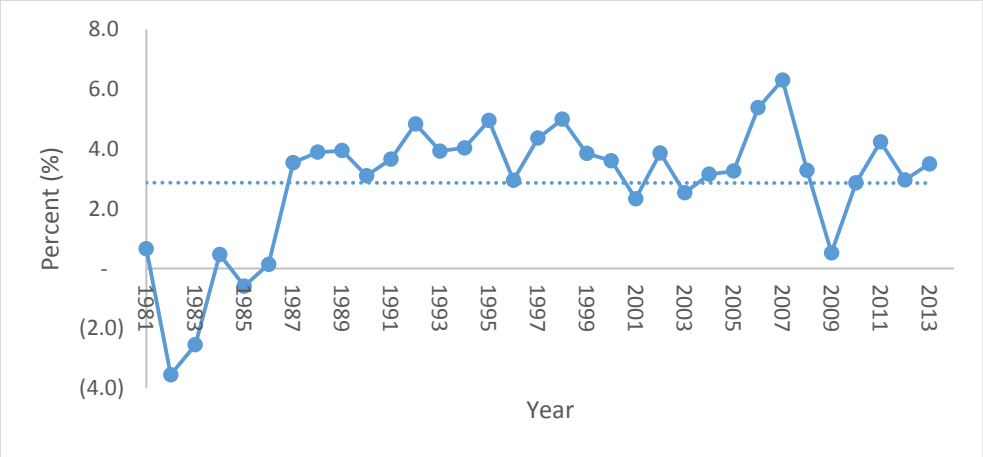

Figure 2. Annual Growth of Real GDP of Guatemala
Years: 1981-2013
Source: Banco de Guatemala

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Table 1. Some macroeconomic indicators 1996-2013

Year	Real GDP growth (%)	Inflation rate (%)	Active* interest rate (%)	Passive* interest rate (%)	Fiscal Deficit as GDP (%)	Exchange rate Variation (%)
1996	2.8	10.85	22.4	11.0	-0.1	4.83
1997	4.1	7.13	16.4	6.4	-0.6	-0.45
1998	4.6	7.48	17.9	7.2	-2.0	5.45
1999	3.7	4.92	20.6	11.3	-2.7	15.50
2000	2.5	5.08	20.1	11.0	-1.9	5.12
2001	2.4	8.91	17.9	8.5	-2.1	1.23
2002	3.9	6.33	16.2	6.9	-1.1	-0.47
2003	2.5	5.85	14.1	4.5	-2.6	1.52
2004	3.2	9.23	13.5	4.5	-1.1	0.09
2005	3.3	8.57	12.7	4.6	-1.7	-3.95
2006	5.4	5.79	12.9	4.8	-1.9	-0.41
2007	6.3	8.75	12.9	4.9	-1.4	0.94
2008	3.3	9.4	13.8	5.5	-1.6	-1.50
2009	0.5	-0.28	13.6	5.6	-3.1	8.01
2010	2.9	5.39	13.3	5.3	-3.3	-1.33
2011	4.2	6.2	13.5	5.2	-2.8	-3.38
2012	3.0	3.45	13.5	5.4	-2.4	0.62
2013	3.5	4.39	13.7	5.5	-2.1	0.32

Source: Banco de Guatemala (BANGUAT)

* According to IMF and Banco de Guatemala, the active interest rate refers to the lending rate that banks charge to the short and medium financing needs of the private sector. The passive interest is the deposit interest rate paid by commercial or similar banks for saving deposits.

In the regional (sub-national) context, Guatemala is divided into eight regions, 22 departments, and 336 municipalities. The densest place is the department of Guatemala, where the capital city of the country is located. Figures 3 and 4 show how the densities of the population were distributed across the municipalities of the country, in 2001 and 2010. There is no significant difference between them, with the exception of two areas: the north side of region VI, where the second most important city of the country (Quetzaltenango) is located; and the second area corresponding to the surrounding municipalities of the metropolitan area (region I). Both regions report more significant concentrations of people in 2010 as compared with 2001 (INE, 2012). Focusing on production in the regions, the agriculture industry predominates in all regions, with the exception only of the metropolitan area (region I), while the manufacturing industry is primarily concentrated in regions I and V (BANGUAT, 2011).

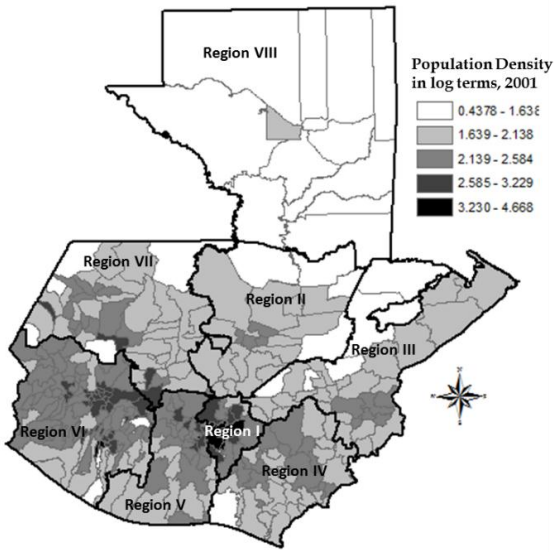

Figure 3. Population Density 2001
In log terms
Source: INE 2012

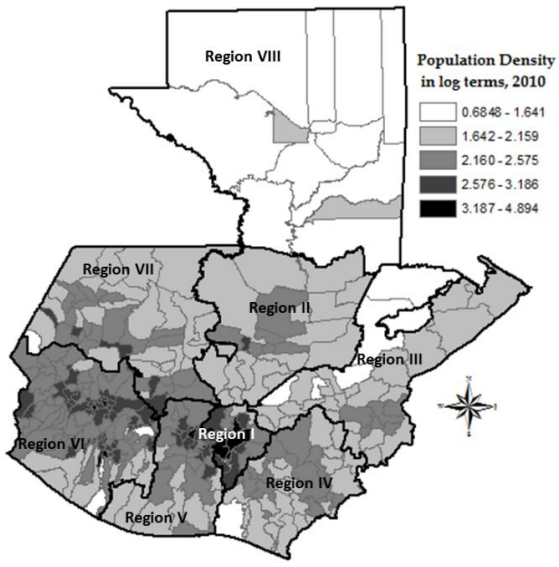

Figure 4. Population Density 2010
In log terms
Source: INE 2012

2.2 Description of labor market in Guatemala

INE of Guatemala reported that out of a population of 15.4 million people, 9.7 million were of working age (i.e., 15 years old and above), of which only 5.9 million people were members of the economically active population (EAP)— that is, those actively working or looking for a job. Over the last four years, the average unemployment rate (open unemployment over EAP) was 3.4% (see Figure 5). However, this rate obscures a reality of the labor market in Guatemala: as in many other developing countries, the labor market is segmented into two sectors, the formal and the informal. According to INE (2013), informal employment accounts for more than 69% of the total employment in Guatemala, and is defined as the segment of the population characterized by those working under impoverished labor conditions, including the absence of legal contracts, low wages, a lack of social security coverage, and low productivity.

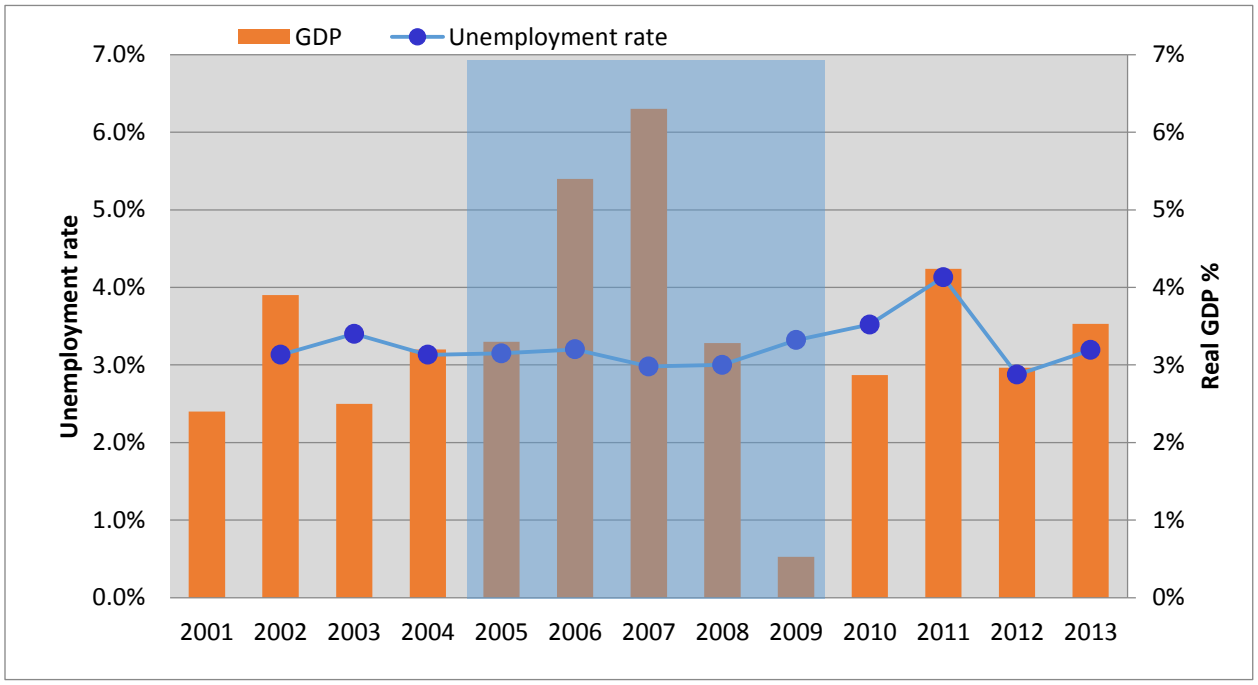

Figure 5. National unemployment rate and real economic growth (GDP %)
Note: The years 2005-2009 contain estimations of unemployment rate elaborated by Lopez (2011).
Source: Unemployment rate 2002-2004, 2010-2013 from INE; Unemployment rate 2005-2009 from Lopez (2011); and real GDP: Banco de Guatemala.

The labor market in Guatemala is also characterized by a minimum wage policy that aims to provide a minimum standard of living for workers. This policy also serves as a benchmark variable for indexing wages for the rest of the country. The constitution of Guatemala (Article 102 f) establishes that the government must convene periodic meetings to revise the minimum wage. These meetings are conducted by the National Commission of Salary, an organization that includes representatives of the central government, two autonomous institutions of the state, a representative of employers at the industry level, and a representative of union labor. The collective agreements are usually enforced by the government, but when this does not occur, or the enforcement is weak, wages are determined with some level of flexibility, but are usually below minimum wage.

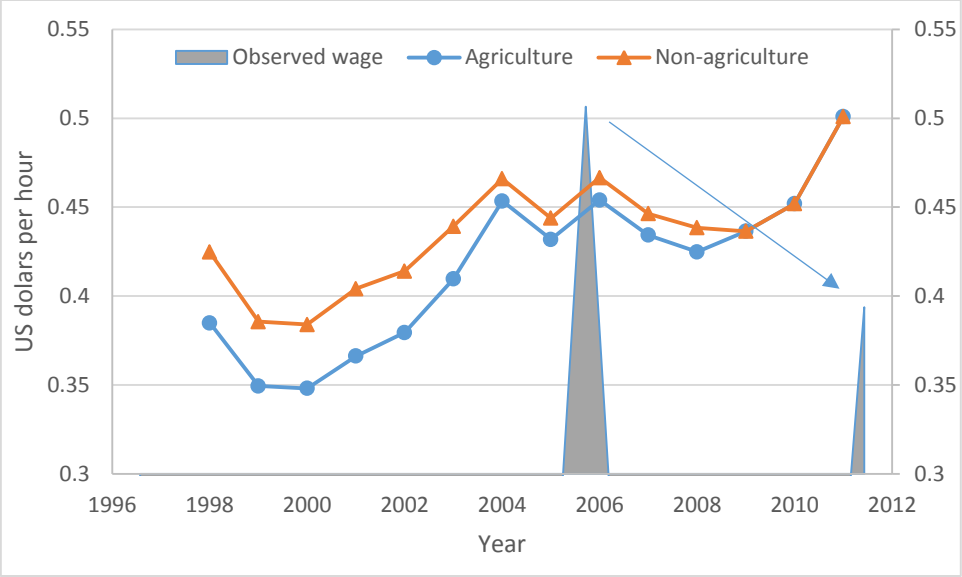

Figure 6. Real hourly minimum wage in Guatemala and observed wage
In US dollars and per economic sector.
Source: Banco de Guatemala and INE.

Figure 6 shows the minimum wage in Guatemala for the agricultural and non-agricultural sectors in real terms and in US dollars. On average, both sectors grew about 8% from 2006 to 2011, but this change contrasts with what workers actually received in the field. INE reports that the real hourly wages workers received in exchange for their labor decreased from US$0.50 in 2006 to US$0.39 in 2011, a decrease of about 11 cents per hour. Although there is no documentation about the reasons of the reduction of the real hourly wages in Guatemala, the International Labour Organization -ILO- explains, through the Global Wage Report 2010-2011, that most of the countries in the world experienced decline in wage growth during the period of crisis in 2007 and post-crisis (2008-2009). According to ILO, the reduction of real salaries is associated to the decline in the growth of labor productivity (measured as GDP per person employed). This is explained through the fact that most of firms were not able to increase their production due to the crisis at that time since sales were low, and as a consequence firms were not able to pay higher salaries.

Table 2 shows that employment in the manufacturing industry is mostly concentrated in the region I, followed by regions VI and V. With respect to numbers per industry and per region (Table 3), the agriculture sector is predominant in all regions, accounting for 47% on average. Services accounts for of 37% of total employment on average across all regions.

Table 2. Distribution of occupation of the Industries across regions

Region	Agriculture	Manufacturing	Services
I	0.04	0.39	0.40
II	0.06	0.01	0.02
III	0.05	0.04	0.06
IV	0.08	0.03	0.05
V	0.19	0.17	0.13
VI	0.32	0.28	0.28
VII	0.20	0.05	0.06
VIII	0.06	0.01	0.01
Total	**1.00**	**1.00**	**1.00**

Source: INE (ENCOVI, 2011)

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Table 3. Distribution of occupation of the industries per region

Region	Agriculture	Manufacturing	Services	Total
I	0.05	0.30	0.65	1.00
II	0.65	0.10	0.25	1.00
III	0.35	0.17	0.48	1.00
IV	0.51	0.12	0.37	1.00
V	0.42	0.23	0.35	1.00
VI	0.38	0.20	0.42	1.00
VII	0.66	0.10	0.24	1.00
VIII	0.71	0.07	0.22	1.00

Source: INE (ENCOVI, 2011)

Table 4 reveals that the average real hourly wages decreased from 2006 to 2011 by almost 21% on average in all regions. The metropolitan area (Region I) and Regions III and VIII were least affected, with 14.5%, 8.6% and 8.6% reductions, respectively; while the most affected are regions II and VII with real wage reductions of 35.7% and 41.3%, respectively. According to the ILO's argument presented before, the reduction of the real wage may respond to reductions of production. In this context, in 2010, the production of the agriculture industry (predominant in almost all regions) reported a reduction as a consequence of the combination of two natural factors that destroyed good part of the production; the tropical storm Agatha -through it constant and heavy raining- and the activity of the Pacaya volcano -through the ejection of debris and ashes. (BANGUAT, 2011) Those natural events affected negatively most the productivity of workers in such industry, which represents the 47% of the occupation of the

workers in Guatemala leading to the deterioration of wages of the agriculture industry. Also, from 2008 to 2010, the industry of construction registered a decrease in its production in real terms of about 16% per year, which remarked the post-crisis period lived in the country as a result of the international crisis in 2007 discussed above. The former are punctual descriptions of the elements that impacted negatively the real wages; however, for the rest of the period under analysis and for the rest of industries, the statistics show a different scenario where the production reported by BANGUAT (2012), and prices (reported by INE, 2012) increased at higher rate than the growth of nominal wages reported in ENCOVI 2006 and 2011; in fact in the period 2006-2011 nominal wages increased 9% in total, the real GDP has an accumulated growth of 18%, and prices registered a total accumulated increase of 32%. Thus, wages are affected not only by those negative factors described before, but by the inability (or inflexibility) to fit with the economic growth of their regions.

Table 4. Average real hourly wages per region.
In US dollars
Years 2006 and 2011

Region	2006	2011	Change in %
Region I	0.64	0.54	-14.5%
Region II	0.51	0.33	-35.7%
Region III	0.47	0.43	-8.6%
Region IV	0.39	0.31	-20.3%
Region V	0.55	0.44	-19.2%
Region VI	0.50	0.37	-24.9%
Region VII	0.52	0.30	-41.3%
Region VIII	0.47	0.43	-8.6%

Source: INE, 2012 (ENCOVI 2006, 2011)

In addition, the spatial distribution of wages for 2006 and 2011 are shown in figures 7 and 8. The wages are normalized with the average of real wages of Region I, indicating that all regions' real wages are below the average wages of the metropolitan area; however, Region IV is the furthest behind in both years, 2006 and 2011, while Regions II and VII showed a deterioration of their average of wages compared to those in the metropolitan area in 2011. As regards the region IV, this is characterized for being a poor region where most of the dwellers are Ladinos and live under subsistence conditions, the technology applied to the production

process is limited and most of the economic activity is dedicated to agriculture. (SEGEPLAN, 2012) The Region II and VII have mostly indigenous population, where a big portion of them live under self-sufficiency conditions. (IDIES, 2012) The most important economic activity is the production of beans and corn, and very few people dedicate to the manufacturing industry to produce candies and agro-manufacturing[2] goods. (SEGEPLAN, 2012) Therefore, wages in those regions are more susceptible to local labor conditions in which very few people is privileged for having a "decent job"[3]; thus, one may assume that unfair wages are imposed by employers, while the existence of high competition for few decent jobs positions are underlying their labor markets.

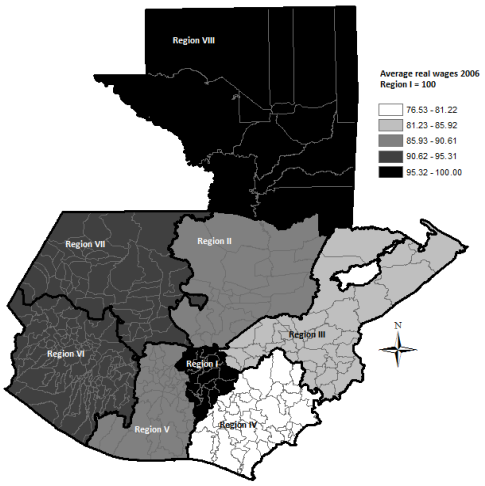

Figure 7. Spatial distribution of average real wages in Guatemala. Year: 2006
Source: Own elaboration with ENCOVI-2006 data.

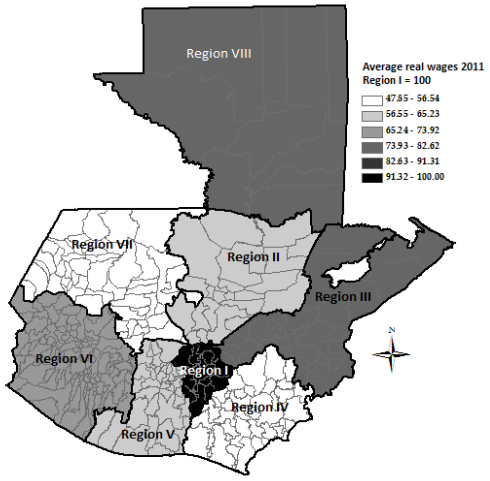

Figure 8. Spatial distribution of average real wages in Guatemala. Year: 2011
Source: Own elaboration with ENCOVI-2011 data.

As regards the unemployment rate reported by INE, the average of all of the regions reported an increase of 0.6 percentage points, increasing from 2.8% in 2006 to 3.2% in 2011.

[2] The agro-manufacturing industry dedicates to transform agricultural goods into finished commodities for market, for instance canned food and coffee mill.

[3] Decent job is referred as the job position inside the formal sector, which includes besides the wage other economic benefits.

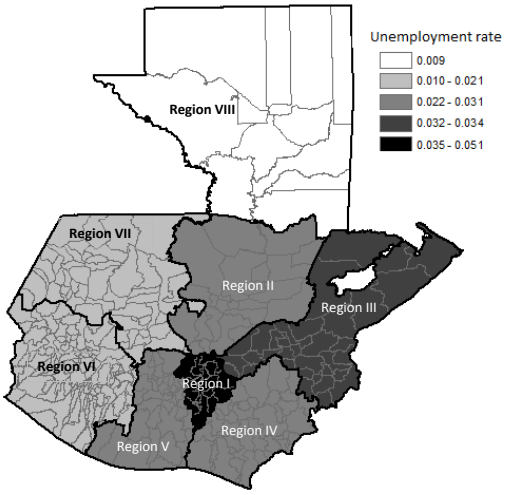

Figure 9. Unemployment Rate per region. Year 2006.
Source: Own elaboration with ENCOVI-2006 data.

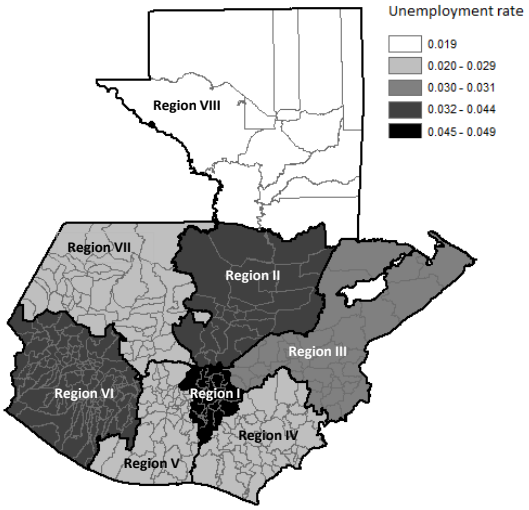

Figure 10. Unemployment Rate per region. Year 2011.
Source: Own elaboration with ENCOVI-2011 data.

From 2006 to 2011, the unemployment rate in Regions II and VI increased by two percentage points, even as other parts of the country registered almost no increase. However, by 2011 the regions with the highest unemployment rates were Regions I, II and VI, which had values of 4.9%, 4.4% and 4.3%, respectively; the other regions registered an average unemployment rate of 2.7%. It is important to notice that besides the Region I (the metropolitan area), Region VI is the second densest region of the country, and the second most populated region; while Region II has the second most populated department on the country (Alta Verapaz). These facts suggest some degree of tightness in their markets, which may play an important role in their wage determination as seen next chapters.

Concerning the underemployment rate, ENCOVI 2006 and 2011 report that on national average, this labor market condition is of 58% and 67%, respectively. The most important characteristic is that underemployment has increased systematically in all regions. This situation has been spurred by the increases of regions I and V as they reported the largest increases with changes of 0.15 and 0.16 percentage points, respectively. Finally, the regions of VI and VII are the ones with highest underemployment as these regions are characterized for being one of the most poorest areas of the country.

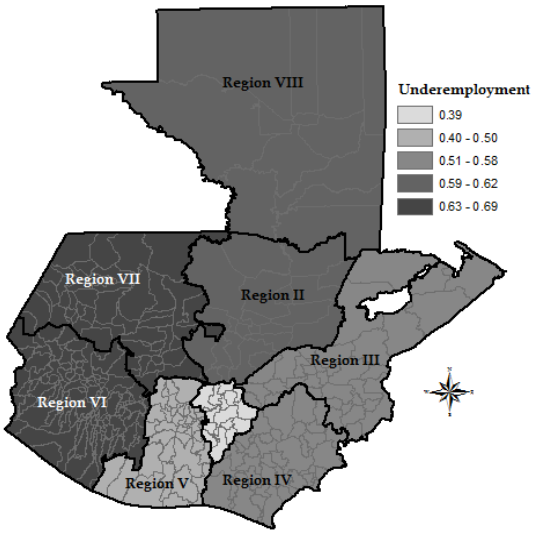

Figure 11. Underemployment Rate per region. Year 2006.
Source: Own elaboration with ENCOVI-2006 data.

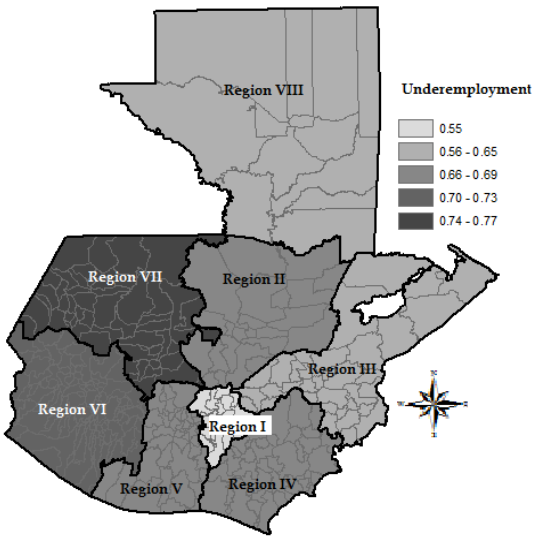

Figure 12. Underemployment Rate per region. Year 2011.
Source: Own elaboration with ENCOVI-2011 data.

2.3 Migration, poverty and education Guatemala

Guatemala is a lower-middle-income country with high social and economic inequality. It has a Gini coefficient of 53.7, rating it one of the most unequal countries in the world (World Bank, 2012). At a national level, in 2011, INE reports that more than 62% of the population lives below the poverty line (see figure 13). Also, ENCOVI-2011 reveals that in terms of income distribution, the bottom 20% of the population earned on average US$35 per month in 2011, while the highest 20% reported average earnings of US$714 per month, more than twenty times higher than that of the lower group.

Some studies (Bruni *et al.*, 2009; Adams, 2005; Vasquez, 2011) have approached this issue by considering different segments of the population: i.e., by ethnic, gender, and regional groups. As regards ethnic inequality, there are four official cultures—Maya, Garífuna, Xinka and Ladino—that in turn are divided into 25 ethno-linguistic groups. Twenty-three of these groups are of Mayan origin, representing about 40% of the total population (INE, 2012). In this context, Adams (2005) and Vasquez (2011) show that such social differentiation in terms of wage differentials is most pronounced between the Ladino population and the rest of the population. Bruni *et al.* (2009) shows that the income inequality between both groups decreased

from 2000 to 2006, but that the differential is still large: in average and in real terms, indigenous workers earn 41% less than Ladinos.

Regarding the inequality by gender groups, the wage gap between men and women is lower. However, Bruni *et al.* (2009) explain this result is biased by arguing that women with lower levels of schooling tend to stay at home, while men with lower education tend to work outside the home at lower wages. Thus, the wage differentials include the comparison between women with higher schooling levels (who earn better wages) and all men (including lower wage earners). Of course, this analysis is not arguing if women have the same opportunity of obtaining a job, but this is left out of context by the moment.

Regarding regional differences, ENCOVI-2011 reveals that most regions have a total poverty rate greater than 50%, excepting regions I (17%) and V (47%). The poverty is primarily focused in both the north and northwest regions with more than 70% of people living in poverty; further, the southwest region of the country exhibits a poverty rate of more than 55% (ENCOVI-2011). As explained earlier, such conditions are a result of the aftermath of the civil war, during which period children were deprived of adequate education, and after which a lack of effective education policy practices produced poor educational quality and coverage among the same populations.

Also, such spatial differences have led to internal migration. In Guatemala, there is not enough statistical evidence to definitively determine internal migration figures (SEGEPLAN, 2012) as the last census of population and housing was taken in 2002. Nonetheless, post-2002, the two surveys of living standard measurement study (ENCOVI) have been conducted by authorities (2006 and 2011), and they can provide some indication of internal migration. Table 5 presents a construction of the distribution of internal migration by destination: Region I is by far the most important destination chosen by immigrants, and it receives more than 49% of the total migration flow. This is confirmed by the revision of the 2011 world urbanization prospect, elaborated by the United Nations, which concluded that Guatemala has one of Latin America's highest projected rates of urban growth, and is expected to see more than 50% of the population in urban areas before 2015. This revelation positions Guatemala, nowadays, as one of only three Latin America countries that currently have less than 50% of the population living in urban

areas (United Nations, 2012). ENCOVI (2011) reveals that out of the seven reasons[4] for moving between departments, labor migration is second in importance, as people seek better job opportunities, better wages, and better labor conditions. In general, the referenced reasons may correspond to the poverty conditions people have to deal with while living in the different regions.

Table 5. Internal migration: the distribution of the internal migration by destination in percentage. Year 2011

Region	Department	Distribution (%)
Region I	Guatemala	48.3%
Region II	Baja Verapaz	1.2%
Region II	Alta Verapaz	2.5%
Region III	El Progreso	3.3%
Region III	Izabal	5.8%
Region III	Zacapa	NR
Region III	Chiquimula	2.1%
Region IV	Santa Rosa	1.7%
Region IV	Jalapa	1.2%
Region IV	Jutiapa	0.4%
Region V	Sacatepéquez	2.9%
Region V	Chimaltenango	2.5%
Region V	Escuintla	6.6%
Region VI	Sololá	0.4%
Region VI	Totonicapán	0.4%
Region VI	Quetzaltenango	6.2%
Region VI	Suchitepéquez	1.2%
Region VI	Retalhuleu	NR
Region VI	San Marcos	1.7%
Region VII	Huehuetenango	2.5%
Region VII	El Quiche	2.1%
Region VIII	Petén	7.0%
Total		**100.0%**

NR: No record of in-migration flows in 2011.
Source: INE (ENCOVI, 2011)

[4] ENCOVI 2011 presents eight answers in its survey to explain the reasons of the internal migration across departments. People answered in the following structure: 1) Labor reasons, 18%; 2) Studies, 3%; 3) Familiar reasons, 44%; 4) Health, 1%; 5) Marriage, 11%; 6) Housing, 11%; 7) Violence 6%; and 8) other, 6%.

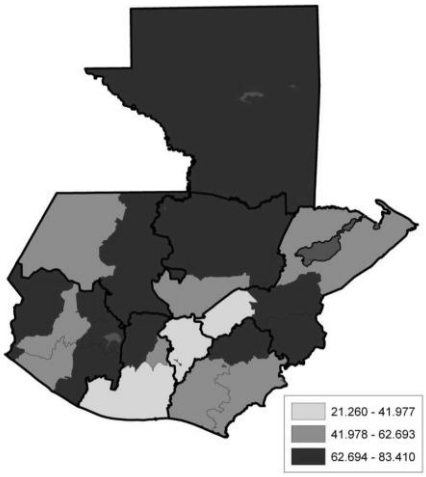

Figure 13. Percentage of total poverty by department in 2011.
Source: Graph elaborated by INE (ENCOVI, 2011).

Another characteristic of the Guatemalan economy is a dependency on remittances. There are an estimated 1.1 million Guatemalans living in other countries (Caballeros, 2013); the money they send home each year has represented about 10% of the GDP of Guatemala since 2002 (BANGUAT, 2014). Funkhouser and Perez (1998) state that there are three effects one can expect to see on those receiving such remittances: more people will abandon the labor force, women (spouses of migrants) will increasingly participate in the labor market, and unemployment will have less effect on the wage rates in regions where remittances are greater, as people will be less concerned about their incomes. Hence, remittances can be considered to be the reservation wage of the beneficiaries, who will have the opportunity to decide the length of time they prefer to spend not participating in the labor force or the amount of time they want to take to look for a desirable job. There are an estimated 3.5 million people receiving the benefits of such remittances (Dalmasso, 2005), and, as a consequence, whether the rest of the other social and economic conditions of the places are kept constant, then the open unemployment and the informal sector have the potential to be reduced (Funkhouser, 1997a).

In sum, the labor market of Guatemala is characterized by having low open unemployment but very high participation rate of labor in the informal sector. As in many developing countries, Guatemala does not have an unemployment benefits policy, meaning that workers are forced to accept improper labor conditions to maintain subsistence, or in the best cases, workers would complement their income through remittances. Furthermore, most regions report having lower wages than in the metropolitan area (Region I) that, according to some studies, is a consequence from workers having an inadequate education. The wage

differentials incentivize people to migrate to the metropolitan area as reported in ENCOVI-2011. Consequently, Region I is the most important destination for internal migration, where population density is greater and the unemployment rate is the higher. Therefore, people take the risk of moving toward the metropolitan area despite not being certain of getting a job, yet there is an expectation of having more opportunities for obtaining a job or doing business.

Finally, the low productivity of the country, the inflexibility of wages during prosperous years, the economic and social inequality of the regions, and the informal sector delivers a framework to study in the present paper. Explicitly, this context creates expectations about role of the regional economic inequalities on the internal migration in the country, where the metropolitan area represents the place with more opportunities for people for doing business or for obtaining better jobs. Also, the local labor conditions may influence the wage determination in which firms have relative power given by the combination of the predominant labor informality in the regions and the very low number of job positions of decent jobs. Thus, such conditions make workers -with the desire of having a decent job- to accept deplorable level of wages. Given these arguments, this research aims, as general objective, to provide an evaluation of them, in which Chapter 4 offers the theoretical background that explains each of the elements of the present context that gives later the foundations of the research inquiries in Chapter 5.

Chapter 3: Wage equations and spatial implications

Wage equations may be characterized as partial equilibrium models intended to represent the relationship between labor and wages. The purpose of this chapter is to provide a review of the most relevant wage equation formulations that can promote the understanding, in different dimensions of analysis, of the motivations of economic agents (workers and firms) to move between regions due to differences in labor market conditions. The models discussed are the Harris and Todaro model, the NEG wage equation, the wage curve of Blanchflower and Oswald, and the Mortensen and Pissarides model. They are the most influential models in literature of wage equations that link migration and labor conditions.

3.1 The Harris and Todaro Model

Harris and Todaro (1970) seek to evaluate rural-to-urban migration patterns in response to economic incentives. They argue that, despite having positive marginal product in agriculture in developing countries, people still move to cities where unemployment is higher. The authors assert that there is a positive relationship between wages and unemployment levels, a phenomenon that can be justified by the compensation differentials idea. A higher wage in the urban area will compensate for the risk of not obtaining a job in the city. Thus, in seeking an explanation for, they decide to discard neoclassic assumptions, such as full employment and wage-price flexibility. Their work also assumes the existence of a minimum urban wage, which is expected to be higher than agricultural wages. The former is an incentive for the labor force to move into such area, and will result in excess supply labor. Forces of the market then operate, tending to adjust wages downward until they are equal to the agricultural sector. Such equilibrium is a result of migration flows that manifests itself in urban population concentrations and higher urban unemployment.

This seminal model considers the study of the migration of workers within an economic system with two sectors, urban and rural. These sectors are differentiated by the type of final production, technology and wage determination. The model uses a Cobb-Douglas production function for both sectors - agriculture and manufacturing goods.

$$Y_a = A_a L_a^{\alpha} \tag{1}$$

$$Y_m = A_m L_m^{\beta} \tag{2}$$

In equations (1) and (2), Y_a and Y_m are the production levels of the agricultural goods and manufacturing goods, respectively; L_a and L_m represent the units of labor from each sector; and, $A_a > 0$ and $A_m > 0$ are parametric constants. Both produced goods and labor belong in their respective perfectly competitive markets. However, when referring to wages, one segment of the urban wages are institutionally determined by the minimum wage, while rural wages are flexible and are determined by the marginal productivity of labor.

$$w_a = \alpha A_a L_a^{\alpha-1} p \quad (3)$$
$$w_m = \beta A_m L_m^{\beta-1} \quad (4)$$

Equations (3) and (4) contain w_a and w_m, which represent the real wage in the agriculture sector (relative to manufacturing goods), and the minimum wage in the urban sector. In addition, p is the relative price of the agricultural good that it is determined by the following expression:

$$p = \rho \left(\frac{Y_m}{Y_a}\right)^{\gamma} \quad (5)$$

Here, $\rho > 0$ and $\gamma > 0$ are parametric constants, in which γ represents the price elasticity with respect of the ratio $\frac{Y_m}{Y_a}$. Finally, the total labor in the economy (L) is constant during the period of analysis. Labor in manufacturing (L_m) is smaller than the total population in the urban area (L_u), while labor in agriculture sector (L_a) is fully employed. Thus:

$$L_a + L_u = L, \quad \text{where } L_u > L_m \quad (6)$$

In order to obtain the short run equilibrium, equation (4) can be rearranged to generate the employment level in the manufacturing sector, as expressed in equation (7); in turn, this is incorporated into equation (2) in order to obtain the production level of the manufacturing sector (equation 8).

$$L_m = \left(\frac{\beta A_m}{w_m}\right)^{\frac{1}{1-\beta}} \quad (7)$$
$$Y_m = A_m^{\frac{1}{1-\beta}} \left(\frac{\beta}{w_m}\right)^{\frac{\beta}{1-\beta}} \quad (8)$$

In order to obtain agricultural production, equation (6) is rearranged and incorporated into equation (1) as follows:

$$L_a = L - L_u \tag{9}$$
$$Y_a = A_a(L - L_u)^{\alpha} \tag{10}$$

As noted earlier, equation (5) represents the relative price of agricultural goods in manufacturing terms. This relationship can be understood using the terms of trade between the sectors, and by incorporating it into the new production equations (8 and 10), the trade is determined as follows:

$$p = \rho \left(\frac{A_m^{\frac{1}{1-\beta}} \left(\frac{\beta}{w_m} \right)^{\frac{\beta}{1-\beta}}}{A_a(L - L_u)^{\alpha}} \right)^{\gamma} \tag{11}$$

Equation (11) is used, together with equation (3) and (9), to obtain the wage equation for the rural sector in manufacturing terms:

$$w_a = \alpha \rho A_a^{1-\gamma} A_m^{\frac{\gamma}{1-\beta}} \left(\frac{\beta}{w_m} \right)^{\frac{\beta\gamma}{1-\beta}} (L - L_u)^{\alpha(1-\gamma)-1} \tag{12}$$

The expression (12) is the short-run equilibrium. It indicates that the rural wage reacts to shocks in the urban sector that, in turn, motivates people to move across sectors and hence regions. In order for migration to flow from the rural to the urban area two situations need to occur; first, the difference between the wages of urban and rural sectors must be positive ($w_m > w_a$), and secondly, people make predictions before moving by considering an expected [minimum] urban wage (w_u^e). Thus, over the long run, Harris and Todaro assert that the equilibrium condition is found when it satisfies the equality between the expected [minimum] urban wage and the rural wage ($w_u^e = w_a$). In the literature, the former expression is known as the Harris-Todaro condition. For the expected urban wage, the authors define it as:

$$w_u^e = \frac{L_m}{L_u} w_m \tag{13}$$

where the ratio $\frac{L_m}{L_u}$ is the probability that a worker living in the urban sectors obtains a job in this sector. The authors add that when this equilibrium condition is reached, the proportion of the population in the urban area is $l^* = L_u^*/L$, and this can be found by integrating equations (12) and (13) on the Harris-Todaro condition as follows:

$$\frac{L_m}{L_u} w_m - \alpha\rho A_a^{1-\gamma} A_m^{\frac{\gamma}{1-\beta}} \left(\frac{\beta}{w_m}\right)^{\frac{\beta\gamma}{1-\beta}} (L - L_u)^{\alpha(1-\gamma)-1} = 0 \qquad (14)$$

Finally, the authors argue that in order to guarantee the stability of the equilibrium condition, the following mechanism (function ψ) must be accomplished:

$$L_u = \psi(w_u^e - w_a), \qquad \psi' > 0, \qquad \psi(0) = 0 \qquad (15)$$

In sum, the decision to migrate depends on expected rather than actual urban-rural wage differential, which in turn depends on the probability to find a job in the urban area. As it is proved in many papers (see Todaro, 1980), there is an apparent paradox in the migration rationale in developing countries. The higher the expected wage differential, the more people is attracted to the urban area, and hence the greater the unemployment in such places. This is a result of a temporal saturation of labor market in which suppliers, mostly unskilled migrants, struggle for finding a job in the city. Consequently, unfortunate workers are forced to supply their labor to part time jobs, which in most of the cases the conditions are squalid due to the lack of labor benefits such as social security insurance, unhealthy environments, low wages, etc. These elements characterize the informal sector, which is highly present in developing countries. (Baltagi *et al.*, 2012; Ramos e*t al.*, 2010) Therefore, the decision of moving must include not only the expected wage differential between urban and rural areas or the probability of finding a new job in the urban area, but the probability of being hired or working in the informal sector.

The temporal saturation of the labor market is induced by the job creation in the urban area; Harris and Todaro (1970) point out that once a new job position is open in the urban area, this will induce to more than one worker in the rural area to emigrate. This brings policy implications, for instance this assertion can be proved as seen in chapter 5 of this research, where is stated that in Guatemala, the policy of public infrastructure investment is bias toward

the most developed municipalities of the country, in which the metropolitan area is the most favored. This situation incentives people and firms to move into such an area, which may induce to create new jobs positions, which in turn influences again the internal migration, and so on. Thus, regional inequalities in job creation may bring saturation in the labor supply, but if the labor market is not ready to receive it, then the original job creation will trigger more urban unemployment or more informal labor; so "the solution to urban unemployment would not be urban employment creation" (Fields, 2007). Alternatively, a policy of rural development aimed to increase rural wages would help to reduce the rural-urban migration. Fields (2007) shows through the empirical evidence in Kenya that an increase of minimum wages in the rural area in this country led to reduce the flows of migration to the urban areas, and hence it helped to reduce the unemployment; however, such type of policy action does not provide similar results in other countries. For instance, in Guatemala the minimum wage has been in frequently review by the authorities each year, dictating increases for both sectors the agriculture and non-agriculture. The wage differential between both minimum wages is zero (see figure 6 in chapter 2), and one should expect to observe some reductions in the flows of internal migration, something that in reality is not happening[5]. United Nations (2012) argues that Guatemala is one of the countries with the highest rate of urbanization in Latin America. Thus, any policy mechanism such as the minimum wage should be accompanied by the strengthened of the state institutions of the country.

3.2 Krugman's Wage Equation

The roots of the new economic geography (NEG) reflect the relationship between nominal wages in a monopolistically competitive sector and some measure of market access or market potential. Krugman, who was inspired by the Dixit and Stiglitz model (1977), developed this theory based on transportation costs, manufacturing sector location, and demand for manufactured goods. The theoretical assumptions of the model are based on the pecuniary externalities reflected in imperfect equilibrium, increasing returns and monopolistic competition. This model is considered to be a full general-equilibrium model in the sense that it is the price system that plays the crucial task of equilibrating agents' decisions. In addition, the

[5] The central government in Guatemala is in charge of enforcing minimum wages, and may be failing for not having strict monitoring controls.

geographical distributions of population, demand and supply of goods and services are considered to be endogenous, meaning that such elements create a platform that helps determine the location decisions that agents make during the production process or investment decisions that, in turn, allow for the prediction of agglomeration or the divergence processes. The model essentially predicts that concentration will occur if a combination of increasing returns to scale and low transportation costs coexist.

Indeed, the new economic geography (NEG) is an appealing theory for explaining spatial variations in economic development. Its origins are to be found in rival theories that may account for spatial variations with the purpose of offering explanations for economic growth. One of the most representative mainstream approaches is the neoclassical theory, and it is based on three assumptions. First, the level of technology is assumed to be given and exogenously determined. Secondly, the production function shows constant returns to scale with a given technology. Thirdly, the production factors have diminishing marginal products. Given these assumptions, the neoclassical theory indicates that economic growth eventually converges in a steady state. Nonetheless, this theory has been criticized because there is not enough empirical evidence to substantiate the theoretical results. Besides, the theory cannot explain why a region with similar socioeconomic characteristics to other regions, grows at a different rate (McCallum, 1996). In addition, Krugman (1998) states that while neoclassical theory insists upon relying on the *invisible-hand*, the NEG postulates that "spatial structure emerges from invisible hand processes."

A second contending theory, the endogenous growth theory, changes the neoclassical paradigm by incorporating elements that are potentially responsible, at least in part, for the economic development of a region. These elements are local resources that are potentially usable in a production process, such as human capital, technology and research and development. Some of the representative authors of the theory are Romer (1986) and Lucas (1988). They promote, through microeconomic foundations, the importance of the role of human capital in the transmission of knowledge and innovations through the spillover effects that, in turn, lead to the economic development process. The rationale for this process requires workforce skills that rely on the allocation of local resources for transmitting the information in a tacit format across space. The most important implication of the last argument is that some form of knowledge is transmitted through human capital in the region, implying that the more

the [linked] human capital in the region there is, the greater the transmission of knowledge, and the greater the influence on the economic development process. Indeed, knowledge is not only a tacit force; it can also be materialized in technological innovations. Some authors (e.g., Alexiadis, 2013) believe that incorporating the spatial dimension in endogenous growth models leads to the emergence of a new tradition: the new economic geography.

NEG theory provides a new dimension for understanding economic geography and location issues. It provides a possible explanation for location decisions made by economic agents, as well as the economic growth of a region, by taking into account the heterogeneity of space, people and firms (Ottaviano, 2011). In fact, some authors have defined that NEG model as the first successful attempt at explaining why similar regions do not register equal economic development. In this sense, Ottaviano (2002) mentions that among the contributions NEG has provided, one can find the enlightenment regarding the importance of the notion of *space* by harmonizing the concepts of market proximity and production concentration. NEG can explain such a relationship through the localized pecuniary externalities expressed in terms of the increasing returns to scale, trade costs, and monopolistic competition that prevail in each region. (Ottaviano and Thisse, 2001)

NEG highlights the relative importance of the *heterogeneity* of space, and it provides explanation for the formation and self-enforcement of the spatial structure of the economy. As regards to heterogeneity, there are characteristics that go beyond the pecuniary externalities and they may represent restrictions on the circulation of the economic agents between locations; example would be, natural resources, proximity to natural means of communication, and climate. There are other elements as well, such as the social and political conditions of the regions that include culture and education. It is also important to consider the basic public infrastructure of the location that allows for the communication with other regions.

As regards the spatial structure of the economy, the foundations of the NEG prove that the spatial concentration of economic activity is a consequence of the predominance of the market expansion effect over the market crowding effect. This is what Ottaviano (2001) refers as the agglomeration process. Baldwin, *et al.* (2003) explain the rationale of this process in three stages. First, when the migration of workers and firms between regions respond to the forces of agglomeration, in which the process is known as market potential or the market access *effect.*

Economic agents respond to the initial economic conditions of the regions, that is, the region with higher wages and lower transportation cost will create an incentive for the economic agents of other regions to move into it. The result is that the production of industrial goods is spurred and new jobs are created; this results in the reduction of the industrial price index and the cost of living in the centripetal-region. This latter result corresponds to the second stage that is a self-reinforcing process where the cost of living is low because of the previously enhanced economic conditions. This condition attracts more firms and workers if other economic conditions, at least, remain unchanged. The above discussion is clearly biased toward explaining the accumulation process that the stronger economic region will undergo during the agglomeration process. However, the NEG model provides an explanation for the opposite effects. The constant inflow of new migrant workers and firms will eventually create a congestion of economic agents in the region, and this situation brings about a higher level of competition among them. The third stage involves a reduction of the profits of the firms. Once market experiments produce such a reduction, the solution for survival involves reducing wages that also involves a reduction of relative wages with respect to other regions. This will create an incentive for economic agents to look for another region that provides better economic conditions, a situation Baldwin, *et al.* (2003) call the market-crowding effect.

3.2.1 The "NEG" wage equation and the market potential

Prior to Krugman's model, the formulation of the concept of market access, or market potential, was introduced by Harris (1954). He defined it as the summation of markets accessible to a point discounted by their distances to the point. It is an index that represents the possibilities of a firm or industry to serve a market from any given location. Harris emphasizes the importance of manufacturing location in the United States in the agglomeration process. The model did not acquire widespread recognition due to its lack of microeconomic foundations, something that Krugman provided much later, in 1991.

The Krugman's model, typically referred to as the NEG model, involves two sectors and two regions. The sectors considered are the competitive sector (C) and the monopolistically competitive sector (M). Finally, it is assumed that the monopolistic sector has transportation costs, whereas zero trade costs are assumed in the competitive sector. The first assumption is that consumer preferences exhibit identical Cobb-Douglas functional forms, in which (α) is the

expenditure share on manufactured goods, *M* is the quantity of manufacturing varieties, and *C* is a composite of the rest of the non-agricultural goods. Thus, the utility function is defined as follows:

$$U(M,C) = M^{\alpha}C^{(1-\alpha)}, \quad 0 < \alpha < 1 \tag{16}$$

The variable *M* in equation (16) is a construction of a CES (constant elasticity of substitution) sub-utility function (see equation 17), where $m(k)$ represents the consumption of variety 'k' of the manufactured goods, σ is the parameter of elasticity substitution between any pair of individual manufactured goods.

$$M = \left[\sum_{k=1}^{N} m(k)^{\frac{(\sigma-1)}{\sigma}}\right]^{\frac{\sigma}{(\sigma-1)}} = \left[\sum_{k=1}^{N} m(k)^{\frac{1}{\mu}}\right]^{\mu} \tag{17}$$

The theoretical model has two factors of production: the manufacturing labor (L_M) and the rest of the non-agricultural labor (L_C), and both are distributed in *J* regions (j = 1, 2… J). For manufacturing labor, there are increasing returns to scale, and these are represented through fixed and marginal costs (see equation 18). In addition, the production of (C) comes about under constant returns to scale. Therefore, it is assumed that units of labor are set equal to production. Thus:

$$L_{Mjk} = a + bQ_{Mjk} \tag{18}$$

$$L_{Cj} = Q_{Cj} \tag{19}$$

An additional assumption is that trade among regions occurs under an iceberg transport cost function, meaning that a portion of the good that is shipped will not arrive at the destination locale, and this portion will vary depending on the nature of the good and the distance that the good is transported. In equation (20), d_{ij} is the distance between locales i and j, and τ the unit transport cost, which is assumed to be one.

$$T_{ij} = (\tau d_{ij})^{-2} \tag{20}$$

Workers have an incentive to move into other regions when their real wages are less than those found in the locale to which they want to move. This flow of migration stops when real wages are equal in all regions. In equation (21), W is the nominal wage, while G is set as the price index for manufactures.

$$\frac{W_i}{G_i^{\mu}} = \frac{W_j}{G_j^{\mu}} \tag{21}$$

The Krugman model suggests that the geographical distribution of industry influences real wages. This implies that linkages among economic agents are responsible for the spatial concentration of workers and firms. For instance, when concentrations of firms occur, the manufacturing good price declines; in turn, this is reflected in an increase in real wages. This situation induces mobile workers to move to the region where real wages are higher -- this is the forward linkage effect. On the other hand, locales with high numbers of workers are the center of attraction for firms. A region with an abundance of labor is perceived by firms to be an attractive production site, with workers being rewarded with higher wages (backward linkages). The forces of attraction explained above are considered to be the self-reinforced mechanism of spatial concentration. In Myrdal's rationale, this is the mechanism of circular and cumulative causation.

In order to appreciate the nature of the general equilibrium model, let equation (22) be the price index of the manufacturing sector, where λ represents the share of the varieties on the manufacturing sector in region i. This equation depends on the wages of the sector (w_i) and on the transportation or trade costs of the sector (T_{ij}), and both of these variables are influenced by the elasticity of substitution (σ).

$$G_j^M = \left[\sum_{i=1}^{R} \lambda_i \left(w_i^M T_{ij}^M\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \tag{22}$$

Therefore, in equilibrium, the wage rate is represented as follows:

$$w_j^M = \left[\sum_{i=1}^{R} Y_i \left(T_{ij}^M\right)^{1-\sigma} \left(G_i^M\right)^{\sigma-1}\right]^{(1/\sigma)} = (P^M)^{\frac{1}{\sigma}} \tag{23}$$

Equation (23) is the so-called nominal wage equation, and it represents the short-run equilibrium of wages driven by the entry and exit of firms, which causes firms to have zero profits. This equation explains the function of the market access or market potential concept, which is positively related to the level of income (Y) and negatively related to the price indexes (G) of the surrounding regions that are weighted by the decreasing function of the transportation costs (T_{ij}). Prices and transportation costs are influenced by the elasticity of substitution (σ) between the varieties (through the price index) and regions (through the transport cost).

Krugman (1991) proposed that the wage equation is part of the new economic geography's core. The essence of the statement highlights the relationship between market access and wages, in which the first variable was proven in empirical research to be the driver of wage variations (Baldwin, 2003; Head and Mayer, 2004). Some authors argue for caution in the evaluation of both variables. First, Leamer and Levinsohn (1995) claimed that empirical research should not be used to test such relationships by comparing the NEG model against alternative models of agglomeration. Instead, they should complement their results. Secondly, Fingleton (2011) mentions that spatial scales matter, and NEG will not always have enough explanatory power to describe economic behavior within countries or at low levels of regional aggregation. The justification for this can be found in Redding and Venables (2004), who explain that the market access or market potential effect is constant over short distances, and thus cannot explain abrupt changes in wage rates. Despite such caveats, this theory is used as a means of measuring the forces of attraction of the agglomeration patterns in Guatemala. The former statements pose some warning in the expectation of the results of this paper; however, there is a need to use NEG to analyze the geographic and socioeconomic characteristics of Guatemala because the model can capture such particularities, and has the advantage of capturing the heterogeneity of the places.

3.3 The Wage Curve

The wage curve hypothesis is referred to as the negative relationship between local unemployment and wages. Blanchflower and Oswald (1990, 1994, 1995, and 2005) proposed the

existence of an inverse relationship between the unemployment rate and wages. This idea contradicts the neoclassical literature about the labor supply function, which argues the existence of the opposite relationship, such as the model from Harris and Todaro (1970) that established it. In order to provide a theoretical basis, Blanchflower and Oswald (1994) examined non-competitive labor market behavior, including efficiency wages and bargaining models. Afterwards, multiple researchers tested the wage curve hypothesis for different regions and countries. The general conclusion is that a relationship between both variables exists and is negative (Nijkamp and Poot, 2005).

The wage curve hypothesis empirically proved that the best way to support its downward shape curve is by using non-competitive labor theories. The counterargument says that if a labor market was competitive, the inequality and the regional economic divergence should be a transitional phenomenon. Thus, one can argue that the former would be true if factor mobility and interregional trade diminished personal and spatial differences over the long run, but the empirical evidence shows the contrary (Blanchflower, 2000; Blanchflower and Oswald, 1994, 2005; Card, 1995). Therefore, local market structure determines the conditions in which firms and workers interact with each other. For instance, under monopsonistic or oligopsonistic competition, firms enjoy free entry to participate in competition, but such initiation comes with some constraints including start-up costs, recruitment and training. On the other hand, workers face job search costs, commuting costs, and migration costs. Longhi, *et al.* (2004) explain that in such labor markets, one expects to observe wages and unemployment being inversely related because either bargaining power or a unilateral wage set-up is imposed that is strengthened by the forces of agglomeration (Sato, 2000).

The wage curve (Figure 14) is a relationship between *local* unemployment and wages. Blanchflower and Oswald proposed in 1990 that wages are a decreasing convex function of the unemployment rate. Since then, many studies have attempted to prove such a relationship. The first group of studies shows that there is an elasticity of about -0.1 in each of over 40 countries (Blanchflower and Oswald, 2005). This means that a worker can expect to earn 1% less in real terms when the unemployment rate increases by 10%, with all other factors remaining constant. The former is a set of the empirical results that provide evidence that wage curve theory is indeed possible. Thus, for the precise and stable results across this group of studies on the topic, the proposal became popular among scholars, and was known as the

empirical "law" of wage curve (Blanchflower and Oswald, 1990, 1994, 1995, 2005; Card, 1995; Baltagi and Blien, 1998; Buettner, 1999; Nijkamp and Poot, 2005; Longhi, *et al.*, 2006; Baltagi, *et al.*, 2010). The second generation of research did not focus on the particular elasticity of -0.1, but rather on the proof that the wage curve was indeed a negative relationship between paid salaries and unemployment in a particular region or nation. Those studies suggest the existence of evidence showing imperfect competitive wage determination where firms are not wage takers, but rather determine wages based on the local unemployment level. In simpler words: "A worker who is employed in an area of high unemployment earns less than an identical individual who works in a region with low joblessness." (Blanchflower and Oswald, 1994)

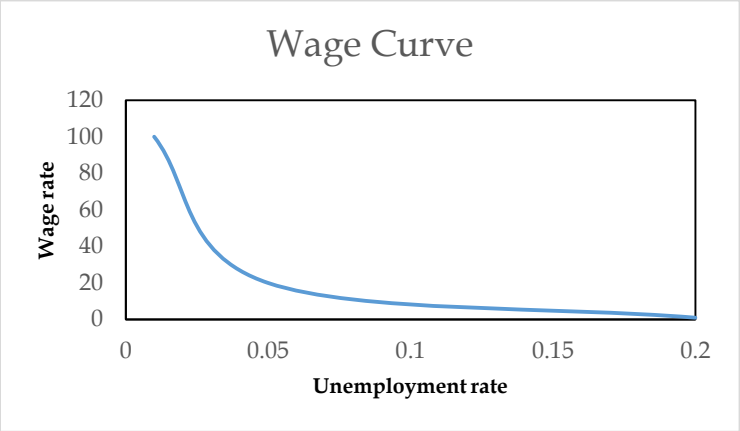

Figure 14. An illustration of the wage curve

Blanchflower and Oswald (1994) argue that through an examination of the results it is possible to assert that every country has its own wage curve. This argument was not challenged because there were very few cases (Albaek, *et al.*, 1999; Lucifora and Origo, 1999; Patridge and Rickman, 1997) that presented results that contradicted the significance and slope of the wage curve. The wage curve hypothesis seems to be generally accepted, but most research does not address social or regional differences within countries. For example, Card (1995) points out that the elasticity of the wage curve is quite different among different population groups, such as males and females, poorly-educated and highly- educated people, urban and rural areas, unskilled and skilled people, and younger and older people.

When the wage curve notion was initially presented, the authors considered it to be a break with traditional macroeconomics analysis because it uses microeconomics tools and data to answer a macroeconomic question (Card, 1995). This led to a debate about what the wage curve really is, and why it is usually confused with, and compared to other labor theories. For instance, the wage curve is not a Phillips curve. The Phillips curve is a negative relationship between *the rate of change* of wages and current unemployment rate, while the wage curve measures *the level* of wages against the unemployment rate (Montuenga & Ramos, 2005). Another case is that the wage curve is not a labor supply function; the debate arises in discussing why unemployment, in the short run, is considered to be part of the labor supply. Therefore, when considering the short run, unemployment and employment are almost mirror images, and the curve would be almost the same, while exhibiting an upward-sloping function. The foundation of the labor supply function rest on the compensating differentials proposed originally by Adams Smith. This theory argues that over the long run, labor markets may experience different unemployment rates. The former suggests that workers are prone to move to where the labor conditions are better. Hence, in equilibrium, employers belonging to a market with deteriorating conditions will adjust wages by increasing them in order to provide an incentive for workers to remain there. The last argument responds to the hypothesis of compensating differentials. The first authors in formalize such argument are Harris and Todaro (1970) and Hall (1970).

Thus, the wage curve hypothesis appears to contradict the theory of *compensating differentials*. However, it is important to recognize the existence of fundamental differences between both approaches. First, the wage curve – as seen in subsequent paragraphs - uses fixed effects to capture the permanent level of unemployment of a given labor market. The result is that the wage curve concerns the effect of contemporaneous unemployment on wages, while the compensating differentials concern the effect of expected unemployment on wages. Townsend (2005) adds that such configurations can influence the negative relationship between wages and contemporaneous unemployment rate, as well as have a positive relationship with respect to expected unemployment.

3.3.1 Representation of the Wage curve

The Mincerian equation was originally formulated to capture the determinants of earnings, including human capital characteristics such as education, skills and experience (Mincer, 1974). This is the most common approach when estimating the wage curve, when unemployment rate is added to the Mincerian wage. Equation (24) illustrates this proposition, where w_{irt} is the wage of the person "i" observed in the labor market "r" in the period "t"; U_{rt} is the unemployment rate of the labor market "r" at the time "t"; X_{irt} is a set of characteristics of the individual "i", which includes information about experience, education, race, gender, etc.; f_r and g_t are fixed effects for each labor market and time periods, respectively and finally, the error term e_{irt}.

$$\ln(w_{irt}) = \beta \ln(U_{rt}) + \delta X_{irt} + f_r + g_t + e_{irt} \quad (24)$$

Blanchflower and Oswald (1994) define the labor market as an economic sector or as a geographical space. Thus, β is the elasticity that defines the wage curve in a particular labor market "r," has been empirically determined to have a value near to -0.1.

3.3.2 Problems with the Blanchflower and Oswald approach

Despite its popularity, the model has some drawbacks. The first drawback is the simultaneity bias. The discussion centers on causality between wages and unemployment, which in turn leads to a bias estimation. The theory argues that unemployment inversely determines wages. However, the contrary can be depicted within the supply and demand framework, which discusses that high wages generate an excess supply of labor, and hence leads to a rise of unemployment. Blanchflower and Oswald (1994) address this problem by using instrument variables such as weather, industry mix, lagged unemployment, spending, etc. Their conclusion is that the wage curve elasticities obtained with these variables are very similar to the one used in equation (24), and hence the variable of unemployment can be used as an exogenous one.

Another problem is the common-group effects. The argument focuses on the fact that the unemployment rate is a more aggregated variable than individual wages. For that reason, the statistical significance tends to be overestimated (Moulton, 1986). In that sense, individuals can share a component of the variance that cannot be attributed to the variables of

unemployment or the set of individual characteristics. Therefore two things can be expected: one, a positive correlation between error components and individuals in same market, and, two, the standard error of the estimation of the elasticity of unemployment will be too small.

The solution to this problem is to consider an econometric estimation of the average of wages of the labor market (w_{rt}) against the unemployment rate of the labor market (U_{rt}) and some control variables (X_{rt}) (See equation (25)). Blanchflower and Oswald (1994) evaluate this approach compared with the one from equation (24) and obtained similar results.

$$\ln(w_{rt}) = \beta \ln(U_{rt}) + \delta X_{rt} + f_r + g_t + e_{irt} \quad (25)$$

A third concern to discuss is the form in which wages are measured, particularly the way in which Blanchflower and Oswald (1994) measured the wage curve for the U.S. In this regard, the authors use information represented by annual earnings to analyze the elasticity of the wage curve. This produces an analysis of the above explanatory variables not against wages, but rather against the hours/year and earnings/hour. Therefore, there is no certainty about estimates of the elasticity of the wage curve because it could respond to the measure of either or both earnings and hours of work; in other words, rather than finding the wage curve, they may have found the hours curve. (Card, 1995)

3.3.3 Foundation of the negative slope: Three models of the labor market

The mainstays of the wage curve hypothesis were originally constructed using three theories in cases where the higher regional unemployment rate depresses regional wages. These models are the labor contract model, the bargaining model, and the efficiency wage model.

3.3.3.1 Labor contract model

This model asserts that workers are paid under competitive conditions. The explanation is based on research by Baily (1977) and Azariadis (1975). They state that a contractual relationship between firms and workers is the optimal way to deal with immobility and product market uncertainty. In principle, this mechanism maximizes the joint welfare of employer and employees pertaining to the contract curve model with an upward slope involving wages and employment. However, Blanchflower and Oswald (1994) argue that the curve is a construction

of a quasi-supply curve, in which is assumed to have risk-adverse employees and neutral-risk firms whose behavior explains the negative slope. For instance, as regards non-pecuniary characteristics, the authors argue that the utility of dwellers is determined by the combination of wages and non-pecuniary (leisure) benefits. Firms in regions with better non-pecuniary conditions tend to pay lower wages because they know people are content with the conditions that the locale provides (Roback, 1982), besides the authors assume that government is paying benefits to laid-off people. Dwellers are consequently less motivated to take the job. On the contrary, firms in locales where living conditions are unpleasant tend to pay higher wages, so more people are disposed to seek work. Therefore, each locale represents a point in the distribution of wages and unemployment that ends up creating the shape of a negatively sloped curve (Blanchflower and Oswald, 1994, page 47).

In spite of this argument, the contractual model is the weakest to explain the wage curve because there is not empirical evidence of causality between wages and unemployment (Card, 1995). The relationship between wages and unemployment is not causal, and both variables are interdependent because wages can induce unemployment or vice versa based on the neoclassical idea; for instance, different regions have different social and economic conditions, and for that reason experience economic booms or slumps at different times (Chung and Hewings, 2014). Thus, under economic booms, firms maximize their profits that are restricted by their employees' minimum requirements. However, such maximization will be influenced by the probability of experiencing economic demand shocks in the locale where firms are situated, that is, during an economic boom period, a firm will hire as many workers as it requires. During an economic slump period, firms will reduce their labor requirements.

3.3.3.2 Bargaining model

The bargaining model comes explains the condition in certain regions and countries where firms' profits are shared with workers. This assertion has two implications: there is a positive *partial* correlation between wages and profit sharing per employee, and there is a negative *partial* correlation between wages and unemployment (Blanchflower and Oswald, 1994). The model suggests that workers surrounded by a high degree of unemployment are not in any position to demand a larger share of the surplus of the firm. This is the case due to the

uncertainty that workers face when searching for a new job after being dismissed, and this can discourage workers from demanding more from employers (Blanchflower and Oswald, 1994); therefore, the higher the level of unemployment in the region, the lower the wage rate.

A bargaining model is a process of a bilateral wage determination. It includes three components: a second-best wage or salary in case negotiations break down, the bargaining power of employees, and the profit-sharing rights that workers may have in a given firm. The key argument that supports the existence of a decreasing relationship between wages and unemployment rests on the second-best wage. The authors explain that this alternative form of pay is an income expectation determined by the current wage (w^0), the benefits in the event that workers become jobless (b), and on the unemployment level (U). The second best wage (a) is represented as:

$$a = b(U) + w^0(1 - U) = w^0 + U(b - w^0) \tag{26}$$

The unemployment condition usually makes a job search more complicated, and leads workers to accept the second best pay. However, one can argue that union workers have better opportunities than individual workers because unions have stronger bargaining power that may create a counter-balancing force during negotiations. As regards the shape of the wage curve, employees with greater profit-sharing in a firm tend to experience a smaller unemployment elasticity of wages, which implies a steeper wage curve than in a locale with fewer unions. Townsend (2005) adds that regions with more union workers are less susceptible to contemporaneous unemployment because the agreements reached between workers and employers usually last an average of three years. The mathematical representation of this approach follows the functional form presented by Menil (1971), which is a Nash bargaining model:

$$w_r \cong a + \frac{\eta}{1 - \eta} . \frac{\pi}{n} \tag{27}$$

The wage equation above indicates that the bargained wage w_r is determined by the three components explained above. First, by the second best wage (a), in cases where no agreement is reached, by the bargaining power of workers (η), and by the share of profits that

workers have in the firm. As a result, this type of model exhibits a negative relationship between wages and the unemployment level as $w_r'(U) < 0$.

3.3.3.3 Efficiency wage model

The third approach of the wage curve is the efficiency wage. This model asserts that firms unilaterally set salaries based on the workers' productivity, while the natural response of the worker is whether or not to shirk work based on this wage. The authors based their work on Shapiro and Stiglitz (1984), who assume that workers tend to shirk because it increases their utility by getting the same pay with less effort on the job. Under the assumption that firms are unable to accurately monitor worker performance, firms assign a premium wage rate to prevent workers from shirking. The former implies that firms are free to pay or punish workers with higher or lower wages depending on the quality of their work. Following this rationale, the authors add that during times of high unemployment, firms are free to apply severe economic punishment by reducing wage rates or by firing workers caught shirking. This set of conditions opens the possibility that firms adjust wage rates downward because economic conditions make the search for a new job more difficult. Therefore, high unemployment rates decrease the expected utility to be derived from shirking, which in equilibrium is the same utility as non-shirking. Finally, Blanchflower and Oswald (1994) conclude that the asymmetric information problem shapes the wage curve, and regions with firms with better developed controls over monitoring and supervision will experience less legible wage curves.

$$w_r = e_r + b_r + \frac{\gamma_r e_r}{(1-\gamma_r)[1-\alpha_r(U_r)]} \tag{28}$$

Equation (28) corresponds to the wage equation in region *r* and its determinants under the efficiency wage approach. Let w_r be the wage, e_r which is the level of disutility from work-effort, b_r is the benefit obtained from being unemployed; the probability of being detected and fired is $(1-\gamma_r) < 1$; and $\alpha_r(U_r)$ is the probability of finding a new job is a function of the unemployment rate, and these have the necessary conditions for being both a convex and decreasing functional form ($\alpha_r'(U_r) < 0,\ \alpha_r''(U_r) < 0$). This kind of wage equation indicates the above argument in which firms must pay premium wages in order to prevent shirking. However, it decreases in the presence of a higher unemployment rate that can be explained using the struggle a worker might face for finding a new job in the labor market.

3.3.4 The wage curve analysis for a developing country

The wage curve aims to demonstrate that labor conditions influence the wage determination. The unemployment is the indicator that serves as proxy to demonstrate such argument, and as explained before the results in many researches for many countries in different periods of time confirm such assertion. Even in few studied cases of developing countries, their results show that unemployment helps to shape the labor market conditions that influence negatively the wage determination.

However, the unemployment rate in developing countries such as Guatemala does not reveal properly the labor conditions of the country as the standard convention of the definition of unemployment contemplates two conditions: that people does not have a job, and they must be actively seeking for a job. The problem with such convention is that many people in developing countries are actually working in part time jobs that are characterized for having deplorable conditions, such as the informal sector. Fields (2011) confirms such argument by explaining that unemployment rates in developing countries are lower than in the developed ones, 4.4% and 8.4% in average respectively (International Labor Organization's –ILO-, 2011), and that such indicator is a poor measure of the labor market distress. For instance, as explained in Chapter 2, the unemployment rate in Guatemala is of about 3.4% in average during the last four years, but this indicator shows only one part of the labor conditions under which people is employed. In Guatemala the 69% of workers belongs to the informal sector, meaning that the worker benefits -such as steady and secure wage, social protection, and minimum labor standards- are not guaranteed. These are also undesirable labor market conditions as the unemployment, which may influence the wage determination. These conditions and the absence of public unemployment benefits in the country give people with no access to a decent job two options: to be unemployed (and receive zero income), or to be employed in the informal sector.

People that is already working may not want to leave their jobs if the outside labor conditions are deplorable. Those who have decent job may not want to bear the risk of losing it for an informal job, and people in the informal sector may not want to leave the current one for a worse job. Though in the latest scenario, workers are more prone to pursue a better options,

and hence are more inclined to bear a risk in case premium wages experiences a significantly decrease in their current job.

Although there is no consensus on a unique definition of the informal sector, one of the origins is explained by Harris and Todaro (1970), who explicate that the informal sector surges as a source of temporal employment for those people immigrating from the rural area and that do not find a decent job. Nowadays, some authors (Loayza, 1996; Ihrig and Moe, 2004; Prado, 2011) have approached the issue through fiscal analysis, in which people in the informal sector is part of an economy that is not taxed, others (Maloney, 2004) define it in a more broad framework by considering the informal sector as the part of the economy that escapes the government regulations in general; others define the sector in a simplistic and unclear way by defining the informality as the casual jobs, temporary jobs, unpaid jobs, subsistence agriculture, multiple job holding. However, the agreement is that the employment in the informal sector is often characterized by poor working conditions, poor pay and the absence of any labor standards for workers. ILO suggests that one way of measuring labor informality is through the underemployment, which comprises underutilized workers in terms of productivity capacity or duration of work. So, ILO defines two types of underemployment: the visible and non-visible underemployment. The visible underemployment is characterized by the insufficient hours of work (because he needs to work more hours) that an individual experiences during a specific period of reference. The non-visible underemployment is the insufficient hourly income of a worker, or is the misuse of occupational skills reflected in an inadequate productivity that causes imbalance between labor and other factors of production.

The intention in the present paper is not to measure the informal sector because it requires deeper understanding of other elements no considered here; however, to estimate a proxy by following the ILO's suggestion allows providing a better picture of the labor conditions of Guatemala. Therefore, going back to the wage curve analysis in which the labor conditions influence the wage determination, it is important to consider in the analysis of a developing country an element such as the underemployment because it represents a threat against the status of the workers. As a consequence, it is expected to observe a higher wage curve than using the standard analysis since the levels of underemployment are considerable higher than the unemployment rate.

Finally, the shadow or hidden unemployment is another labor market condition that may influence the wage determination in the market. It is defined as the unemployed people with the desired of working but is not actively searching it. (Gastwirth, 1973; Mincer, 1973) The shadow unemployment include discouraged workers -individuals that wishes to work, but are not looking for one because they believe that is not available at a desired wage-, teenager, students, and homemakers. They will incorporate to the labor force only if someone offers a job position with a specific desired wage.

Under the wage curve rationale, shadow unemployment would represent a real threat against the workers only if people is visible within the labor market, i.e. if these people is not actively competing for a job position then firms would not be aware of their interest or existence. Also, shadow unemployment may not represent a good instrument for explaining the changes in wages because of the problem of causality between the explained and explanatory variables. Thus, one way of the causality is that wages respond to the influence of unemployment which in turn responds to the fluctuations of the shadow unemployment. The size of the labor force can be affected by the inclusion of new workers that were belonging to the economically inactive population or labor reserve, and hence affect the unemployment rates. The other way of causality refers the shadow unemployment definition per se. The wage rate is the responsible of encouraging people to go back to the labor force, and hence the size of the labor force will change only if wages change.

3.4 The Mortensen and Pissarides Model

In principle, the basis of this theoretical labor market rests on recognition of the existence of search friction in labor markets. Search friction is understood as the mobility costs (monetary or non-monetary) that firms and workers face when trying to fill positions by firing and hiring workers, or the time it takes to find a job, respectively (Zenou, 2009). The former argument has other implications. For instance, some vacancies will be filled by unemployed job seekers, and both variables can grow at the same rate. In a mathematical manner, this situation is understood as a case of a constant return to scale function in a "matching function" (Pissarides, 1979).

$$M = m(U, V) \tag{29}$$

The above expression represents the number of jobs (M) created during a specific period of time. It will depend on both the number of unemployed people seeking jobs (U), and the number of job vacancies (V). This model uses a microeconomic foundation to explain aggregated variables, such as unemployment. Petrongolo and Pissarides (2001) explain that this model requires information from four sources in the labor market. First, aggregated data on job vacancies and unemployment, which are used to check their relationship known as the Beveridge curve. Secondly, information derived from aggregated data on the flows of unemployment and employment for an economy, which is particularly important for conducting an analysis of a labor market of a specific economic sector (e.g. manufacturing). Thirdly, it uses information about a labor market during a specific time period, and for either time-series or panel data. Fourthly, it requires information about transitions between unemployment to employment on the worker level.

It is important to understand how labor frictions work. They provide arguments that partially help explain the relationship between unemployment and wages in local labor markets. In other words, this model helps us understand why workers accept or refuse jobs, and why firms offer job vacancies under certain conditions. Workers and firms make decisions based on social and economic conditions in their locales such as unemployment benefits, imperfect information, heterogeneity within locales, opportunity of mobility, and congestion. The former suggest that both individual and locale factors play a role in determining the decision to accept or reject a job offer during the matching process. In addition, the model can take into account other elements that play an important role in the matching process, such as technological advances. They have demonstrated to society that virtual places (in informatics) can generate matches because they are fast, cheap and useful for advertising purposes for workers and firms.

The research literature on *search theory* has sought to understand the dispersion of equilibrium wages, i.e., if workers have the same productive skills, why they do they fail to obtain the same earnings? On the other hand, there is a need to understand how *labor-market tightness* (the number of offers over unemployed workers) determines the matching process between workers and firms. The former explains how the matching process is carried out

through a division of the surplus between firms and workers. This theoretical contribution is found in the work of Pissarides (1985), Pissarides and Mortensen (1994, 1999), and Burdett-Mortensen (1998), and their work involves the simplification of the search problem in a general equilibrium framework derived from the "Diamond paradox" (see Albrecht, 2011).

This model was designed to facilitate understanding of the equilibrium or "natural" rate of unemployment (Albrecht, 2011). The model has two sides, the workers and firms. One assumes a continuum of workers that is uniformly distributed along the interval [0,1], and each worker has preferences represented by:

$$E_0 \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t c_t \tag{30}$$

where c_t is consumption and r is the discount rate that is greater than zero. Workers are assumed to have linear utility over the consumption of a homogenous good, making them risk neutral under circumstances of uncertainty. Workers are employed or unemployed. In the first case, workers receive a payment of w for their services in a firm, and are not searching for a new job during the same period t. In the second case, when workers are not working at the beginning of the period t, they receive a payment of b, the unemployment benefit. It is expected that they will receive job offers that they are free to accept or reject.

The second part of the market is populated by an infinite mass of risk-neutral firms that have preferences that are reflected in the expression (31), where π_t represents a firm's profits, and x_t denotes any disutility experienced due to posting a vacancy during period t.

$$E_0 \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t (\pi_t - x_t) \tag{31}$$

The model requires a series of assumptions, such as firms discounting future income at the same rate as workers do, a firm is a job, all firms have the same productivity, a firm is also an input (entrepreneurship), a firm and a worker produce y units of homogeneous output during a period of time t, and that $y > b > 0$.

Workers and firms do not match immediately, and frictions occur in a labor market when finding or posting a job. Let the number of unemployed workers be (u_t), and a portion of the number of job vacancies (v_t) in a period t. Allow the number of matches be m_t which responds to the matching function $m_t = m(u_t, v_t)$. This is a continuous and increasing function in u_t and v_t, it is concave and homogeneous of degree 1. Also, $m(u_t, 0) = m(0, v_t) = 0$ for all $u_t, v_t \geq 0$. In addition, define the rate $\frac{v_t}{u_t}$ as θ_t, which is the *labor-market tightness*. Hence, the probability that an individual unemployed worker is matched with a job vacancy in period t is given by $\frac{m(u_t,v_t)}{u_t} = m\left(1, \frac{v_t}{u_t}\right) = m(1, \theta_t)$; and the probability that a firm will match a posted-vacancy with a worker is $\frac{m(u_t,v_t)}{v_t} = m\left(\frac{u_t}{v_t}, 1\right) = m\left(\frac{1}{\theta_t}, 1\right)$. Therefore, when *labor-market tightness* is quite restrictive, the chance of a firm matching a posted vacancy is higher, i.e., $\lim_{\theta \to 0} m\left(\frac{1}{\theta}, 1\right) = 1$. On the other hand, when *labor-market tightness* is non-restrictive with regard to job offers, the chance of an unemployed worker of finding a job is high, say $\lim_{\theta \to \infty} m(1, \theta) = 1$.

Once workers and firms meet, they set up a contract for a period t, at the end of which, the worker has the probability δ of being separated from the firm. If the firm fails to make any matches, it will incur a cost of k for each period until it obtains a match. Finally, any firm that does not post any vacancies and finds no matches will receive zero utility.

In the steady state equilibrium, the mass of unemployed workers and the mass of firms that post vacancies in every period t are represented as $u_t = u$ and $v_t = v$, respectively. In addition, the model considers two flows of movement of workers between unemployment and employment. From unemployment to employment, there is an endogenous flow rate of the labor-market tightness $\alpha(\theta) = \frac{m(u_t,v_t)}{u_t} = m(1, \theta_t)$, and in the opposite direction there is an exogenous flow rate of job separation δ. The former implies that in the steady state the unemployment rate is determined as follows:

$$\alpha(\theta)u = \delta(1 - u) \quad \rightarrow \quad u = \frac{\delta}{\delta + \alpha(\theta)} \tag{32}$$

The above expression (32) shows the relationship in equilibrium (unique) between job vacancies and unemployment. Pissarides (2000a) argues that this is the first key equation in the model. It is known as the *Beveridge Curve*.

Following the steady state condition, once there is a match of workers negotiating a wage w for their services with the firms, and those firms obtain profits from their services, the process is known as *job creation*. So, allow the value of the match to a worker obtaining a wage w be $W(w)$, and the value of the match to a firm paying the wage w be $J(y-w)$. As regards those workers who remain unemployed, U denotes their value for maintaining their status quo. V represents the value to a firm of posting a vacancy. Therefore, workers and firms will reach an agreement at some wage w if their surplus from the match exceeds or is equal to zero (their values are denoted as $W(w)-U \geq 0$ and $J(y-w)-V \geq 0$, respectively). The total surplus from the matching is then represented as the sum of the individual surpluses $(W(w)+J(y-w)-U-V)$, providing the basis of the determination of the equilibrium wage under the Nash Bargaining model (Pissarides, 2000) as follows:

$$w = \arg\max_{w'} \left[W(w') - U\right]^{\alpha} \left[J(y-w') - V\right]^{1-\alpha} \tag{33}$$

Subject to

$$W(w') - U \geq 0$$

$$J(y-w') - V \geq 0$$

Here α is a parameter that measures the worker's power in the bargaining process, and has a range $0 \leq \alpha \leq 1$. The authors argued that the goal of this optimization is not to solve an individual agent problem, but rather to obtain an outcome from a bargaining process between workers and firms. Thus, the optimal outcomes require two steps. First, the discounted values

(at rate r) of $W(w)$, $J(y-w)$, U and V are obtained. These can be obtained using some mathematical strategies:[6]

$$rW(w) = w + \delta[U - W(w)]$$

$$rJ(y-w) = y - w + \delta[V - J(y-w)]$$

$$rU = b + m(1,\theta)(W - U)$$

$rV = -k + m\left(\frac{1}{\theta}, 1\right)(J - V)$ where $U - W(w)$ is capital loss associated with returning to unemployment.

$V - J(y-w)$ is the capital loss for having a job position be a vacancy.

$(W - U)$ is the expected gain when the worker is hired by a firm.

$(J - V)$ is the surplus obtained from the matching process

In the second step, the steady state firms have a value $V = 0$ because they are indifferent between the alternatives having a zero value on J , and posting a vacancy. Thus, the new total surplus is:

$$S = W + J - U \tag{34}$$

In addition, the maximization problem above yields:

$$\alpha[J(y-w) - V] - (1-\alpha)[W(w) - U] = 0 \tag{35}$$

The two equations above lead to the conclusion that with Nash Bargaining the workers and firms will obtain a constant fraction α and $(1-\alpha)$, respectively, from the total surplus. Consequently, solving the variables generates the following values:

The total surplus, $S = \frac{k}{(1-\alpha)m\left(\frac{1}{\theta},1\right)}$

(36)

The wage curve, $w = y - (r+\delta)(1-\alpha)S$

[6] It requires the use of Bellman equations. See Pissarides (2000)

(37)

The worker value when employed, $W = \frac{w+\delta\alpha S}{r}$

(38)

The worker value when unemployed, $U = \frac{w+(\delta-r)\alpha S}{r}$

(39)

Once a job is created, a firm's production continues until a negative idiosyncratic shock hits the firm. As a consequence, such an occurrence decreases the firm's value $J(y-w)$ until the job position is terminated, and the worker moves from being employed to being unemployed; the former is known as *job destruction*.

As regards the notions *job creation* and *job destruction*, the reasoning can be expanded into the *job chain* approach. Persky *et al.* (2004) argues that job creation can be originated from job positions that are already occupied for a worker, i.e. if a worker move into a new job position, the space he is leaving attracts other workers from other jobs, and so on down with other workers. The authors mention that such chain is broken when a job position is occupied by someone who was previously unemployed, or by someone that is immigrant and is looking for a job. This notion serves as platform to understand the linkages between labor markets from different regions. For instance, a potential case where employment from suburban areas can initiate a job chain and breaks down in the inner city: a person who is traveling many miles to his work may want to find a job near to his house (say in suburbs) looking to reduce transportation costs, and once he gets the job and accept it, his old job position will be open for someone else that is working and looking for a new job, this last position will be available for someone else until is filled by an unemployed or immigrant, which is when the chain breaks. Thus, when looking into the immigrants' case, it is possible to argue that people moving from other regions will not necessarily join the unemployed labor force as stated in the Todaro paradox.

3.5 Wage Equations and multi-markets

This section highlights the importance of recognizing markets as economic spaces or regions, while also emphasizing how they are economically interrelated. Earlier discussion centered on how workers and firms react to labor market conditions within their region, including the driving forces that motivate workers and firms to move between places, and how wages are set. Existing research focuses on wage equations, so it is important to consider regional interrelations in a country that go beyond differentiating between rural-urban or core-periphery areas, and to include effects of neighboring areas. Very few papers have explored these issues (Longhi *et al*, 2006; Palombi and Fingleton, 2013); fewer still have analyzed them in developing countries (Baltagi *et al*., 2012).

Longhi *et al*. (2006) evaluate the performance of the wage curve by considering the geography of labor markets. They point out that if the wage curve is analyzed from the efficiency wage angle, the changes of wage will depend on the costs of geographical labor mobility. Such costs can be high, and may discourage workers from seeking more suitable employment in other regions, where they would have to commute daily, or to migrate entirely. This condition gives monopsonic power to the employers to determine wages, as explained above. Further, Longhi *et al*. (2006) mention that locales surrounded by regions with higher wages tend to lose local workers to these higher-wage-paying regions; thus, employers with monopsonic power will have to increase their wages to either retain their workers or to attract more employees, if necessary. The authors also add the findings of Buettner (1999) with regard to unemployment in neighboring regions. Buettner (1999) finds that the unemployment rate of neighboring regions diminishes workers' capacity of negotiation, becoming a potential threat to these workers as markets tighten. From the econometric point of view, Longhi *et al*. (2006) found that the sum of the local and neighboring effects is greater than the elasticity estimated in a model without spatial considerations, so ignoring the spatial configuration may produce misleading results. Longhi *et al*. (2006) show that the results obtained from the wage curve in more isolated places are stronger than in agglomerated regions. This is justified by the mobility costs associated with job search, which can be higher if the place is located in remote regions.

Palombi and Fingleton (2013) argue that most of the wage curve literature ignores the role of employment conditions of proximate labor markets, such as wages and unemployment rates. As such, it essentially neglects the interactions between regional economies. Such an

oversight raises potential problems of bias estimation of the variables (Baltagi *et al*., 2012), since the unemployment rate of a region is usually spatial correlated in clustered areas (Sato, 2000). Thus, Palombi and Fingleton (2013) implement a wage curve functional form in which the spatial interaction of wages and unemployment are present, and test it against two other alternative earning specifications such as the NEG wage equation and the urban economics (UE) model. Both of these are differentiated by the importance attributed to the market linkages; that is, NEG focuses on the inter-regional linkages, while the UE is motivated by the intra-regional linkages. The conclusion of Palombi and Fingleton (2013) is that the wage curve holds as predicted by Blanchflower and Oswald (year) even with a spatial configuration, but when compared against the other two models, the wage curve seems to be not superior in statistical terms. It is important to consider this robust result because it proves that the inclusion of spatial linkages is not only important, but demonstrates that it is not part of a misspecified model.

Considering spatial linkages in the wage equations helps to clarify the key issues of the integration of labor markets. It is clear that labor markets in the examined regions are influenced by the labor conditions of the neighboring regions. In fact, Manning and Petrongolo (2013) ask, "How local are labor markets?" This is because the spatial configuration of a region has significant policy implications with respect to effectiveness; for instance, if a labor market is very local (i.e., it has a poor interrelation with other markets), then a policy of intervention in the labor market will be more effective in the disadvantaged places; on the other hand, if the labor market of a region is highly linked with those of its neighbors, then intervening in the underprivileged region may produce negative results in the economy, including the migration of workers from advantaged places. Thus, the understanding of the spatial linkages of the labor markets provides a map of the performance of wages and incidence of unemployment in regions, which in turn gives intervention policies the opportunity to be more meaningful and efficient.

Chapter 4: Wage equations and Guatemalan applications

4.1 Hypothesis of the research

As mentioned before, the regions in Guatemala are economically different when looking at the distribution of occupations by industry, unemployment rates, and wages. Likewise, there exists a pattern of wage concentration in the country, in which the metropolitan area concentrates the highest wages as it has the most competitive labor market of the country, and hence motivates to migrate into such an area because of better economic incentives. It is argued that this occurrence will persist as the metropolitan area is primarily dedicated to the services and manufacturing industries, implying that skilled labor will prefer to work in such a region, even as the area reports also the highest rates of unemployment. In addition, underemployment is present in all regions, and it is more relevant than unemployment as shown before. This situation opens the scenario for an additional analysis based on the underemployment, which is the latent variable not contemplated in previous researches for the Guatemalan case and other developing countries, when trying to explain the labor market conditions for wage determination. This description provides the characterization of the labor market in Guatemala, in which they play an important role in shaping the patterns of wage distribution and wage determination; hence, two hypotheses can be drawn.

Regarding the flows of internal migration, it is discussed that labor market conditions may play an important role in attracting workers into specific areas, mainly into the metropolitan area. Assuming that wages and job opportunity are the incentives for economic agents to move across regions in Guatemala, the first hypothesis is that the economic development of the locales, represented by the market access of the new economic geography (NEG) analysis, explains the spatial wage distribution in Guatemala during 2006-2011, and hence the flows of migration based on labor incentives. Through this statement, I explore whether it is possible to unveil some pattern of country-wide wage distribution that responds to the elements of transportation costs, imperfect competition, and increasing returns. Based on the economic description of Guatemala in chapter 2, one can expect that the incentives of the flows of internal migration are driven by the economic advantage that metropolitan areas have over other regions of the country in terms of wages, infrastructure, transportation costs, etc.

Therefore, we expect to observe an association between the economic development of a locale represented by an index of market access and wages. This premise is sustained by the argument that agglomeration effects of the core region on the rest of the country provide a possible explanation for the decision of economic agents to move due to income, prices, and trade costs. If the results reveal that NEG influences the spatial wage distribution, then it will be capable of providing essential tools that definitively explain indirectly the internal migration in Guatemala.

On the other hand, the descriptive analysis presented in chapter 2 reveals not only that wages differ across regions, but that real wages in all regions are declining. It is assumed that the environment created by the local and neighboring labor market conditions have a strong influence on the wage determination in each Guatemalan region during 2006-2011. This statement assumes that firms have monopsony power in the regions to recruit workers as firms are in position of determining wage rates based on the labor market conditions. Unlike what has been argued by Blanchflower and Oswald regarding the negative relationship between unemployment and wages, the present statement includes the evaluation of the roll of the underemployment over wages to test not only that unemployment is responsible in part of the low wages, but that underemployment (which may represent in part the informal sector of employment) may constitute a greater threat against workers in the country.

Hence, formally, the second hypothesis is that wages in developing countries, such as in Guatemala, are more prone to be affected by the underemployment rather than unemployment during 2006-2011. Furthermore, regions are not territorially large in Guatemala, and workers may also respond to labor market conditions of the neighboring regions which, as described in chapter 3, may reinforce the influence of local market conditions.

Analysis of such a statement provides the necessary tools for spatially comprehending the labor market of Guatemala; furthermore, it complements traditional research on the country's labor market when looking into regional linkages. This claim tests a modified version of the Blanchflower and Oswald wage curve, and extends it into spatial analysis. The importance of the second hypothesis rests on the claim done by Blanchflower and Oswald (2005), who states that the wage curve exists in almost every country. However, the implicit question rests on the international comparison of the labor market conditions, i.e. are them the

same in all countries? In Guatemala, unemployment may not be that relevant as there exist great participation of labor in the underemployment, and great level of poverty. This is an exercise that will give the opportunity to extend the theory of wage curve beyond the analysis of the effects of unemployment. Also, on the side of the spatial analysis, few authors have addressed such topic within this theory, which highlights even more the results for policy implications.

Each hypothesis is tested under a different methodology; their results are discussed in the following sections.

4.2 NEG wage equation

The NEG wage equation is estimated under a pooled cross section approach containing variables in log terms. This equation explains that wage rates depend on market potential (equation 40). The incorporation of such variables uses the methodology proposed by Fingleton (2009), Head and Mayer (2005), and Redding and Venables (2004), in which labor efficiency becomes part of the mechanism of association. Thus, the rationale for the model takes four assumptions into account.

First, the efficiency of the workers is an important factor in the process of production. Second, technology is assumed to be homogeneous across regions. The skills of the workers thus make a difference in production levels, meaning that productivity is more efficient where labor is more skilled. The extended model of the wage equation is shown in equation (41), and contains the new variable that describes the efficiency *A* for region *i*.

$$\ln w_i^M = \frac{1}{\sigma} \ln P_i \tag{40}$$

$$\ln w_i^M = \frac{1}{\sigma} \ln P_i + lnA_i \tag{41}$$

Third, having an efficient labor force depends on the level of education and on the public capital stock endowed in each region. Fourth, there are spillover effects. The level of efficiency in a given region is influenced by the variables of human capital and public capital

endowed in other regions. These characteristics are exhibited in equation (42), where *X* represents the vectors of variables that contain information about the locale that influence labor efficiency; *W* represents the spatial matrix that explains the neighbor spillover effect upon the region under analysis; finally, the vector ε represents the random shocks generated by other variables not included in the model.

$$\begin{gathered} lnA = \rho W lnA + Xb + \varepsilon \\ \varepsilon \sim N(0, \Omega^2) \\ \ln A = (I - \rho W)^{-1}(Xb + \varepsilon) \end{gathered} \tag{42}$$

As mentioned above, the underlying assumption in this paper is that human capital (HC) and public investment (PK) variables are determinants of the level of labor efficiency, and, hence, for the level of wage rates within the regions. Thus, higher levels of human capital lead to higher levels of labor efficiency. In addition, the greater the public capital stock, the better the conditions for labor to perform, resulting in higher efficiency. The equation (42), therefore, has the vector of *X* that contains such variables. The weight matrix has a dimension of (R×R), and this captures the regional interaction for the R regions in the system. The degree of interaction within the W matrix is denoted by (w_{ij}). This will be zero when two regions do not interact, or when the comparative analysis of one region is made with respect to the same region $(i = j)$. In addition, the value of (w_{ij}) will be non-zero when two regions interact. In this paper, the contiguity matrix, the queen matrix, and the inverse distance matrix are considered to check the robustness of the regression.

Equation (43) represents the incorporation of equation (42) into equation (41), the measurement error is τ, and for the sake of simplicity we assume that $\frac{1}{\sigma} = a$; thus, the theoretical base model is represented as follows:

$$\begin{gathered} \ln w^M = a \ln P + (I - \rho W)^{-1}(Xb + \varepsilon) + \tau \\ \tau \sim N(0, \Pi^2) \end{gathered} \tag{43}$$

For the sake of convenience in the elaboration of the nested models, and using Fingleton's modeling (2006, 2008, 2009), equation (43) is pre-multiplied by $(I - \rho W)$. This procedure provides the option of proposing different models to help promote robustness in the results.

$$(I-\rho W)\ln w=(I-\rho W)a\ln P+(Xb+\varepsilon)+(I-\rho W)\tau$$
$$\ln w=\rho W\ln w+a_1(\ln P-\rho W\ln P)+(Xb+\varepsilon)+(I-\rho W)\tau \quad (44)$$

Equation 44 contemplates the estimation of the parameter ρ by following Fingleton's strategy used in his 2006 and 2009 papers, the objective of which is to accommodate the endogeneity of the spatial lag of wages ($W\ln w$). The process includes an iterative routine of estimations that initiates with $\rho=\rho_1$ which helps to estimate ($\ln P-\rho_1 W\ln P$); the model is then regressed to obtain a new $\rho=\rho_2$, which is used to recalculate ($\ln P-\rho_2 W\ln P$) the complete model and to obtain $\rho=\rho_3$, and to continue the iteration until $\rho_i-\rho_{i-1}<0.00001$. Finally, the variables of X are substituted for human capital HK (education attainment) and public capital PK (infrastructure), and for the simplicity of the model, the moving average of the errors is dropped. The models to be run are represented in table 6:

Table 6. Nested models

	Assumption	Model
I)	Full model	$\ln w=\rho W\ln w+a_1(\ln P-\rho W\ln P)+(+a_0+a_2 lnHK+a_3 lnPK+a_4 WlnHK+a_5 WlnPK)+\varepsilon$
II)	Without HK and PK spillover effect	$\ln w=\rho W\ln w+a_1(\ln P-\rho W\ln P)+(a_0+a_2 lnHK+a_3 lnPK)+\varepsilon$
III)	Public Capital has no influence	$\ln w=\rho W\ln w+a_1(\ln P-\rho W\ln P)+(a_0+a_2 lnHK)+\varepsilon$
IV)	PK has not influence and spillover effect from market potential is removed	$\ln w=a_1\ln P+(a_0+a_2 lnHK)+\varepsilon$
V)	No spillover effects at all	$\ln w=a_1\ln P+(a_0+a_2 lnHK+a_3 lnPK)+\varepsilon$
VI)	Exogenous spatial lags in HK and PK	$\ln w=a_1\ln P+(a_0+a_2 lnHK+a_3 lnPK+a_4 WlnHK+a_5 WlnPK)+\varepsilon$
VII)	Exogenous spatial lag only in HK	$\ln w=a_1\ln P+(a_0+a_2 lnHK+a_3 lnPK+a_4 WlnHK)+\varepsilon$
VIII)	Simple market potential	$\ln w=a_1\ln P+(a_0)+\varepsilon$

4.2.1 Data for NEG equation

This paper uses data from approximately 23,947 individuals (people) belonging to 22 departments in Guatemala for two years. Such information comes from the two living standard surveys (ENCOVI) of 2006 and 2011. These surveys provide information on wages at the individual level educational attainment, demography, and labor market indicators that help to construct the unemployment and underemployment rate per department. Table 7 shows the summary statistics of the data used in this research. Regarding nominal wages, people reported the wages earned per month and hours worked in the last week; this information serves to construct the hourly wages by assuming that the months have on average 4.2 weeks. The real hourly wage is obtained by deflating the nominal hourly wage by the consumer price index of each region that is reported by INE for each year.

"Education level" is represented by seven dummy variables that correspond to no-education, kindergarten, elementary education, middle school, high school, undergraduate, and graduate studies. The "Ethnic" variable refers to the distinction between indigenous peoples and Ladinos. The "Social Security" variable indicates whether the worker has some affiliation to the social security institute of Guatemala (IGSS). This variable serves only to distinguish who is not in the informal sector, though it does not actually reveal the real labor market structure. "Gender" represents the distinction between men and women. In addition to the information in the table, it is considered the use of 12 industry dummy variables such as agriculture, mines, manufacturing, electricity, construction, commerce, transportation and communications, banking services, government, education, health care, and other. Likewise, workers are distinguished by 9 occupational categories: public sector employee, private sector employee, day laborer, domestic employee, non-agricultural self-employee, agricultural self-employee, non-agricultural employer or master, agricultural employer or master, and unpaid family worker.

Table 7. Summary Statistics

Variable	Year	Mean	Stand. Dev.	N
Nominal wage	2006	5.7528	3.1555	11721
	2011	6.3569	3.1052	12227
Regional CPI	2006	156.2748	3.1555	8
	2011	212.2310	3.1052	8
Population	2006	13,018,759		
	2011	14,713,763		
Public Capital	2006	469,081	492,282	22
	2011	570,728	618,894	22
Education level	2006	3.1114	1.2981	11721
	2011	3.1129	1.3023	12227
Age	2006	31.1364	13.6391	11721
	2011	31.8576	13.7174	12227
Ethnic	2006	0.6861	0.4641	11721
	2011	0.6536	0.4758	12227
Social Security	2006	0.3231	0.4677	11721
	2011	0.2458	0.4305	12227
Gender	2006	8,567	0.4435	11721
	2011	9,022	0.4398	12227
Unemployment	2006	0.0175	0.0082	22
	2011	0.0353	0.0101	22
Underemployment	2006	0.5760	0.0963	22
	2011	0.6789	0.0627	22

Moran's test		Neighboring wage	
		2006	2011
Wage	2006	0.5946***	
	2011		0.6454***

Source: ENCOVI 2006 and 2011, INE 2013
1) Wages are nominal and it is hourly.
2) CPI base year: 2000.
3) Education refers to the level reached.
4) Ethnic: 0 for indigenous and 1 for Ladinos.
5) Social security: 0 don't have, 1 have social security.
6) Gender 0 for woman and 1 for man.
7) Unemployment and underemployment per department.
*** Significant at 1%

The market potential is constructed using equation 23, and compares the use of income, prices for each department, and the transportation costs between departments. The variable of income is included in the set of information provided by ENCOVI; prices are those used in the estimation of real wages described above; for transportation or trade costs, this paper assumes that costs correlate with distances (Hanson, 2001; Brakman, *et al*., 2004). Thus, there are two scenarios to consider. First, when measuring the distances between departments, the costs are estimated by assuming that they increase with the distance between departments *i* and *j*.

Second, distances within departments are taken to be zero. The parameter sigma in the final estimation of the market access is set to 6.25 as suggested by earlier literature in Fingleton and Longhi (2013).

For the public capital stock, the estimate is based on the amount of money spent by every municipality for roads, sewers, water, electricity production, and other kinds of infrastructure that complement the process of the production of firms, or which complement the level of utility or satisfaction of the inhabitants in each municipality. This information was obtained from the INE, and was transformed on a perpetual inventory basis, standardized according to the population of each municipality and deflated using regional price indexes to obtain data in real terms.

4.2.2 Results

Tables 8 and 9 show the first group of estimates of the wage equation of the NEG model. They include the results of equation (43), and assume that the parameter rho is zero in obtaining a baseline model. The estimates are obtained from pooled cross section models with the control variables of public capital, schooling, age, ethnic group, social security and gender; they also include dummy variables for industry and category of occupation, department, and time fix effects. The difference between both tables of estimations consists in the inclusion of neighboring effects of public capital and real hourly wages. Both tables report that all estimates are statistically significant, showing consistent results across the nested models.

Although the estimates of market access are statistically significant—on average across the eight nested models the elasticity is of about 0.02 in table 8 and 0.004 in table 9—these estimates are considerably lower when comparing them against findings in other developing countries such as in Brazil with elasticities of above 0.3 (Vasconcelos *et al.,* 2007) and 0.15 (Monteiro, 2006); and in the Spanish case, for which Lopez *et al.* (2008) report an elasticity of about 0.08. The results in the present paper can be interpreted as follows: from column 1 of table 8, if market access increases on average 1%, the individual wages will be on average in 0.04% higher; from in column 1 table 9, if market access increases on average 1%, the individual wages will increase on average 0.01%. Thus, these results seem to explain the spatial distribution of wages in Guatemala, though poorly. As for the control variables, in column 7 of table 8, all of them are

statistically significant and report the expected sign. For instance, for every level of schooling reached by the worker, wages are reported to be 19.2% higher on average. The experience of workers that is represented by their age has positive effect on wages, but diminishing as years pass. Women earn 18.0% less than men. Those with social security earn on average 26.7% more than those who do not have such a social benefit. Ladinos earn 9.90% more than indigenous workers. Finally, when controlling for public capital, for every 1% of increase on this expenditure, the individual wages are 0.049% higher. When the model control for region fixed effect, the estimate of market access becomes smaller and negative, while the rest of control variables continue to be consistent as before.

Table 8. Market Access: without neighboring influence

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Market Access	0.044 ***	0.04 ***	0.021 ***	0.02 ***	0.013 ***	0.017 ***	0.018 ***	-0.007 **
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Dummy (Time)		-0.142 ***	-0.177 ***	-0.174 ***	-0.151 ***	-0.151 ***	-0.126 ***	-0.124 ***
		(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.008)
Public Capital			0.04 ***	0.046 ***	0.04 ***	0.046 ***	0.049 ***	-0.032 *
			(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.019)
Schooling			0.347 ***	0.323 ***	0.26 ***	0.263 ***	0.192 ***	0.182 ***
			(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Age			3.54 ***	3.518 ***	2.882 ***	2.985 ***	2.617 ***	2.646 ***
			(0.121)	(0.12)	(0.116)	(0.114)	(0.111)	(0.108)
Age^2			-0.474 ***	-0.473 ***	-0.388 ***	-0.405 ***	-0.355 ***	-0.361 ***
			(0.018)	(0.018)	(0.017)	(0.017)	(0.016)	(0.016)
Ethnic				0.14 ***	0.1 ***	0.103 ***	0.099 ***	0.063 ***
				(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
Social security					0.337 ***	0.333 ***	0.267 ***	0.242 ***
					(0.008)	(0.007)	(0.008)	(0.008)
Gender						0.215 ***	0.18 ***	0.185 ***
						(0.007)	(0.008)	(0.008)
Region fixed effect	no	no	no	no	no	no	no	yes
Dummy (Industry)	no	no	no	no	no	no	yes	yes
Dummy (Occupation)	no	no	no	no	no	no	yes	yes
Observations	23,947.00	23,947.00	23,947.00	23,947.00	23,947.00	23,947.00	23,947.00	23,947.00
F	924.363	652.417	1058.44	975.215	1167.875	1178.138	530.664	326.089
Prob > P	0	0	0	0	0	0	0	0
R-Squared	0.037	0.052	0.21	0.222	0.281	0.307	0.357	0.386

Standard errors in parentheses
Note: In logarithm terms.
* p<.1,* * p<.05,* ** p<.01

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Furthermore, table 9 shows similar behaviors in the same estimates described above, but neither public capital nor neighboring public capital are consistently significant. Neighboring wages have a positive and strong influence on local individual wages. When the average of wages in neighboring regions increases by 1%, the local individual wages report an increase in

average of 0.97%, which suggests a strong spatial correlation that can be confirmed in the in the spatial Moran-test described above. However, the inclusion of neighboring variables may introduce a source of endogeneity in a least squared model, so table 10 presents estimates with the iterative model proposed by Fingleton (2006 and 2009) from equation 44. One of the goals here is to have a complete setting of variables explaining the behavior of individual wages through the consideration of neighboring wages while accommodating the endogeneity influence. Therefore, the expression $(\ln P - \rho W \ln P)$ referred in the strategy (table 6) is interpreted as the market access.

Table 9. Market Access: with neighboring influence

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Market Access	0.012 ***	0.009 ***	0.003	0.003 **	0.000	0.003 *	0.004 **	-0.005
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)
Neighboring wage	1.194 ***	1.541 ***	1.233 ***	1.139 ***	0.929 ***	0.928 ***	0.976 ***	0.808 ***
	(0.027)	(0.037)	(0.035)	(0.038)	(0.037)	(0.037)	(0.035)	(0.173)
Public Capital		-0.015 **	-0.01	-0.016	-0.026	-0.043 ***	-0.031 *	-0.025
		(0.007)	(0.018)	(0.018)	(0.017)	(0.017)	(0.016)	(0.02)
Dummy (Time)		0.139 ***	0.061 ***	0.042 ***	0.021 **	0.018 *	0.054 ***	0.046
		(0.01)	(0.01)	(0.011)	(0.01)	(0.01)	(0.01)	(0.036)
Neighboring Public Capital			0.004	0.022	0.042 *	0.078 ***	0.062 ***	-0.092
			(0.026)	(0.026)	(0.025)	(0.025)	(0.024)	(0.14)
Schooling			0.318 ***	0.312 ***	0.256 ***	0.259 ***	0.188 ***	0.182 ***
			(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Age			3.435 ***	3.436 ***	2.864 ***	2.968 ***	2.611 ***	2.642 ***
			(0.118)	(0.117)	(0.114)	(0.112)	(0.109)	(0.108)
Age^2			-0.463 ***	-0.463 ***	-0.387 ***	-0.404 ***	-0.356 ***	-0.36 ***
			(0.017)	(0.017)	(0.017)	(0.017)	(0.016)	(0.016)
Ethnic				0.046 ***	0.027 ***	0.03 ***	0.025 ***	0.062 ***
				(0.008)	(0.008)	(0.007)	(0.007)	(0.008)
Social security					0.311 ***	0.307 ***	0.24 ***	0.242 ***
					(0.008)	(0.007)	(0.008)	(0.008)
Gender						0.218 ***	0.178 ***	0.185 ***
						(0.007)	(0.008)	(0.008)
Region fixed effect	no	no	no	no	No	no	no	yes
Dummy (Industry)	no	no	no	no	No	no	yes	yes
Dummy (Occupation)	no	no	no	no	No	no	yes	yes
Observations	23,947.00	23,947.00	23,947.00	23,947.00	2,403.00	2,404.00	23,947.00	23,947.00
F	1488.929	797.976	997.695	892.014	1026.731	1057.385	539.081	313.381
Prob > P	0	0	0	0	0	0	0	0
R-Squared	0.111	0.118	0.25	0.251	0.3	0.327	0.378	0.386

Standard errors in parentheses
Note: In logarithm terms.
* p<.1,* * p<.05,* ** p<.01

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Table 10 shows that all estimates are similar to those in table 8 and 9. That is, all estimates are statistically significant, and in particular the market access: for every 1% increase

of the market access, individual wages will report an increase of 0.004%, a very inelastic value. The rest of control variables are very similar to those in tables 8 and 9, respectively.

Table 10. Market Access: Iterative process with neighboring wage influence

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Neighboring wage	1.085 ***	1.037 ***	0.992 ***	0.968 ***	0.000	0.992 ***	0.962 ***	0.99 ***	0.82 ***
	(0.034)	(0.033)	(0.032)	(0.034)	(0.035)	(0.035)	(0.035)	(0.034)	(0.169)
Market Access	0.008 ***	0.004 **	0.004 *	0.003	0.003	0.004 *	0.004 **	0.004 **	-0.007 *
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)
Dummy (Time)	0.077 ***	0.06 ***	0.037 ***	0.03 ***	0.019 *	0.046 ***	0.037 ***	0.054 ***	0.05
	(0.009)	(0.009)	(0.009)	(0.009)	(0.01)	(0.01)	(0.01)	(0.01)	(0.036)
Ethnic	0.065 ***	0.034 ***	0.024 ***	0.027 ***	0.03 ***	0.026 ***	0.027 ***	0.024 ***	0.062 ***
	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
Social security	0.416 ***	0.362 ***	0.307 ***	0.307 ***	0.307 ***	0.288 ***	0.228 ***	0.24 ***	0.242 ***
	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)
Gender	0.208 ***	0.219 ***	0.216 ***	0.216 ***	0.218 ***	0.201 ***	0.182 ***	0.178 ***	0.185 ***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)
Schooling		0.229 ***	0.26 ***	0.26 ***	0.259 ***	0.214 ***	0.205 ***	0.188 ***	0.182 ***
		(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Age			2.968 ***	2.968 ***	2.969 ***	2.737 ***	2.729 ***	2.611 ***	2.641 ***
			(0.112)	(0.112)	(0.112)	(0.11)	(0.11)	(0.109)	(0.108)
Age^2			-0.403 ***	-0.403 ***	-0.404 ***	-0.372 ***	-0.371 ***	-0.356 ***	-0.36 ***
			(0.017)	(0.017)	(0.017)	(0.016)	(0.016)	(0.016)	(0.016)
Public Capital				0.01 *	-0.045 ***	-0.041 **	-0.034 **	-0.033 **	-0.021
				(0.006)	(0.017)	(0.017)	(0.017)	(0.016)	(0.02)
Neighboring Public Capital					0.085 ***	0.074 ***	0.073 ***	0.07 ***	-0.11
					(0.025)	(0.024)	(0.024)	(0.024)	(0.14)
Region fixed effect	no	no	no	no	no	no	no	no	yes
Dummy (Industry)	no	no	no	no	no	yes	no	yes	yes
Dummy (Occupation)	no	no	no	no	no	no	yes	yes	yes
Observations	23,947.00	23,947.00	23,947.00	2,403.00	2,404.00	2,414.00	23,947.00	23,947.00	23,947.00
F	1291.358	1361.441	1289.843	1161.284	1057.253	611.152	832.393	538.978	313.422
Prob > P	0	0	0	0	0	0	0	0	0
R-Squared	0.245	0.285	0.327	0.327	0.327	0.36	0.358	0.378	0.386

Standard errors in parentheses
Note: In logarithm terms.
* p<.1,* * p<.05,* ** p<.01

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Table 11 shows the results of the spatial panel data, and it is delimited to the department and 2 years of information. The objective of including such a model is to control for the spatial spillover. The model includes the variables of public capital, neighboring public capital, schooling, unemployment, and underemployment. Overall, the results which are represented by the direct and indirect impacts show that market access is negative and statistically not significant; thus, it is not possible to provide an interpretation of the estimate. The control variables such as public capital, neighboring public capital, and schooling in column 2 show that their direct impacts are 0.32, -0.65 and 1.38, while the indirect impact is only significant in the schooling when reporting an impact of 1.54.

Table 11. Spatial panel data

Estimates	*1*	*2*	*3*	*4*
Market Access	0.003	-0.004	-0.006	-0.003
	(0.005)	(0.005)	(0.005)	(0.005)
Public Capital	0.18*	0.152**	0.164**	0.165**
	(0.088)	(0.055)	(0.056)	(0.054)
Schooling	0.975***	0.653***	0.73***	0.722***
	(0.145)	(0.124)	(0.131)	(0.12)
Neighboring Public Capital	-0.278*	-0.307***	-0.314***	-0.286**
	(0.13)	(0.085)	(0.089)	(0.089)
Unemployment			-0.015.	
			(0.009)	
Underemployment				-0.32***
				(0.059)
Impacts	*1*	*2*	*3*	*4*
Market Access				
Direct	0.006	-0.009	-0.012	-0.004
Indirect	0.004	-0.01	-0.011	-0.003
Public Capital				
Direct	0.33*	0.321***	0.327***	0.278***
Indirect	0.242	0.359	0.307	0.158
Schooling				
Direct	1.787***	1.378***	1.454***	1.22***
Indirect	1.312	1.542*	1.367	0.692
Neighboring Public Capital				
Direct	-0.51*	-0.648***	-0.626***	-0.483***
Indirect	-0.374	-0.725	-0.588	-0.274
Unemployment				
Direct			-0.031*	
Indirect			-0.029	
Underemployment				
Direct				-0.54***
Indirect				-0.306

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4.2.3 Discussion

The purpose of using the NEG wage equation is to test whether or not the market access in Guatemala influences the spatial distribution of wages. Almost all specifications presented above show that the market access estimates are statistically significant but very small, meaning that any variation will have little impact on wages. This result is not congruent with empirical literature regarding other countries, as most of them report elasticities in a range between 0.1 and 0.85. (Some empirical evidence: Brakman *et al*., 2004; Fomchenko, 2008; Vansconcelos, *et al*., 2007)

Therefore, the results show that in Guatemala, wages do not respond to the market access of the regions, implying that economic development of the locales in terms of opportunity of job and business do not necessarily represent better real wages. In contrast, the

other control variables that identify the economic and demographic characteristics of the population such as schooling level, ethnic group, age, gender, affiliation to social security, industry, profession are statistically significant and show the expected sign. The effects of the variables of public capital and neighboring public capital cannot be concluded under this analysis because it shows disgruntled signs; thus, depending on the specification of the model, it can exert a positive or negative influence on real hourly wages. This situation will be discussed in the next chapter.

To emphasize that market access is not having a strong effect on real hourly wages does not imply that it is irrelevant for policy implications. In fact, it shows that the economic growth of the regions within Guatemala are not associated to the individual benefits of the workers; indeed this was anticipated earlier in this paper when looking into the figures 2, 7 and 8, which show reductions of the real wages in certain regions even while the country is experiencing economic growth. The implication is that during the period between 2006 and 2011, prices increased at a higher rate than the nominal income in the different regions of the country. This may occur for an excess of labor supply in Guatemala. Many people are looking for decent jobs, which are very limited in Guatemala; thus an excess of labor supply induces wages to be low as forces of the labor market adjust them. Consequently, people who do not find a decent job have to look for short term solutions while continuing to pursue their desired position; this can mean be working for fewer hours than desired due to a dearth of jobs, or it can mean working for a salary that is lower than the minimum legal wage. These short term solutions disclose part of the structure of the labor market in Guatemala, which gives firms the power of wage determination over the workers. As a result, wages tend to be as low as firms want to pay, which induces the low rate of increase of the observed nominal wages in the period under analysis.

Another factor to discuss is the effect of internal migration. Market access in metropolitan areas is significantly greater than in any other region within the country, making them attractive places to do business because of the economies of scale; therefore, one would expect to observe a higher demand of workers than any other place. This expectation incentivizes workers from other regions to move into the metropolitan areas, which translates into the high levels of immigration as reported in the ENCOVI's 2006 and 2011. So, the demand of workers is easily fulfilled in the metropolitan area because the supply is greater than the

demand, and those without a decent job will end up being underemployed, implying lower wages. Hence, market access does not represent a good measure of the spatial distribution of wages in Guatemala because the excess of labor supply in the country overrides the potential benefits that any region would enjoy from its economic growth.

Market access can be interpreted as the economic prosperity of a place derived from the job and business opportunities that arise from increasing return of scales, lower transportation costs, and proper income. Therefore, the policy implication is derived from the fact that economic prosperity is not reflected in wages due to the excess of labor supply. It can be then inferred that the problem in metropolitan area is a consequence of the internal migration, while in the other regions the problem is a result of low production in the non-agriculture sectors. Thus, the efforts must be focused on the balance of labor allocation by incentivizing the production in the regions outside the metropolitan area. People in those regions have very few job opportunities in the non-agriculture sectors and are forced to accept underemployment or to move to another place. Consequently, this effort would help to reduce the massive process of internal migration, which would improve the labor situation in the metropolitan areas.

Thus, while market access explains very little of the spatial wage distribution, it does explain some of the incentives of the flow of internal migration, as market access is most likely to represent a better place for production and labor markets in terms of economies of scale and job opportunities. To prove this argument it is necessary to leave open a new area for future research, requiring the collection of data on internal migration and analyzing it against the market access.

4.3 Wage curve

The wage curve follows the traditional specifications explained in the literature of the previous chapter. This includes a Mincerian wage equation expanded by the unemployment rate. The specification is later altered by including the spatial interactions with other labor markets. The first form of estimation occurs on the individual level, and is specified in log form as follows:

$$\ln(w_{irt}) = \beta_0 + \beta_1 \ln(U_{irt}) + \sum_{j=2} \beta_j X_{irt} + f_r + g_t + e_{irt} \quad \text{where } e_{irt} \sim iid(0, \sigma^2) \tag{45}$$

The extended wage equation with spatial interaction becomes:

$$\ln(w_{irt}) = \beta_0 + \beta_1 \ln(U_{irt}) + \theta\big(W * \ln(U_{jrt})\big) + \sum_{j=2} \beta_j X_{irt} + f_r + g_t + \varepsilon_{irt}$$
$$\text{where } \varepsilon_{irt} \sim iid(0, \sigma_\varepsilon^2) \tag{46}$$

The subscripts *i*, *r*, and *t* stand for individual, region, and year, respectively. The dependent variable $\ln(w_{irt})$ refers to the log of the wage in real terms; $\ln(U_{irt})$ is the log of the annual unemployment rate of the region where the individual resides; $\ln\big(U_{jrt}\big)$ is the average unemployment rate of the neighbor regions *j* where the individual "i" does not reside. The set of variables in X_{irt} contains the control variables such as schooling level and ethnic group of the individual, the industry in which he or she works, and his/her occupation; it also includes fixed effects for region and year (f_r, g_t). The equation also includes the stock of infrastructure of the region where the individual works. Finally, W is the spatial weight matrix which captures the spatial interaction of the regions.

As noted, one critique of the former functional form is that it contains observations of different (individual and regional) levels of aggregation, which leads to the problem of bias estimation of the standard errors. In order to solve this problem, Blanchard and Oswald (2005) recommend using a second form of estimation based on regional mean regression. Unlike the previous form, this takes the average of the wages and individual characteristics of the observed individuals. This is another robust test of the results where the problems of estimation of the standard errors are smoothed. By following such recommendations, the new models are presented in the equations 47 and 48, which can be represented in a panel data.

$$\ln(w_{rt}) = \beta_0 + \beta_1 \ln(U_{rt}) + \sum_{j=2} \beta_j X_{rt} + f_r + g_t + e_{irt}$$
$$\text{where } e_{rt} \sim iid(0, \sigma^2) \tag{47}$$

$$\ln(w_{rt}) = \beta_0 + \beta_1 \ln(U_{rt}) + \rho(W * \ln(w_{rt})) + \theta(W * \ln(U_{rt})) + \sum_{j=2} \beta_j X_{rt} + f_r + g_t + \varepsilon_{irt}$$
$$\text{where } \varepsilon_{rt} \sim iid(0, \sigma_\varepsilon^2) \tag{48}$$

In addition to this modification, the paper also uses a multilevel model (see chapter 5 for its theoretical explanation). This model is an extension that allows the inclusion of at least two levels of aggregation, usually individual data level and regional data. This kind of model makes it possible to reduce the bias problem of overestimation of the parameters, while keeping the original complete database. One further advantage of this model is that it captures two levels of standard errors which allow us to understand the real effect of the regional and individual variables. The expression is as follows.

$$\ln(w_{irt}) = \gamma_{0,0,t} + \beta_1 \ln(U_{rt}) + \rho(W * \ln(w_{rt})) + \theta(W * \ln(U_{rt})) + v_{r,t} + \sum_{j=2} \beta_j X_{irt} + f_r + g_t + u_{0,r,t} \quad (49)$$

$$\text{where } \varepsilon_{rt} \sim iid(0, \sigma_\varepsilon^2), \text{ and } \sigma_\varepsilon^2 = \sigma_v^2 + \sigma_u^2$$

In equation (50), the expression $\sigma_\varepsilon^2 = \sigma_v^2 + \sigma_u^2$ represents the sum of the within-group and between-group variances of production. This information makes it possible to estimate the intra-class correlation that provides a better visualization of the incidence of every level of aggregation variable on the results of the model.

$$\rho = \frac{\sigma_u^2}{\sigma_v^2 + \sigma_u^2} \quad (50)$$

4.3.1 Data about wage curve

As in section 4.2, the data is obtained from ENCOVI 2006 and 2011 provided by INE. The information of wages, unemployment and underemployment are the same as described before, but with the addition of shadow unemployment (See Table 7).

4.3.2 Results

The estimation of the wage curve is based on the Guatemala Living Standard Measurement Study of 2006 and 2011, and it is estimated through the Mincerian wage equation augmented with local and neighboring unemployment under a pooled-cross section analysis. Later the wage curve is tested against alternative wage curve models where the variable of unemployment rate is substituted by rates of shadow unemployment and underemployment

for obtaining a robust result of the role of the local labor market conditions as an important factor in the process of wage determination. Again, the set of results are described below, while the discussion of their implications are covered at the end of this section.

The results presented in Table 12 are estimates obtained from a least squares method with fixed effects on time and region. There are six nested models, from which the full model is represented in column 6. The econometric representation of this table is shown in equation (45), and includes regional unemployment, gender, age, affiliation to social security, and schooling. It also includes three dummy variables: the industry where people work, the profession or type of position they hold in the industry where they work, and the ethnic group, for differentiating the effects between Ladinos and indigenous people.

All nested models include the logarithms of unemployment rate. The estimates are statistically significant and reflect a negative influence of unemployment on individual wages in their regional labor markets. The former suggests that the wage curve exists in Guatemala, and the value found in the full model is about -0.04. The former means that when holding the rest of the control variables constant, for every 1% of increase in the unemployment rate, the average wages will be 0.04% lower.

The values of the control variables are statistically significant, showing the expected signs based on previous empirical literature. For instance, when controlling for gender, male salaries are about 18.5% higher than female salaries. Age as an experience indicator is positive, statistically significant, and diminishing. After controlling for social security, the models show that workers with such benefits earn in average 24.3% more than workers without. This variable serves to discriminate between workers from the formal and informal sectors. (Ramos and Saranac, 2010; Baltagi *et al*., 2012; Gunther and Laune, 2012.) With respect to schooling, the higher the level of schooling, the higher the wages. For every extra level of school education reached, wages are on average 18.2% higher than the average wages earned by people with one lower level of education. Finally, the group of people that identifies themselves as Ladinos earn 6.3% more than the rest of people in average. In addition, models from columns four to six in Table 12 control for dummy variables of industry and profession.

Table 12. Wage curve: without neighboring influence

	1	*2*	*3*	*4*	*5*	*6*
Unemployment	-0.047 ***	-0.06 ***	-0.06 ***	-0.047 ***	-0.043 ***	-0.038 **
	(0.018)	(0.017)	(0.016)	(0.015)	(0.015)	(0.015)
Dummy (Time)	-0.119 ***	-0.121 ***	-0.102 ***	-0.097 ***	-0.103 ***	-0.095 ***
	(0.016)	(0.015)	(0.014)	(0.014)	(0.014)	(0.013)
Gender		0.225 ***	0.224 ***	0.209 ***	0.189 ***	0.185 ***
		(0.008)	(0.007)	(0.008)	(0.008)	(0.008)
Age		-0.225 ***	2.996 ***	2.775 ***	2.771 ***	2.651 ***
		(0.008)	(0.112)	(0.11)	(0.11)	(0.108)
Age^2		4.674 ***	-0.407 ***	-0.378 ***	-0.377 ***	-0.362 ***
		(0.118)	(0.016)	(0.016)	(0.016)	(0.016)
Social security			0.313 ***	0.29 ***	0.231 ***	0.243 ***
			(0.007)	(0.008)	(0.008)	(0.008)
Schooling			0.26 ***	0.208 ***	0.2 ***	0.182 ***
			(0.006)	(0.007)	(0.007)	(0.007)
Ethnic				0.066 ***	0.065 ***	0.063 ***
				(0.009)	(0.009)	(0.008)
Region fixed effect	yes	yes	yes	yes	yes	yes
Dummy (Industry)	no	no	no	yes	no	yes
Dummy (Occupation)	no	no	no	no	yes	yes
Observations	23,947.00	23,947.00	23,947.00	23,947.00	23,947.00	23,947.00
F	144.689	247.153	425.658	346.604	403.956	333.205
Prob > P	0	0	0	0	0	0
R-Squared	0.122	0.212	0.333	0.367	0.365	0.385

Standard errors in parentheses
Note: In logarithm terms.
* p<.1,* * p<.05,* ** p<.01

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Table 13 contains the results for the equation (46). Unlike the previous table of results, this one includes the neighboring regions' influence on the unemployment rate over the individual wages in the local labor market. Overall, the results are not very different from those presented in table 12. The wage curve reports an elasticity value of -0.0365. When checking for the average influence of the unemployment rate of neighboring regions, under the full model the estimate is statistically significant and negative (-0.0346), meaning that for every 1% of increase of the difference between the neighboring unemployment rate and the local market, the local individual wages will be on average 3.49% lower. This result shows the expected effect on wages as suggested by Buettner (1999), Longhi *et al*. (2006), and Palombi and Fingleton (2013) meaning that the neighboring labor conditions may represent a threat against workers when determining wages.

Table 13. Wage curve: with neighboring influence

	1	*2*	*3*	*4*	*5*
Unemployment	-0.0169*	-0.0636***	-0.0618***	-0.0464***	-0.0365***
	(0.008)	(0.007)	(0.007)	(0.006)	(0.006)
Neighboring Unemployment	-0.0710***	-0.0497***	-0.0381***	-0.0365***	-0.0346***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
Gender		0.2157***	0.2375***	0.2171***	0.1997***
		(0.012)	(0.010)	(0.012)	(0.012)
Age		0.0419***	0.0339***	0.0307***	0.0290***
		(0.002)	(0.002)	(0.002)	(0.001)
Age^2		-0.0005***	-0.0004***	-0.0003***	-0.0003***
		(0.000)	(0.000)	(0.000)	(0.000)
Ethnic		0.2609***	0.1286***	0.1264***	0.1234***
		(0.011)	(0.010)	(0.010)	(0.010)
Schooling			0.1296***	0.1035***	0.0913***
			(0.004)	(0.004)	(0.004)
Social Security			0.3243***	0.2990***	0.2493***
			(0.012)	(0.012)	(0.012)
Region and time fixed effect	yes	yes	yes	yes	yes
Dummy (Industry)	no	no	no	yes	Yes
Dummy (Occupation)	no	no	no	no	yes
AIC	18600.5294	17253.8171	14945.7999	14398.9769	14084.5432
BIC	18644.3753	17326.8936	15033.4917	14567.0529	14289.1574
Log lik.	-9294.2647	-8616.9085	-7460.9000	-7176.4885	-7014.2716
Chi-squared	648.9784	2231.9675	5349.3290	6301.6678	6843.8646
p	0.0000	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses
Note: In logarithm terms.
* p<.1,* * p<.05,* ** p<.01

Table 14. Wage curve by demographic groups and industry sector Ladino and Indigenous group

Group		*2006*	*2011*
Ladino	Manufacturing	-0.097*	-0.163***
	Non-manufacturing	-0.116**	-0.12**
Indigenous	Manufacturing	-0.158**	-0.09*
	Non-manufacturing	-0.117**	-0.131***

Note: In logarithm terms.
Models include regional and time fixed effects.
+ p<.1, * p<.05, ** p<.01, *** p<.001

Table 15. Wage curve by demographic groups and industry sector
Men and Women groups

Group		*2006*	*2011*
Men	Manufacturing	-0.14***	-0.106**
	Non-manufacturing	-0.125***	-0.121**
Women	Manufacturing	-0.15	-0.101*
	Non-manufacturing	-0.103**	-0.123**

Note: In logarithm terms.
Models include regional and time fixed effects.
+ p<.1, * p<.05, ** p<.01, *** p<.001

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When considering the estimations by demographic groups (tables 14 and 15), it is possible to show that the wage curve persists in every group with an elasticity very close to -0.1. For instance, in 2006, for every 1% of increase in the unemployment rate on average, Ladinos in the manufacturing sector experience a negative pressure in their wages of -0.097%, while indigenous people have a negative impact in their wages of -0.158%. Considering the results by groups of men and women, both results show that the wage curve is represented with elasticities of -0.14 and -0.15, respectively in 2006; that is, for every 1% of increase of unemployment rate, men will report a decrease in their wages of 0.14% and women of 0.15%.

Shadow unemployment and underemployment

Turning now to other labor market conditions, the next table of results shows the estimation of the effect of shadow unemployment on wages. As mentioned above, shadow unemployment is defined as the people unemployed and not looking for a job that may incorporate into the labor force only if someone offers them a position. The literature suggests that shadow unemployment may not represent a good instrument for explaining the changes in wages because of the problem of causality between the explained and explanatory variables; i.e., wage levels may induce people to be part of the labor force or not, and potential changes in the labor force may induce fluctuations in the wage rates. Although this issue must be carefully considered in future study, I present its estimation in table 16 to show how shadow unemployment is associated to wages. The shadow unemployment shows strong and negative effects over the average of individual wages. The elasticity is -0.05, meaning that for every 1% of

increase in shadow unemployment, the individual wages will be on average 0.05% lower. The estimates of the rest of the control variables are the similar to those in the table 13.

In spite of the results, in this paper it is considered that shadow unemployment does not really represent an active threat to current workers in the labor force, as they are not actively competing for the same jobs. People experiencing shadow unemployment have high levels of wage reservations, meaning that people will take a job only if wages are enough high to satisfy their well-being. This does not necessarily represent a labor market condition that puts pressure on wages unless the matching process fails due to a low labor supply. Davig and Mustre (2013) show that shadow unemployment is most likely to have an impact over the unemployment and the underemployment because of the addition of people in the labor force, yet the authors remark that the potential effect is usually low. So, shadow unemployment is unlikely to explain the behavior of real hourly wages under the traditional wage curve analysis.

Table 16. Wage curve: Shadow unemployment

	1	***2***	***3***	***4***	***5***	***6***
Shadow Unemployment	-0.093 ***	-0.078 ***	-0.067 ***	-0.059 ***	-0.058 ***	-0.05 ***
	(0.019)	(0.018)	(0.017)	(0.016)	(0.016)	(0.016)
Dummy (Time)	-0.168 ***	-0.178 ***	-0.158 ***	-0.142 ***	-0.144 ***	-0.131 ***
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)
Gender		0.224 ***	0.224 ***	0.208 ***	0.189 ***	0.185 ***
		(0.008)	(0.007)	(0.008)	(0.008)	(0.008)
Age		4.662 ***	2.985 ***	2.765 ***	2.763 ***	2.643 ***
		(0.118)	(0.112)	(0.11)	(0.11)	(0.108)
Age^2		-0.662 ***	-0.406 ***	-0.376 ***	-0.376 ***	-0.36 ***
		(0.017)	(0.016)	(0.016)	(0.016)	(0.016)
Social security			0.313 ***	0.29 ***	0.231 ***	0.243 ***
			(0.007)	(0.008)	(0.008)	(0.008)
Schooling			0.259 ***	0.208 ***	0.2 ***	0.182 ***
			(0.006)	(0.007)	(0.007)	(0.007)
Ethnic				0.065 ***	0.064 ***	0.062 ***
				(0.009)	(0.009)	(0.008)
Region fixed effect	yes	yes	yes	yes	yes	yes
Dummy (Industry)	no	no	no	yes	no	yes
Dummy (Occupation)	no	no	no	no	yes	yes
Observations	23,947.00	23,947.00	23,947.00	23,947.00	23,947.00	23,947.00
F	145.532	247.453	425.759	346.749	404.185	333.324
Prob > P	0	0	0	0	0	0
R-Squared	0.123	0.212	0.333	0.367	0.365	0.386

Standard errors in parentheses
Note: In logarithm terms.
* p<.1,* * p<.05,* ** p<.01

Table (17) shows underemployment as a labor market condition that represents a threat to the determination of individual wages. After controlling for demographic characteristics, the elasticities of underemployment are shown to be a statistically significant negative. For instance, under the full model in column 6, for every 1% increase of underemployment, the individual wages will be on average 0.11% lower. The control variables are very similar to those in the previous tables in which the wages of women are 18.5% lower than those of men; those with social security have wages 24.2% higher than those without; every upper schooling level represents on average wages 18.2% higher; and, finally, Ladinos earn wages 6.2% higher than the rest of the ethnic groups.

Table 17. Wage curve: Underemployment

	1	*2*	*3*	*4*	*5*	*6*
Underemployment	-0.234 ***	-0.137 **	-0.083	-0.089	-0.116 **	-0.109 **
	(0.065)	(0.062)	(0.057)	(0.056)	(0.056)	(0.055)
Dummy (Time)	-0.117 ***	-0.146 ***	-0.136 ***	-0.12 ***	-0.118 ***	-0.107 ***
	(0.013)	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)
Gender		0.224 ***	0.224 ***	0.208 ***	0.189 ***	0.185 ***
		(0.008)	(0.007)	(0.008)	(0.008)	(0.008)
Age		4.661 ***	2.985 ***	2.765 ***	2.76 ***	2.641 ***
		(0.119)	(0.112)	(0.11)	(0.11)	(0.108)
Age2		-0.662 ***	-0.406 ***	-0.376 ***	-0.376 ***	-0.36 ***
		(0.017)	(0.017)	(0.016)	(0.016)	(0.016)
Social security			0.313 ***	0.289 ***	0.23 ***	0.242 ***
			(0.007)	(0.008)	(0.008)	(0.008)
Schooling			0.26 ***	0.208 ***	0.2 ***	0.182 ***
			(0.006)	(0.007)	(0.007)	(0.007)
Ethnic				0.066 ***	0.064 ***	0.062 ***
				(0.009)	(0.009)	(0.008)
Region fixed effect	yes	yes	yes	yes	yes	yes
Dummy (Industry)	no	no	no	yes	no	yes
Dummy (Occupation)	no	no	no	no	yes	yes
Observations	23,947.00	23,947.00	23,947.00	23,947.00	23,947.00	23,947.00
F	144.987	246.786	424.99	346.329	403.787	333.115
Prob > P	0	0	0	0	0	0
R-Squared	0.122	0.212	0.332	0.367	0.365	0.385

Standard errors in parentheses
Note: In logarithm terms.
* p<.1,* * p<.05,* ** p<.01

Table (18) shows the effect of the neighboring underemployment on the local individual wages. Almost all estimates of the neighboring underemployment in the nested models are negative, though under the full model is not significant. The interpretation of the estimates is

for every 1% of increase of the difference of the underemployment rate of the neighbors against the local underemployment, the local individual wages will be 0.01% lower. This new model results in an increase in the effect of the local underemployment, when reporting an estimate of -0.4552 in the full model.

Table 18. Wage curve: Underemployment and neighboring underemployment

	1	*2*	*3*	*4*	*5*
Underemployment	-0.5947***	-0.6132***	-0.5138***	-0.4769***	-0.4552***
	(0.040)	(0.038)	(0.035)	(0.034)	(0.034)
Neighboring underemployment	0.0015	-0.0131*	-0.0142**	-0.0100*	-0.0073
	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
Gender		0.2152***	0.2237***	0.1847***	0.1621***
		(0.010)	(0.009)	(0.010)	(0.010)
Age		0.0392***	0.0295***	0.0283***	0.0267***
		(0.002)	(0.001)	(0.001)	(0.001)
Age^2		-0.0005***	-0.0003***	-0.0003***	-0.0003***
		(0.000)	(0.000)	(0.000)	(0.000)
Ethnic		0.1381***	0.0392***	0.0406***	0.0389***
		(0.011)	(0.010)	(0.010)	(0.010)
Schooling			0.1296***	0.1165***	0.1038***
			(0.003)	(0.004)	(0.004)
Social Security			0.2773***	0.2755***	0.2285***
			(0.009)	(0.009)	(0.009)
Region and time fixed effect	yes	yes	yes	yes	yes
Dummy (Industry)	no	no	no	yes	yes
Dummy (Occupation)	no	no	no	no	yes
AIC	21922.6342	20770.2978	17942.2156	17551.3180	17176.6840
BIC	21967.7869	20845.5522	18032.5209	17724.4032	17379.8709
Log lik.	-10955.317	-10375.149	-8959.1078	-8752.6590	-8561.3420
Chi-squared	1168.5154	2539.4873	6293.2317	6991.5159	7603.8712
p	0.0000	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses
Note: In logarithm terms.
* p<.1,* * p<.05,* ** p<.01

It can be seen in table 19, wages are affected by the joint influence of department unemployment and underemployment. In the full model, the estimates of the labor market conditions are statistically significant and negative when reporting values of -0.027 and -0.132, respectively. We observe that underemployment has more relevance than unemployment, and provides more meaningful results for a developing country, as discussed in the previous chapter. Finally, the results and interpretation of the control variables are very similar to those in the above tables.

Table 19. Wage curve: Unemployment and underemployment

	1	*2*	*3*	*4*	*5*	*6*
Unemployment	-0.045 ***	-0.042 ***	-0.038 ***	-0.035 ***	-0.027 **	-0.027 **
	(0.014)	(0.014)	(0.012)	(0.012)	(0.012)	(0.012)
Underemployment	-0.297 ***	-0.2 ***	-0.136 **	-0.128 **	-0.144 **	-0.132 **
	(0.068)	(0.065)	(0.06)	(0.058)	(0.058)	(0.057)
Dummy (Time)	-0.088 ***	-0.111 ***	-0.11 ***	-0.113 ***	-0.114 ***	-0.113 ***
	(0.034)	(0.032)	(0.03)	(0.029)	(0.029)	(0.029)
Gender		0.224 ***	0.224 ***	0.209 ***	0.189 ***	0.186 ***
		(0.008)	(0.007)	(0.008)	(0.008)	(0.008)
Age		4.659 ***	2.984 ***	2.763 ***	2.76 ***	2.639 ***
		(0.118)	(0.112)	(0.11)	(0.11)	(0.108)
Age2		-0.661 ***	-0.405 ***	-0.376 ***	-0.376 ***	-0.36 ***
		(0.017)	(0.016)	(0.016)	(0.016)	(0.016)
Social security			0.313 ***	0.29 ***	0.23 ***	0.242 ***
			(0.007)	(0.008)	(0.008)	(0.008)
Schooling			0.26 ***	0.208 ***	0.2 ***	0.182 ***
			(0.006)	(0.007)	(0.007)	(0.007)
Ethnic				0.065 ***	0.064 ***	0.062 ***
				(0.009)	(0.009)	(0.008)
Region fixed effect	yes	yes	yes	yes	yes	yes
Dummy (Industry)	no	no	no	yes	no	yes
Dummy (Occupation)	no	no	no	no	yes	yes
Observations	23,947.00	23,947.00	23,947.00	23,947.00	23,947.00	23,947.00
F	139.136	238.364	411.083	338.189	392.523	326.012
Prob > P	0	0	0	0	0	0
R-Squared	0.122	0.212	0.333	0.367	0.365	0.386

Standard errors in parentheses
Note: In logarithm terms.
* p<.1,* * p<.05,* ** p<.01

The estimates in Table 20 correspond to the multilevel model. These results are presented in order to provide a robust verification of the results shown in the previous tables regarding the wage curve. The elasticities of unemployment, underemployment, and shadow unemployment have values of -0.02, -0.20 and 0.06, respectively. The unemployment and the underemployment confirm the negative influence of the undesired labor conditions over the wage determination, while the shadow unemployment is positive. With respect to the neighboring effect of the labor market conditions, the estimates are not statistically significant, implying that they have no meaningful effect under this kind of model. On the other side, the control variables show similar estimates among the three models, which are very similar to those in the above tables, and demand the same statistical interpretation.

Table 20. Wage curve: Multi-level model and three labor market conditions

	1	2	3
Unemployment	-0. 0289*		
ρ value	0.000		
Underemployment		-0.2038*	
ρ value		0.1101	
Shadow Unemployment			0.0686**
ρ value			0.0097
Gender	0.2405***	0.2401***	0.2402***
	(0.007)	(0.007)	(0.007)
Age	0.0314***	0.0313***	0.0313***
	(0.001)	(0.001)	(0.001)
Age^2	-0.0003***	-0.0003***	-0.0003***
	(0.000)	(0.000)	(0.000)
Ethnic	0.0561***	0.0560***	0.0558***
	(0.009)	(0.009)	(0.009)
Schooling	0.1284***	0.1283***	0.1283***
	(0.003)	(0.003)	(0.003)
Social Security	0.2914***	0.2908***	0.2916***
	(0.007)	(0.007)	(0.007)
Neighborhood unemployment	-0.0315		
ρ value	0.002		
Neighborhood underemployment		0.092	
ρ value		0.0379	
Neighborhood shadow unemployment			-0.1352
ρ value			0.002
Observations	23948	23948	23948
Log lik.	-16063.5802	-16058.8928	-16057.1109
Chi-squared	8566.2822	8317.6767	8743.9825
p	0.0000	0.0000	0.0000

Standard errors in parentheses
Note: In logarithm terms.
Models include regional and time fixed effects.
+ p<.1, * p<.05, ** p<.01, *** p<.001

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4.3.3 Discussion

The results reveal that both unemployment and underemployment exert important influence on the wage determination in each region in Guatemala, and more relevant is the finding that underemployment has more influence on wage determination than unemployment during 2006-2011. In addition, the neighboring labor market conditions can also influence the local wage rates in negative manner, posing the roll of labor market at regional level in an important framework for policy implications. Hence, it is possible to confirm the second hypothesis of this study, meaning that the wage curve exists in Guatemala. Indeed, it is important to remark that the wage curve constructed using the underemployment is more relevant, which highlights the importance of the conditions and characteristics of the country, where informality constitutes the most conspicuous feature. In more detail, the wage curve can be appreciated at different levels of analysis, that is, at country and regional level, interregional spillovers, and even when

splitting the analysis by demographic groups, one can see that the wage curve is still persistent for Ladinos, indigenous, women or men to nearly the degree. The results are consistent and relatively close to -0.1, as reported in the empirical literature.

As mentioned above, Guatemala has an average unemployment rate of 3.4%, while reporting 69% of the labor force working in the informal sector. The implication is that workers and firms are more aware of the existence of underemployment than of unemployment in the regions within the country. Underemployment is seen as the second best option that workers have in the absence of decent jobs. Workers experiencing underemployment are constrained to accept low wages in the labor market of Guatemala, or to work less time than desired. Therefore, the local atmosphere of high underemployment produces uncertainty for workers when searching or keeping a job, which when having it, workers have limited empowerment to negotiate better wages and working conditions. This happens as firms capitalize on the lack of public benefits for unemployed workers, meaning that if a person does not have a job then is very probable that this person will not account for any income; thus, people are forced to take jobs with low payment or low number of hours of working.

With respect to neighboring unemployment and underemployment rates, the idea was to understand the role of neighboring labor markets over local wages, which in turn helps to understand the linkages and levels of integration between the labor markets within Guatemala. Both neighboring unemployment and underemployment have a negative effect on local wages, meaning that neighboring labor market conditions diminish workers' capacity for wage negotiation, becoming a potential threat to these workers as markets tighten (Buettner, 1999; Longhi *et al*., 2006; and Palombi and Fingleton, 2013). The implication is related mostly to the internal migration of workers. On the one hand, people decide to move because the labor market in the origin region is not capable of providing enough jobs or good jobs in the non-agriculture sector; in case of staying, workers are forced to be underemployed. Thus, the decision to move between labor markets is encouraged by the opportunity for better jobs. Receptor regions, as the metropolitan area, are likely to report an increase of labor force, which pushes wages down. So by grabbing the initial and final statements of the above rationale, one can conclude that underemployment and unemployment in less developed regions affect wages in more developed neighboring regions after workers decide to move, implying a temporal process of adjustment of labor forces. On the other hand, the rationale of the effect of

underemployment and unemployment that comes from the neighboring developed regions have different linkages, fitting better into the rationale of the traditional wage curve due to two arguments. First, it is presumed that the internal migration cannot be the mean of transmission of the effects of such labor market conditions, as the pattern of the internal migration is moving toward the metropolitan area and not vice versa. Second, more developed regions, such as the metropolitan area, represent an extension of the labor market for firms located in the non-metropolitan area, and hence firms will take advantage of the wage determination when observing the process of pauperization in the metropolitan area, and workers that decide to stay in their regions are exposed to conditioning that firms can impose on the wage premium.

4.4 Remarks on wage equations

As mentioned in chapter 3, wage equations are partial equilibrium models that are representing the relationship between labor market conditions and wages. The objective is to show that economic conditions of the regions are associated to wages rates in Guatemala, and hence the association of both kinds of variables would explain some of the incentives that economic agents have when deciding to move across regions.

It was expected that market access would positively explain the spatial distribution of wages as it represents the economic prosperity of regions, i.e. the better economic environment, better wages; also, it was expected that labor market conditions, expressed in terms of unemployment and underemployment, would influence wage rates in a negative manner, for instance the higher the unemployment or the underemployment rate in a region, the lower wages.

The results show that wages are not responsive to market access, meaning that to presume that economic growth will automatically bring about increases in average relative wages and positive wage equalization would be seriously misplaced. On the other hand, wage curve provides explanation of how wages can be determined as it shows that unemployment and underemployment have a very important role in the wage determination, which lead to worse economic inequalities within and between the regions.

At this point, it is convenient to remark the Guatemalan context in the analysis. The finding that wages do not respond to economic development has to be with the high level of informality in the labor market, which is characterized for low both productivity and income (even lower than the legal minimum wage). Indeed, the metropolitan area is far developed with respect many other regions of the rest of the country, but it has also a great mass of informal workers (more than 50% of the labor force, INE 2013). Thus, the rationale of a positive association between wages and prosperity does not have place in this reality. This is because the economic growth of the place is not enough to create new decent jobs and hence to absorb the supply of labor. The former argument is reinforced by the finding of the modified wage curve, in which is used the underemployment rather than unemployment. As explained before, the results show a great negative effect of underemployment over wages because there is an excess of labor supply, caused by both the natural growth of the population and by the internal migration flow. The immediate implication is the creation of a monopolistic power of wage determination that firms acquire due to the labor conditions, which implies obstacles for any wage increasing or wage negotiation, or worse off, it implies wage decreasing in real terms as shown before.

As previously mentioned in chapter 2, Guatemala experiences a great economic inequality, while in turn the current conditions of the labor market are not allowing alleviating such situation as new decent jobs are not created and as wages are not increasing in real terms. In this sense, there is not a short run hope in which the economic conditions will improve because there is not any economic policy aimed to fix such situation in the country. Although the economic inequality is not related exclusively to wages and jobs, as policy maker, it should be at least the first stage aimed to work on it. Labor market conditions are the key to alleviate the macroeconomic situation in Guatemala. Better supervision on wage determination by the authorities should be implemented, as it may allow a fair negotiation of wages, which cannot be currently due to the monopolistic power of the firms. Also, the government should implement a strategy of job creation through the monetary or tax incentives, but this strategy should be implemented mostly outside the metropolitan area for it will alleviate both the saturation of labor supply and it will improve the economic conditions of the rest of the regions. A very particular example of a strategy to follow is to promote the investment in infrastructure in other regions, which would make more attractive to capital's owners to undertake new business and

thus to create new jobs. Finally, the roll of the labor market in Guatemala is determined by the gap between supply and demand of jobs, by the low wages, and by the lack of policy intervention in which authorities ensure fair deal to workers.

Chapter 5: Public investment and its spillover effects on economic performance across the regions of Guatemala

The concept of public investment encompasses both financial expenditure and the social and physical capital deployed by the central government, local government, and public corporations. The goal of public investment is to cover market failures that the private sector is unwilling or unable to correct. This is done through intervention in public goods, to the benefit of the general population. Unlike the private sector, the public sector does not seek to profit from its investments; rather, it aims solely to benefit the population through the improvement of, among others, health care, education, research, public facilities (e.g., schools and hospitals), electricity, roads, and transportation systems. Thus, one of the important roles of a public entity is to support the creation and maintenance of the social and economic growth that helps to secure and enhance the welfare of society. How can it be determined whether public investment is accomplishing its role? How does public investment influence the economic performance of a particular locale? Such broad questions are beyond the scope of this paper, and would need to address the entire range of social and physical investments. Thus, in what follows, the concepts of public investment will be restricted to the expenditure of physical capital, including the construction and maintenance of roads and basic services such as sewers, electricity, and water. Furthermore, this paper defines economic performance as the change in production levels and productivity by firms.

Economists and planners from different schools of thought have debated the effects of public investment. The topic was first discussed formally twenty years ago, beginning with the early works of Aschauer (1989a, 1989b) and Holtz-Eakin (1994). The issue has focused not only on the relationship between public investment and economic performance but also on the direction of causation, all without reaching a definite conclusion. Aschauer (1989) and Munnel (1991) argue that public investment positively influences economic growth, while Holtz-Eakin (1994) and Boarnet (1998) argue that the higher the level of a locale's economic development, the higher the demand for public investment.

This paper seeks to analyze the relationship between public investment and economic performance of municipalities in Guatemala. As noted above, in what follows, economic

performance is measured through productivity and production at the firm level. Therefore, to measure economic performance, defined as productive and production at the firm level, this paper uses panel data from two econometric models based on the endogenous growth model. The first model uses a Cobb-Douglas production function widely accepted by researchers to calculate productivity, and then use it as explained variable. The second model uses a multilevel analysis to estimate the effects of public investment on production. Since the estimations follow from the endogenous growth model, the methodology includes the variables of human capital, research and development, and weighted neighbor public investment to test for the existence of positive spillover effects.

Existing studies have rarely focused on developing countries, choosing instead to focus on developed countries such as the United States and Europe. In light of this oversight, this paper explores the role that public investment has played in Guatemala, and, more specifically, within and between its 78 municipalities. The contribution of this work is thus threefold. First, it provides a discussion in a new economic dimension, as most of the academic studies of Guatemala have been made at the national level. Second, the paper contributes to the discussion of public investment and economic performance in a developing country. Finally, the evaluation of public capital is relevant from a regional policy point of view: it helps to explain the role of public capital on productivity and production in municipalities, while enhancing the understanding of the role of subnational economies. These findings will be of value in discussions about optimal policies designed to address issues of economic spatial inequities in two ways. First, they reveal the effectiveness of public capital distribution between municipalities on regional elements of economic growth. Second, they measure the economic might of the metropolitan area against the rest of the country.

This paper provides evidence that public investment has positively influenced productivity and production at the municipality level and, hence, economic performance. The positive role of neighboring area's public investment is especially noticeable when the municipalities are part of a metropolitan area. The findings are negative when neighbors are not part of a metropolitan area.

The current paper is organized as follows. Section 5.2 presents a brief explanation of the economic and social situation in Guatemala. Section 5.3 provides a review of the theoretical and

empirical literature related to the topic. Section 5.4 describes the data and methodology used to measure the impact of public investments on the economic performance of firms. Finally, sections 5.5 and 5.6 offer results and a discussion of the findings of the paper with concluding remarks, respectively.

5.1 Overview of the Guatemalan scenario

Guatemala is divided into 22 political administrative departments and 334 municipalities. As of 2014, it has an estimated population of about 15 million. The country is the largest economy in Central America (CMCA, 2010), but has one of the lowest GDP per capita in that region (World Bank, 2009) and exhibits substantial welfare inequalities (United Nations Development Programme, UNDP). The World Bank (2006) estimates that about 51% of Guatemala's population lives in poverty. It is important to recognize the historical roots of this inequality, due to certain social and political issues. The most recent and relevant event was the civil war period between 1960-1996. The war devastated the country and produced incalculable human losses, destroyed large portions of the country's infrastructure, and significantly curtailed economic development. As a result, the lion's share of the country's social and physical investment programs are concentrated in a small number of areas within the country, resulting in a disproportionate spatial allocation of the private and public capital in the nation throughout the 36 years of conflict.

After the war ended and the peace agreements signed, Guatemala faced physical deficiencies and significant poverty gaps. Almost every economic program in the nation since the war (see Romero 2010 for a complete list and details of socioeconomic programs for 1985-2009) was developed for the explicit purpose of reducing the poverty-gap through social programs. The results of such programs are constantly monitored by NGO's and international organizations in order to examine their impact on the population (UNDP). Overall the focus has been on improvements of socioeconomic indicators such as malnutrition, illiteracy, and poverty. Less attention has been directed to the economic performance of firms at the regional or municipal level to see how, for instance, the construction and repair of localties' infrastructure influences firms' productivity and production. Outside of SEGEPLAN (1999 and 2000), there is no published literature of such evaluation. Therefore, analyzing every component of the economy is undeniably important, especially in terms of the ability of policy

makers to comprehend the country's economic performance. Most official economic reports are published with a national focus, and it is unknown how this kind of investment has affected the economies of the different regions of Guatemala. The next section presents details of the sources of municipal revenue and how they contribute to public investment in infrastructure.

5.1.1 A glance at the municipalities:

The municipalities of Guatemala are autonomous state entities whose functions are based on congressional decree 12-2002. The municipalities' functions include managing water resources; sewer and street lighting services; the local and physical administration of the market installations; the collection, treatment and disposal of solid waste; the construction and maintenance of local and urban roads; the provision of municipal police services; and, administration and civil registration. In addition, the municipal code establishes competencies for the authorities who regulate passenger transportation and cargo; the approval of licensing of the construction of public and private works; compliance with standards of sanitary control of production, marketing, and consumption; the management and administration of municipal pharmacies; the development and management of parks, gardens, and recreational areas; and the management of preschool and primary education, including literacy programs and bilingual education.

The funding for municipal governments has four sources. The first includes local revenues collected from property taxes and the income tax[7]. These also include non-tax revenues derived from the property sales and municipal services, services contributions, and administrative improvements, including the provision of utilities. The second source of income is the constitutional assignment, a revenue transfer from the central government mandated by the Political Constitution of the Republic of Guatemala (PCRG) of 1985. This mandate represents the obligation of the state to promote decentralization (Article 119 of PCRG). It also responds to the fact that most municipalities are not capable of collecting sufficient taxes to fund locally-based programs of regional development. Article 257 of the PCRG dictates that the Central Government must include in the General Budget of Ordinary Revenues of the State a 10% share of this same budget for the municipalities of the country. Ninety percent of this share must be designated to "educational, preventative health, infrastructure and public services

[7] This income tax refers to a municipal tax that is charged based on the provisions of the law of municipal ornaments (Congressional decree No. 121-96).

programs and projects that improve the quality of life of the inhabitants." The remaining 10% is used to finance functioning.

The third source of municipalities' revenue derives from the "IVA-PAZ" tax, or "peace value added tax." This is not an extra tax, but rather constitutes one part of the value added tax collected by the central government. The income passes to municipalities through annual transfers mandated by the Peace Accords of 1996, which promote the reconstruction of the country after the war. These funds are to be disbursed by municipalities as follows: 25% goes to functioning expenditure and 75% goes to public investment in infrastructure (Congressional decree 27-92 reformed). Although the nature of the assignment is clear, its mechanism is not yet well-defined. Currently, the transfer process begins with municipalities presenting a project to SEGEPLAN. SEGEPLAN then evaluates and prioritizes the projects through the National System of Public Investment Projects (SNIP). This accomplishes two objectives: promoting an efficient framework that allows for the coordination of public investment expenditure, and ensuring national oversight of approved projects. Finally, SEGEPLAN sends their considerations to the congress of the republic for the formal authorization of the transfers. Ideally, the congress of the republic approves the technical distribution recommended by SEGEPLAN, expecting the best results from the monetary assignment. Nonetheless, the distribution of the transfers are usually modified based on congress power-politics, an issue not discussed in this study. This mechanism is one of the most controversial in Guatemala, and is frequently singled out for criticism by political analysts and experts (Palma 2010, Espana 2011, and Gramajo 2012).

The final source of municipal government revenue comes from the vehicle and motor circulation tax. Of the total amount collected by central government, 50% goes to municipalities, of which the municipalities have to allocate 97.5% to pavement and sidewalk construction with the rest going toward operation expenditures.

5.2 Theoretical Framework

This paper seeks to analyze the effects of public investment on the performance of firms. The baseline of the economic analysis, and the central argument to be used in this paper, will be endogenous growth theory. This theory suggests that structural internal shocks can alter the

steady-state of the per capita income in an economy; that is, economic growth is an endogenous outcome of an economic system and not a result of outside forces (Romer, 1994). This paper will use this premise to discuss how the usual factors of production (capital and labor) affect the output and productivity of the firms. Furthermore, the discussion of endogeneity suggests the inclusion of additional factors as determinants of firms' performance: key factors such as research and development and human capital. Romer (1990) introduces the notion of the existence of spillover effects of growth produced by the flow of knowledge into localities as a result of the emanating industries' interactions. Lucas (1988) notes that human capital works as an economic-growth engine because it is the one factor capable of addressing growth and prosperity.

In addition, the initial work of Aschauer (1989) and Munnell (1990b, 1992), as well as recent empirical papers by Bronzini, *et al*., (2009), Gomez and Fingleton (2011), and others, have suggested that physical public investment is also a key factor in determining the private output and productivity of firms. This assertion is justified by the belief that physical investments provide better conditions to the community by reducing manufacturing and trade costs to consumers and producers. In consequence, these investments stimulate local consumption by encouraging increased production. Assuming that public resources are locally invested, a positive shock to the infrastructure will lead to enhanced prosperity in the area. This is expected to happen when the public capital stock is below the optimal level in a municipality.

5.2.1 Public Investment

Public investment is assumed to be important for economic growth because it enhances the productive apparatus of private firms. For example, Aschauer (1989) asserts that public investment has large positive effects on productivity and economic growth. Munnell (1992) confirms this finding by stating that public capital investments expand the productive capacity of a specific locale by increasing and/or improving local resources. Other authors (Esfahani and Ramirez, 2002; Bronzini, 2009) have also stated in empirical papers that public investment has improved economic performance in the United States, Europe, and Latin America.

The rationale for such benefit comes from the assumption of complementarity between private and public capital that, in turn, creates a crowd-in effect in the locale. However, public

capital must be invested in infrastructure—such as roads, water systems, sewers, and electricity— to have any effect. Otherwise, an excess of public capital for other purposes will create a negative effect or *ex post* crowd-out effect in the region by increasing taxes or real interest rates (when financed through bonds) (Aschauer, 1989a).

Given the state of Guatemala's expenditures between 2001 and 2008, it is important to determine whether these investments have stimulated economic growth and productivity. Some authors have argued that public investment is the key to growth generation for some economies. For instance, Pereira and Roca (2003) argue that public infrastructure investment is beneficial for access to regional markets because it creates a network of resources through infrastructure installation, which in turn lead to local and regional improvements. Thus, the investment in public capital involves the possibility that an individual municipality may experience positive spillover effects from investment in neighboring municipalities. Gomez and Fingleton (2011), and Ezcurra, *et al*. (2005) point out that spillovers generated by public investments are important when analyzing productivity in the private sector during the decision-making phase of a plan of production. Thus, public investment can lead to the creation of benefits in the region where the investment was made. The classic example is the construction of a road or highway that can reduce the cost to firms that send merchandise from the point of production to the points of sale. Overall, this encompasses the improvement of the local conditions for production, commerce, transportation, and other factors.

Boarnet (1998), on the other hand, discusses the possible consequences of negative spillover effects. He suggests that if public investment is productive for a certain place, then it will enhance the comparative advantage of such a place relative to others. The reason behind this assertion is the assumption of complementarity between public capital and private capital investments. This effect will be reflected negatively on the neighbor locales through the reduction of marginal rates of productivity of their private capital. This condition, combined with limited public investment, generates competition for public investment. This case has the potential to be appraised because of the third source of revenues of municipalities: the yearly congress allocation noted above.

There has been an extensive and inconclusive discussion in the literature about the direction of causality, the existence of positive or negative spillovers, and the degree to which

the public crows-out or crowds-in private investment. Some authors have suggested that this direction is not as evident as many economists have asserted. For example, Holtz-Eakin (1994) notes that public capital can affect productivity and production, but that it is necessary to consider that economic growth can shape the supply of, and demand for, public capital. He adds a caveat, mentioning that already-wealthy regions are likely to spend more on public capital, but this does not imply that they are therefore more productive localities.

5.2.2 Human Capital and Research & Development

Human capital and research & development, represented respectively through the people skills and knowledge, are two endogenous factors that contribute to the sustained long-run growth of the economy. They are the assets that a place have to produce economic prosperity if both factors are combined properly.

As regards Human capital, empirical evidence shows that it is significantly linked to growth of productivity (Romer, 1990) and to economic growth (Mankiw, *et al*., 1992). Lucas (1988) argues that human capital is one of the engines of growth in an economy through the way skill levels affect worker productivity. Lucas (1988) also suggests that human capital makes a difference in terms of prosperity because it is an important asset possessed by each individual. In that sense, disparities in economic prosperity are related to both "where-is" the knowledge and "who-has" the knowledge. "Educated" regions tend to be more prosperous, but this depends on both the existing levels of education and on the opportunities to access it. This assertion is confirmed by Glaeser (2000), who argues that access to skilled human capital incentivizes firms to cluster; consequently, the aggregation of skills in a region may increase new ideas for production and productivity, leading to greater prosperity. Florida (2002) argues that these skills come from a "creative class," consisting of people dedicated to the creation of knowledge.

Mankiw *et al*. (1992) state that human capital has a vital role in describing the prosperity of a locale. This is because human capital is the primary input in the production function. Such an assertion is echoed by Barro, *et al*. (1995), Benhabib and Spielged (1994) and Sala-i-Martin (1997) who report that human capital plays an important role in prosperity, when other factors in economic growth models are controlled for. One reason is that human capital involves the

relative level of education (average schooling in an area); this drives economic growth because it increases the ability to adopt existing and new technologies and thereby spur production. The quality of human capital is thus an important factor because the level of knowledge that workers possess can contribute to the adoption of domestic and foreign innovations by local firms.

Concerning Research & Development (R&D), it is another relevant factor in the endogenous growth model because it consists of creating ideas, knowledge, and technical processes aimed at enhancing the production of goods and services. This variable is usually accompanied by human capital in the production function to create enhanced technical progress and productivity for a firm. Hence, investment in R&D is highly related to the sustained long-run growth of an economy (Grossman and Helpman, 1990; Romer, 1990) because the increase in productivity may lead to an increase in profits.

In addition, Romer (1994) argues that efforts and results from investing on R&D are not exclusive to a particular firm because ideas and knowledge tend to spill over to other economic agents. R&D usually diffuses through human and industry networks; thus, ideas and innovations produce improvements in the productivity of firms in a region. In fact, Audretsch and Feldman (2005) assert that there exists a spatial scope wherein firms benefit from knowledge spillovers because tacit and non-rival elements can be transmitted through agents in the economy, on an individual-to-individual basis, or through existing backward and forward linkages of firms. Thus, investment in R&D may become a social knowledge that promotes the productivity of all firms in a region. In this regard, Schmitz and Musyck (1994) argue that such social knowledge is a natural response of an industrial organization constructed by clustered firms or firms from a same region, whereas government or government-sponsored institutions must support the creation and transmission of innovations through public programs of technological development.

Pioneer discussions around the geographical transmission of knowledge focus its attention in the spatial extension that knowledge can reach. Arrow (1962) mentioned that there is no reason for imposing a territorial or political border for delimiting the transmission of knowledge, which implies that knowledge can flow across space freely because it has non-rival use. On the other hand, Jacobs (1969) argues that geography proximity matters in transmitting

knowledge because the use or demand of a particular idea or knowledge may change from place to place. Although both authors differ in the spatial extent of the transmission of knowledge, both agree in the idea that knowledge is tacit and it can be transmitted between people and firms across space. One of the first mechanisms of analysis of such spatial extent is done by Jaffe (1989), who tests the effects of localization of education centers against innovation of firms. The results show that the spillovers influence specific geographical areas where universities and research laboratories are present. This influence is positive and improves local innovation and hence productivity of the firms. In addition, Mansfield (1995) complements the former argument by arguing that research laboratories of universities provide source of greater innovation. Also, Audretsch and Feldman (2005) add that universities behave as catalyst that boosts the knowledge spillover because they provide and facilitate linkages to external generating-knowledge produced in other states or countries. Thus, it can be said that "location and geographic space become key factors in explaining the determinants of innovation and technological change" (Audretsch and Feldman (2005).

5.2.3 Hypothesis

Formally, the hypothesis of the current paper is that expenditure on physical public investment in the municipalities of Guatemala positively influences the economic performance of their locales and the neighboring municipalities. To test this hypothesis, the theoretical framework presented above motivated the current research to look for evidence that explains the effects of public investment on productivity and production in the firms of 78 municipalities of Guatemala during the period of 2001-2008. By doing so, it analyzes the role of the three cited elements—R&D, human capital, and public infrastructure— in terms of their contributions to total factor productivity of the firms.

5.3 Data and Methodology

5.3.1 Data

The data information covers the period from 2001 to 2008 for which information regarding output, private capital, and labor were provided by firms in a series of surveys conducted by

DINEL (Central Bank of Guatemala and National Institute of Statistics program). The information about output was measured using firms' deflated sales. The data regarding private capital were transformed into private capital stock using the perpetual inventory method, including a general rate of depreciation of five percent. There are problems with this method; for example, it uses assumptions of both the initial capital stock at the beginning of the period and the rate of depreciation. Nevertheless, given the problems involved in information gathering, the initial stock will be considered in terms of the first flow of capital reported by the firms; the rate of depreciation has been taken from previous papers by Pereira (1999) and Moran and Valle (2001). Through such information, the Total Factor Productivity can be derived from a Cobb-Douglas production function, which will be explained in a later methodological section.

Data on public investments are derived from the yearly budget of the 78 municipalities of Guatemala. These data series have been deflated and normalized according to the population of each municipality, which is provided by the National Institute of Statistics (INE); it is also transformed into public capital stock using the same method of perpetual inventory.

Determining the human capital involved requires two sources. The first is the Guatemala census 2002, from which the number of people with different levels of education can be obtained. They are divided into three levels: elementary school, middle school, and high school. The second source is provided by the Ministry of Education, and consists of the number of graduated students from the three levels of education in each municipality. These data were used to construct a human capital index based on the methodology created by Loening (2002), who used the perpetual inventory methodology. Census 2002 provides the education level of the people enrolled in the school, adding to every year the new number of students that enrolled in the schools per level net of dropouts. This figure is then applied to the rate of depreciation, representing demographic dynamics such as migration and mortality rate. The data are also normalized by the population of each municipality.

Finally, due to the limitations of existence and accessibility of R&D data at the regional level, this paper presents a construction comprising two sources of information. The first uses information of total national firms' expenditures on capacitation and education that is estimated in the national accounts office of the Central Bank of Guatemala. This estimation is presented in monetary real terms at a national level yearly. The second source corresponds to the location of

the various universities and technological institutes located in the different municipalities in Guatemala. The assumption is that firms use such centers of education to prepare their workers for the production process with knowledge transmitted by the education centers and through sharing information and experiences with participants from other firms. The rationale of the construction of the R&D data at regional level follows the argument discussed in the section of human capital and R&D, in which the number of centers of education and instruction mentioned above are collected to create a national structure based on their location. Then, the sum of the national expenditure on R&D (deflated by regional prices) is distributed on such structure to obtain the amount of money spent per municipality. This will provide a proxy for regional expenditure on R&D.

Table 21. Summary statistics

Variable	Obs	Mean	Std. Dev.
log of deflated sales	13930	11.80914	2.042503
log of labor as input	13930	4.265844	1.423447
log of capital stock as input	14240	10.92422	2.329111
log of TFP	13930	6.320823	1.048056
log of public capital stock	14240	-0.518201	0.941267
log of research and development	13760	-9.938221	0.639381
Number of people with Elementary school (per capita)		0.2331091	0.0572097
Number of people with Middle school (per capita)		0.3722351	0.137542
Number of people with High School (per capita)		0.3582439	0.1787336

The following three graphs show the behavior of the data in the period 2001-2008:

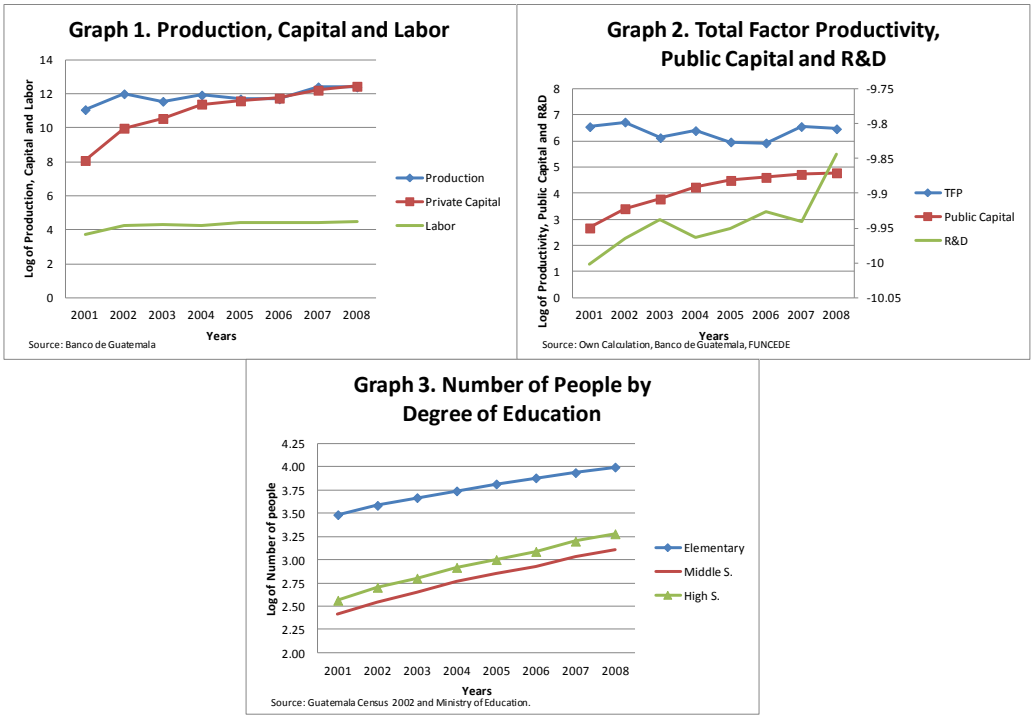

Figure 15. Illustration of dataset.

5.3.2 The methodology

5.3.2.1 The basic model

The analysis is centered on the economic performance of firms located in the 78 municipalities. Measures of production and productivity of firms are needed but there no survey data for productivity exists. In order to obtain such a variable, the most widely-used approach is the Cobb Douglas function (Romp et. al, 2007), which assumes constant returns to scale and perfect competition. The Cobb-Douglas function is expressed using labor and physical capital as inputs, and total factor productivity as the technological catalyst that drives production Y in the firm i at time t, as expressed in equation (51):

$$Y_{i,t,r} = TFP_{i,t,r} L_{i,t,r}^{\alpha} K_{i,t,r}^{\beta} \tag{51}$$

The subscripts i = 1, 2, 3, …. N is the firm index; t = 2001, 2002, …, 2008 is the yearly index; and r = 1, …, 78 is the municipality index where firms belong. *Y* is the output of firm *i* at time *t* belonging to region *r*; *L* is the labor input; *K* is the private capital input; α is the labor income share; and β is the private capital income share.

The mechanism for computing the TPF is to encompass output, employment and private capital as shown in equation (52):

$$\frac{Y_{i,t,r}}{L_{i,t,r}^{\alpha} K_{i,t,r}^{\beta}} = TFP_{i,t,r} \tag{52}$$

From these formulations, it is possible to estimate equation (53), which describes the endogenous growth model, where "A" is the unexplained technical progress; $TFP_{i,t,r}$ is the total factor productivity that represents the technical change driven by human capital (HC) available in the municipality where the firm locates its plant, research and development (R&D) available in the municipality that lead to innovations, and public investment (PK) executed in the municipality r at the time t, as shown below:

$$TFP_{i,t,r} = A_{i,t,r} HC_{i,t,r} RD_{i,t,r} PK_{i,t,r} \tag{53}$$

Transformed into log terms, (53) may be re-written as:

$$\ln(TFP_{i,t,r}) = \ln(A_{i,t,r}) + \beta_1 ln(HC_{i,t,r}) + \beta_2 \ln(RD_{i,t,r}) + \beta_3 ln(PK_{i,t,r}) + e_{i,t,r} \tag{54}$$

Considering that the unexplained part of the TFP can be contained in two (time and region) fixed effects and derived from the form $\ln(A_{i,t}) = \theta_i + \theta_t$, equation (55) below presents the first baseline model to analyze the contribution of public investment in productivity. In addition to the elements expressed in this equation and the fixed effects, the model will include some control variables for agglomeration, the economic sector, and the distinction between core and periphery regions. For simplifying the notation, the log terms in the equation are presented in lowercase:

$$tfp_{i,t,r} = \theta_r + \theta_t + \beta_1 hc_{i,t,r} + \beta_2 rd_{i,t,r} + \beta_3 pk_{i,t,r} + \sum_n \gamma_n z_{i,t,r} + \varepsilon_{i,t,r} \tag{55}$$

One advantage of considering the fixed effects of time and region is that they can provide estimates per region and per year, avoiding the unnecessary imposition of homogeneous coefficients across regions. At the same time, the fixed effects method offer a technique that can help to reduce endogeneity due to omitted variable bias problem. In other words, fixed effects on region help to capture time-invariant unobservable factors that do not change in each region, including the geography of the place. Fixed effects on time help to capture unobservable factors in the regions in average within each period of time, for instance an electoral year.

5.3.2.2 The extended model:

One purpose of this paper is to measure the spillover effects across municipalities; this will be accomplished using a spatial weight matrix (W). It is important to recognize that the inclusion of this variable is not without criticism in terms of the role it plays and the form in which it is included in the analysis. On the positive side, the inclusion of the estimation of economic linkages across the regions via distance based measures offers an opportunity to capture the effects of neighbors. On the other hand, there is concern about the degree to which bias might be introduced into the model, for instance a misspecification of the model (Anselin, 1988). Crespo and Feldkircher (2012) offer significant and critical empirical evidence about the importance of choosing a weight matrix. They handle spatial dependence among observations while taking care of uncertainty for choosing different spatial structures through a Bayesian model averaging. One of their goals is to evaluate how values of parameters changes with different W in a simulation study, and show that choosing the W matrix is critical for the estimation of the parameters of the covariates because W may lead to wrong conclusions. In spite of such efforts, there is still no consensus of how to determine the W, for instance, LeSage and Fischer (2008) argue that one way to choose the W is by using the "goodness of fit statistics".

For dealing with this potential problem, the present paper presents different weight matrices to apply in the extended model (equation 58) for comparing the results and obtaining robust conclusions. The present paper uses the time-distance inverse matrix, the Queen matrix,

the Euclidean matrix and the 6th-nearest neighbor matrix; all of which are row-standardized such that:

$$w_{r,s}{}^{*} = \frac{w_{r,s}}{\sum_s w_{r,s}} \tag{56}$$

Therefore, equation (57) below expresses the weighted physical public investment of the region r according to distance with respect to region s (where $r \neq s$). Thus:

$$PKW_{r,s} = \sum_s w_{rs}{}^{*} PK_s \tag{57}$$

In a similar manner to the basic model, the baseline extended model is expressed in log terms,

$$tfp_{i,t,r} = \theta_r + \theta_t + \beta_1 hc_{i,t,r} + \beta_2 rd_{i,t,r} + \beta_3 pk_{i,t,r} + \beta_4 pkw_{i,r,s} + \sum_n \gamma_n z_{i,t,r} + \varepsilon_{i,t,r} \tag{58}$$

5.3.2.3 The Multilevel Analysis:

The third model studies the impact of public investment in infrastructure on firm's production by using multilevel analysis. The multilevel analysis is a hierarchical linear model that takes into account the spatial disaggregation of the economic and social units, i.e. in regional economics is common to observe nested regional information containing different level of aggregation: for instance, countries containing information of regions, regions containing information of cities, and cities containing information of individuals. It allows breaking the assumption that all observations have identical distributions, while still considering independence. Usually, the estimation of the multilevel analysis entails the estimation of the effect of the mean of a particular group of individuals, while estimating the effect of the mean of the region where the group of individuals belongs. Indeed, Corrado and Fingleton (2011) state that many economic researches containing spatial econometric models don't consider the hierarchical information of the space, which misleads the analysis of the spatial lags variables when failing to provide inference of the effects coming from different hierarchical levels. This is because requiring the regression coefficients in all regions to be the same is generally too restrictive as each region has different economic and social characteristics. Chung and Hewings

(2013) demonstrate that when considering hierarchical models, is possible to achieve an accurate estimation of the influence of shocks with different levels of information. For example, when considering a hierarchical model, they found that the dependency on national production has a weaker influence on regional economies than when considering a non-hierarchical model.

The following model is intended to provide estimates of the influence of public capital on production of the firms. The model captures the effect of information coming from the firm and municipality level, and the goal is to examine the robustness of the influence of public investment on firms' economic performance. Thus, the first step is to identify an equation that represents the random behavior on every level:

$$Y_{irt} = \beta_{0rt} + v_{irt} \tag{59}$$

The production Y of the firm i nested in the region r during year t is equal to the average of the production in region r for every year t plus an individual random error v_{irt}. In addition, there exists the possibility that all of the firms in a specific region can be affected by a common influence within the region u_{0rt}. Hence:

$$\beta_{0rt} = \gamma_{00t} + u_{0rt} \tag{60}$$

Therefore, taking into consideration the structural equation that comes from combining equations (59) and (60), the errors v_{irt} and u_{0rt} are assumed to have a zero mean and variances of σ_v^2 and σ_u^2, respectively. Therefore, $\sigma_\varepsilon^2 = \sigma_v^2 + \sigma_u^2$ represents the sum of the within-group and between-group variances of production. Taking these into consideration, it is possible to calculate the intra-class correlation (ρ), which is a measure of the proportion of the variance explained at the group level:

$$\rho = \frac{\sigma_u^2}{\sigma_v^2 + \sigma_u^2} \tag{61}$$

Equation (61) makes it possible to detect whether the local conditions of the region during a specific year influence the production of the firm located in that region. When the rho value (ρ) approaches zero, it is possible to assert that the production of the firm i is no longer attributable to regional influences r.

The next step consists of adding the fixed effects as represented in the equation (12).

$$y_{i,r,t} = \gamma_{0,0,t} + \beta_1 hc_{i,r,t} + \beta_2 rd_{i,r,t} + \beta_3 pk_{i,r,t} + \sum_n \gamma_n z_{i,t,r} + u_{0,r,t} + \delta_1 l_{i,r,t} + \delta_2 k_{i,r,t} + v_{i,r,t} \quad (62)$$

In addition, an extended model (equation 63) will be used that includes the spatial effects from the other regions.

$$y_{i,r,t} = \gamma_{0,0,t} + \beta_1 hc_{i,r,t} + \beta_2 rd_{i,r,t} + \beta_3 pk_{i,r,t} + \beta_4 Wpk_{i,r,s} + \beta_5 Whc_{i,r,s} + \beta_6 Wrd_{i,r,s} + \sum_n \gamma_n z_{i,t,r} + u_{0,r,s} + \delta_1 l_{i,r,t} + \delta_2 k_{i,r,t} + v_{i,r,t} \quad (63)$$

The following specification (64) has two purposes. First, it provides an elasticity of the private inputs for a proxy of productivity. Second, it allows us to control for a potential multicollinearity problem involving private capital and labor variables. Indeed, the association between labor and private capital can be highly correlated in the sense that firms prepare their plan of production by considering the combination of both variables and not separately. One way to solve this problem is by normalizing the Cobb-Douglas production function with respect to labor inputs as follows:

$$(y_{irt} - l_{irt}) = \gamma_{00t} + \beta_1 hc_{irt} + \beta_2 rd_{irt} + \beta_3 pk_{irt} + \beta_4 Wpk_{irt} + \beta_5 Whc_{irt} + \beta_6 Wrd_{irt} + \sum_n \gamma_n z_{i,t,r} + u_{0rt} + \delta_2 (k_{irt} - l_{irt}) + v_{irt} \quad (64)$$

5.4 Results and Discussion

The results and discussion in this section evaluate this paper's hypothesis: expenditure on physical public investment in the municipalities of Guatemala positively influences the economic performance of their locales and that of the neighboring municipalities.

The results are divided in two groups of tables. The first group (Tables 22-25) contains the evaluation of the productivity of the firms through a panel data analysis with region and time fixed effects; while the second group (Tables 26-28) comprises the evaluation of the firms' production with the hierarchical model of multi-level analysis. The results include the local

public capital stock variable and the public capital stock of the neighboring regions. Corresponding to the endogenous growth model discussed earlier, the tables also contain the estimates of the explanatory variables of R&D and human capital; in addition, the estimations include other variables that control for agglomeration and for the economic sector (manufacturing or services) where they participate. In addition, the second group of tables includes the estimates of the inputs of labor and private capital stock used by the firms in their plan of production. At the end of the description of the results, it is provided a discussion of them.

5.4.1 Effects on Productivity:

Tables 22 and 23 refer to the specifications presented in equations (55) and (58), respectively, which differ according to their inclusion of the regional effects of public investment generated by the neighboring municipalities. Table 24 contains the estimates of the equation (58), and it analyzes the economic performance by two groups of observations: one for the municipalities that belong to the metropolitan area, and another for municipalities belonging to the non-metropolitan area. The table 25 provides a robust test of the estimate of the parameter of the spatial weight matrix used in equation (58), in which three spatial structures are imposed in addition to the original time-distance weight matrix: the Euclidean matrix, the Queen matrix, and the 6^{th} nearest matrix. All estimations include time and region fixed effects, representing the manner in which firms adjusted their productivity for other events besides the variables under consideration. Discussions of the regional fixed-effect include the situation that firms faced in their operational locations in the period under analysis, such as the social and economic characteristics of the location, and other factors not considered in the research. The year fixed-effect concerns the events that influence the productivity of the firms during particular years, such as hurricane Stan in 2005, tropical Storm Barbara in 2007, river floods, volcanic activities, and other natural events that the model does not take into account in a specific year.

Therefore, table 22 below reports that the estimates corresponding to the public investment variable support the hypothesis that public investment benefits the firms' productivity in Guatemala. All of the estimates in the table show that the elasticity of public investment is positive and statistically significant. According to the findings in the estimate in

column nine, for every 1% increase in public investments normalized with respect the population of the municipality, TFP is enhanced by 0.09%. Further, the normalized R&D variable reveals that for every Q.1.00 [8] of increase in R&D expenditure, the firms' productivity increases by 0.018%. This estimate is expected as those reported in many papers usually are in a range between 0.01%-0.98%. (For a summary of estimates, see Medda and Piga, 2014). The human capital levels do not exert a significant influence on firms' productivity on average at the national level, excepting by elementary school, which is negative; this issue will be discussed later. When controlling for public capital in the metropolitan area, it seems that it would have positive effect on the average productivity of the country; however, the estimate is not significant, and the analysis is left to be analyzed in the table 24. Also, the productivity of in the metropolitan area seems to be 39% lower than in the rest of the country, while the agglomeration measured by population density appears to have little influence over productivity. Finally, the differentiation of productivity between manufacturing and service sectors is not distinguishable under this model as the estimate is not statistically significant.

[8] Exchange rate in 2008: Q7.78 = US$1.00, so Q.1.00 is about US$0.129

Table 22. Productivity and public investment within the municipality

	1	2	3	4	5	6	7	8	9
Public Investment	0.0574*	0.0740**	0.0929**	0.0827**	0.0804**	0.0932**	0.0906**	0.0854**	0.0911**
	(0.0284)	(0.0286)	(0.0289)	(0.0288)	(0.0296)	(0.0289)	(0.0297)	(0.0296)	(0.0297)
Metropolitan PK	0.1076***	0.0607+	0.0318	0.0409	0.0319	0.0298	0.0226	0.0229	0.0200
	(0.0304)	(0.0320)	(0.0327)	(0.0327)	(0.0336)	(0.0329)	(0.0337)	(0.0338)	(0.0338)
Metropolitan Area	-0.2660	-0.3326+	-0.3747+	-0.3610+	-0.3732+	-0.3775*	-0.3872*	-0.3863*	-0.3908*
	(0.1912)	(0.1916)	(0.1917)	(0.1918)	(0.1921)	(0.1918)	(0.1921)	(0.1922)	(0.1921)
Sector	-0.0271	-0.0272	-0.0276	-0.0273	-0.0272	-0.0276	-0.0275	-0.0273	-0.0275
	(0.0177)	(0.0177)	(0.0177)	(0.0177)	(0.0177)	(0.0177)	(0.0177)	(0.0177)	(0.0177)
Density	0.0001	0.0003**	0.0001	0.0003**	0.0004**	0.0001	0.0001	0.0003**	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
R&D		0.0249***	0.0200***	0.0219***	0.0220***	0.0197***	0.0186***	0.0197***	0.0181***
		(0.0053)	(0.0054)	(0.0054)	(0.0054)	(0.0055)	(0.0055)	(0.0055)	(0.0055)
Human Capital Elementary S.			-3.5140***			-3.1937**	-3.3222***		-2.7287*
			(0.7995)			(0.9762)	(0.9891)		(1.1390)
Human Capital Middle School				-0.9823**		-0.2293		-1.0708**	-0.5025
				(0.3286)		(0.4011)		(0.4154)	(0.4783)
Human Capital High School					-0.3755**		-0.1020	-0.1144	-0.0283
					(0.1434)		(0.1649)	(0.1756)	(0.1792)
Constant	6.7985***	4.7539***	18.0650***	7.1923***	5.5574***	17.4211***	17.6430***	7.7816***	16.5279***
	(0.3937)	(0.5886)	(3.0851)	(1.0059)	(0.6444)	(3.2843)	(3.6555)	(1.0769)	(3.8064)
N	13930	13930	13930	13930	13830	13930	13830	13830	13830
F	96.2496	90.6565	85.6723	84.8675	83.1300	79.9787	78.3981	78.0628	73.5678
P	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses
Note: In logarithm terms.
+ p<.1, * p<.05, ** p<.01, *** p<.001

The second case is presented in Table 23. It adds the regional spillover effects generated by public investments in neighboring municipalities. The baseline model is in column 9 and represents the results of equation 58 as proposed in the previous section. As in the first case, the estimates are constructed based on region and time fixed effects. The elasticity of the public capital stock is not much different from the previous tables as the estimate is 0.095, meaning that for every 1% of increase of the expenditure on public capital, the productivity of the firms would be 0.095% higher. Concerning the neighboring public capital, the estimate is considerable higher than the effect from the local expenditure. The elasticity is 0.42 with 10% of statistical significance. This can be interpreted as follow: in a particular locale, the average productivity of the firms would be 0.42% higher for every 1% of increase of the average neighboring expenditure on public capital. Such difference between the local and neighboring effect is expected because the construction of the neighboring public capital is an average of heterogeneous amounts of expenditure on public capital, i.e. it includes extreme poor expenditures per capita of small municipalities, and large amounts per capita expenditure from

other municipalities. As regards research and development, it has statistical importance overall with an elasticity of 0.018% in column 9. On the other hand, human capital, as seen in the previous table, exhibits results that are not significant. In addition, firms located in the metropolitan area are in average less productive than outside the region by 40%, while the population density is not statistical significant. These results suggest a possible differentiation of productivity effects between the two aggregate areas: the metropolitan and the non-metropolitan, which are covered in table 9.

Table 23. Productivity and public investment with municipal spillover effects, time and region fixed effect

	1	2	3	4	5	6	7	8	9
Public Investment	0.0585*	0.0753**	0.0955***	0.0854**	0.0826**	0.0961***	0.0939**	0.0884**	0.0946**
	(0.0284)	(0.0286)	(0.0289)	(0.0288)	(0.0296)	(0.0290)	(0.0297)	(0.0296)	(0.0297)
Neighbor Public K.	0.2906	0.3179+	0.3994*	0.4057*	0.3421+	0.4159*	0.4060*	0.4002*	0.4226*
	(0.1825)	(0.1824)	(0.1832)	(0.1843)	(0.1871)	(0.1843)	(0.1879)	(0.1882)	(0.1884)
Metropolitan Area	-0.2741	-0.3423+	-0.3888*	-0.3764*	-0.3853*	-0.3934*	-0.4024*	-0.4016*	-0.4073*
	(0.1912)	(0.1916)	(0.1918)	(0.1919)	(0.1922)	(0.1919)	(0.1922)	(0.1923)	(0.1923)
Density	-0.0000	0.0002+	-0.0000	0.0002+	0.0003*	-0.0000	-0.0000	0.0002+	-0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)
R&D		0.0252***	0.0201***	0.0219***	0.0223***	0.0198***	0.0188***	0.0198***	0.0182***
		(0.0053)	(0.0054)	(0.0054)	(0.0054)	(0.0055)	(0.0055)	(0.0055)	(0.0055)
Human Capital Elementary S.			-3.6838***			-3.2307***	-3.5278***		-2.8502*
			(0.8032)			(0.9762)	(0.9936)		(1.1402)
Human Capital Middle School				-1.0885**		-0.3295		-1.1690**	-0.5809
				(0.3321)		(0.4035)		(0.4179)	(0.4795)
Human Capital High School					-0.3971**		-0.1107	-0.1157	-0.0259
					(0.1439)		(0.1649)	(0.1756)	(0.1792)
Constant	8.1042***	6.1579***	20.4722***	9.2476***	7.1124***	19.6469***	20.2370***	9.8052***	19.0543***
	(0.9094)	(0.9978)	(3.2763)	(1.3724)	(1.0672)	(3.4287)	(3.8471)	(1.4370)	(3.9690)
N	13930	13930	13930	13930	13830	13930	13830	13830	13830
F	89.0508	84.4103	80.2995	79.5546	77.8240	75.3206	73.8096	73.4852	69.5566
p	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses
Note: In logarithm terms.
+ p<.1, * p<.05, ** p<.01, *** p<.001

In order to provide a better interpretation of these results, the models in column nine of each table, 22 and 23, are provided again, but this time such models are differentiated by two groups that distinguish the location of the firms under analysis, metropolitan area and rest of the country.

So, table 24 shows that there is strong evidence that public investment significantly influences the productivity of firms located in the same place where the investments were made. In the table, columns two and four represent the full model described in table 23 for the metropolitan area and the rest of the country, respectively; for every 1% of increase of public capital stock in each of those regions, firm's productivity will increase by 0.0953% and 0.1124%, respectively. Firms in municipalities from the non-metropolitan area are more benefited by the public infrastructure than those in the metropolitan area. This might be true as the infrastructure in the metropolitan area is significantly more developed than in the rest of the country as discussed in chapter 4. This result is expected due to the diminishing effects that the regions experience as it will be discusses later.

Table 24. Metropolitan and non-metropolitan area: Productivity and public investment with municipal spillover effects

	Metropolitan		Non-metropolitan	
	1	2	3	4
Public Investment	0.0761*	0.0953**	0.1038**	0.1124**
	(0.0331)	(0.0333)	(0.0372)	(0.0372)
Sector	-0.0333+	-0.0336+	0.0259	0.0235
	(0.0182)	(0.0182)	(0.0639)	(0.0638)
Density	0.0002	-0.0002	0.0012*	0.0009
	(0.0002)	(0.0002)	(0.0006)	(0.0006)
R&D	0.0367**	0.0432***	0.0054	0.0017
	(0.0117)	(0.0117)	(0.0081)	(0.0082)
Human Capital Elementary S.	-0.7809	-1.7847	-1.6925	-1.7785
	(1.9410)	(1.9471)	(1.7208)	(1.7165)
Human Capital Middle School	-0.9337	-1.7084*	0.0854	-0.2745
	(0.7206)	(0.7332)	(0.9286)	(0.9332)
Human Capital High School	0.2403	0.5127	-0.0580	0.0968
	(0.3100)	(0.3135)	(0.2552)	(0.2593)
Neighbor Public K.		1.3361***		-1.3808**
		(0.2410)		(0.4401)
Constant	8.4635	19.4547**	11.3590*	9.6802+
	(6.7638)	(7.0403)	(5.6044)	(5.6154)
F	79.0010	75.9659	11.8905	11.8120
p	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses
Note: In logarithm terms.
+ p<.1, * p<.05, ** p<.01, *** p<.001

Also, the model depicts the influence of the public investments made in the neighboring municipalities that acquire statistically significant influence on the firm's productivity. That is, it is possible to appreciate how firms on the periphery are negatively affected (-1.38%) while firms in the metropolitan areas are positively influenced (1.34%) by public investments executed

in neighboring municipalities. The R&D variable is still positively significant, but one can see that the impact is greater in the metropolitan than in the periphery area. About human capital, the estimates continue to be non-significant for the productivity of firms.

Table 25. Robustness of the weight neighbor matrices: Metropolitan and non-metropolitan area

	Metropolitan area				Non-metropolitan area			
	1	2	3	4	5	6	7	8
Public Investment	0.0953**	0.1078**	0.0902**	0.1269***	0.1124**	0.1190**	0.1369***	0.1304***
	(0.0333)	(0.0335)	(0.0332)	(0.0337)	(0.0372)	(0.0373)	(0.0373)	(0.0375)
Neighbor Public K.	1.3361***				-1.3808**			
	(0.2410)				(0.4401)			
Sector	-0.0336+	-0.0338+	-0.0335+	-0.0341+	0.0235	0.0217	0.0166	0.0184
	(0.0182)	(0.0182)	(0.0182)	(0.0181)	(0.0638)	(0.0637)	(0.0634)	(0.0636)
Density	-0.0002	0.0004	0.0001	-0.0003	0.0009	0.0013*	0.0012+	0.0012+
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0006)	(0.0006)	(0.0006)	(0.0006)
R&D	0.0432***	0.0444***	0.0402***	0.0422***	0.0017	0.0163+	0.0041	0.0001
	(0.0117)	(0.0117)	(0.0117)	(0.0117)	(0.0082)	(0.0086)	(0.0080)	(0.0081)
Human Capital Elementary S.	-1.7847	0.7800	-0.9629	-7.4322***	-1.7785	-1.4579	0.6440	-0.1696
	(1.9471)	(1.9543)	(1.9393)	(2.1262)	(1.7165)	(1.7151)	(1.7544)	(1.7439)
Human Capital Middle School	-1.7084*	-1.8520*	-1.9908**	-1.4585*	-0.2745	0.1195	-0.6981	-0.0997
	(0.7332)	(0.7346)	(0.7489)	(0.7223)	(0.9332)	(0.9250)	(0.9305)	(0.9242)
Human Capital High School	0.5127	0.7211*	0.6352*	0.7811*	0.0968	0.0613	0.0383	0.0178
	(0.3135)	(0.3191)	(0.3192)	(0.3174)	(0.2593)	(0.2561)	(0.2534)	(0.2543)
Euclidean PK		3.3078***				-1.4053***		
		(0.5331)				(0.3708)		
Queen PK			1.5121***				-1.9194***	
			(0.2954)				(0.3388)	
6th Near PK				1.6954***				-1.6753***
				(0.2238)				(0.3710)
Constant	19.4547**	17.5260*	16.4016*	39.8167***	9.6802+	6.2111	0.2303	2.7345
	(7.0403)	(6.9094)	(6.9324)	(7.9158)	(5.6154)	(5.7454)	(5.8910)	(5.8909)
N	12057	12057	12057	12057	1773	1772	1773	1773
F	75.9659	76.5309	75.6352	77.9067	11.8120	12.1428	13.4404	12.5836
P	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses
Note: In logarithm terms.
+ p<.1, * p<.05, ** p<.01, *** p<.001

As part of the validation process of the relationship between the variables under study, and as discussed in the methodology section, it is convenient to present a robustness check for the performance of the spatial weight matrix. Thus, in Table 25 is possible to see two aspects: first, all weight matrices conserve their significance and their sign as reported in the previous table. Second, even with the four different configurations of spatial matrices, all variables including public investment and neighboring public investment keep their consistency with respect to the previous results. The matrices used in the model are: travel time distance, Euclidean distance, Queen-matrix, and 6th nearest-matrix.

5.4.2 Effects on Production:

In checking the effects of public investment on production, the multilevel analysis method allows for an understanding of the interaction of the effects on two levels: the firm and municipality levels. Table 26 shows where the stock of private capital and labor force represent the firm level effects, while the variables used to explain the regional effects --public investment, R&D and human capital— are the same as those used in previous cases. The baseline model in table 26, in column 5, shows that it is possible to see that the elasticity provided by private capital and labor force are strongly significant: they have valuations of 0.27% and 1.01%, respectively. This demonstrates that the labor force is the most important factor of production in terms of inputs. Unlike the previous models, constant return to scale was not imposed to let all parameters free to vary. Regarding the public capital, the estimates show that for every 1% increase in its investment, the output of firms report an increase of 0.087%. However, when public works are generated in neighboring municipalities, the effect is stronger and negative (-0.10%); this result will be discussed later. In addition, when checking the R&D variable, no statistical evidence suggests that it has an influence on the decision of firms' production. Human capital reveals significant effects at 5% in all levels of education completion, where the elementary and middle school levels show negative effects on production, while high school level shows positive influence on production. The estimate for distinguishing the productivity of the metropolitan area is not significant, also for population density which measures the effect of agglomeration on productivity. Finally, as regards the interclass parameter, the regional variables substantially explain the influence on the decision of production of the firms; that is, the part of the variance that comes from the municipal variables is reduced from 50% (in column 2) to 36% (in column 5).

Table 26. Multilevel analysis Public investment effect and its spillovers effects

	1	2	3	4	5
Private Capital	0.2611*** (0.0053)	0.2609*** (0.0053)	0.2614*** (0.0053)	0.2615*** (0.0053)	0.2661*** (0.0054)
Labor	1.0133*** (0.0071)	1.0132*** (0.0071)	1.0128*** (0.0071)	1.0128*** (0.0071)	1.0094*** (0.0072)
Sector	-0.1069*** (0.0159)	-0.1075*** (0.0159)	-0.1068*** (0.0159)	-0.1065*** (0.0159)	-0.1063*** (0.0160)
Public Investment		0.0152 (0.0205)	0.0641* (0.0270)	0.0640* (0.0270)	0.0871** (0.0283)
Neighbor Public K.			-0.3250*** (0.0480)	-0.3132*** (0.0529)	-0.1070+ (0.0608)
Metropolitan PK			-0.0448 (0.0395)	-0.0467 (0.0396)	-0.0590 (0.0402)
Metropolitan Area			-0.0250 (0.1041)	0.0023 (0.1217)	-0.0402 (0.1249)
Density				-0.0000 (0.0000)	0.0001 (0.0001)
R&D				0.0011 (0.0011)	0.0008 (0.0013)
Human Capital Elementary S.					-1.1101** (0.3486)
Human Capital Middle School					-0.7187** (0.2470)
Human Capital High School					0.3069* (0.1563)
Constant	4.4765*** (0.0651)	4.4887*** (0.0676)	4.3108*** (0.0743)	4.2606*** (0.0920)	9.6063*** (1.1819)
Interclass Parameter	0.5002	0.5048	0.4775	0.4059	0.3611
p	0.0000	0.0000	0.0000	0.0000	0.0000
ll	-18310.18	-18312.89	-18296.24	-17752.23	-17724.65

Standard errors in parentheses
Note: In logarithm terms.
+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Table 27 provides the estimates of equation 64, containing the baseline model in column 5. It shows that firms' production levels are more responsive to public works within the municipality (0.28%). In similar fashion to Table 11, here the results reveal that production is negatively responsive to neighboring public investment (-0.03%), but that there is a problem of significance. Finally, the interclass parameter confirms that the municipal variables have a strong incidence in the plan of production by reducing its coefficient from 24% to 7%.

Table 27. Endogeneity: Multilevel analysis Public investment effect and its spillovers effects

	1	2	3	4	5
Private Capital/labor	0.2262*** (0.0068)	0.2261*** (0.0069)	0.2260*** (0.0069)	0.2260*** (0.0069)	0.2346*** (0.0069)
Sector	0.0491+ (0.0267)	0.0432 (0.0267)	0.0440+ (0.0267)	0.0439 (0.0267)	0.0489+ (0.0267)
Public Investment		0.1118*** (0.0278)	0.2021*** (0.0387)	0.2025*** (0.0387)	0.2820*** (0.0391)
Neighbor Public K.			-0.2617*** (0.0480)	-0.2636*** (0.0508)	-0.0353 (0.0460)
Density			-0.0000 (0.0000)	-0.0000 (0.0000)	0.0001+ (0.0000)
Metropolitan PK			-0.0852 (0.0556)	-0.0847 (0.0558)	-0.1418** (0.0517)
Metropolitan Area			0.1646 (0.1420)	0.1631 (0.1430)	0.1143 (0.1255)
R&D				-0.0001 (0.0011)	0.0002 (0.0011)
Human Capital Elementary S.					-1.6974*** (0.3047)
Human Capital Middle School					-1.0649*** (0.2269)
Human Capital High School					0.3223* (0.1414)
Constant	5.5521*** (0.0622)	5.6327*** (0.0684)	5.4518*** (0.0785)	5.4569*** (0.0955)	13.8345*** (1.0242)
Interclass Parameter	0.1940	0.2378	0.2258	0.2040	0.0777
P	0.0000	0.0000	0.0000	0.0000	0.0000
Ll	-12076.6450	-12072.4718	-12068.2585	-12074.1527	-11886.0742

Standard errors in parentheses
Note: In logarithm terms.
+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Table 28 shows the same baseline model as in Table 27, but it differs according to the location of the firms—the metropolitan and periphery areas. Public investments within the municipality register a more effective influence in the production decisions in the peripheral areas than in the metropolitan areas. In columns 2 and 4, elasticities of 0.19% and 0.29% are reported, respectively. When public works occur in neighboring municipalities, in both regions the effects of it are not statistical significant on the firms' production.

Table 28. Core-Periphery: Multilevel analysis Public investment effect and its spillover effects

	Metropolitan Area		*Non-metropolitan area*	
	1	2	3	4
Private Capital/labor	0.2446***	0.2446***	0.1669***	0.1668***
	(0.0074)	(0.0074)	(0.0191)	(0.0192)
Public Investment	0.1858***	0.1891***	0.2833***	0.2858***
	(0.0452)	(0.0463)	(0.0392)	(0.0399)
R&D	0.0117***	0.0122***	0.0022+	0.0022+
	(0.0032)	(0.0037)	(0.0012)	(0.0012)
Human Capital Elementary S.	-4.8158***	-4.7647***	-1.2878***	-1.2440***
	(1.0557)	(1.1029)	(0.2985)	(0.3502)
Human Capital Middle School	1.7530+	1.7273+	-1.3006***	-1.3080***
	(0.9475)	(0.9666)	(0.2285)	(0.2311)
Human Capital High School	0.0945	0.0815	0.3750*	0.3751*
	(0.4294)	(0.4350)	(0.1482)	(0.1485)
Sector	0.0325	0.0325	0.2125**	0.2132**
	(0.0283)	(0.0283)	(0.0782)	(0.0784)
Density	-0.0003*	-0.0003*	0.0000	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Neighbor Public K.		-0.0212		-0.0152
		(0.0880)		(0.0593)
Constant	20.7684***	20.6240***	12.8670***	12.7036***
	(2.6597)	(2.7953)	(1.0165)	(1.2211)
Interclass Parameter	0.0908	0.0950	0.0635	0.0625
P	0.0000	0.0000	0.0000	0.0000
Ll	-10380.5852	-10382.0710	-1496.9893	-1498.8663

Standard errors in parentheses
Note: In logarithm terms.
+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Regarding the effect of R&D on production, it is statistical significance at 10% with very small estimates, that is to say, for every Q1.00 of increase of expenditure on R&D, the production of firms is increased in average by 0.01%. Considering the human capital variable, populations in municipalities of both regions with elementary school show negative influence in the average production of firms. Middle school shows significant and positive effect on the average production in metropolitan area and negative effect in the rest of the country. High school level is positive in both areas, but it is only statistically significant in the non-metropolitan area with effect of 0.37% over the average production in these area. Finally, the control variable for agglomeration does not have statistical significance on the average production in any area.

5.4.3 Marginal Effects of public capital on productivity of firms

Below, figure 16 shows the yearly average marginal effect of public capital investment on the average productivity of firms located in the same municipality. It is important to recall that the analysis is based only on the 78 municipalities. Based on the results, it is possible to discuss the existence of two groups of municipalities where firms leverage more efficiently the benefits of the public capital. The first group is composed by those municipalities ranked in the top 5 most benefited, they are the Soloma (Region 7), Huehuetenango (Region 7), Ciudad de Flores (Region 8), Poptún (Region 8), and San Andres (Region 8). In the second group, we find the municipalities that are geographically clustered with others that report similar marginal effects of public capital. These municipalities are concentrated in the region 5 (Escuintla), and in the north coast (region 3).

The implication for the top 5 is that those municipalities located in region 8 are characterized for having very low population density surrounded by great extension of jungle, and regarding their non-agriculture production, they mostly dedicate to provide services of tourism. So that, it is expected that any kind of public investment favor significantly their economic development because firms depend strongly on adequate infrastructure for their production of services. Those municipalities in region 7 are located in a very poor department (Huehuetenango); however, the effectiveness of the public capital is located in the capital city of the department, which is the one (within the department) that dedicates in part to manufacturing and services. In the second group of municipalities, those clustered in the south side of the country belongs to the second most important area of the country that dedicates to manufacturing industry (light and semi heavy industries); the other cluster of municipalities located in the north coast (Izabal) are municipalities that depend on the two most important maritime ports of the country (Puerto Barrios and Santo Tomas de Castilla), they represent the most important entrances to the country's imports. For that reason such municipalities depend strongly on proper infrastructure to produce the services of transportation and commerce.

Figure 17 shows the marginal effect of the neighboring public capital. The more benefited municipalities are located in the south of the country. In region I, we find Villa Canales, and from region V Escuintla, Santa Lucia Cotzumalguapa, La Gomera and Nueva Concepcion. In the north side of the country, the most benefited are Puerto Barrios (region 3), Poptún, San Benito, and Ciudad Flores (region 8). An extreme result is obtained from

municipalities of Alta Verapaz (region 2), which are affected negatively by the neighboring effects of public investment in infrastructure.

For those municipalities reporting greater benefits, one would expect to observe such pattern as they belong to the geographic clustered municipalities discussed above. The collective effort reported in this area supports the productivity of firms that dedicate mostly to non-durable manufacturing industries. Puerto Barrios is another municipality that obtains benefits from the neighboring because the latter provides the road access to the most important commercial port in Guatemala. That is to say, the most efficient way to transport merchandise to and from this port must be through the municipalities that surround the port, mainly from the south of Puerto Barrios. Concerning those municipalities from the north of the country, it is expected to observe such pattern as the infrastructure development of such an area is very limited as explained before. Finally, the municipalities reporting negative effect are locales from the highlands of Guatemala; their result is not expected, and must be addressed more in detail for future analysis.

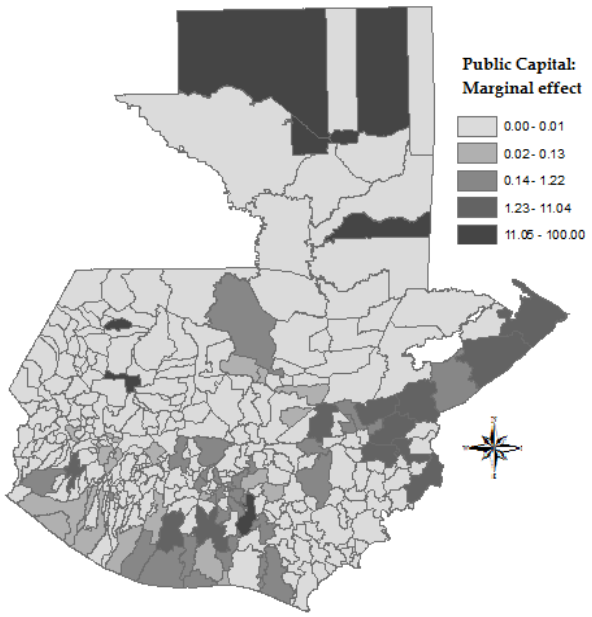

Figure 16. Marginal effect of public capital by municipality

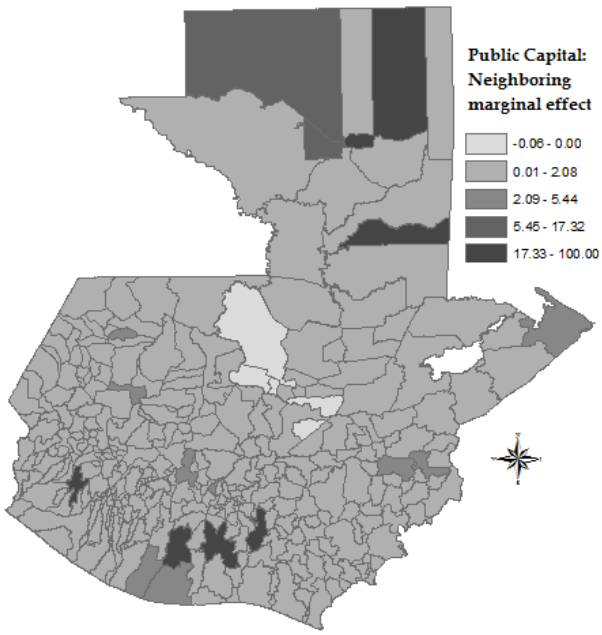

Figure 17. **Marginal effect of neighboring public capital by municipality**

5.4.4 Discussion

The results presented above suggest that the statistical evidence supports the hypothesis of this paper, in that public capital in infrastructure invested by municipalities positively influenced the economic performance of firms in Guatemala during 2001-2008.

In this regard, it is important to note that there are two cases in which to analyze the influence of the public capital stock over the economic performance of the firms. First, public capital stock has a positive and significant effect on productivity and on the production of firms that are located in the same municipality where the capital is invested. Based on the literature covered before, this result is expected because public capital increases or improves the local resources in infrastructure, which lead to reduced operational costs to the firms, or complement the production process of the firms (Aschauer, 1989; Munnell, 1992; Gomez and Fingleton, 2011). In addition to this result, it is found that the strength of influence of public capital varies depending on the location of the municipality; it was expected that the influence of public

capital in the non-metropolitan area should have greater effect on firms than municipalities in the metropolitan area because the marginal productivity of public capital has a diminishing behavior in which poorer municipalities may experience larger effects than do the richer ones. This situation may happen as poorer municipalities have more margin for improvement due to the lack of adequate infrastructure. (Pelaez, 2011) In that sense, the top 5 most benefited municipalities by public capital belong to poor regions (regions 7 and 8). In addition, results show that firms located in the municipalities of region 3 and 5 are capable to leverage better the investment of public capital. They show more homogeneous marginal effect across their regions, which implies better distribution of the economic benefits in their places. Although, I cannot prove it due to lack of documentation, this result can be an example of healthy policy coordination between such municipalities.

Second, the public capital stock invested in neighboring municipalities has significant influence on the local firms' productivity. However, the influence will be positive or negative depending on where the firm is located; i.e., whether the firm belongs to a municipality in a metropolitan or non-metropolitan area. In addition, neighboring public capital stock seems to have a bigger influence than local public investment. Two factors are important to understanding this finding. One is that the results in this paper do not capture the interconnectivity between municipalities (the infrastructure on highways), allowing us to focus on the local conditions. The other factor is that neighboring effects of public capital is a weighted average of the public capital stock of the neighboring municipalities, meaning that municipalities with higher levels of investment will exert more effect. The influence of neighboring public capital, however, depends on the location of the municipality, whether it is in a metropolitan or a non-metropolitan area. In the metropolitan area, the influence of the neighboring public capital is positive. It may respond to the case in which municipalities have better logistics and coordination, as in the case of the municipality of Guatemala City. One expects to observe the most developed public infrastructure there, which in turn would act as a complementary factor of production by virtue of allowing a crowding-in effect. Hence, firms in municipalities in close proximity to the capital city obtain benefits due to region-wide physical linkages, such as a better transportation system, electric system grids, and water system, among other factors. In the non-metropolitan area, the influence of the neighboring public capital is negative. As mentioned above, firms and skilled workers will locate where there are more local

advantages for their production processes or more opportunities for obtaining a job, respectively. In terms of infrastructure stock, the better the infrastructure conditions the more attractive the place to produce. In Guatemala there is a large gap in terms of economic development between the metropolitan and the non-metropolitan areas (see Chapter 2 for a supporting argument); therefore, it is expected that many firms will prefer to settle in the first place, which would attract qualified productive factors, producing in turn a crowding-out effect in the non-metropolitan area. Consequently, any improvement in public infrastructure in the metropolitan area will negatively affect the economic performance of the municipalities from the non-metropolitan areas.

Local public capital stock has a positive influence on the production of the local firms. This result is expected because when firms' productivity is enhanced by the new or improved public infrastructure, their potential production is increased, and in turn it may increase local incomes, which stimulate local markets. This is confirmed by Pereira and Roca (2003), who argue that public capital affects output both directly and indirectly. Directly, because public capital is a complementary input to the process of production of the firms, which represents a positive externality to private production. Thus, the greater public capital stock, ceteris paribus, the higher the output. Public capital affects output indirectly when it enhances the use of private inputs, such as capital and labor; for instance, with an efficient way of commuting, workers may decrease opportunity costs in terms of time and price.

The public capital stock from the neighboring municipalities has a negative effect on the firms' production of local municipalities (though it has no statistical significance effect). Public capital from neighboring municipalities influences the relocations of local productive factors, but it does not necessarily imply a direct influence on local output, unless the municipalities compete for a common external market. Firms with lower marginal costs or firms with more efficient production process, due to better local public infrastructure, have the potential of increasing the production at lower prices, and hence these firms will have the opportunity of selling more of their product. This argument is supported by Boarnet (1998), who states that public investment has the potential of enhancing the comparative advantages of one place over others, creating negative spillover effects.

As discussed above, local public investment influences positively firms' output both directly and indirectly; therefore, proper investment in public infrastructure enhances the economic performance of municipalities, leading to increased prosperity. It is necessary to recall two issues from earlier discussion regarding the monetary assignment for public capital; first, SEGEPLAN initially suggests a technical monetary distribution of funds to municipal projects that are prioritized on efficiency basis; second, the representatives of the congress of the republic of Guatemala modify such an original proposal for a new one based on political arguments. So, in spite of the positive influence of the local investments on the economic performance of the municipality, the neighboring investments exert some negative influence on the municipalities of the non-metropolitan areas. This concern arises because a poorly planned monetary assignment can induce qualified resources, such as skilled labor and private capital, to in-migrate to the metropolitan area. As a result, the gap of the economic development between the big two regions may deteriorated further. Therefore, representatives of the congress should be well-served to follow technical distributions of the monetary funds that consider such problems, while avoiding political redistributions.

The expenditure on research and development aims to provide experimental and theoretical knowledge for enhancing the process of production of firms. As mentioned above, the results of the estimations in this study show a high and positively-correlated effect on firms' productivity. It is important to remark on two issues in the Guatemalan case. First, the amount of money spent for R&D in the country represents, on average during 2005-2008, less than 0.05% of the GDP (BANGUAT, 2010; SENACYT, 2009), or the equivalent of 48 million dollars in real terms. Second, R&D is done mostly by universities and in a lower proportion by technological institutes of the government and NGO's. The location of such centers of capacitation are not evenly distributed across the country: 19% of them are located in 20 municipalities of the metropolitan area, whereas the remaining 81% are distributed among the remaining 314 municipalities of the country; in other words, there are about 3 centers of capacitation per municipality in the metropolitan area, while almost 1 center per municipality for the rest of the country. Also, R&D in Guatemala is characterized by diminishing returns, and because of the size of the investments on R&D one can argue that the country is at an early stage, where any monetary amount of investment in R&D leads to exert great effect on productivity of the firms.

Thus, this paper argues that the current influence of R&D on the production of the firms is, at the moment, insignificant. In order to discuss such a result, it is convenient to recall that R&D is a long-term investment, where benefits are to be perceived only if firms' workers are capable of applying the learned skills, and only if firms are capable of providing continuity in the R&D investing. Scherer (1999) points out that most private R&D projects do not actually earn positive returns, although firms expect to obtain back such investments as an asset for future profits.

It is important to remark that knowledge is a public good; thus, authorities should take the initiative of creating pools of knowledge that spill over to firms and workers. This carries an important implication in that authorities must conciliate coordination that encompasses all kind of institutions and individuals capable of transmitting knowledge and technology. This is by no means a new suggestion, because in Guatemala there is already a national plan of development that aims to promote a scientific network; nonetheless, its influence has not yet produced important results. Since 2004, the expenditure on R&D with respect to the GDP has grown from 0.03% to 0.07%, as of 2008 (SENATYC, 2010). Thus, it is imperative that the authorities provide significantly more financial support for this public program, in which more firms and people with limited resources can have access to appropriate capacitation.

In the present study, human capital is interpreted as the education level that people have in the municipalities, and are available for hiring by the firms. In theoretical terms of endogenous growth model, the role of human capital is to facilitate and adapt the technological advances into the process of production (Romer, 1990). Thus, the transmission channel of the influence of human capital to firms' productivity rests on education and on the ability of adapting technological advances into the production process. The results of the present research do not show significant influence on the productivity of the firms. Given the socioeconomic characteristics of the country, the results are not surprising. The lack of well-educated people implies that the municipalities have limited ability to use or create new technology; in 2011, the national average of schooling years in Guatemala was reported to be 3.7 (INE, 2012), reaching barely the elementary school level. Benhabib and Spiegel (1994) argue that education is essentially a prerequisite for adoption and innovation, which enhances the economic and productivity growth of a locale. Also, when looking into human capital effects over firms' production in Guatemala, it is possible to distinguish that people with elementary and middle

school level of education in the municipalities have negative impact, while people with high school reports positive impact. Hua (2005) provides an argument to explain these results. The author claims that education should play positive effect in improving technological progress, but also in adapting foreign technology; thus, education level matters. Hua adds that if people with higher education exerts positive effect on technical progress through R&D, then people with basic education (such as elementary and middle school level) may not exert such effect, or worse off, they may exert negative influence due to inadequate use of technology.

Furthermore, as discussed previously, R&D increases productivity only if human capital is capable of translating the knowledge and ideas into the process of production. Therefore, authorities must pay careful attention to human capital. Firms having access to human capital with mostly low education have to face some risks; for instance, workers might not be capable of assimilating new knowledge and technology into the production process, or may run the risk of not properly using advanced technology. For these reasons, authorities must prioritize expenditures on education in the national budget, but such outlay must support meaningful and effective programs in which childhood and adult populations receive appropriate education. In this regard, the Central American Institute for Fiscal Studies (ICEFI) argues that two issues are occurring systematically with education. While the government has increased the monetary assignment to education to hire more teachers, the initial enrollment of students has dropped; i.e. there are more teachers but relatively fewer students to teach. If this situation continues, the capacity to adapt to new technology and knowledge will be poor; consequently, firms will be less productive, which could potentially lead to less economic growth in the long-term.

Finally, some issues are not discussed in the present paper. First, this study did not seek to analyze the effects of public investment on the agricultural sector of the country. Second, the paper did not consider the public investments in highways networks that the central government funded. It is assumed that it did not change drastically during the period of this study. Third, the study did not differentiate among the quality of the public works, which implies that there was no control over the big projects (white elephants) and their efficiency in different locations. Fourth, the study used limited time series data. This brings difficulty in evaluating the results over time that would allow for understanding the in-depth effects that public capital has over the long run.

5.5 Conclusion

The results obtained in the present chapter confirm the proposed hypothesis. This assertion comes by showing that the expenditure on physical public investment in the 78 municipalities of Guatemala during the period 2001-2008 positively influences the economic performance in their locales. Regarding the neighboring public investment, it is not possible to either confirm or reject the idea that it enhances the local economic performance of firms of the municipalities. Although the results suggest different kinds of influences, depending on the region under analysis, it requires more detailed information and other econometrical tools to determine its direction and level of influence.

The empirical literature about endogenous growth model and public investment is large, but the literature focused on developing countries is scarce. The role of the public capital stock in Guatemala is important because it provides better background conditions for the economic performance of the firms. It is necessary to coordinate the planning systems of the municipalities in order to improve the benefits to society. As discussed above, the municipalities that are adjacent to the capital city benefited from the centrifugal forces that the city spreads about, while the peripheral areas suffer from polarization effects. Hence, it is possible to develop better coordination and to target efforts at stimulating an alternative growth poles that promote regional development.

Chapter 6: Discussion and Conclusion

The high rate of urbanization in Guatemala is the key part to understand the nature of the research. It means to denote both the polarized internal migration and the existing aggravated economic inequality in the country. As mentioned there, such issues have incidences in the performance of the markets, income distribution, regional disparities, and hence on the regional economic growth, which condition the economic growth of a nation. Clearly, such situation implies planning challenges that policy makers must address for improving the economic welfare of inhabitants of the locales in Guatemala.

The results presented before dropped three considerations around the elements mentioned in the above paragraph, showing that the labor market in Guatemala is flawed by imperfections, such as monopolistic power by firms and persistent underemployment; also the considerations show that state intervention is necessary for balancing the current economic conditions in Guatemala, for instance, the investment in public capital. Thus, the first consideration is that the economic prosperity represented by the market access is not associated to the spatial distribution of wages. As most of the country is in relative precariousness with respect to the metropolitan area, one would expect, for instance, to observe that wages in the metropolitan area behave alongside with the improvement of its market access. However, there is little empirical support of it, and such argument can be justified, in part, by assuming that the metropolitan area is not growing enough to absorb all labor supply in decent jobs, which is fed in good measure by the high rates of internal migration. In this regard, ENCOVI (2006) shows that among the reasons for migrating the second most important is for labor opportunities. This is a topic covered by Hagen (2008), who indicates that it is normal that individuals or groups of people may decide to move from one geographical location to another for employment possibilities. So, given the size of the market access in the metropolitan area, it is expected an increase of the labor supply due largely to internal migration, which results in underemployment. This argument brings into discussion the second consideration, the labor market in Guatemala is not enough large for hiring all people for decent jobs in all regions in Guatemala.

It was discussed in previous chapters that in Guatemala exists a large informal sector, meaning low incomes, fewer hours of working than the desired, and low productivity. This is

an expression of the existent labor gap –between supply and demand- in Guatemala, a situation that firms take in advantage for determining wages under their contractual conditioning. The labor gap in Guatemala forces people to accept jobs under poor conditions as there is not any policy of unemployment subsidy that economically supports their time of job search; this situation explains the low rate of unemployment as people do not have other ways for obtaining their income. This condition highlights the importance of focusing in the modified wage curve, in which the effects of underemployment is more relevant than the effects of unemployment over wages in the country. This is true even at interregional level, where the spillover effects of underemployment have negative effect on wages because the regions complement each other as extensions of their own market. Ernst and Berg (2009) argue that the quality of employment and decent jobs are key characteristics of a labor market aimed to promote economic development. Thus, underemployment is a perfect reflection of the economic reality of the country, and the fact that underemployment is not decreasing remarks the absence of short and medium terms solutions for inequality and poverty.

The third consideration, public capital is necessary for boosting the economy in each region. It was shown above that public capital has positive effect on firms' productivity and production when invested in the same locale where firms operate. Also, depending where the public capital is allocated and depending where the firms are located, the neighboring effect of the public capital can be either positive or negative. When firms are located in the metropolitan area the effects of public capital allocated in any part of the country is generally positive, while if the firm is located in the non-metropolitan areas the effect is negative. This result is analytically comparable with the previous considerations because public capital may incentive economic agents to migrate due to the quality or improvement of the public infrastructure. The budgetary assignment of public capital in infrastructure has been historically biased toward the metropolitan area, which remark the existent economic inequality in the country in a geographical context. Thus, public infrastructure also contributes to incentive the migration process that aims toward the metropolitan area. By considering such argument, it was shown the existence of non-metropolitan regions where public capital is better used and where spatial spillovers are better conducted; thus, placing more public infrastructure in such places would improve productivity, incomes, and hence it would reduce poverty; all of them are elements that may alleviate the regional disparities in the country.

The three considerations are embedded by the effects of internal migration has caused, which can be said is a consequence of the economic inequality between economic agents and places, as it is motivated by people who decide to move for reducing their gap related to the difference between their own economic and social position and that of people in other wealthier places. However, it is happening that economic conditions are getting worse in all regions of the country, including in the metropolitan area. Wages are already low and are even decreasing in real terms because the labor markets in the regions in Guatemala are not competitive among them. The lack of adequate planning, by the state authorities, which does not include the consideration of the internal migration as an issue to be addressed (SEGEPLAN, 2012) is fearfulness as the conditions are deteriorating, i.e., the number of migrants is considerable high and continuous in 2006 and 2011, which is inducing the creation of more workers in the informal sector each year, and hence lower wages. The metropolitan area is significantly more prosperous than any other region in Guatemala, which makes it attractive to migrants, yet its economic performance is not enough to accommodate all them. This raises labor-market implications as regard internal migration policies as it is assumed that the internal migration is pushing wages down. It is important to encourage people, when deciding to move into another locale, to immigrate to non-metropolitan areas; this can be done by encouraging private capital to invest in other places rather the metropolitan area. Also, the geographical distribution and assignation of public capital for investment in infrastructure is currently flawed by political actions not oriented by technical recommendations; then, it is imperative that legislators should follow the technical recommendations originally given by SEGEPLAN, which is oriented to be efficient under their considerations.

As explained in chapter 2, the origin of the regional disparities in Guatemala has an historical context; however, it is possible to argue that such inequality has been fueled by unwise policy actions of public investment, including public education and health, and public infrastructure, among others. This situation gave foundation, in consequence, to a monopolistic power dominated by firms, in which excess of labor supply and poor human capital creates a system that deepen the economic disparities. The informality in the economic system evidences such reality, in which it is needed the participation of the State to balance such conditions.

Thus, authorities must focus on long term planning aimed to direct private and public investment into the different regions in Guatemala, designed to give more labor opportunities

to economic agents. Using the argument provided by Hirschman (1958), this mechanism would incentive the forward linkages of the industries in Guatemala as better human capital and more infrastructures would support the production process of the firms through more and better inputs; also, it would support the backward industry when expanding their demand for inputs that involves national production, such as transportation, commerce, etc. In addition, by considering the spatial spillovers, it would be incumbent on policy makers to know the size of the effects that such investment would exert in the locales and in the neighboring, which brings into the analysis the need of knowing the correct mix of investments in each region based on the entrepreneurial abilities of each place.

Finally, Larrain (2006) mentions that "the effect of a major change in the institutional development of a country or region may exceed the cumulative effect of the implementation of economic policies." Hence, as regards the labor market in Guatemala, the public institutions of the State must be capable of providing labor protection to workers, like ensuring at least the minimum wage. Thus, the institutions in Guatemala most be strengthened to accomplish the basic roll of supervision and enforcement of the laws which would support the enhancement of the economic conditions of the country.

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