THREE ESSAYS ON DEVELOPMENT AND HEALTH ECONOMICS

BY

KARELYS KATINA GUZMAN FINOL

DISSERTATION

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Doctoral Committee:

Associate Professor Angela C. Lyons, Chair
Associate Professor Mary Arends-Kuenning
Professor Paul E McNamara
Professor David Bardey

ABSTRACT

My dissertation consists of three chapters with studies on development in the context of Colombia, a developing country. The main topics approached are agricultural economics, public finances, and health economics. The first chapter evaluates the effects of climatic variables on one of the most important staples in the world. The second chapter analyzes the effects of one of the biggest migration shocks in recent years on the health expenses of the main recipient country. The third one studies the relationship between liquidity and quality of care. Each chapter used data at different granularity levels: The first chapter at the department level, the second at the municipality level, and the third at the hospital level.

In the first chapter, my co-authors and I estimate the effects of annual temperature and precipitation on rice yields in Colombia from 1987 to 2016. The analysis explores the degree of variation in response to climate changes across the country's diverse topography. Since there are two growing seasons in Colombia, the effects of the weather conditions for these two seasons are independently investigated. Additionally, rice yields are projected for two periods (2046-2065 and 2081-2100) based on the RCP 4.5, 6.5, and 8.0 of future climate scenarios. We found a positive effect of rainfall and temperature on yields, although one variable attenuates the effect of the other. The temperature was the main driver of yields in the early season, and precipitation was the main driver in the later season. Effects were larger in departments with higher altitudes. Projections show that temperature and precipitation changes will cause rice yields to increase by 10% over 2046-2065, and 2081-2100, with respect to the reference period 1987-2016.

In the second chapter, my co-author and I evaluate the effects of Venezuelan migration on health expenditures for 23 main cities in Colombia between 2013 and 2019. Venezuelan migration to Colombia increased significantly since 2016 when the border between the two countries was re-opened after being closed for one year. In Colombia, local governments channel their health expenditures into four accounts: the subsidized regime, public health, services provided to the uninsured population, and other expenses. We investigate whether the migration effect differed for each account. The identification strategy is based on the 2SLS methodology. We found that total health expenditures, and public health expenditures specifically, increased with the number of migrants coming from Venezuela (Colombian returnees and Venezuelans). An increase in the number of migrants by 1,000 increased total health expenditures for the municipalities by 1.05%, and public health expenditures by 0.61%. However, migration did not significantly affect expenditures in the subsidized regime or the subaccount covering the uninsured population's attention (PPNA). This

result suggests that local governments tried to contain the negative externalities of public health produced by the migration shock and that as the migration from Venezuela continues, local governments might need to secure resources to grant public health programs continuity.

The third chapter estimates the effects of the accounts receivable to sales ratio, a liquidity indicator, on six quality of care indicators: waiting time for getting an appointment with a General Doctor, waiting time for emergency care, hospital readmission rate, satisfaction rate, number of General Doctors, and number of nurses. I also examine the effects of accounts receivable on the failure to pay staff, and the relationship between the former variable and other liquidity indicators, such as the percentage of assets in cash, the current liquidity ratio, and the cash ratio. The identification strategy is based on the 2SLS methodology, using information reported by public hospitals between 2009 and 2019. Results show that the accounts receivable to sales ratio had a positive effect on the number of General Doctors and nurses. Additionally, results suggest that even though public hospitals have faced severe delays in collecting payments they have assigned appointments with General Doctors and provided care for users at the emergency department in acceptable time windows. Moreover, accounts receivable did not influence the readmission rates and patient satisfaction either.

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CHAPTER 1: THE SENSITIVITY OF RICE YIELDS TO WEATHER VARIATION IN COLOMBIA

With Angela C. Lyons, Sandy Dall'Erba and Jorge Eiras-Barca

Current and future food security worldwide is deeply connected to the supply side, specifically the country's agricultural productivity. Crop yields are one of the preferred measures used to determine productivity within the agricultural sector. Because there are limitations on the amount of land available for food production, current agricultural policies focus on how higher yields can be achieved to obtain higher production amounts with the least amount of land possible. Therefore, crop yields are critical to allowing a country to sustain adequate food security levels in the short and long run.

Rice is the number one staple food for the world's poorest and undernourished people. The grain makes up 20 percent of the world's dietary energy supply—more than wheat (19 percent) and maize (5 percent) (FINAGRO, 2014; Rebolledo et al., 2018). Therefore, rice production is critical to global food security. However, the world's annual rough rice production will have to increase markedly over the next 30 years to keep up with population growth (Lomax, 2017; Seck et al., 2012). To achieve this, the sector should work on varietal development, improved rice production methods, and coping with climate change (Seck et al., 2012). The downside of rice production is that it is a significant user of land and water (Lomax, 2017), and this could be a source of concern for two reasons (Seck et al., 2012). First, the arable land in the world is becoming scarcer and more degraded. Second, the average water availability per person in big rice producers like China and India is lower than in other countries (Water Scarcity Clock, 2023).

Colombia is a South American country where rice is an economically and socially important commodity, and it has a privileged position in terms of land and water availability. According to the Food and Agriculture Organization of the United Nations -FAO- (2002), approximately half of the land that could go into agricultural production is in seven tropical countries, including Colombia[1]. Also, the average water availability per person in Colombia by 2020 was greater than 1,700 m3, while in China and India, this one was less than 500 m3 (Water Scarcity Clock, 2023). Colombia is one of the most important rice producers in South America. In 2021, its production was 3.3 million tons, only below Peru (3.5) and Brazil (11.6). In terms of rice yield, Colombia is farther below in the South American ranking. In 2021, its average yield was 6.11 tons/ha, while in Uruguay and Peru, on top of

[1] The others are Angola, Argentina, Bolivia, Brazil, Democratic Republic of Congo and the Sudan.

that list were 9.40 tons/ha and 8.32 tons/ha, respectively (FAO, 2002), which shows that the Colombian rice sector has the potential to keep growing and improve its productivity.

Rice is the food most consumed in Colombia by individuals between 2 and 64 years of age (ICBF, 2006). On the supply side, around 500,000 families make a living in the rice sector (Portafolio, 2019). In 2018, the rice sector comprised 9.4% of the national cultivated area. During the same year, its value chain generated 2.7% of the direct jobs in rural areas and 5.1% of the indirect ones (DANE, 2017a; Portafolio, 2018). Rice is considered one of the 15 fundamental products for the development of the agricultural sector in Colombia due to its contribution to food security, rural employment, and domestic trade (FINAGRO, 2014).

Yet, Colombia faces several challenges when it comes to rice production. First, the production of rice is mainly intended for domestic consumption. Colombia does not export rice regularly. Between 2019 and 2021, the average rice production in Colombia was 3.2 million tons, of which 69% was allocated for domestic consumption. Imports of paddy and white rice were 11% of the national production (FEDEARROZ, 2023) and came mainly from the United States and Peru. Since Colombia meets its demand for rice mainly from domestic production, consumer welfare is highly susceptible to changes in price. A 20% increase in the price of rice implies that the indigence rate increases from 10.4% to 10.8% and the poverty rate increases from 32.7% to 33.6% nationwide (Fedesarrollo & ANDI, 2013). The effect is especially marked in rural areas where a 20% increase in the price of rice increases the incidence of indigence from 22.7% to 23.5% and the incidence of poverty from 46.9% to 47.9% (Fedesarrollo & ANDI, 2013). Rice consumption is higher in the rural areas than in the urban areas.

Second, the demographic composition of rice producers in Colombia raises additional concerns. The latest figures show that 49% of producers are over 50 years of age and only 11% have a university education (DANE, 2016a). These socio-demographic trends suggest that Colombia could face challenges with its ability to produce rice in the short and long run and even sustain current production levels. The seriousness of the situation is magnified by the fact that producers' low earnings continue to augment inequalities between urban and rural populations, especially when it comes to producers' ability to create sustainable livelihoods for themselves and their families. In the future, Colombia is likely to see further reductions in the number of rice producers, as more of the younger generation is likely to leave the rural areas to complete a college degree and pursue careers with better income prospects.

Lastly, national aggregate figures suggest that Colombia is already experiencing stagnation in the rice sector. Between 2000 and 2016, the area planted increased by an average of 2% annually, while the yields remained almost constant at an average of 6 tons per hectare per year (DANE, 2016b). In fact, in 2014 Colombia ranked only 11 out of the 23 Latin American and Caribbean countries when it came to rice yields (Rebolledo et al., 2018). Since the initiation of the free trade agreement in 2012, farmers, industry leaders, and academics have argued that the sector lacks greater productivity and is not prepared to compete internationally, especially with the United States (Chica, Tirado, & Barreto, 2016; MINAGRICULTURA; 2018; Portafolio, 2019).

The productivity of a crop depends on its fertilization and nutrition. The climate (temperature, solar radiation, precipitation, and humidity) affects the absorption and availability of nutrients. According to the National Federation of Rice Farmers (referred to in Spanish as FEDEARROZ), temperature influences the growth rate of rice from germination to 3-5 weeks thereafter (FEDEARROZ, 2015). If the temperature increases, the rate of growth will increase. Beyond 3-5 weeks, the temperature has little effect on growth. During the reproductive phase, the ideal temperature range is between 21 and 35 ºC. Near and during the flowering period, temperatures below 20 ºC or above 35 ºC make the plant sterile. The plant´s requirements for nutrients increase with temperature.

Water availability is crucial for growing rice. While most crops require 2,000 to 7,000 m^3 of water per hectare, rice cropping needs up to 22,000 m^3 when it is cultivated using irrigation (DNP, n.d). There are two rice production systems in Colombia: rainfed and irrigated. The rainfed system depends on the occurrence, intensity, and frequency of precipitation. For the irrigated system, the source of water is the irrigation districts, but the distribution of the precipitation throughout the year is still a key factor. While the initial stages of the growing season should coincide with the period when there are the highest levels of precipitation, the harvest season should coincide with the dryer conditions (DNP, n.d).

In this study, we focus on the effect of temperature and precipitation variations on rice yields. Specifically, we assess the role of weather conditions on rice yields in Colombia between 1987-2016. The yields summarize how well farmers perform during a determined period. We build a panel over a sample of departments that produce 99% of the nation’s paddy rice using data that were collected between 1987 and 2016. In addition to running the estimates for the overall sample, we explore how the sensitivity of the yields to the climatic variables varies across highland and lowland departments (heterogeneity in space), and how the results change if the weather is measured over the growing seasons instead of the entire year (time heterogeneity). Finally, we forecast rice yields for two periods (2046-2065 and 2081-2100) based on future temperature and precipitation estimated using RCP 4.5, 6.5, and 8.0 climate scenarios[2].

This paper contributes in three key ways to the growing literature that investigates the impacts of weather and climate change on crop production in developing countries. First, our paper uses a finer spatial scale and a larger sample than previous studies on rice production in Colombia. Previous studies such as Cortés and Alarcón (2016) focused on Cundinamarca only (a department located in Colombia's main rice-growing region), while BID, CEPAL, and DNP (2014) focused on four departments that represented only 7.7% of the total planted area in the country. We provide estimates for twenty departments. Second, our study provides new and stronger evidence of the relationship between weather and rice yields, as we estimate both the magnitudes of the temperature and precipitation effects on rice yields. Our projections for future rice yields are the third major contribution of this paper. We project rice yields in each of the producing regions in Colombia for the rest of the 21st century. While previous work on Colombia has used the Special Report on Emissions Scenarios (SRES) to examine various climate change scenarios, we use the more updated version of these scenarios, the Representative Concentration Pathways (RCP).

In the past, extreme events in Colombia have affected the production of rice, causing economic losses for farmers. For instance, in 2010-2011, *La Niña* brought heavy rains, floods, and landslides (Arias, Martínez, & Vieira, 2015), resulting in the GDP growth rate falling by 0.2 percentage points. Agriculture has been the most impacted economic sector. According to CEPAL (2012), losses incurred by rice farmers in 2010-2011 represented 38% of the gross value of production lost among all temporary crops. In the second half of 2014, some regions of the country lost 35% of the rice that had been planted due to *El Niño*, which significantly decreased rainfall over the region (DANE, 2015). Floods and droughts were the cause of 44% of losses in planted areas in 2016 (DANE, 2016a). Between 2016 and 2017, planted areas that were lost due to flooding increased by 209% (DANE 2018b). Therefore, anomalous weather events have increasingly been affecting rice production in Colombia.

As this study will show, temperature and precipitation have had a positive effect on rice yields for the period 1987-2016. When the effects for each growing season are examined separately,

[2] RCP is the acronym for Representative Concentration Pathway which is used to describe a set of scenarios used to predict how future global warming will contribute to climate change. These are based on key variables such as future greenhouse gas emissions, developments in technology, changes in energy generation and land use, global and regional economic circumstances, and population growth (Vuuren et al., 2011; IDEAM et al., 2015).

temperature is found to have a larger impact on yields in the early season, while precipitation has a larger impact in the later season. In terms of spatial heterogeneity, significant differences are observed between departments with higher and lower altitudes. Finally, projections using various climate change scenarios reveal that rice yields are likely to increase in 15 out of the 20 producing regions in 2046-2065 and 2081-2100. On average, we anticipate that rice yields will increase by 10% compared to yields for the period 1987-2016.

The remainder of this paper proceeds as follows. The next section provides a review of the literature focusing on the sensitivity of rice yields to weather conditions. After describing the data and methodology used to assess the impact of weather on yield variations, we present the estimation results. We then predict future rice yields based on projections of temperature and precipitation in Colombia. Some concluding remarks and future research directions are provided in the last section.

1.1.Literature Review

The use of panel data to measure the relationship between weather and economic outputs is increasingly common in literature (Deschenes & Greenstone, 2011; Dell, Jones, & Olken, 2014; Dall'erba, Chen & Nava, 2021). Previous research has used year-to-year variation in the climatic variables to identify their economic impacts on agricultural productivity. These studies provide evidence of unanticipated weather events (e.g., weather shocks) rather than changes in climate, which correspond to the expected average weather conditions (Blanc & Reilly, 2017). When the farmers decide how much and when to plant, they rely on their expectations about the weather. The panel approach identifies the net effect of weather shocks on the outcome of interest (Dell et al., 2014), which makes it a more suitable approach to answering our research question.

There is consensus within the literature about which climatic variables should be used to estimate the impact of climate change on rice yields. Temperature (minimum, maximum, mean), precipitation, and solar radiation are the most used variables (Yao, Xu, Lin, Yokozawa, & Zhang, 2007; Zhang, Zhu, & Wassmann, 2010; Liu et al., 2016). Other authors have also considered relative humidity (Zhou, Li, Dong, & Wenxiang, 2013) and wind speed (Yu, Zhang, & Huang, 2014). The relevance of each variable can vary across regions and time periods under study. For example, in northeast China, the growing season's minimum temperature was found to be the main driver of rice yields (Zhou et al., 2013). However, in southern China, Liu et al. (2016) concluded that rice yields depend positively on temperature and negatively on solar radiation and precipitation. In Colombia, Banco Interamericano de Desarrollo et al. (2014) and Ramírez-Villegas et al. (2012) included only temperature and precipitation. In some cases, the effects of climatic variables on yields can change across the crop's development. For example, Delerce et al. (2016) found that one of the varieties of crops analyzed in some Colombian municipalities was positively affected by nighttime temperatures in the reproductive stage and accumulated solar radiation during the ripening stage.

While crop yields are affected by climatic variables, they also can be affected by non-climatic variables. The effects of non-climatic factors on rice yields have been captured in various ways. Zhou et al. (2013) found that average yield changes were significantly impacted by climatic variables, as well as crop management, use of fertilizers, increases in CO2, improvements in technology, and other non-climatic factors. Liu et al. (2016) included a time trend in their regression models to capture the impacts of non-climatic factors and found that time trends significantly affected crop yields. The magnitude of non-climatic effects can also vary. In northeast China, approximately 92.8% of the increase in rice yields was ascribed to non-climatic factors (Zhou et al., 2013); while in southern China, non-climatic factors accounted for approximately 60% and 70% of the variability for early and late rice yields, respectively (Liu et al., 2016). For the cultivars analyzed by Delerce et al. (2016) in Colombia, the climatic factors explained 54% to 94% of the spatio-temporal variability in yields.

Among all the non-climatic factors, the price of rice is often assumed to be endogenous, and therefore it has been disregarded in the analysis of crop yields. Prices have also not been included as part of the control variables when evaluating the weather effects on rice yields in the international literature (Yao, Xu, Lin, Yokozawa, & Zhang, 2007; Zhang et al., 2010; Zhou et al., 2013; Yu et al., 2014; Liu et al., 2016) and in the Colombian literature (Delerce et al., 2016). Moreover, researchers such as Berry and Schlenker (2011) have found that net yield-price elasticities for U.S. crops are close to zero[3]. As it is suggested in the previous literature, we do not include the price of rice as a control variable in our estimations.

1.2. Data and Descriptive Analysis

Geographically, Colombia is divided into 32 departments. Data on the total number of hectares of rice harvested, the total amount of rice produced, and rice yields are collected at the department level from the *Information and Communication Network of the Colombian Agricultural Sector* (AGRONET, 2017). The data has been collected annually since 1987. Our sample tracks 20 rice

[3] The authors estimated net yield-price elasticities which combine two effects. First, when a crop price increases, there is a more intensive use of existing land (positive effect on yields). Second, if the new land called into production is less productive than previous land, this has been found to have a negative effect on yields (Berry & Schlenker, 2011).

producing departments from 1987 to 2016 (the period under analysis). For the purposes of this study, we measure rice yields by the total tons of rice produced per harvested hectare as follows:

$$Y_{it} = \frac{\left[\left(Y_{irrigation_{it}} * Hectares_{irrigation_{it}}\right) + \left(Y_{rainfed_{it}} * Hectares_{rainfed_{it}}\right)\right]}{Total\ Hectares_{it}}. \quad (1.1)$$

Data for monthly mean temperature and precipitation are reported by the weather stations from the *Institute of Hydrology, Meteorology and Environmental Studies*, also known by its Spanish acronym, IDEAM, which is a government agency of the *Ministry of Environment and Sustainable Development in Colombia*[4]. The station-level data for temperature and precipitation are averaged across departments to match with the geographical unit for the rice data. Temperatures are reported in terms of Celsius. Precipitation is reported as cumulative rainfall in meters per year. Delerce et al. (2016) also examine the relationship between weather and rice yields for some cultivars in Colombia using cumulative rainfall during the year instead of mean rainfall. We also construct annual measures for temperature and precipitation since information on rice yields is only available annually for Colombia.

There are two rice production seasons in Colombia. The first one spans the first six months of the year while the second spans the rest of the year (FEDEARROZ, 2017). Most rice production traditionally occurs in the first half of the year. In 2016, 68.8% of the annual planted area, and 25.8% of the annual production was carried out in the first half of the year (FEDEARROZ, 2017). In the second half of the year, these percentages were reversed, since a good part of the cultivated area in the first six months was harvested in the late season. The share of rice planted in the second half of the year was 31.2%, which comprised 74.2% of annual production (FEDEARROZ, 2017). Because rice is grown all year long in Colombia, our main analysis is conducted at the annual level rather than seasonally. Other researchers have used growing-degree-days to capture weather variability in countries such as the U.S. (e.g., Schlenker & Roberts, 2009). However, Colombia does not experience significant variations in temperature and precipitation throughout the year. It is located near the equator and so it only has two seasons: dry and rainy (Bohorquez-Penuela & Otero-Cortes, 2020).

To estimate periods of anomalous weather, dummy variables are constructed to indicate if precipitation and temperature were above the upper 90th percentile or below the lower 10th percentile of the entire distribution for each department. A similar approach was used by Dall'erba and

[4] Note that the dataset is not available publicly. It was requested by the authors and is available to other researchers upon request.

Domínguez (2016) to determine the impacts of extreme rainfall and temperature events on farmland values in the Southwestern United States.

Additionally, a set of indicators are used to capture key macroeconomic characteristics for each department. We include Gross Domestic Product (GDP) per capita, obtained from the *National Administrative Department of Statistics of Colombia* (DANE, 2018a, 2018c), and geographic characteristics on altitude and surrounding area for each department, taken from the municipal panel catalog of the University of the Andes Foundation (UNIANDES, 2018). Altitude is recorded in meters above sea level (m.a.s.l.). Finally, we also include population density (population per km^2).

Table 1.1 reports the department-level summary statistics for the key variables included in our analysis. The mean temperature in the departments that produce rice in Colombia was 24.83°C between 1987 and 2016, while the average precipitation was two meters per year. On average, more than 21 thousand hectares of rice were harvested per year in Colombia, which resulted in 110,991 tons of rice being produced. The average rice yield was 4.90 tons per hectare per year.

Table 1.1. Department-level summary statistics for the Colombian rice sector

Variables	Mean	Std. Dev.	Min	Max
Temperature (°C), T	24.83	3.22	15.81	29.59
Precipitation (m/year), P	2.12	1.00	0.49	6.17
Area harvested (hectares)	21,181	28,194	50	132,000
Production (tons)	110,991	163,864	170	838,220
Yield (tons per hectare)	4.90	0.98	2.29	7.70
Number of departments	20			

Decisions on how much rice to plant, where to plant, and when to plant are highly dependent on the availability of water. Between 1987 and 2016, irrigated and rainfed agricultural systems were the systems most commonly used to produce rice in Colombia. With the rainfed system, farmers rely on rainfall for water, whereas with the irrigated system, farmers apply water from other sources such as freshwater from streams, rivers and lakes, or groundwater. The irrigated system is the predominant method used, but requires more investment in the construction of water resource management systems. The rainfed system requires less investment but can only be used in regions that experience a unimodal pattern of rainfall (DANE, 2017b).

FEDEARROZ (2017) classifies the departments in Colombia into five regions based on their agronomic and economic characteristics. These regions are referred to as: *Central*, *Llanos*, *Bajo Cauca*, *Santanderes*, and *Costa Norte* (see Appendix A1). Table 1.2 presents the summary statistics for our key variables and highlights some of the differences across these five regions. In Centro, Santanderes, and Costa Norte, more than 80% of the planted hectares rely on irrigation, whereas in the regions of Cauca and Llanos, the rainfed system is predominant. On average, these two regions are responsible for 95% of the total hectares cultivated with the rainfed system in the country. The yields produced by the irrigated system are higher than those produced by the rainfed system in every region.

Table 1.2. Regional-level summary statistics on the Colombian rice sector

Variables (average per year)	Centro	Llanos	Bajo Cauca	Santanderes	Costa Norte
Area harvested (hectares)	23,382	42,098	13,999	14,678	9,318
Percentage of hectares cultivated with irrigation	0.84	0.28	0.13	0.87	0.99
Yield from irrigated system (tons per hectare)	6.31	4.93	4.96	5.31	4.89
Yield rainfed system (tons per hectare)	4.78	4.62	3.91	2.40	2.95
Production (tons)	148,887	200,411	56,739	75,999	44,149
T (Celsius)	21.82	26.06	26.36	21.74	27.91
P (m/year)	2.28	3.00	2.05	1.80	1.32
Altitude (masl)	1,041	299	415	1,369	63
Number of departments	6	4	4	2	4

Figure 1.1 shows how the total hectares of rice planted, the total amount of rice produced, and the amount of rice produced per hectare has changed over time via both the rainfed and irrigated agricultural systems. Although irrigation is the predominant production system in the country, Figure 1.1 shows that, in the last ten years, an increasing share of rice production comes from rainfed systems. According to FEDEARROZ (2017), the increase in the area cultivated with rainfed systems has negatively affected national yields, because the quality of the soil used is not necessarily the best for rice cultivation. Since 1987, an average of 394,063 hectares of rice have been planted annually in Colombia; 65% of these hectares have been cultivated with irrigation and 35% with rainfall. The average yield per year in the rainfed areas has only been 4.3 tons of rice per hectare, compared to 5.7 in the irrigated areas. The bottom graph in Figure 1.1 shows that the gap in yields per hectare between the irrigated and rainfed systems increased until 2000, then decreased between 2000 and 2004. After that year, changes in the gap were less consistent, up until 2011 when the gap narrowed.

Figure 1.1. Harvested area, production, and average yields by the production system

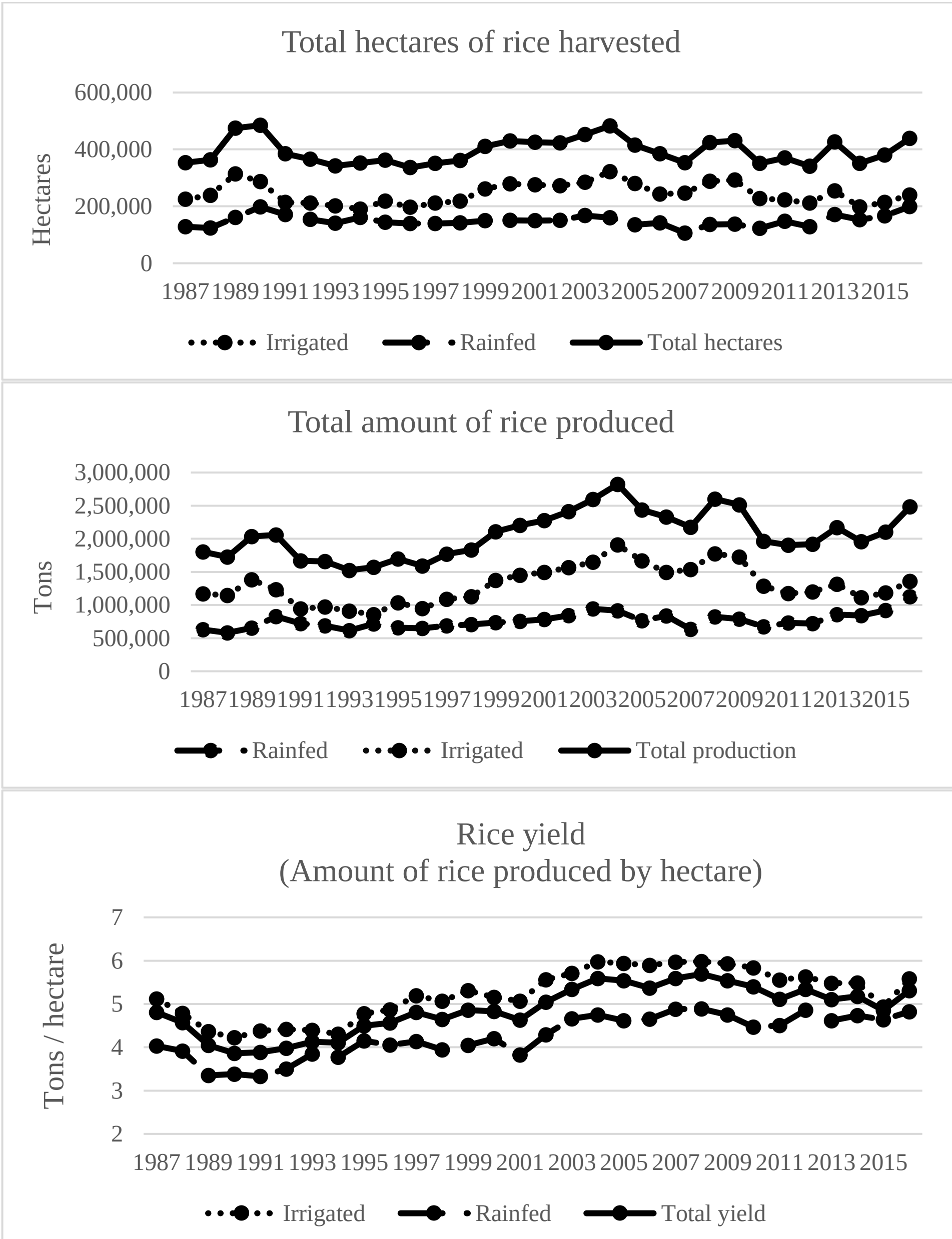


Figure 1.2 shows how annual temperature and precipitation have varied over time. The average temperature has been fairly stable over this time period, hovering between 24 °C and 25 °C. However, there has been a steady increase in average temperature levels since 2010. Between 1987 and 2016, the average temperature increased by 0.58°C. Although the change in precipitation over this same time period was found to be negligible, there was considerable variation from year to year. Annual means of precipitation amounts tended to be between 1,700 and 2,700 mm. Some of the variations in precipitation were a result of *El Niño* which took place in 1986-87, 1991-92, 1997-98, and 2014, and *La Niña* which occurred in 1988-89, 1999-00, 2005, and 2010-11 (IDEAM, 2007; CEPAL, 2012). Events such as *La Niña* resulted in considerable economic losses for Colombia, especially in terms of the volumes of rice that had wilted, died, and could not be harvested. The affected areas saw significant decreases in crop yields (CEPAL, 2012).

Figure 1.3 presents the results for the non-parametric local polynomial regressions related to the yields and the weather without imposing a linear model or using more controls (Sheahan & Barrett, 2017). Accordingly, the relationship between temperature and yields is non-linear, while the relationship between precipitation and yields is positive. The graph indicates that departments with an average temperature of approximately 20 °C have the lowest yields in the sample.

Figure 1.2. Cumulative precipitation and average temperature (Celsius) in Colombian rice producer departments

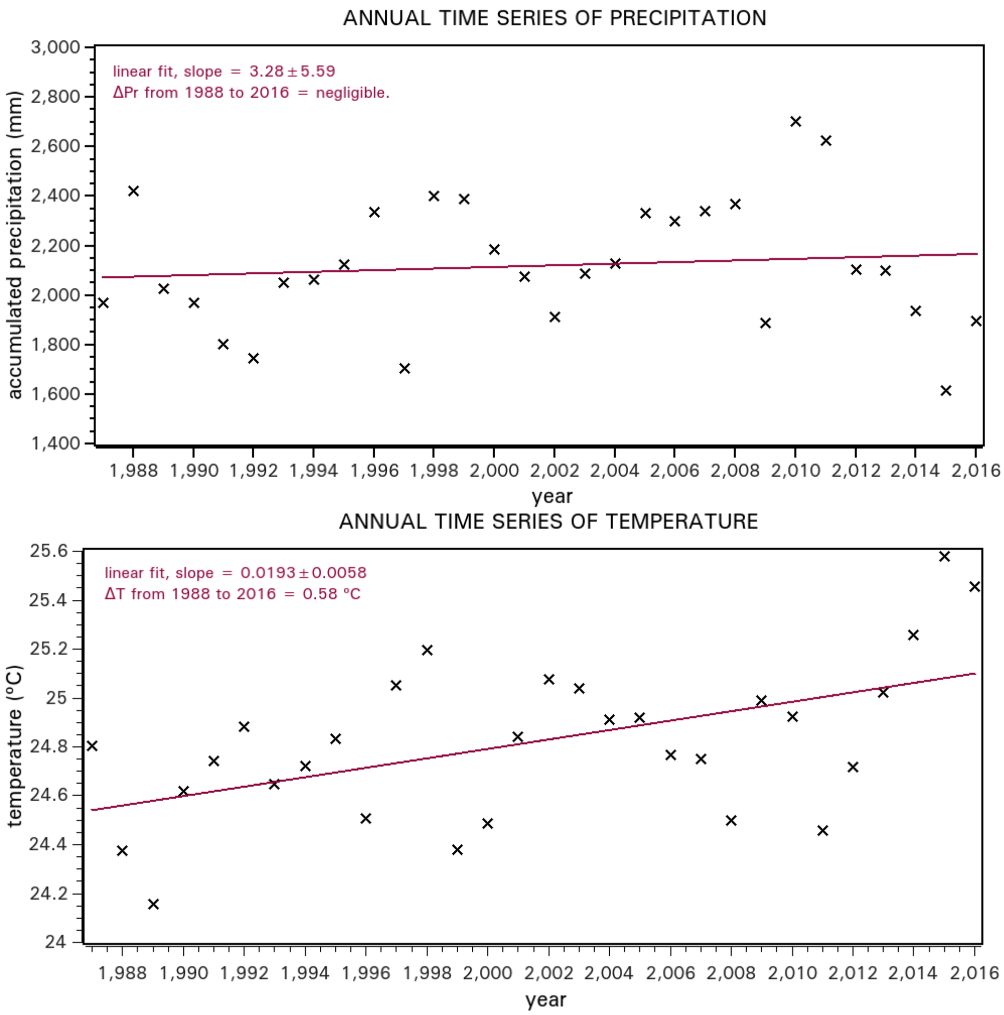
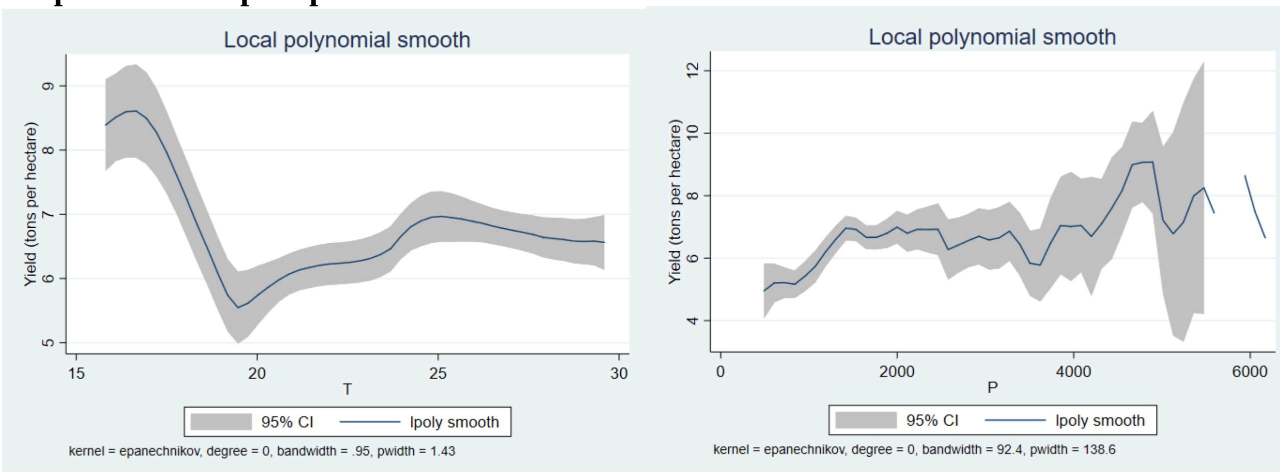


Figure 1.3. Local linear non-parametric regression of rice yields (tons per hectare) by annual temperature and precipitation



1.3. Econometric Model and Results

To empirically examine the effects of the weather variables on rice yields, we estimate the following panel data model:

$$y_{it} = W_{it}'\beta + X_{it}'\gamma + \theta_{Rt} + \alpha_i + \varepsilon_{it}, \qquad (1.2)$$

where i ={1, …, 20}, *t*={1987, …, 2016}, *R*={1, …, 5}, and $\varepsilon_{it} \sim (0, \sigma_{\varepsilon}^2 I_n)$.

In this model, the dependent variable, y_{it}, is rice yields in the i^{th} department in year *t*. The independent variables are represented by the vector, W_{it}, which is a vector of weather variables. This includes temperature, precipitation, and anomalous weather events (upper and lower 10% of each department's variable distribution as described earlier). The squared values for temperature (T_{it}) and precipitation (P_{it}) are included to capture their non-linear effects on yields. Additionally, an interaction term between temperature and precipitation ($T_{it}*P_{it}$) is included since one might influence the effect that the other has on yields. An additional vector, X_{it}, is included to control for non-climatic factors such as GDP per capita and population density. GDP per capita is a proxy for the economic growth of the department. The more economic growth a department experiences, the more rice farmers are able to access resources to invest in infrastructure and technology that, in turn, could increase yields. Population density is a proxy for the rurality level of the department[5]. Areas with

[5] There are other variables potentially related to rice yields (e.g., investment in infrastructure, labor intensity, research, technology, soil preparation, and the use of chemical pesticides and fertilizers) that are not observable annually at the department level in Colombia. This might be considered a limitation of this study. However, note that regional time-fixed effects and fixed effects at the department level are included in the models to disentangle the effects of the weather conditions from possible sources of omitted variable bias (Dell et al., 2014).

higher population densities are likely to be associated with more urbanized regions that have easier access to labor and other production inputs, which could favor productivity.

The fixed effects at the department level, α_i, account for all the unobserved variables, like the soil characteristics, that are constant over the studied time period. Equation (1.2) also includes a regional time-fixed effect, θ_{Rt}, that captures unobserved effects shared by all the departments of the same region in a specific year. The models are estimated using a balanced panel.

Table 1.3 reports the results from the OLS estimation and the associated heteroscedasticity-consistent standard errors[6]. Column (1) presents the results for Model (1) without the fixed effects. The model includes temperature, precipitation, and squared terms for each of the variables. It does not include controls for the fixed effects and macroeconomic characteristics. The findings show that temperature significantly increases yields, but at a decreasing rate, whereas precipitation significantly decreases yields, but at an increasing rate. Columns (2)-(4) present the results for the fixed-effect models. The models include the same variables as Model (1) – namely, temperature and precipitation. Additionally, Model (2) includes departmental fixed effects and regional time-fixed effects. Model (3) includes both fixed effects and macroeconomic characteristics (GDP per capita and population density). The effect of anomalous weather episodes is included in Model (4). Finally, Model (5) includes the interaction term, $T_{it}*P_{it}$, which takes into account the relationship between these two variables. To calculate the marginal effects of temperature and precipitation on yields for Model (5), which includes the interaction term, we took the derivative of the function in Equation (1.2) with respect to T_{it} and P_{it}, at their mean values[7].

According to the results in column (5), temperature and precipitation have a positive effect on rice yields. However, because the coefficient of the interaction term is negative and significant, each variable attenuates the effect of the other. In other words, the effect of precipitation depends on temperature and vice versa. The significant squared temperature term indicates non-linear yield responses to changes in temperature. When T_{it} and P_{it} are at their mean values (25 °C, 2.12 m/year)

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[6] The estimations have robust standard errors. I am clustering the standard errors at the department level (the unit of study), which accounts for heteroskedasticity problems because accommodates and adjusts for the correlation of observations within values of panelvar. Specifically, I run the estimations in STATA using the command xtreg, fe vce(robust *panelvar*), where *panelvar* is the identifier for each department.

[7] The marginal effect of T = $\delta Y/\delta T = \beta_1 + (2\beta_2 * \bar{T}) + \beta_3 * \bar{P}$, where β_1, β_2 and β_3 are the estimated coefficients for T and T^2, and T*P, respectively. All of them are variables in the W_{it} vector. $\bar{T}$ and $\bar{P}$ are specific values for temperature and precipitation. In our models, we use the means values for $\bar{T}$ and $\bar{P}$. In the same way, the marginal effect of P = $\delta Y/\delta P = \beta_4 + (2\beta_5 * \bar{P}) + \beta_3 * \bar{T}$, where β_4, β_5 and β_3 are the estimated coefficients for P and P^2, and T*P, respectively. All of them are variables in the W_{it} vector.

an additional degree of Celsius increases yields by 0.04 tons per hectare, and an additional meter of rain per year increases yields by 0.09 tons per hectare.

Table 1.3. Effects of annual temperature and precipitation on rice yields

	(1)	(2)	(3)	(4)	(5)
T	0.834***	0.868**	0.758**	0.903**	1.242***
	(0.184)	(0.364)	(0.325)	(0.374)	(0.302)
P	-0.865***	-0.378	-0.326	-0.144	1.352*
	(0.176)	(0.233)	(0.259)	(0.264)	(0.708)
T*P					-0.051**
					(0.020)
T^2	-0.020***	-0.016**	-0.014*	-0.016**	-0.022***
	(0.004)	(0.008)	(0.007)	(0.008)	(0.006)
P^2	0.116***	0.055	0.050	0.035	-0.007
	(0.030)	(0.034)	(0.037)	(0.040)	(0.041)
Anomalous high T				-0.125	-0.123
				(0.113)	(0.113)
Anomalous low T				0.029	0.028
				(0.097)	(0.097)
Anomalous high P				-0.134	-0.131
				(0.123)	(0.121)
Anomalous low P				0.129	0.171
				(0.099)	(0.106)
GDP per capita			-0.005	-0.004	-0.002
			(0.006)	(0.006)	(0.006)
Population density			-0.005**	-0.005**	-0.005***
			(0.002)	(0.002)	(0.001)
Department fixed effects	No	Yes	Yes	Yes	Yes
Region*year fixed effects	No	Yes	Yes	Yes	Yes
Observations	555	555	555	555	555
R-squared	0.13	0.73	0.73	0.73	0.74
Adjusted R-squared	0.13	0.62	0.63	0.63	0.64
Number of departments		20	20	20	20

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The coefficient associated with GDP per capita is not significant, but population density was found to be negatively correlated with rice yields, which means that we find higher yields in areas where the population density is lower. One way to think about this is that, in more urban areas, there is higher competition for the water that is available and a larger population using water, which in turn might lower the water and other resources available for rice production. The negative relationship between population density and yields is likely explained by the fact that rice production takes place in more rural areas, which are less inhabited.

An alternative approach to capturing the time dynamics of weather on rice yields is to include a time trend. An example of a time trend could be the knowledge and experience farmers acquire when dealing with new weather conditions and how they learn to make adjustments so as to maintain or increase their yields. This process is assumed to be homogenous across all departments within the country. We test the robustness of our findings in Table 1.3 by re-estimating Equation (1.2) with a linear time trend, $\delta Trend,$ instead of a spatially specific time fixed effect (θ_{Rt}). The equation is specified as follows:

$$y_{it} = \beta \mathrm{W}_{it} + \gamma \mathrm{X}_{it} + \delta \mathrm{Trend} + \alpha_i + \varepsilon_{it}. \quad (1.3)$$

The variable *Trend* is assigned numerical values. For every department i, we assign a value of 1 for the year 1987, a value of 2 for 1988, and so on. The last observation for department *i* is in 2016 which has a value of 30. The vectors of control variables, W_{it} and X_{it}, are the same as those included in Equation (1.2).

Table 1.4 displays the results. The magnitude and sign of the coefficients for the climatic variables do not change significantly with respect to the estimates presented in Table 1.3 for Equation (1.2). Therefore, our results are robust regardless of whether a regional time-fixed effect or a time trend is included in the models. According to Model (4) in Table 1.4, When T_{it} and P_{it} are at their mean values (25 °C, 2.12 m/year), an additional degree of Celsius per year increases yields by 0.14 tons per hectare; while an additional meter of rain per year increases yields by 0.37 tons per hectare. The coefficient associated with the linear time trend (*Trend*) indicates that yields follow a positive trend through the period under study. As we mentioned, Equation (1.3) assumes that the trend is homogenous across all departments within the country. This assumption, however, does not hold for all departments in Colombia[8]. Moreover, the adjusted R-squared in Tables 1.3 and 1.4 suggests that the model in Equation (1.2) is more appropriate than the one in Equation (1.3)[9].

Departments are divided into municipalities. Given this, one might question why the analysis was conducted at the department level and not at the municipality level since the latter is a smaller geographic unit. We estimated the regressions at the municipal level for the period 2007-2016 using the available data. We did not find a significant relationship between the climatic variables and rice yields. The reason is that the political division between municipalities does not necessarily correspond to geographical limits. For example, two small municipalities located next to each other might not

[8] We calculated the trend for every department, and these are different for each of them. These results are available from the authors upon request.

[9] Some concerns might arise, because the percentage of hectares cultivated with irrigation is not included as a control variable in our models. However, the decision of producing rice with a rainfed or irrigated system depends on precipitation and the rain pattern (unimodal or bimodal), which are likely to be highly correlated with the percentage of hectares cultivated with irrigation. For this reason, we decided not to include it as a control variable in our models. If it is included, the signs and magnitude of the coefficients associated with the temperature and precipitation do not change significantly, especially with respect to the estimations presented in Column 5 of Table 1.3. The full estimation results are available from the authors upon request.

exhibit enough climatic differences. Therefore, climatic variations across municipalities may not be significant enough to explain part of the variation in rice yields. For this reason, it is necessary for the geographical unit to be larger in geographical size.

Table 1.4. Robustness check: Effects of annual temperature and precipitation on rice yields with a time trend common to all departments

Variables	1	2	3	4
T	1.079***	0.988**	1.151**	1.788**
	(0.362)	(0.376)	(0.456)	(0.777)
P	0.438*	0.473*	0.456	2.457***
	(0.252)	(0.251)	(0.264)	(0.702)
T*P				-0.070***
				-0.021
T^2	-0.021**	-0.019**	-0.020**	-0.030**
	(0.008)	(0.008)	(0.009)	(0.014)
P^2	-0.041	-0.043	-0.036	-0.083**
	(0.040)	(0.040)	(0.042)	(0.031)
Anomalous high T			-0.292*	-0.299**
			(0.140)	(0.135)
Anomalous low T			-0.029	-0.036
			-0.091	-0.084
Anomalous high P			-0.110	-0.136
			-0.095	-0.099
Anomalous low P			-0.071	-0.021
			(0.114)	(0.112)
GDP per capita		-0.026**	-0.025**	-0.023*
		(0.011)	(0.011)	(0.011)
Population density		-0.004*	-0.003	-0.003**
		(0.002)	(0.002)	(0.002)
Trend	0.048***	0.056***	0.057***	0.059***
	(0.004)	(0.006)	(0.006)	(0.006)
Constant	-10.41**	-8.872*	-12.20*	-22.00*
	(4.294)	(4.561)	(5.883)	(10.75)
Observations	555	555	555	555
Department fixed effects	Yes	Yes	Yes	Yes
R-squared	0.39	0.41	0.42	0.44
Adjusted R-squared	0.38	0.40	0.41	0.43
Number of coddep	20	20	20	20

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

1.3.1. Heterogeneity in space: The role of altitude

In Colombia, rice is produced at sea level up to 2,000 m.a.s.l (AGROPINOS, 2022). Throughout the country, a negative relationship between altitude and temperature has been observed such that high-altitude areas present lower temperatures. However, the relationship between altitude and precipitation might not be as clear, since there could be a high variance in precipitation among areas with the same elevation. In our data, the correlation between temperature and altitude is -0.93, while that between precipitation and altitude is 0.22. Both correlation coefficients are significant at the 5% level or better. As it is countrywide, the relationship between precipitation and altitude is weaker than its relationship with temperature among the rice-producing areas. This is more evident graphically (see Figures 1.4 and 1.5).

Figure 1.4. Precipitation (mm) and altitude (m.a.s.l) in rice producing departments (1987-2016)

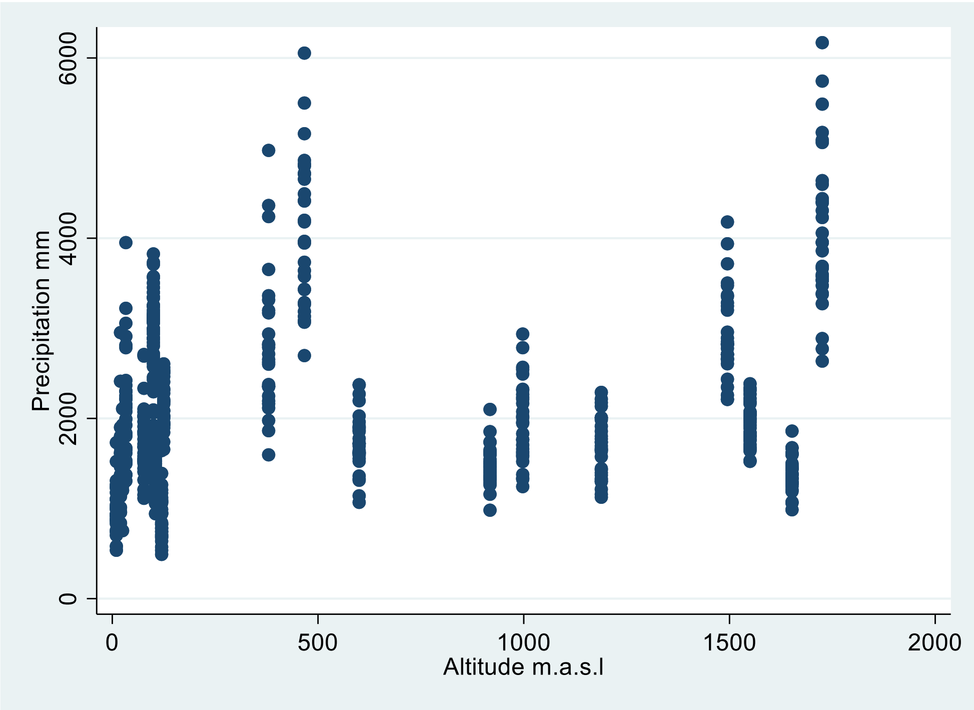
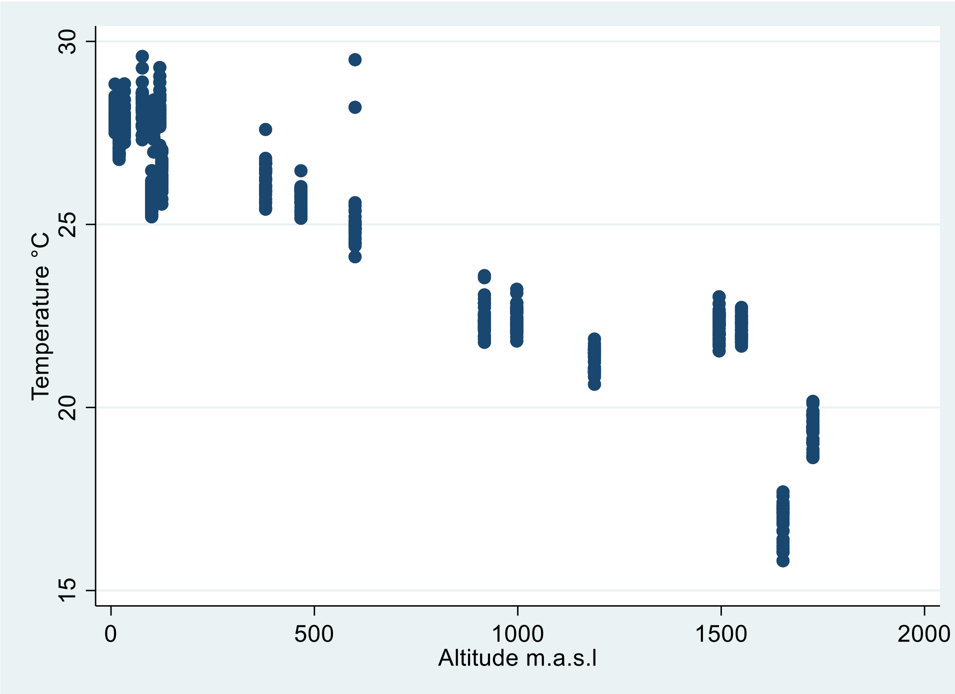


Figure 1.5. Temperature (°C) and altitude (m.a.s.l) in rice producing departments (1987-2016)



Given the country's topography, the effect of temperature and precipitation could vary between lowland and highland departments[10]. Table 1.5 presents some descriptive statistics for departments whose altitude is above or below the median value for our sample of departments in Colombia (1,112 m.a.s.l.). Note that 15 of the 20 departments are (on average) below sea level. Also, note that the difference in mean temperature is higher than the difference in mean precipitation and yields.

Table 1.5. Summary statistics by altitude

Altitude dummy variable	Altitude (MSL)	T (Celsius)	P (m/year)	Yield (tons per ha)	Departments
=1 (altitude>median altitude of the country)	1,522.20	20.41	2.41	4.91	5
=0 (altitude<median altitude of the country)	273.27	26.33	2.02	4.90	15

To separate the marginal effects for departments with altitudes above and below the median sea level, we estimated Equation (1.2), interacting each independent variable with a dummy equal to 1 if

[10] Dall'erba and Dominguez (2016) found this form of spatial heterogeneity to be highly significant among Southwestern counties in the United States.

the department altitude is higher or equal to the median value of the altitude in the sample. The Chow test results indicate that the null hypothesis of no structural change is rejected (p-value = 0.000). Results show that temperature and precipitation have a positive effect in both the highlands and the lowlands (see Table 6). However, the interaction term is no longer significant for departments with higher altitudes, which means that temperature does not attenuate the effects of precipitation in those areas (and vice versa). One of the meteorologists working at Fedearroz (the National Rice Producers Association in Colombia) explained that in elevated areas (more than 500 m.a.s.l) high luminosity (instead of precipitation) is the key variable to ensuring high yields since in many cases the water is provided by the irrigation systems. Then, higher precipitations do not weaken the positive effects of solar radiation (associated with higher temperatures).

In departments with higher elevation, when T_{it} and P_{it} are at their mean values (20.41 °C, 2.41 m/year), an additional degree of Celsius per year increases yields by 0.14 tons per hectare, while an additional meter of rain per year increases yields by 0.44 tons per hectare (Table 1.6). In departments with lower elevation, when T_{it} and P_{it} are at their mean values (26.33 °C, 2.02 m), an additional degree of Celsius per year increases yields by 0.02 tons per hectare, while an additional meter of rain per year increases yields by 0.11 tons per hectare. The larger magnitudes of the effects of temperature in the highlands versus the lowlands are supported by Ramírez-Villegas et al. (2012) who conclude that higher temperatures in the highlands shorten the growth cycle, allowing farmers to plant more frequently to increase revenue.

Table 1.6. Effects of annual temperature and precipitation on rice yields by altitude

	Higher altitude	Lower altitude
T	1.302**	2.614**
	(0.573)	(1.112)
P	-1.42	3.161*
	(1.019)	(1.583)
T*P	0.050	-0.116*
	(0.042)	(0.062)
T^2	-0.029*	-0.044**
	(0.016)	(0.021)
P^2	0.091**	-0.023
	(0.035)	(0.043)
Anomalous high T	-0.084	-0.152
	(0.154)	(0.143)
Anomalous low T	0.105	-0.021
	(0.281)	(0.127)
Anomalous high P	-0.313***	-0.076
	(0.107)	(0.142)
Anomalous low P	-0.203	0.312**
	(0.213)	(0.111)
GDP per capita	0.036	-0.003
	(0.032)	(0.006)
Population density	-0.011	-0.006***
	(0.010)	(0.001)
Region*year and department fixed effects	Yes	
Adjusted R-squared	0.64	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

1.3.2. Heterogeneity in time: The two growing seasons of Colombia

After investigating spatial heterogeneity's role, we now test for the possible presence of heterogeneity in time. Indeed, while Colombian farmers plant rice throughout the year, the volume planted varies from month to month. Moreover, planting and harvesting periods are different across regions (FEDEARROZ, 2021; DNP, 1980). Therefore, it is likely that the weather conditions experienced during some periods of the year are more likely to have an impact on yields than others.

In order to evaluate the effects of weather on rice yields during the growing season, it would be necessary to use historical information on the hectares planted per month, so as to identify the months that are most critical to the growing stages of rice. However, these data are not available for the period under analysis. Information for 2016 indicates that, for the periods of March to May and September to November, 57% and 22% of the rice areas were planted respectively. Based on this information, we assume that the growing seasons correspond to those trimesters. We further assume that these are the growing seasons for the entire sample. Table 1.7 presents the results for the estimations of Equation (1.2), where growing season conditions are used instead of annual temperature and precipitation. In this equation, T_{mm} and T_{sn} represent the annual early (March-May) and late season (September-November) temperatures respectively. Similarly, P_{mm} and P_{sn} represent the annual early and late season amounts of precipitation.

The results in Table 1.7 show that early season temperature (indexed as "*mm*") and late season precipitation (indexed as "*sn*") are the most significant factors impacting rice yields. When T_{mm} and P_{mm} are at their mean values (24.99 °C, 606.06 m/year), an additional degree of Celsius per year increases yields by 0.03 tons per hectare (See Column (3) of Table 7). During the first semester of the year, precipitation does not appear to have a statistically significant effect on yields. Neither is there any attenuation of the effects between temperature and precipitation. These results could be explained by the regional distribution of the planting areas and the timing of the rice growing stages in Colombia.

Approximately 65% of hectares cultivated with rice are planted in the early season under the rainfed system (FEDEARROZ, 2017, 2018). Most of the area planted is located in Llanos Orientales, where there is just one rainy season that goes between March (or April) and October (FEDEARROZ, 2021; FEDEARROZ 2011). Thanks to this unimodal wet season, Llanos Orientales plants rice mainly with a rainfed system during the first half of the year. The other regions (Costa Norte, Centro, Bajo Cauca, and Santanderes) plant rice evenly throughout the year thanks to having two rainy seasons per year or their irrigation systems. However, the vegetative stage of rice growth takes place during the first 45 days (on average) after planting the seeds. According to the meteorologist from Fedearroz, the plant is less sensitive to weather variations at this stage. This could explain the small coefficient for temperature and the insignificant one associated with precipitation for the trimester considered.

As for the results in the late season, we find that when T_{sn} and P_{sn} are at their mean values (24.66 °C, 660.52 m/year), an additional meter of precipitation per year decreases yields by 0.43 tons per hectare. It is important to notice that the direct effect of precipitation is positive, but it is attenuated by the temperature, as the coefficient associated with the interaction term is negative and significant. T_{sn} does not appear to have a statistically significant effect on yields. This could be explained partially by the length of the rice cycle in Colombia. Harvesting occurs five or six months after the land preparation and around four months after the germination of the seeds. Therefore, some of the rice planted between September and November in year t will be harvested in year t+1., potentially affecting the yield sensitivity to weather variation during this trimester[11].

Table 1.7. Effects of the growing season temperature and precipitation on rice yield

	(1)	(2)	(3)
Tmm	0.675**	0.742**	0.671**
	(0.320)	(0.297)	(0.285)
Tsn	0.407	0.408	0.392
	(0.372)	(0.354)	(0.385)
Pmm	-0.688	-0.456	-0.350
	(1.128)	(1.159)	(1.102)
Psn	3.254**	3.560**	3.761**
	(1.434)	(1.307)	(1.442)
Tmm*Pmm	0.009	0.006	0.006
	(0.042)	(0.043)	(0.041)
Tsn*Psn	-0.162***	-0.164***	-0.170***
	(0.045)	(0.043)	(0.047)
Tmm^2	-0.014*	-0.014**	-0.013**
	(0.007)	(0.006)	(0.006)
Tsn^2	-0.006	-0.006	-0.006
	(0.007)	(0.006)	(0.007)
Pmm^2	0.176	0.132	0.098
	(0.160)	(0.179)	(0.170)
Psn^2	0.193	0.109	0.083
	(0.219)	(0.207)	(0.220)
Anomalous high T		-0.066	-0.071
		(0.109)	(0.111)
Anomalous low T		0.049	0.047
		(0.101)	(0.091)
Anomalous high P		-0.033	-0.030
		(0.110)	(0.109)
Anomalous low P		0.116	0.104
		(0.096)	(0.099)
GDP per capita			-0.008
			(0.006)
Population density			-0.005***
			(0.002)
Region*year fixed effects	yes	yes	yes
Department fixed effects	yes	yes	yes
Observations	555	555	555
Adjusted R-squared	0.63	0.63	0.64
Number of Departments	20	20	20

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[11]Again, the full estimation results are available from the authors upon request.

1.3.3. Future Rice Yields and Climate Change in Colombia

Recall that in Equation (1.2), we estimate the coefficients for temperature and precipitation at the department level (see again Table 3). We project future rice yields based on these coefficients and also use projected weather data from the Beijing Normal University Earth System Model (BNU-ESM) output prepared for the Coupled Model Intercomparison Project (CMIP5) (Ji et al., 2014). This project produced a dataset of long-term simulations of climatic variables for different locations around the earth, based on different CO2 scenarios. Each scenario addresses a different possibility for population growth[12], fossil fuel use, technological advancement, economics, and land use changes (van Vuuren et al., 2011; Core writing team, Pachauri, R.K., & Meyer, L.A., 2014; University Corporation for Atmospheric Research, 2022).

The experiments included in the CMIP5 are the work of the World Climate Research Programme's (WCRP) Working Group on Coupled Modelling (WGCM) (comprised of 20 climate modeling groups from around the world), with input from the International Geosphere-Biosphere Programme's (IGBP) Analysis, Integration, and Modeling of the Earth System (AIMES) project (Taylor, Stouffer, & Meehl, 2012)[13]. Since all the processes and relationships between different parts of the Earth system are not fully understood by the researchers, any model that projects weather variables, like CMIP5, embeds some uncertainties. However, as the University Corporation for Atmospheric Research (2022) explains, most of the uncertainty in these models comes from the fact that future human behavior (e.g., how much pollution humans will be adding to the atmosphere) is also unknown. Weather projections from the World Climate Research Programme were used in the Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC). It is the best information available to project future rice yields in Colombia.

We analyze the CMIP5 dataset to obtain future values for temperature and precipitation at the department level for Colombia using three scenarios (RCP 2.6, RCP 4.5, and RCP 8.0) for both a mid-term (2046-2065) and a long-term (2081-2100) projection period. Specifically, we average future temperature and precipitation across the grid cells in each department. We then project future rice yields for the three scenarios and two periods.

We apply a bias correction to both the precipitation and temperature fields obtained from the future projection ensemble. To this end, we compare the historical period of these simulations (1987-

[12] The population's projections for the scenarios come from the United Nations projections (Wayne, 2013).
[13] Taylor et al. (2012) explained how the experts in atmospheric sciences should deal with the specific limitations of the data included in the CMIP5.

2005) with the reliable reanalysis data (observations) obtained from the ERA5 dataset (e.g., CS3, 2017)[14]. Data contained in ERA5 are often considered to be the most representative of real meteorological and climatic conditions in retrospective analysis. We use the discrepancies between ERA5 and the data simulated (CMIP5) to correct values forecasted by the simulations. This bias correction is carried out to minimize potential overestimations or underestimations in the values for projected temperature and precipitation levels.

To estimate future rice yields, we assume that the population density and the per capita GDP in Colombia for the periods 2046-2065 and 2081-2100 will be constant and equal to the average of these variables in 1987-2016. Both variables are included in the estimations of Equation (1.2). There might be concern about this assumption since both population density and per capita GDP will change over time. Also, this method does not allow for the adaptation of farmers, or it assumes that they do not implement any changes in their practices to adapt to less favorable climatic conditions. However, keeping everything else constant (besides the weather data), allows us to know the change in yields that is due exclusively to new weather. This setting is common in the literature where variables are projected using future weather data and coefficients estimated with a model on historical data (Bozzola et al., 2018). Also, it is important to recall that the projections used for temperature and precipitation are already considering different possibilities for many socioeconomic variables.

The RCP 2.6 scenario projects an incremental increase in global temperature of between 0.9 ºC and 2.3 ºC by 2100 relative to the pre-industrial era. In the case of the RCP 8.5, the projected increase in global temperature is expected to be between 3.2 ºC and 5.4 ºC. While the former is probably underestimating the future impacts of greenhouse gas emissions on temperature levels, the latter is likely overestimating the impacts. Therefore, we also consider the RCP 4.5 scenario, which projects that the incremental increase in global temperature will be between 1.3 ºC and 3.2 ºC by the end of this century. Among these three scenarios, there is a general consensus within the climate community that RCP 4.5 is likely to provide the most reliable projections of future conditions. For the purposes of this paper, we focus on presenting the results for the RCP 4.5 scenario. The results for the RCP 2.6 and RCP 8.5 scenarios are largely consistent and are available upon request.

Figure 1.6 shows that for the period 2046-2065 the average annual temperature is expected to increase between 0.84 ºC and 1.49 ºC among the rice-producing departments with respect to the base period (1987-2005). The departments where temperatures are expected to increase the most would be

[14] ERA5 is the fifth generation of the European Centre for Medium-Range Weather Forecasts (ECMWF) atmospheric reanalyses of the global climate. See: https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5

Caqueta, Guaviare, and Meta, located in the Central region, and Llanos Orientales (see Appendix A1). The temperature would then continue to rise in all departments, with average annual temperatures expected to increase by 1.48 ºC in 2081-2100 compared to the base period (Figure 1.7). Again, the rice-producing departments in the Central region and Llanos Orientales would be most impacted.

In 2046-2065, the RCP 4.5 scenario generates similar rainfall forecasts compared to those generated using the RCP 2.6 and 8.5 scenarios. According to the RCP 4.5 scenario, precipitation is projected to decrease in seven of the 20 producing departments (Figure 1.8). The greatest reductions will occur in rice-producing departments located in the Northern tip of Colombia, especially in Sucre (-57%), Magdalena (-51%), and La Guajira (-45%). The greatest increases in rainfall will occur in Valle del Cauca (+111%), Meta (70%), and Santander (64%) located in the Eastern and Central regions. In the future, these regions are expected to have the highest rainfall in the country. Additional projections using the RCP 4.5 scenario show that any changes in expected rainfall levels between 2046-2065 and 2081-2100 would not be significant (Figure 1.9).

Figure 1.6. Temperature for RCP 4.5 scenario 2046-2065 (Left). Difference in average annual temperature in 2046-2065 (RCP 4.5 scenario) with respect to the reference period 1987-2005 (Right)

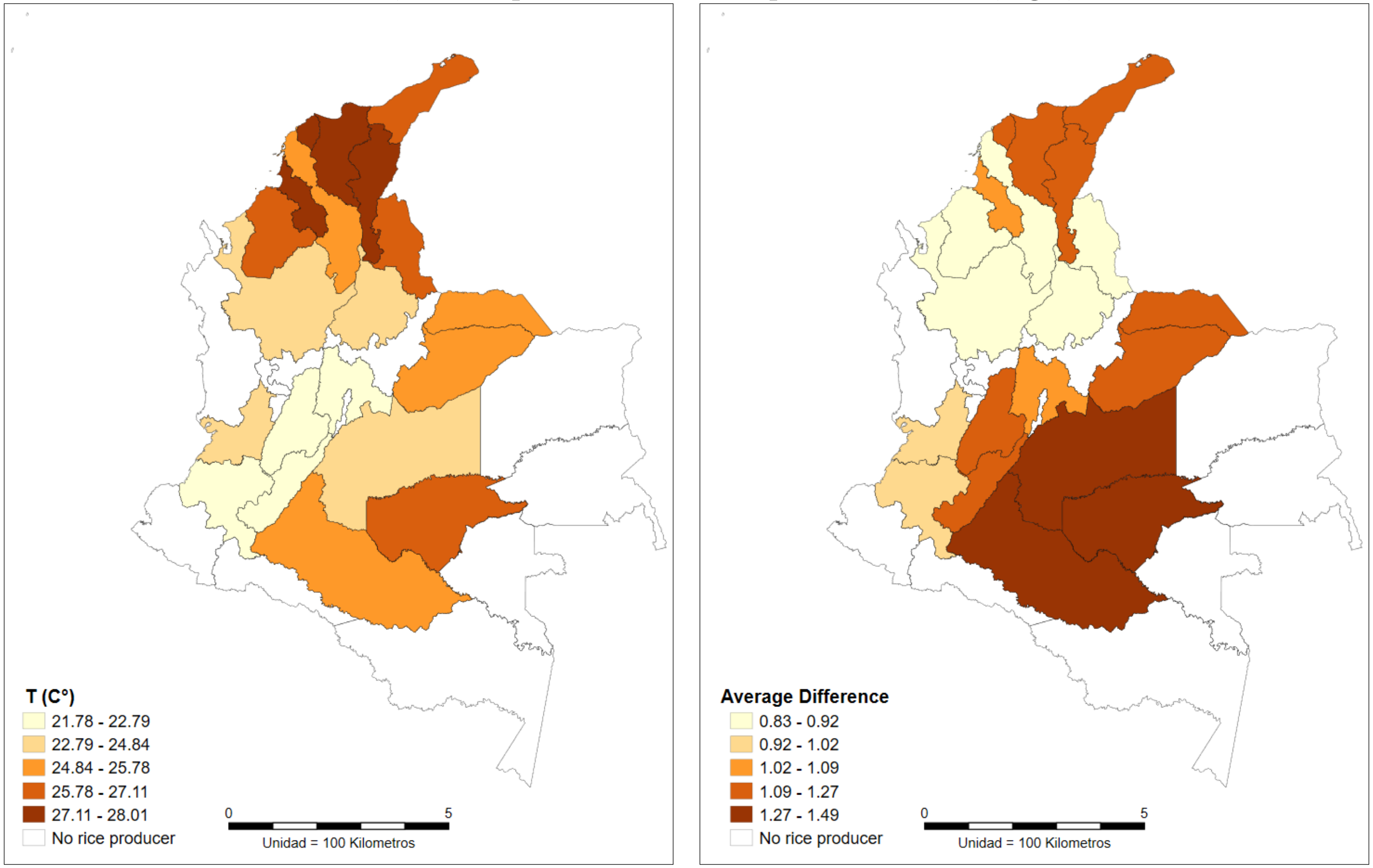


Figure 1.7. Temperature for RCP 4.5 scenario 2081-2100 (Left). Difference in average annual temperature in 2081-2100 (RCP 4.5 scenario) with respect to the reference period 1987-2005 (Right)

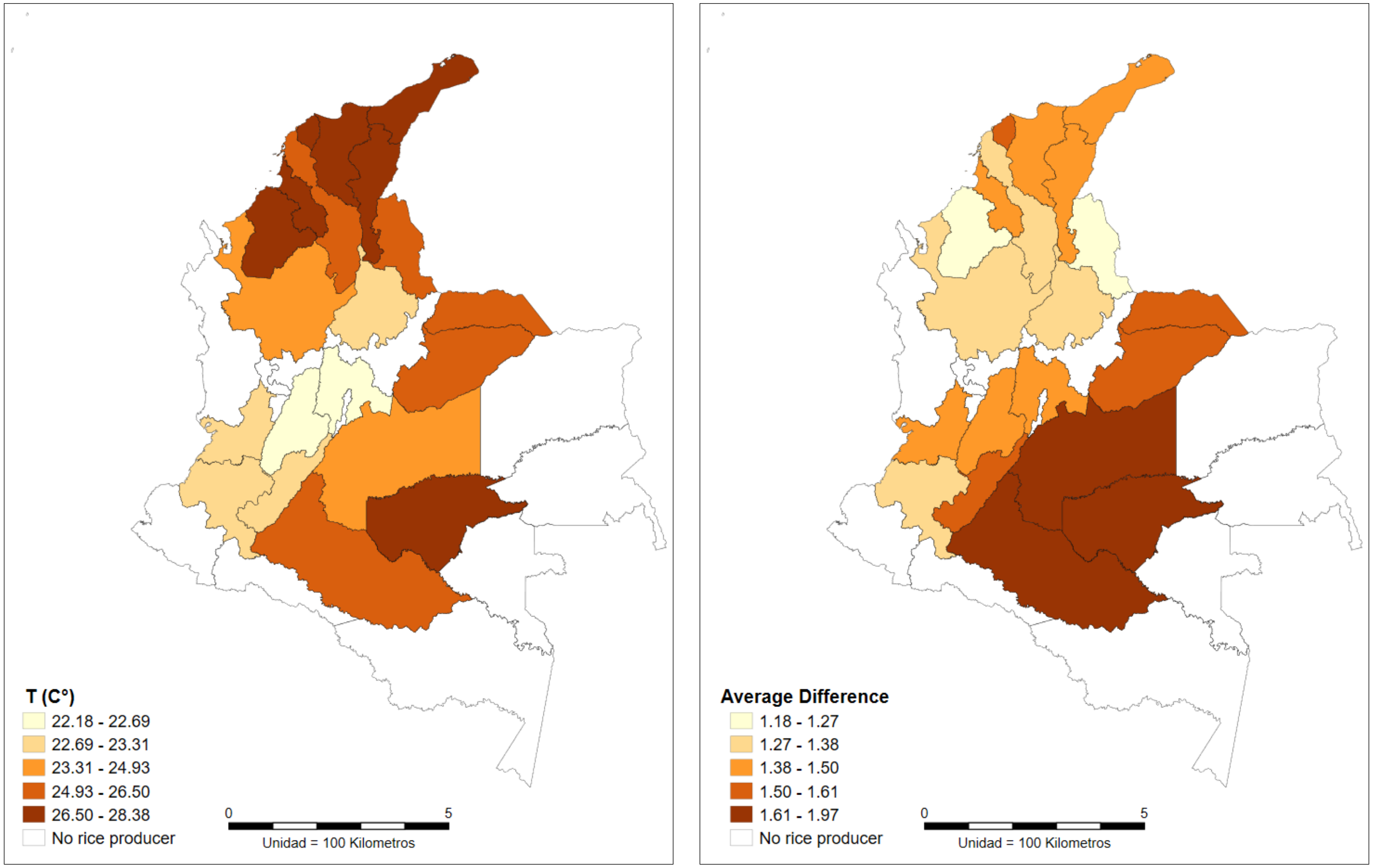
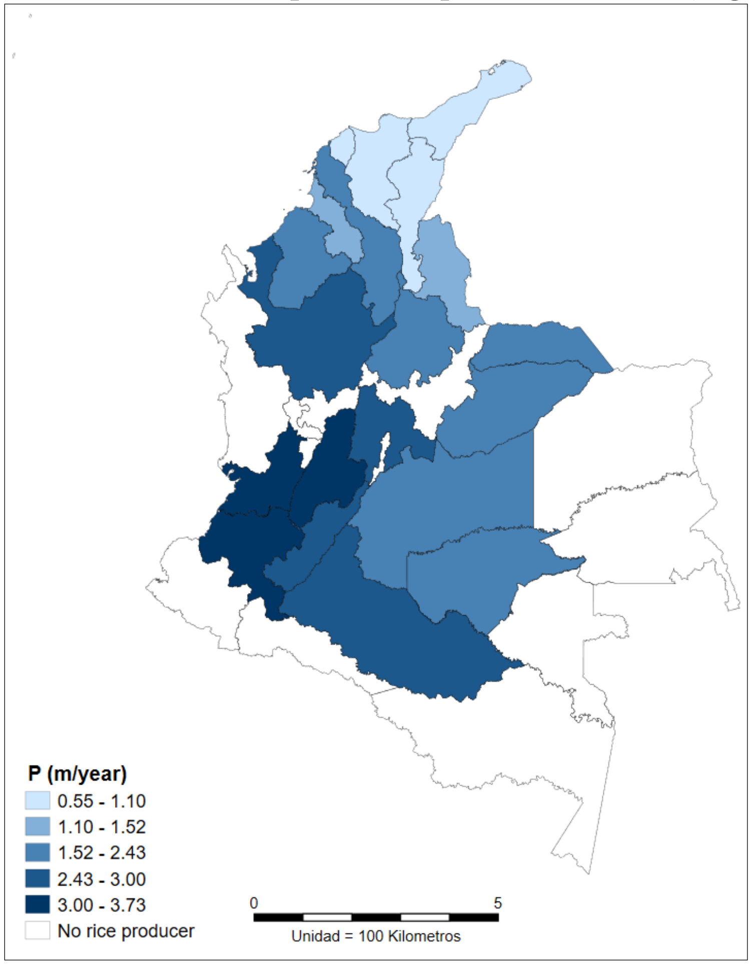


Figure 1.8. Precipitation for the RCP 4.5 scenario 2046-2065 (Left). Percentage change in mean precipitation using RCP 4.5 scenario in 2046-2065 with respect to the period 1987-2005 (Right)



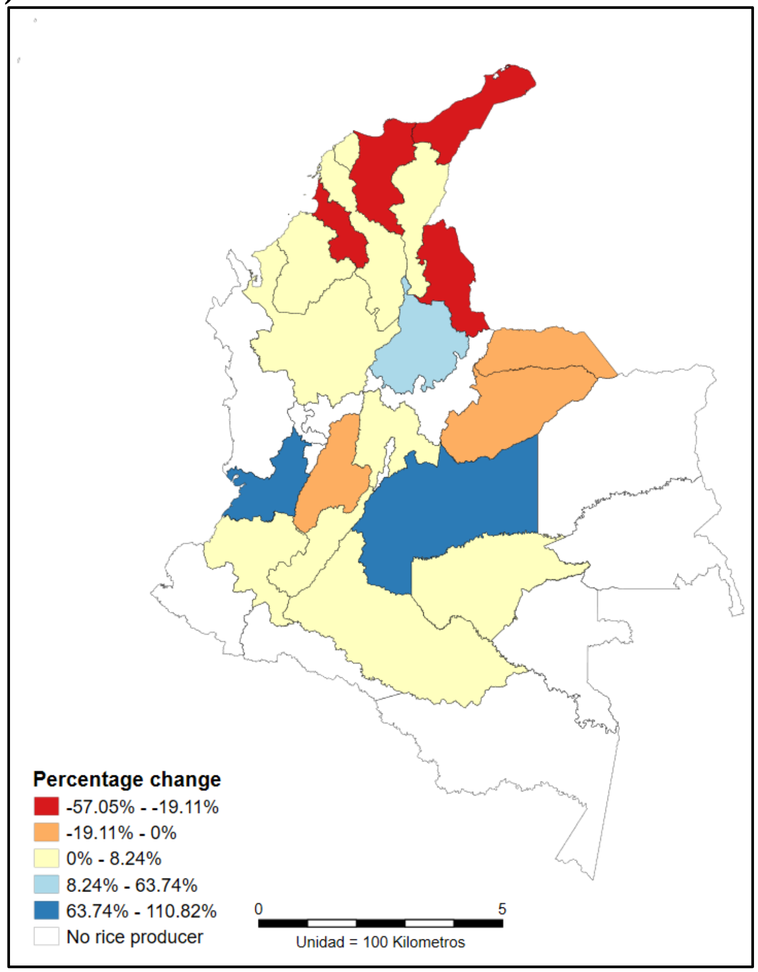
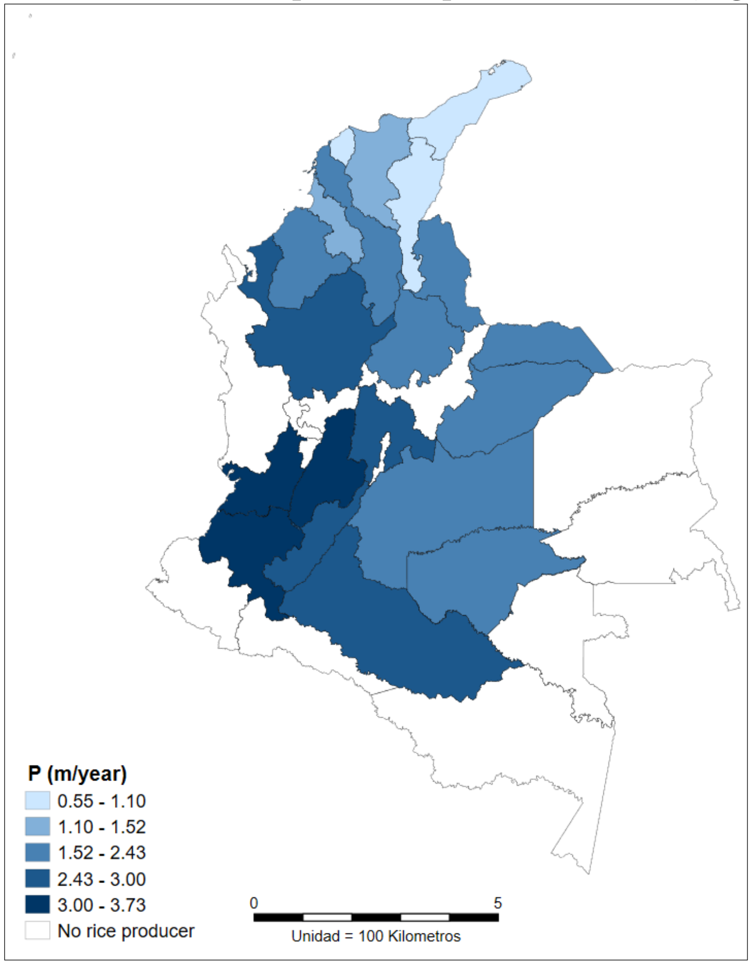
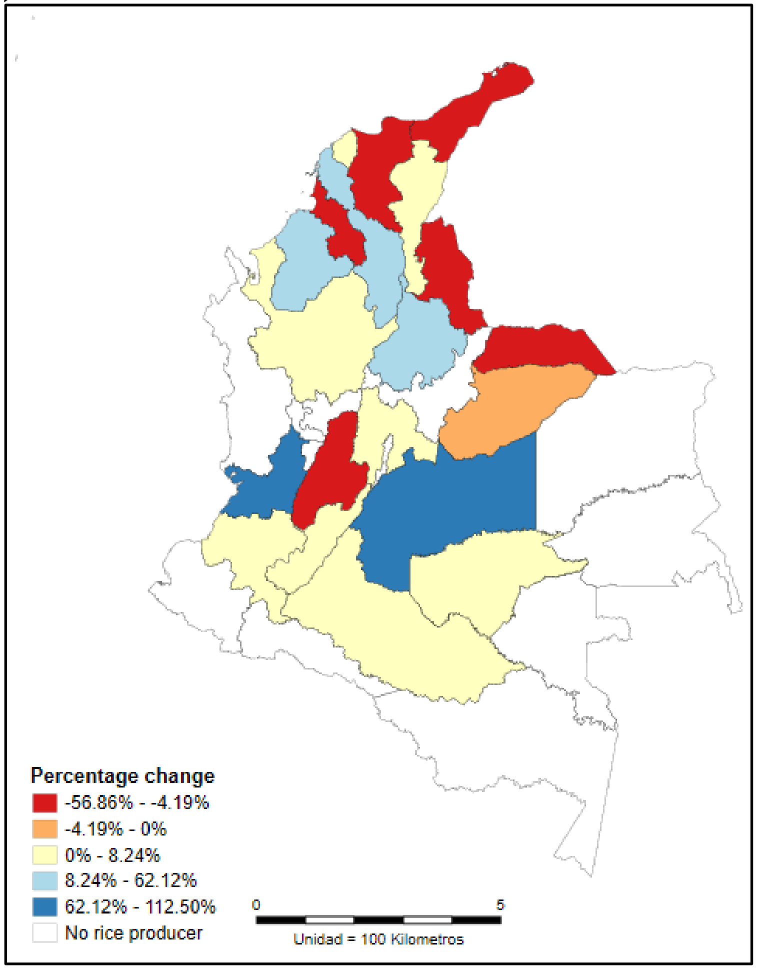


Figure 1.9. Precipitation for the RCP 4.5 scenario 2081-2100 (Left). Percentage change in mean precipitation using RCP 4.5 scenario in 2081-2100 with respect to the period 1987-2005 (Right)





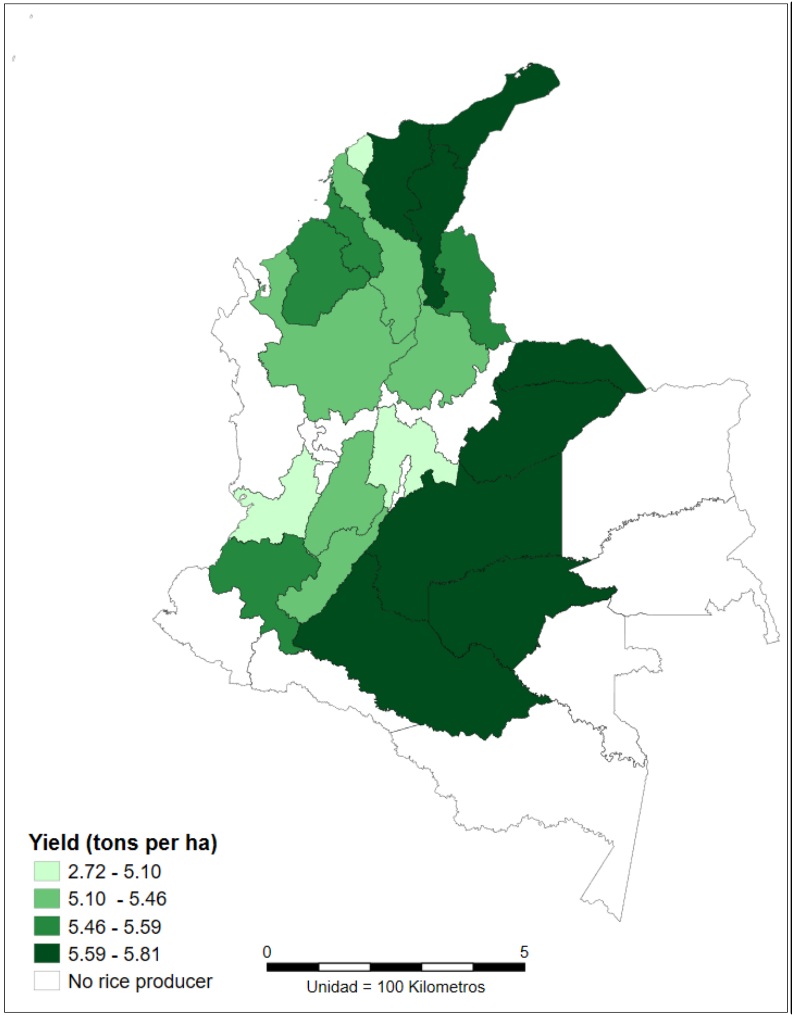
Our estimates using the projections generated by the RCP 4.5 scenario indicate that rice yields would increase in 15 of the 20 producing departments for the period 2046-2065. These estimates are similar across the three RCP scenarios[15]. According to RCP 4.5, average yields will increase by 10% at the national level compared to the average over 1987-2016. The departments with the highest rice yields will change. In 1987-2016 this group included departments in the Centro region, such as Tolima, Huila, Valle, and Cundinamarca. In 2046-2065 and 2081-2100, the departments with the highest rice yields (the "winners") are expected to be mostly in the Llanos Orientales region (Arauca, Caquetá, Guaviare, Meta, and Casanare) (Figure 1.10). Notice that according to our projections, the potential "losers" departments cultivate rice with the irrigated system mainly, while "the winners" with the rainfed system. These results imply that the yields would increase the most in departments highly dependent on the rain to produce rice. In real life, rice producers in the "losers" departments could strengthen their irrigation system and implement other strategies to compensate for the potential adverse effects of climate change in those regions. However, the projections show that the yields would increase the most in departments highly dependent on the rain because these do not take into account the potential farmers' adaptation. As we mentioned, they relied only on the coefficients estimated and the future values of temperature and precipitation. In 2081-2100 the rice yield is expected to increase compared to the period 1987-2016, but it would not be very different from that forecasted for the period 2046-2065 (Figure 1.11).

In the first part of this paper, we showed that temperature and precipitation had a positive effect on rice yields in Colombia from 1987 to 2016. In this section, we relied on future weather data to project yields, which will increase on average from 4.88 in 1987-2016 to 5.36 tons per hectare in 2045-2065. A couple of papers have explored the impact of future weather conditions on rice yields in Colombia. Ramírez-Villegas et al. (2012) found that by 2050 the temperature will increase between 2 ºC and 2.5 ºC in 65% of the current rice producing areas, and 61% of those areas could experience a 3% increase in precipitation. Hence, if this projection and ours are realized, given the positive relationship between these two variables and rice yields, production should increase in the coming decades. More recently, BID et al. (2014) made predictions for three periods (2011-2040, 2041-2070, and 2071-2100) using three IPCC SRES scenarios (A1B, B2, A2). The authors estimated how rice yields would change due to future climatic conditions in four producing departments. Their results

[15] Confidence intervals for the projections are presented in Appendix A2.

coincide with ours in that the performance will be reduced in Tolima and Casanare. However, for Huila and Norte de Santander, the conclusions are reversed.

Figure 1.10. Average annual rice yields for RCP 4.5 scenario in 2046-2065 (Left). Percentage change in rice yields using RCP 4.5 scenario in 2046-2065 with respect to the period 1987-2016 (Right)



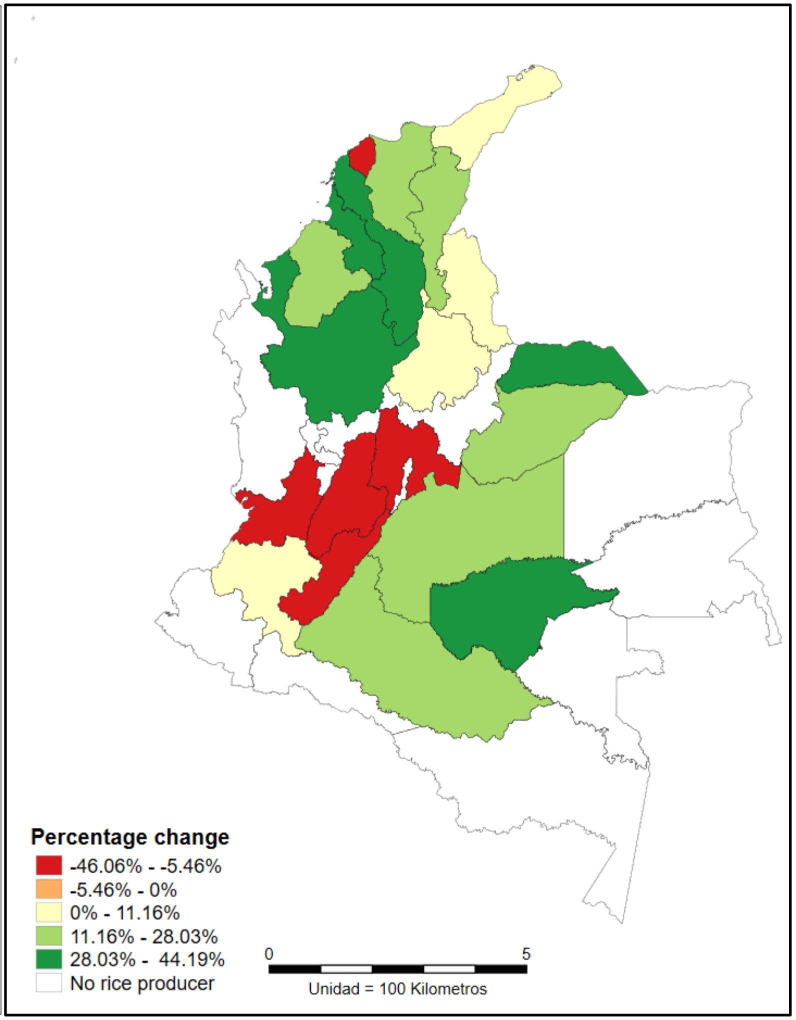
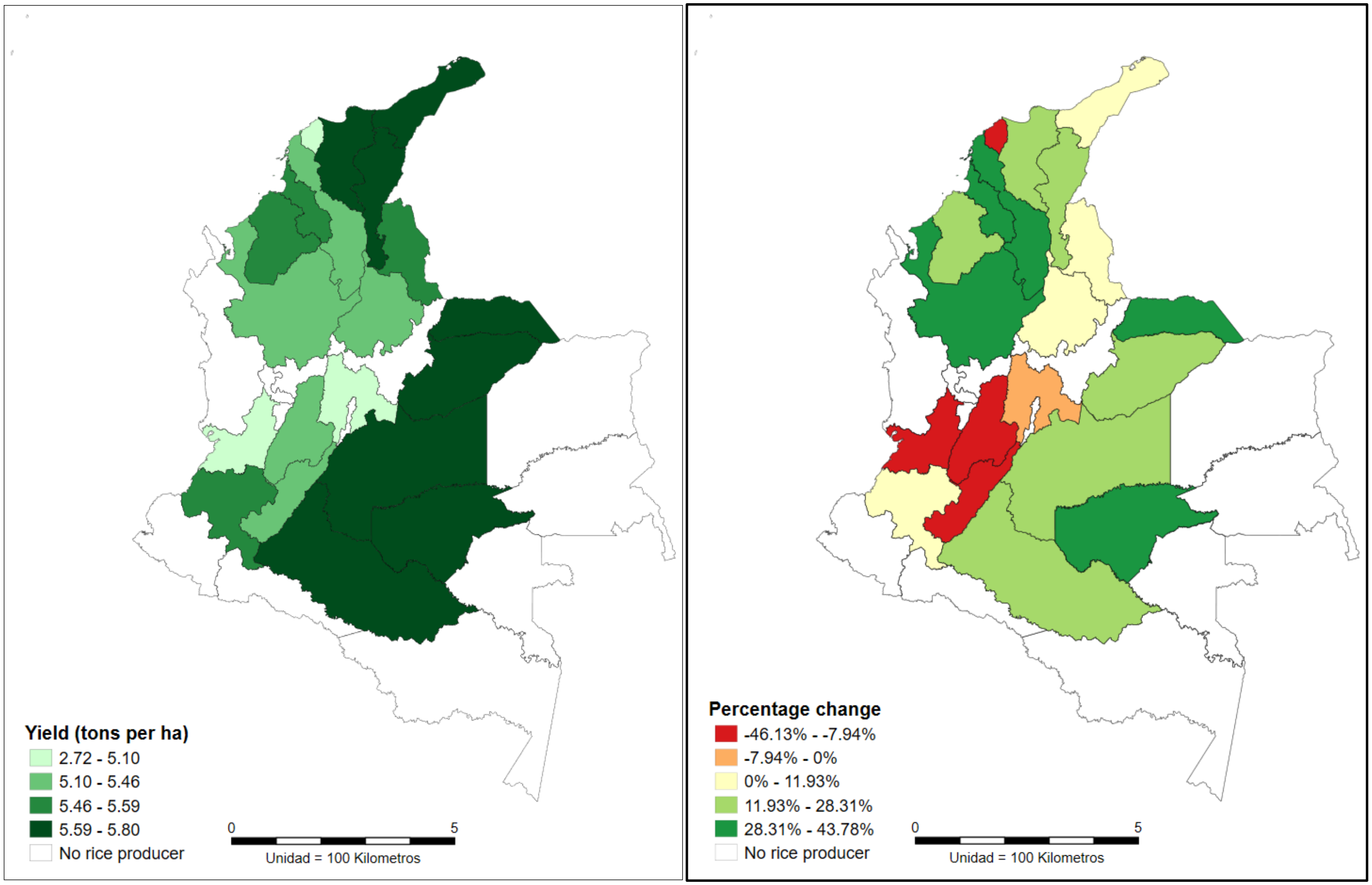


Figure 1.11. Average annual rice yields for RCP 4.5 scenario in 2081-2100 (Left). Percentage change in rice yields using RCP 4.5 scenario in 2081-2100 with respect to the period 1987-2016 (Right)



1.4. Policy Implications and Conclusions

This paper examines the effects of weather variations on rice yields across Colombian departments. Rice is one of the fundamental products for the development of the agricultural sector in this country, due to its contribution to food security and rural employment. We found a significant effect of rainfall and temperature on rice yields in Colombia. Even though both effects are positive, one variable attenuates the effect of the other. Hence, the magnitude of their effects depends on the specific values they take. Our results indicate that, when T_{it} and P_{it} are at their mean values (25 °C, 2.12 m/year), an additional degree of Celsius increases yields by 0.04 tons per hectare, and an additional meter of rain per year increases yields by 0.09 tons per hectare.

The positive effects of temperature and precipitation are consistent with various forms of heterogeneity. Still, their magnitudes are different in areas with low and high altitudes. The attenuation effect is not present in lower altitudes, where other variables like solar radiation could play a more important role in determining rice yields. We also considered the effects of temperature and precipitation on rice yields during the key trimesters of rice planting in Colombia (March-May and September-November). We found that temperature is the main driver of yields in the first trimester, while it is precipitation in the second trimester. Also, the positive effect of precipitation is attenuated by temperature, to the point where the precipitation effect could become negative. These results might be analyzed in light of where the production is taking place, which production system is being used (irrigated or rainfed), and which stage of the rice growth cycle is taking place.

Finally, we predicted rice yields for two time periods (2046-2065, 2081-2100) using temperature and precipitation projected based on RCP scenarios 4.5, 6.5, and 8.0. If only temperature and precipitation change, rice yields will increase in 15 out of the 20 departments in our sample. At the national level, this increase would be an average of 10% between the base period and the two future periods considered (2046-2065, 2081-2100). Notice that we are not implying that extreme weather events would not have a negative impact on rice yields. In those departments for which the yield would decrease according to our projections, rice is produced with the irrigated system mainly. Therefore, rice producers in those areas could strengthen their irrigation system from now on. Strategies such as investments in technology, and research would help to achieve higher yield growth and compensate for the potential adverse effects of climate change in those regions. Our results do imply that the geographical areas with the highest rice yields could change in the future, as a consequence of changes in temperature and precipitation. This could motivate policymakers to evaluate the likelihood and feasibility of relocating future rice production in Colombia.

Future development of this work could measure the sensitivity of rainfed versus irrigated departments to weather changes. Results along these lines could provide the government and the farmers with the incentives necessary to protect the rice sector against uncertain climate conditions and/or to relocate production.

An additional step would be to understand better the relationship between rice yields and poverty. This could be done based on monetary and non-monetary poverty measures. For the latter, one could rely on the multidimensional poverty index available in Colombia. It covers fifteen factors that limit an individual's quality of life (illiteracy, unemployment, critical overcrowding, among others). Additionally, since rice production is mainly carried out in rural areas, it would also be worth analyzing whether higher rice yields are able to reduce socioeconomic inequalities (e.g., poverty, income inequality, food insecurity) between rural and urban areas of the country.

Finally, while we recognize that food security cannot be guaranteed only by increasing rice yields, our exercise has revealed how necessary it is to increase the productivity of Colombian agriculture. Many of the challenges that the rice sector faces are common to other types of crops. The limitations of predicting future weather conditions (especially precipitation) increase with the length of the time period being considered. However, this paper has used the best information available for Colombia. The results can help policymakers appreciate the regional differences embedded in our future yield forecasts. Questions such as where to produce rice, who will produce it, how to ensure water to sustain the irrigation districts, how to reduce inequalities in access to irrigation districts, and what type of public investments are necessary to produce enough food for everyone, will continue to be part of the food security debate in Colombia. To this end, this paper provides useful and necessary insights. Rice is the primary staple crop and food source in Colombia. Any discussion and public policy related to food security will need to start with an overall assessment of the current supply chain related to rice production. It will also need to include an evaluation of the anticipated future supply chain disruptions, which we have shown are likely to come from future changes in weather conditions.

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CHAPTER 2: VENEZUELAN MIGRATION SHOCK IN COLOMBIA AND ITS FISCAL IMPLICATIONS FOR THE HEALTH SECTOR AT THE LOCAL LEVEL

with Angela C. Lyons

Since 2014 there has been unprecedented, mostly forced, migration from Venezuela due to harsh conditions such as a rise in violence, food shortages, and the lack of access to public utility services (Quintero & Fish, 2020; Reina et al., 2018). At least 5.2 million Venezuelans were compelled to flee their country, representing one of the largest displacement crises in the modern era (Bahar et al., 2020; Quintero & Fish, 2020), and the fastest-escalating displacement of people across borders in Latin American history (Freier & Parent, 2018). The land border between Colombia and Venezuela spans more than 2,219 km (Ministerio de Relaciones Exteriores de Colombia, 2017a; Tribín et al., 2020), which could partially explain why Colombia is the country that has received the most migrants from Venezuela, especially since August 2016 when the border between these two countries was re-opened by the Venezuelan government one year after it had been closed. Colombia received 33% of the migrants in 2017 (Organización Internacional para las Migraciones [OIM], 2018). By 2019, more than 1.7 million Venezuelans were in Colombia (Ministerio de Relaciones Exteriores de Colombia, 2019). Some of the migrants were Venezuelans and some were Colombians who were living in Venezuela but were forced to return to Colombia. In 2021, there were 1,842,390 Venezuelan migrants in the country, making up about 3.5% of the population living in the country (Ministerio de Relaciones Exteriores de Colombia, 2021).

Immigrants from Venezuela arrive with healthcare needs and may increase the incidence of infectious diseases in Colombia. Between 2012 and 2018, the Venezuelan migration resulted in higher incidences of vaccine-preventable diseases (including chickenpox and tuberculosis) and sexually transmitted diseases (including HIV and syphilis) within Colombia (Ibanez et al., 2020a; Doocy et al., 2019). At the same time, there was an increase in adverse maternal and neonatal health outcomes among Venezuelans in the Colombian border state of Norte de Santander (Doocy et al., 2019). Pregnant women in cities near the Venezuelan border experienced anemia, depression, and were victims of domestic violence (Fernandez-Nino et al., 2019).

Colombian government policies to attend to the migrants' needs have been very generous, granting free access to emergency and preventive health services to all Venezuelan refugees in the country independent of their migratory status (Ibanez et al, 2020b; Departamento Nacional de Planeación [DNP], 2018). The total cost of programs represented between 0.07% and 0.17% of

Colombia's national GDP in 2017, while in 2020 it was between 0.19% and 0.26% (Melo et al., 2020). In 2017, healthcare was 37% of the total cost of the programs to assist migrants (Reina et al., 2018). The monthly average number of Venezuelans treated in emergency rooms and hospitalizations went from 123 in 2015 to 7,766 in 2018 (Ministerio de Salud y Protección Social de Colombia, n.d). This generosity might raise concerns about its fiscal impact and could feed outbreaks of xenophobia from Colombian citizens, who might be unhappy with a distribution of resources that favors foreigners, even though they are also facing challenging socioeconomic circumstances (Inter-agency Coordination Platform for refugees and migrants from Venezuela [R4V], 2020; Vega-Mendez & Visconti, 2021).

In this study, we examine the fiscal consequences of migration. More precisely, we evaluate the effects of Venezuelan migration on subnational governments' health sector expenditures and sub-accounts. Municipalities channel their health expenditures into three sub-accounts: subsidized regime, public health, and services not covered with subsidies on demand, hereafter referred to as PPNA (by its Spanish acronym). The subsidized regime covers health insurance for Colombian citizens and regular migrants who cannot afford it because they are informal or low-income workers[16]. The public health subaccount covers expenses related to health promotion and disease prevention programs. The PPNA subaccount corresponds to payments for all the provided services that were not covered by health insurance. Municipalities must pay for these services to insurance companies or providers. In addition, this subaccount covers payment for emergency care that both locals and foreigners without medical insurance have the right to receive. The Central Government transfers resources to the municipalities to administer each one of these subaccounts. Municipalities could also use their own resources to fund their health expenditures. Those could come from tax collection, royalties, loans, and donations. Estimating the migration effects on each of the health expenditures subaccounts helps us to identify if there has been a reallocation of the resources among them.

The evidence presented in this study contributes to several branches of literature. First, this study contributes to the literature investigating the fiscal cost of migration (Dustmann et al., 2010; Elsner & Concannon, 2020; Ruist, 2019; Hennessey y Hagen-Zanker, 2020; Organisation for

[16] To be part of the subsidized health regime, Colombian natives and Venezuelan immigrants must have their economic situation scored by the Colombian government. On the other hand, formal workers who contribute funding to the Colombian health system through payroll taxes belong to the contributory health regime.

Economic Cooperation and Development [OECD], 2017; Rector and Richwine, 2013; Camarota, 2004; Holler and Schuster, 2018), as well as the ones that study how migration affects the government allocation of resources and its distribution among citizens (Gerdes, 2011; Gisselquist, 2014; Tabellini, 2019; Alesina, Baqir & Easterly, 1999).

Second, this analysis focuses on the much narrower fiscal question of how the health expenditures of cities are affected by immigration. Very few studies evaluate health spending in this context and the evidence has shown mixed results (Bettin & Sacchi, 2020; Francesca & Petretto, 2019; Hasan et al., 2019). While there was a negative relationship between the share of immigrants and public health expenditures in Italy during the period 2003-2016 (Bettin & Sacchi, 2020), the arrival of new immigrants in 33 OECD countries over the period of 2000–2015 did not cause a significant rise in public healthcare expenditures (Hasan et al., 2019).

It is important to note that until now most studies have focused on migration from a developing country to a developed country or between developed countries (Bonilla-Mejia et al., 2020; Blyde et al., 2020; Francesca & Petretto, 2019, Chapter 11, p. 153; Quak, 2019; d'Alvis et al., 2018; OECD, 2013, 2014). Therefore, this study also adds to the studies on migration flows between developing countries, the so-called South-South migration. The Colombian case is even more interesting because its local governments are the ones in charge of the health services provision and the identification of the population that could get subsidized health insurance coverage.

Most of the migration literature in Colombia has aimed to address its effects on labor market outcomes (Peñaloza, 2019; Santamaria, 2019; Caruso et al., 2019; Bonilla-Mejia et al., 2020; Bahar et al, 2021) and on crime levels (Reina et al., 2018; Franco, 2020; Knight & Tribin-Uribe, 2020; Ibanez et al., 2020b). Only two papers have explored the effects of Venezuelan migration on government expenditures in Colombia, but they focus on migration costs covered by the Central Government. Reina et al. (2018) estimated that the fiscal cost for the care of the migrant population from Venezuela in 2017 was between 0.07% and 0.17% of GDP. Melo-Becerra et al. (2020) estimated that the fiscal cost associated with Venezuelan migration reached 0.12% of GDP during the period 2017-2019. Expenditures on health services reached 0.06% of GDP. Both studies highlighted the difficulty of estimating the costs of migration at the local level due to the lack of information. The following analysis attempts to fill this gap in the literature since this study assesses migration effects for the 23 main cities in Colombia, not only on the total health expenditure but on its sub-accounts.

The rest of the paper is organized as follows. Section 2.1 describes Colombia's response to the mass of migrants from Venezuela. Sections 2.2 and 2.3 describe the data and present some descriptive analysis. Sections 2.4 and 2.5 present the empirical strategy and results, and the last section provides some concluding remarks.

2.1. Context: Colombia's response to the mass of migrants from Venezuela[17]

The increase in the entry of people from Venezuela to Colombia began in 2014, as a result of the fall in the international price of oil, which exposed the inconsistencies in the macroeconomic management of Venezuela (Reina et al., 2018). Migration was boosted in 2015 when then-Venezuelan President Hugo Chávez began to deport Colombians due to political conflicts between the two countries (Sayara International, 2018). Some of these Colombians returned with their families, which included Venezuelan spouses and children. However, the greatest increase in migration was observed in the data consistently from 2016 when the Venezuelan government reopened the border after about a year of being closed (Tribín et al., 2020; Santamaria, 2020; Peñaloza, 2019). As of December 2022, around 7 million Venezuelans are out of their country, and 34.74% are in Colombia (Universidad del Rosario & Fundación Konrad Adenauer, 2022).

No centralized source fully documents the population that has arrived in Colombia from Venezuela or their quality of life. On the contrary, different government institutions, universities, and journalistic teams have independently collected data about how migrants live. According to the survey on the quality of life and integration of Venezuelan migrants in Colombia (*Encuesta de calidad de vida e integracion de los migrantes venezolanos en Colombia*), 92.4% of migrants were living on lease or sublease in 2020, and 48.7% of families were living in critically overcrowded conditions (Proyecto Migración Venezuela, 2021). Similar results were found for a sample of Venezuelans with Special Permit of Permanence (*Permiso Especial de Permanencia*, known as PEP)[18] interviewed by the National Planning Department (DNP) of Colombia in 2020 (DNP,

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[17] See Selee and Bolter (2020), Chaves-Gonzalez and Echeverria-Estrada (2020) for a comparison of the responses to the Venezuelan Migration response between the Latin American and Caribbean countries.

[18] The Special Permit of Permanence (PEP) was created in July 2017 to allow Venezuelans to work in Colombia. “The PEP allows a regular stay for a period of 90 days, renewable for equal periods for up to 2 years" (Sayara International, 2018). Before 2017, formal employment for Venezuelans was only permitted through a work visa (Ministerio de Relaciones Exteriores de Colombia, 2017).

2021). Among this sample of Venezuelan migrants, 29.4% of them did not have gas service in their homes, 13.3% did not have sewerage service, and 9.22% did not have an aqueduct service.

Colombian officials have provided temporary shelters for Venezuelans (Grattan, 2018). The first refugee camp was set up in 2019 in Maicao, a city on the border with Venezuela, where the migrants can live for up to a month while they find a more permanent home (Rotunno, 2019; Otis, 2019; Voice of America English News, 2018)[19]. However, most Venezuelans do not live in refugee camps or ghettos, as happens in other countries that receive migrants (Rosales, 2020). Actually, there is evidence of spatial integration with the Colombian natives. In Bogotá, the capital of Colombia, the migrant population from Venezuela is spatially integrated, that is, there are no ghetto-like sectors in which migrants concentrate without mixing with the locals. Instead, the migrants follow a similar pattern of population distribution by socioeconomic strata to that of the locals of Bogotá because they are mainly concentrated in the middle and lower strata. This could exacerbate the housing deficit, the lack of urban equipment, and the difficulty of accessing services that the inhabitants have in those places (Rosales, 2020).

The DNP recently created an index to find out how integrated the Venezuelans are in the country based on a set of socioeconomic indicators (DNP, 2022)[20]. The index is made up of indicators grouped into 4 axes: coverage of basic needs, economic integration, social integration, and public management of migration. The DNP found that in the departments and cities studied, people from Venezuela had an acceptable degree of integration[21]. Moreover, according to the survey on the quality of life and integration of Venezuelan migrants in Colombia, 75.5% of Venezuelans reported that they felt integrated into Colombian society (Proyecto Migración Venezuela, 2021).

The Colombian government gradually developed a series of measures to meet the needs of the growing population entering the country (DNP, 2018)[22]. These measures started with the implementation of various mechanisms for identifying migrants, which in turn allowed them to be

[19] There is also evidence of people living in the streets, but not an official record of how many.

[20] Venezuelans and Colombians share the same language and are culturally similar.

[21] For the 24 departments under analysis, IMI averaged 5.4 points, and 5.6 points for the 23 capital cities. IMI is interpreted according to the following ranges: the initial level of integration corresponds to scores under 4; the basic level is equivalent to between 4 and 5 points, the acceptable range goes from 5 to 6 points, and finally, the advanced level refers to figures greater than 6 points.

[22] See Sayara International (2018) for a chronology of the bilateral crisis between Venezuela and Colombia and the administrative and legal measures taken to deal with recent migrant inflows.

classified according to their immigration status. There have been three types of migration by Venezuelan citizens: pendulum, regular, and irregular migration (Ministerio de Relaciones Exteriores de Colombia, 2017). Pendulum migrants consist of citizens who reside in the border areas and regularly move between the two countries, even registering several entries and departures per day (Ministerio de Relaciones Exteriores de Colombia, 2018). Venezuelans in regular migration status possess a foreigner identification card, passport, diplomatic card, or PEP. Venezuelans with irregular status are those whose legal documents have expired or those who entered the country through unauthorized sites (Ministerio de Relaciones Exteriores de Colombia, 2018).

The ability of migrants to access health services depends on their legal status. As of 2018, the government has established that the following migrants have access to the subsidized health care regime: Colombians returning with their families, Venezuelans with regular status, Venezuelans who registered upon entering Colombia (*Registro Administrativo de Migrantes Venezolanos*, known as RAMV), PEP holders, and indigenous people along the border with Venezuela. Irregular migrants can access emergency care and public health programs (DNP, 2018). Venezuelans who are not yet affiliated with the subsidized regime can access emergency care and delivery care only.

Between 2017 and 2019, the number of services provided to Venezuelans went from 357,000 to more than 4 million (Ministerio de Salud y Protección Social, 2022). Also, the number of Venezuelans who received health care went from almost 41,000 in 2017 to 558,000 in 2019. In 2021 the services exceeded 5 million and the number of attended was 648,000. Despite the increases in health care provision, there are still deficiencies in access to services for the migrant population; 54.6% of immigrants (Venezuelans and Colombian returnees) who were interviewed in 2022 stated that they needed some health services (Departamento Administrativo Nacional de Estadística [DANE], 2022). Among them, 74.3% were able to access the services needed, while 25.7% reported not being able to access those services. Deficiency in access to services may be due to a lack of information because only 21.3% of those surveyed claimed to have received information on how to access health services.

The lack of access to services also may be caused by the fact that many immigrants living in Colombia still do not have health insurance. Regular migrants in Colombia could belong to one of two health regimes: (1) the contributory regime, if they are formal workers who contribute to the system through payroll taxes; or (2) the subsidized regime, if they are informal workers, low-income workers, or unemployed. Health insurance for members of the subsidized regime is funded by the government. As of August 2022, around 924,000 Venezuelans had full access to the health system by being enrolled in one of those regimes (Ministerio de Salud y Protección Social, 2022). However, 66.1% of the Venezuelans in Colombia interviewed in 2020 said they did not have health insurance, and 64.4% of them reported that the reason was because they did not possess any legal documents (Proyecto Migración Venezuela, 2021). Even among those with legal documents, the percentage of enrollment is low. In 2020, 73.2% of PEP holders had no insurance (DNP, 2021).

The Colombian health system is comprised of various agents: the Central Government, subnational governments (departments and municipalities), insurance companies, and service providers (clinics, laboratories, hospitals, human capital). The central government transfers resources annually to the departments and municipalities to provide health services based on the population served in the previous year, among other factors. Municipalities spend their health budget in the three subaccounts previously described: the subsidized regime, the public health, and the services not covered by the insurance (the PPNA). Healthcare provision for migrants is paid for through these three subaccounts and prioritizes care in three key respects. First, it makes emergency care feasible for irregular migrants and those who are constantly moving back and forth across the border. Second, it provides regular migrants the opportunity to obtain health insurance subsidized by the government if they cannot pay for it by themselves. Third, and finally, it strengthens public health management in the most affected territorial entities (Ministerio de Salud y Protección Social de Colombia, n.d; Ministry of Health and Social Protection; 2019). Therefore, it is reasonable to hypothesize that migration could be affecting health expenditures at the local level and how those expenditures are allocated and distributed among the three subaccounts.

2.2. Data

We use city-annual data from 2013 to 2019 to conduct the empirical analysis. The data that we use can be grouped into three categories.

2.2.1. Venezuelan Migration

The number of migrants is taken from the Colombian Household Survey (Gran Encuesta Integrada de Hogares)—collected by the Colombian National Statistical Office (GEIH-DANE)[23]. The survey consists of a repeated cross-section that has been administered monthly since 2010. It gathers detailed sociodemographic and labor force information at the household level (DANE, 2020). The GEIH-DANE applied a migration module to all household members beginning in April 2013 (Caruso et al., 2020). This information allows the characterization of long and short-term migrations, both of nationals and foreigners. For the practical purposes of this article, short and long-term migrants from Venezuela are identified as those who have resided in Colombia for one to five years (Tribín et al., 2020).

Colombia is a fiscally decentralized country with three layers of government: central government, 33 departments, and more than 1000 municipalities. The survey offers information for 23 main cities (the 13 largest cities as well as the 10 medium-sized cities), seven of which include contiguous municipalities that are part of the local labor market (metropolitan areas). This study focuses on these 23 cities, which account for 51% of the population and 59.7% of the reported migrants (Bonilla-Mejia et al., 2020). However, the sample presents a marked underrepresentation of smaller municipalities.

The GEIH-DANE survey data are representative of the national, departmental level, and 13 main cities (Reina et al., 2018). Because the expansion factors used to make inferences about the Colombian population are based on the 2005 Census, the migrant data are not representative of the remaining 10 cities. This can lead to the underestimation of households with more migrants (Tribín et al., 2020). However, the survey replicates the regional distribution of migrants and trends over time very well. In addition, as the data were collected from a statistically representative and random sample, the results of a characterization carried out from the GEIH can be extrapolated to whatever the real size of the migration is (Reina et al., 2018). The survey includes information on

[23] Data are available at http://microdatos.dane.gov.co/index.php/catalog/MICRODATOS/about_collection/42/1

regular and irregular migrants and allows for the identification and characterization of migrants of Colombian and Venezuelan nationality (Reina et al., 2018).

2.2.2. Health Expenditures

The information on municipal expenditures comes from the National Planning Department of Colombia (DNP)[24]. The DNP registers the investments of the municipalities, classifying them by sectors and their sources of funding.

2.2.3. Controls and instrumental variable

We collected information on the number of Colombian citizens affiliated with the subsidized regime, and the Multidimensional Poverty Index (MPI). These come from the municipal panel constructed by the Center for Economic and Development Studies of the Universidad de Los Andes (CEDE). We use these variables as controls in the estimations. Additionally, we use data about population size from the National Administrative Department of Statistics in Colombia.

To construct the instrument for the number of migrants, we measure migrant networks using the 2005 Colombian population Census, which includes questions on nationality. We calculated the share of Venezuelans in the population for each municipality in Colombia[25]. In order to measure the intensity of the Venezuelan crisis, we collected information on the Venezuelan CPI from the Central Bank of Venezuela[26]. Table 2.1 presents summary statistics for the variables used in this study.

[24] Data are available at https://sisfut.dnp.gov.co/app/descargas/visor-excel
[25] Data are available at http://systema59.dane.gov.co/bincol/rpwebengine.exe/PortalAction?lang=esp
[26] Data available at https://www.bcv.org.ve/estadisticas/consumidor

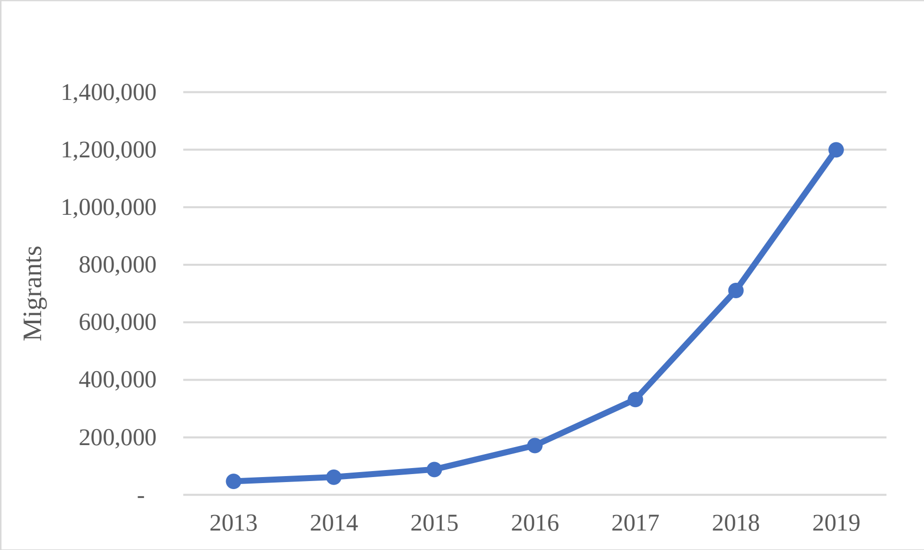
Table 2.1. Descriptive Statistics

Variable	Average	Std. Dev.	Min	Max
Number of migrants	16,288	41,902	0	381,591
Health expenditure per capita (constant pesos of 2019)	376,940	147,472	10,211	768,487
Subsidize regime expenditure per capita (constant pesos of 2019)	343,540	152,547	602	749,666
Public health expenditure per capita (constant pesos of 2019)	14,628	8,359	4,008	60,009
PPNA expenditure per capita (constant pesos of 2019)	9,453	22,011	0	249,414
Population with subsidized health insurance in 2012	231,660	247,295	50,591	1,251,955
Multidimensional Poverty Index in 2005	44.38	12.71	24.30	72.10

2.3. Descriptive Statistics

According to the GEIH, migration from Venezuela has increased mainly since 2016 when the Venezuelan government reopened the border with Colombia (Figure 2.1). Migrants almost doubled between 2015 and 2016. By 2019, the number of migrants from Venezuela was 48 times that of 2014. Between 2013 and 2019, the participation of migrants in the Colombian population increased significantly in all regions, especially in the cities along the border with Venezuela (Figure 2.2). Cúcuta, a city on the border with Venezuela, exhibited the highest percentage of migrants in 2013; while by 2019, that percentage had increased throughout the entire national territory. Note that in 2013, the highest percentage of migrants in the municipal population corresponded to 1.61%. By 2019, it had risen to 14.06% (Figure 2.2).

Figure 2.1. Migrants from Venezuela in Colombia (2013-2019)



Between 2013 and 2019, health care was the most important spending category among the 23 cities in our sample. On average, it represented 32.3% of total spending, followed by education (31.4%), transportation (9.2%), and water supply (3.9%). The share of health expenditures as a percentage of total expenditures at the city level went from an average of 30.5% between 2013 and 2015 (before the border between Colombia and Venezuela was re-opened) to an average of 33.6% between 2016 and 2019 (after the re-opening of the border).

As explained in Section 2.1, the municipality's expenditures are classified into three subaccounts: subsidized regime, public health, and PPNA. The composition of health spending did not undergo any significant changes in the study period (Figure 2.3). However, we can see an increase in PPNA participation and a decrease in public health participation after 2016. The category Other in Figure 2.3 corresponds to investment in infrastructure and equipment in public hospitals, development of financial recovery plans for public hospitals, care for the victims of forced displacement due to violence, and health expenses due to emergencies and disasters. Expenses in this category were the second most important in 2016, 2017, and 2018.

Figure 2.2. Migrant share of the total population by region, 2013 and 2019

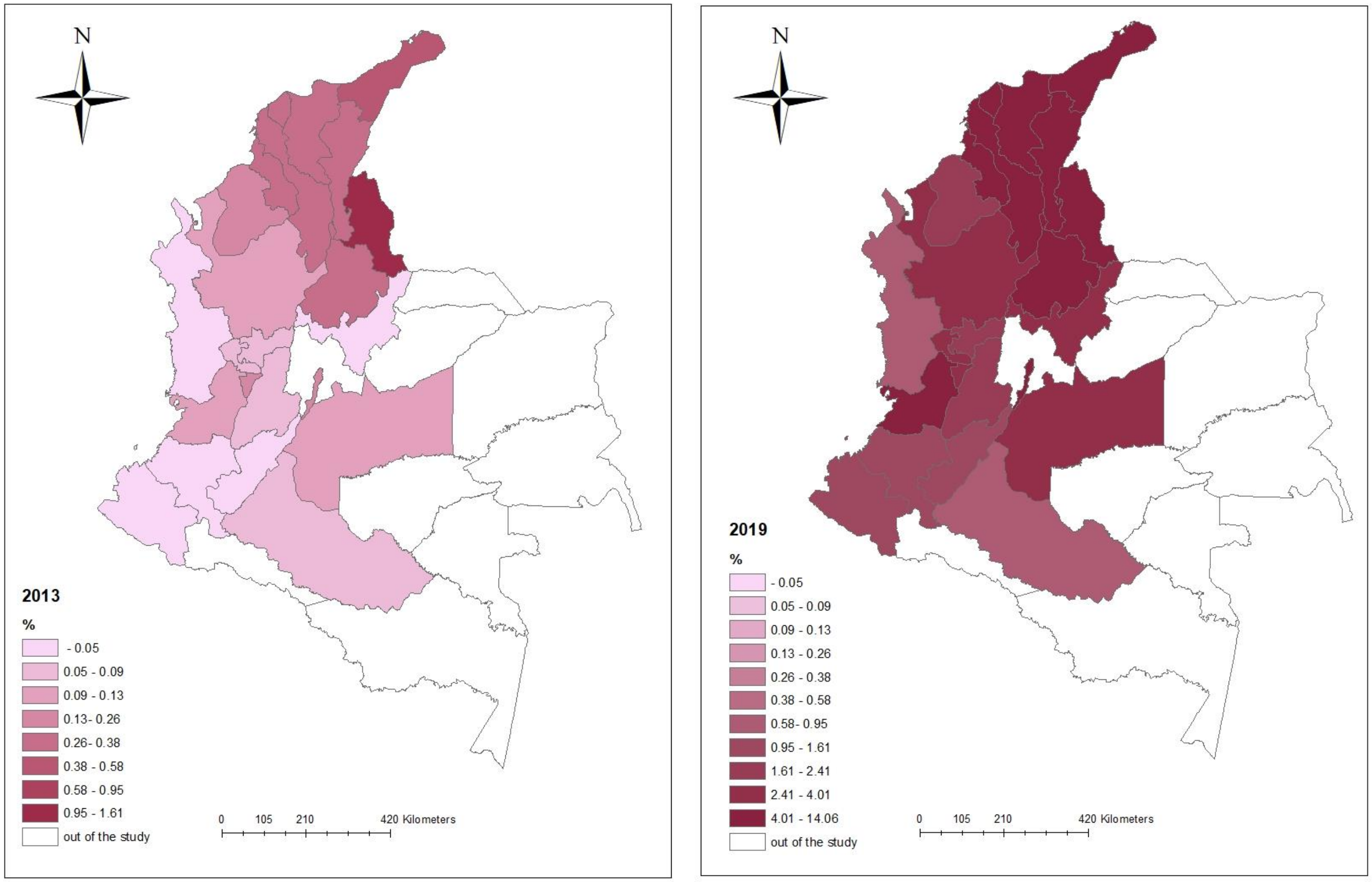
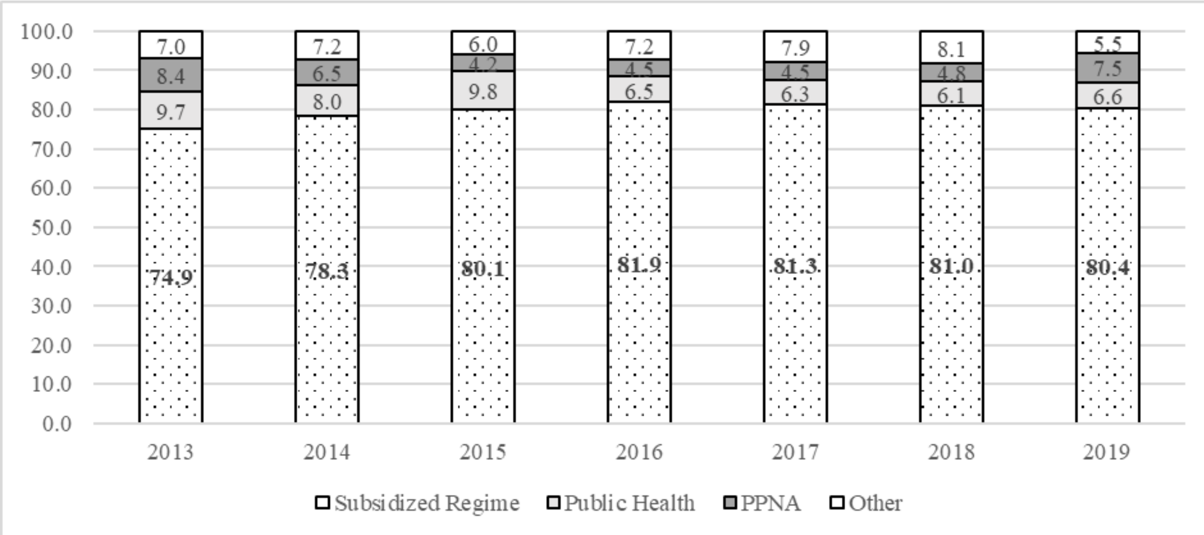
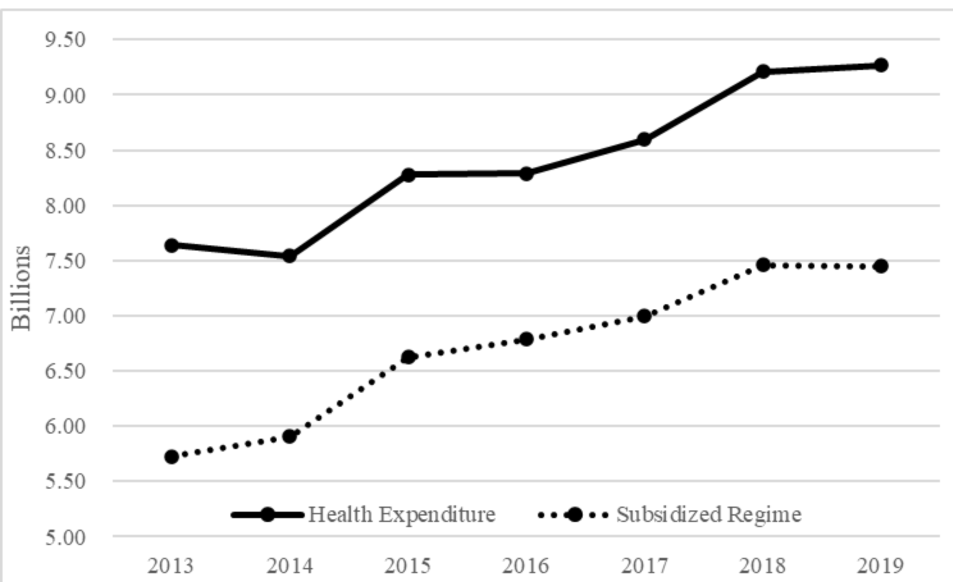


Figure 2.3. Participation of each subaccount in health expenditure (%)



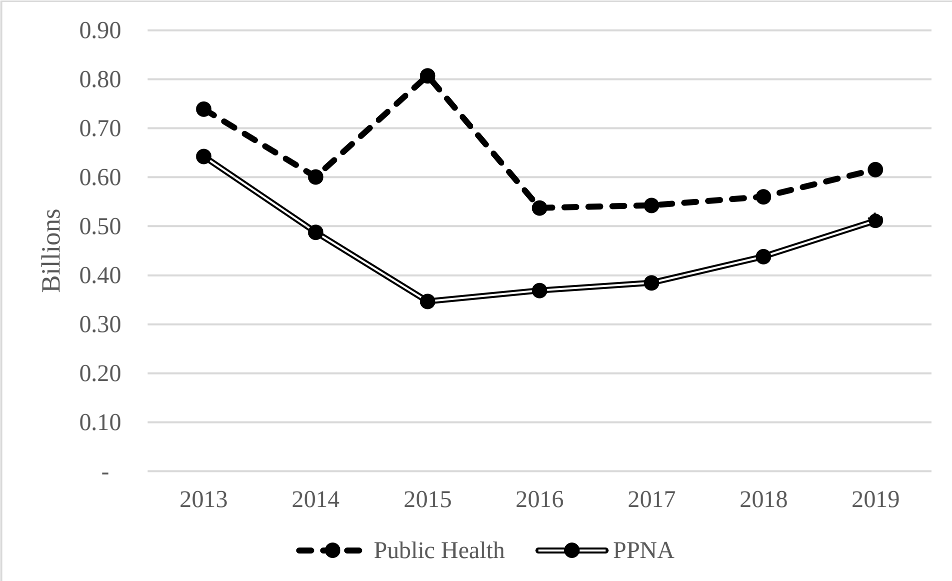
The growth in migrants from Venezuela appears to have coincided with an increase in total health expenditures. The subsidized regimen expenses followed a similar trend (Figure 2.4). PPNA and public health expenditures have been on a positive trend since 2016, after the re-opening of the border and during the boost in migration from Venezuela (Figures 2.4 and 2.5)[27].

Figure 2.4. Total health and subsidized regime expenditure 2013-2019 (2019 pesos)



[27] The increase in 2005 in public health expenditures was due to the increase in this sub-account in Bogotá, the capital city of Colombia.

Figure 2.5. Public health and PPNA expenditures (2019 pesos)



Colombia shares a 2,219-kilometer border with Venezuela (Universidad del Rosario & Fundación Konrad Adenauer, 2019). Out of the 1,122 municipalities in Colombia, 40 of them border Venezuela. Among the 23 cities in our sample, there are 4 located in departments (or states) that are along the border. Table 2.2 presents the comparison of per capita health expenditures before and after the reopening of the border for the cities (in states) along the border and the ones outside of the border.

Table 2.2. Health expenditures per capita (2019 pesos)

	Cities on the border		Cities outside the border	
Per capita expenditures	2013-2015	2016-2019	2013-2015	2016-2019
Health Expenditure	458,394	523,117	307,686	330,414
Subsidize Regime	432,010	500,696	233,816	229,621
Public Health	13,373	15,224	30,301	19,487
PPNA	7,105	3,452	21,065	17,547

Health spending increased for cities on the border and outside the border. However, expenditures in the subsidized regime increased for cities along the border and decreased for cities outside of the border. Recall that the central government sends resources to the municipalities to finance the health insurance of the people who belong to the subsidized regime. Municipalities with more people in the subsidized regime receive more resources. A higher expenditure in the subsidized regime subaccount can be explained by greater growth in the population affiliated with the subsidized regime. Also, the premiums paid to the insurers for services given to certain populations such as women, children, and the elderly are higher. Cities with a greater proportion of the population with these characteristics will also have higher expenditures in the subsidized regime.

Note also that, while public health spending is higher in cities outside the border, it increases in cities along the border and decreases in cities outside of the border. The Central Government transfers resources to the municipalities to fund this sub-account. Cities with higher poverty, higher public health risks, higher population dispersion, and more population to attend receive more resources (Ley 715 de 2001). Additionally, cities can use their own resources (generated in the collection of taxes, for example) to cover these expenses. Any of those variables can influence per capita spending on public health to be higher in cities outside of the border. It should be noted that among them are large cities such as Bogotá (Colombia's capital city), which may collect more taxes than the smaller cities on the border.

Achieving universal health insurance coverage and decreasing expenses in the PPNA subaccount is a goal of the national government. The idea behind this is that, as coverage increases (which implies more people are affiliated with the contributory or subsidized regime), the lower will be the expenses associated with services outside the package covered by health insurance and with people who do not have insurance. Therefore, it is not surprising that PPNA spending was lower after the border was re-opened in 2016. PPNA expenditures decreased to a greater extent in the border cities, which is consistent with higher subsidized regime expenditures in those places.

A two-sample t-test was performed to compare health expenditures between the cities on the border and the ones outside the border. There was not a significant difference in expenditures on the subsidized regime, public health, and PPNA, as long as in the total health expenditures (Appendix Table A1). Moreover, there was not a significant difference in the number of migrants between those two groups of cities. What we see in Colombia is that migrants many times settle in cities like Bogota, Medellin, and Cali, which are not on the border but might offer better job opportunities. Therefore, our identification strategy will not exploit the closeness to the border as the source of exogeneity to study the migration effects.

2.4. The empirical analysis

To empirically investigate whether the Venezuelan migration shock had an impact on health expenditures in Colombia, we estimate the following model:

$$HEP_{ct} = \alpha + \beta Migrants_{ct} + \gamma(\mathbf{Z_c} * \boldsymbol{y_t}) + \mu_c + \delta_t + \epsilon_{ct} \qquad (2.1)$$
$$c = 1, 2 \ldots .23; \quad t = 2013, 2014, \ldots 2019.$$

The dependent variable, HEP_{ct}, is the log of real health expenditures per capita in city c, at year t[28]. We also use as dependent variables the log of per capita real expenditures in the subsidized regime, the public health sub-account, and the PPNA. The main explanatory variable is $Migrants_{ct}$, which is the number of residents in city *c* who reported in the GIEH-DANE survey for year *t* that they were living in Venezuela five years prior to being surveyed[29]. The estimates for β represent the average effect of one thousand additional migrants on the health expenditure per capita.

Our other control variables include μ_c (city fixed effects), which accounts for all the time-invariant characteristics of the geographic units, and δ_t, which controls for the time-fixed effects or all the shocks common to all the cities in the sample. We assume that migrants might be able to anticipate that future trends in health expenditures in each city depend on the previous conditions of certain variables. For this reason, we also control for the interaction of some variables measured before the re-opening of the Colombian-Venezuelan border (defined by Z_c) and year dummies (defined by y_t). These interactions account for potential differential non-parametric trends on characteristics such as poverty and the population subsidized with health insurance. The variables included in Z_c are the multidimensional poverty index (MPI) in 2005 and the total number of persons (both Colombians and Venezuelan migrants) affiliated with the subsidized regime in 2012. Both variables are good predictors of local health spending. We further consider the possibility that Venezuelan migrants can differentiate Colombian cities in terms of their poverty levels and the potential quality of life and resources that could be available to them when choosing the city where they are going to locate. Likewise, it is assumed that cities with higher levels of poverty have higher healthcare expenditures, as well as cities that have more persons affiliated with the subsidized regime. The main challenge in investigating the relationship between migration and government spending on health is that the locational decisions of the migrants may be potentially endogenous. Identifying the

[28] Constant pesos in 2019.
[29] The variable was divided by 1,000 for ease of interpretation of the results.

impact of migration on government health expenditures could be biased if migration decisions are affected by the health policies of the destination country. For instance, if migrants move to the host country with their children, they may prefer to migrate to regions where their children can benefit from free health services and where the quality of the healthcare system is high. In Colombia, such disparity in health care policies among the municipalities does not exist on paper. The health insurance premium and the package of services that are covered are the same throughout the country. However, bigger cities with larger populations offer more specialized services and have more providers per capita. This could affect the provision of healthcare services – both in terms of access and quality. This, in turn, might be correlated with other factors that could affect the locational decisions of the migrants, like more job opportunities. Moreover, omitted unobservable factors might drive migrant distribution across Colombia, resulting in differences in health expenditures across regions and municipalities.

We account for this potential endogeneity regarding the self-selection of migrants into certain geographic areas using a Bartik-type instrumental variable approach (Bartik, 1991). Following Bonilla et al. (2020), we use an instrument that accounts for the interaction between the regional distribution of migrant networks in 2005 and the timing of the Venezuelan crisis (see Equation 2.2). Migrant networks are measured by the share of the native Venezuelan population in the Colombian population registered in the 2005 Census, long before the crisis began. The temporal variation of the Venezuelan economic crisis is measured with the consumer price index (CPI), which reflects the country's loss of purchasing power. The idea behind the instrument is that, as the Venezuelan crisis intensified, Colombian cities with a higher share of Venezuelans in 2005 received more migrants. Formally, we define the instrument as follows:

$$Instrument_{ct} = Migration\ network * CPI = \left[\frac{Venezuelans_{c,2005}}{Total\ population_{c,2005}} * \ CPI_t\right], \qquad (2.2)$$

where $Venezuelans_{c,2005}$ is the number of Venezuelans living in city *c* during 2005, $Total\ population_{c,2005}$ is the total population in city *c* during 2005, and CPI_t is the consumer price index in Venezuela in year *t*.

From here, we estimate a two-stage least squares regression using an instrumental variable (2SLS) that follows that of Bartik (1991). The first stage of the estimation is given by:

$$Migrants_{ct} = \alpha + \theta[Migration\ network * CPI]_{ct} + \gamma(\mathbf{Z_{i,t}} * \boldsymbol{y_t}) + \mu_c + \epsilon_{ct} \qquad (2.3)$$

The identification strategy requires the instrument to predict migration flows accurately. The first-stage regression of our main specification confirms that this is the case (see Table 2.3). This regression measures the strength of the relationship between the migration shock to the distribution of the ratio of Venezuelans to native Colombians in 2005 interacted with the Venezuelan CPI as an indicator of the country's level of socioeconomic crisis. The estimated coefficient is 1.084 (with standard error 0.201), indicating a significant positive correlation between the two variables. The F test of excluded instruments is 33.39, ruling out the possibility of a weak instrument problem. Also, the Kleibergen-Paap LM statistics verify that the model is not underidentified.

Goldsmith-Pinkham et al. (2018) show that the Bartik instruments are numerically equivalent to using the initial shares, interacted with time-fixed effects, as instruments in a weighted GMM estimation (Mckenzie, 2018). This result implies that the year-fixed effects included in our estimations could be absorbing the CPI effect. Hence, the exogeneity of the instrument relies mainly on the exogeneity of the initial shares. In other words, shares should be as good as random (Byrne et al, 2021). Byrne et al. (2021) proposed a placebo test to verify the exogeneity of the initial shares. They say, "If impacts of exposure are only expected after a certain time period (..), then we should not expect impacts of exposure on outcomes in earlier time periods". In our case, the shocks used to construct exposure occurred after 2016. Bonilla et al. (2020) ran the placebo test for the instrument we are using. They showed that the effect of migrant networks is only statistically significant after June 2016, when the Colombian-Venezuelan border reopened. This implies that our measure of migrant networks does not have persistent effects on health expenditures, or that health expenses were not significantly different in cities with more Venezuelan population before the migration wave in 2016. Therefore, Bonilla et al. (2020) proved that the initial shares in our instrument are exogenous.

The exclusion restriction requires that the instrument (i.e., the migration network that was formed in 2005) only affects current and local health expenditures through migration to that city in the current year (Jaeger et al., 2018). We argue that this is the case in our study. Bonilla et al. (2020) compare the 2005 Population Census with previous Censuses in Colombia, which show that the share of Venezuelans in each city is highly persistent over time. However, because there is not enough evidence that shows that the Colombian government funded health expenditures of Venezuelans living in Colombia in 2005, it is hard to prove that migration in 2005 would have affected health expenditures per capita during our study period (2013-2019). Therefore, our instrument would not be violating the exclusion restriction because is not capturing the longer-term adjustment process of the health expenditures (the outcome of interest) to previous migration inflows.

Table 2.3. First-stage estimates

	(1)
Migration network * CPI	1.084***
	(0.201)
year = 2014	-0.737
	(18.30)
year = 2015	0.626
	(18.30)
year = 2016	1.950
	(18.30)
year = 2017	7.066
	(18.30)
year = 2018	25.15
	(18.30)
year = 2019	55.04***
	(18.33)
2014*affiliated with subsidized regime	5.98e-06
	(1.88e-05)
2015*affiliated with subsidized regime	8.42e-06
	(1.88e-05)
2016*affiliated with subsidized regime	2.20e-05
	(1.88e-05)
2017*affiliated with subsidized regime	5.71e-05***
	(1.88e-05)
2018*affiliated with subsidized regime	0.000150***
	(1.88e-05)
2019*affiliated with subsidized regime	0.000254***
	(1.88e-05)
2014*MPI	-0.000312
	(0.366)
2015*MPI	-0.0172
	(0.366)
2016*MPI	-0.0372
	(0.366)
2017*MPI	-0.178
	(0.366)
2018*MPI	-0.701*
	(0.366)
2019*MPI	-1.696***
	(0.372)
Constant	2.039
	(3.197)
City FE	yes
Observations	161
Number of cities	23
Adjusted R-squared	0.79
F statistic	33.99
Kleibergen-Paap LM (*p-value*)	0.000

*** p<0.01, ** p<0.05, * p<0.1

Some might consider that the instrument works for the first wave of migration but not so well for the last wave. If the first wave of migration refers to the first Venezuelans that leave their country, it might be rather the opposite. Those Venezuelans were richer than the ones who arrived in Colombia when the borders were opened in 2016. Therefore, they did not need to rely on their network as much as the poorer Venezuelans. According to Reina et al. (2018) *, "The first Venezuelans who left their country, were high-income Venezuelans who, due to their relationships or because they had enough income to establish themselves abroad. They emigrated to avoid damage to their assets by the Venezuelan government…Their main destinations were developed countries such as the United States or European countries". As the economic crisis intensified, the incentives for the middle and lower classes to migrate also increased. Therefore, most migrants who arrived in Colombia, after the reopening of the border, were those who had limited opportunities to settle anywhere else. Therefore, they relied on their networks to choose where to go and understand how to access food, healthcare, and get a job. Therefore, as the estimations for the first stage show, the instrument (the interaction of the Venezuelan network in 2005 and the CPI) is a good predictor of the migrants for each of the 23 cities in my sample.

2.5. Results

We present the OLS estimates in Table 2.4. This shows a positive correlation between the number of migrants and the public health expenditures per capita and a negative correlation between the number of migrants and the PPNA expenditures per capita. On the other hand, Table 2.5 shows the estimated LATE (local average treatment effect) of migration on health expenditures and its components: subsidized regime, public health, and PPNA. In other words, it presents the effects of migration for those cities affected by the instrument. According to the 2SLS estimations, an increase in the number of migrants by 1,000 increases total health expenditures by 1.05% (Column 1) and public health expenditures by 0.61% (Column 3).

Results also indicate that migration had no impact on the subsidized regime. Although migration increased significantly after 2016, it took some time for the Colombian Government to grant health insurance to Venezuelan migrants. Colombian returnees could request it as soon as they arrived. However, unemployed, low-income, and informal workers from Venezuela received the right to join the subsidized regime in 2017, under the condition of first obtaining the PEP[30]. Irregular migrants had to register in RAMV[31] to be able to request subsidized health insurance. This registration process did not start until 2018. Later, the government granted PEPs to people registered in the RAMV. As mentioned in Section 2.1, there is evidence that even PEP holders, who have the right to obtain insurance, have not requested it and that many migrants have not received information about how to get subsidized health insurance. As a result of all this, the number of migrants with subsidized health insurance might not have increased as expected, and the local expenditures in this sub-account may not have increased as well.

We also did not find a significant impact of migration on PPNA expenditures. This subaccount covers services provided to the uninsured population or services outside the provided health insurance plan. This would be the sub-account potentially affected by migrants without health insurance and seeking emergency healthcare services. Some factors could explain this result. Even though there is evidence that public hospital bills were sent to municipalities for emergency services provided to migrants (Melo-Becerra, et al, 2020), municipalities have not paid those bills fully yet. Therefore, they are not registered in the municipalities' budget during the period considered in this study. This is consistent with documented long delays in payments to hospitals (Guzman, 2023), and implies that further increments in the PPNA sub-account were likely observed after the municipalities paid them. It is also possible that migrants refrained from seeking health care for fear of deportation, or perhaps they did not require attention.

As a robustness check, we use a different instrument that also exploits the networks between Venezuelans and Colombians. This time we multiply the Venezuelan CPI by the share of Colombians living in Venezuela in the total population for each city in 2005 (Equation 2.4):

$$Alternative\ instrument_{ct} = Migration\ network * CPI = \left[\frac{Colombians\ living\ in\ Venezuela_{c,2005}}{Total\ population_{c,2005}} * CPI_t\right] \quad (2.4)$$

The reasoning behind this instrument is the same as that for the instrument we presented in Equation (2.2) Namely, the more Colombians from city *c* living in Venezuela in 2005 (before the

[30] PEP stands for *Permiso Especial de Permanencia* (Special Stay Permit).
[31]The Colombian government implemented the Administrative Registry of Venezuelan Migrants (RAMV) census process in 2018 to register irregular migrants in the country and collect information about them.

migration wave in 2016), the more migrants would decide to arrive to that city, since they might have family and friends still living there that can help them resettle.

Results in the Appendix presented in Table A2 show that the first stage is accurate. The migration network based on the proportion of Colombians living in Venezuela in 2005, and its interaction with the Venezuelan CPI, is significantly associated with higher migration levels. The F test of excluded instruments is 34.38, ruling out the possibility of a weak instrument problem. Also, the Kleibergen-Paap LM statistics verify that the model is not underidentified. Table A3 shows that the 2SLS results are very close in magnitude and significance to the ones from the main model presented in Table 2.5.

Table 2.4. Effects of migration on health expenditures per capita in Colombia (OLS)

VARIABLES	(1) Total Health Expenditure	(2) Subsidized Regime	(3) Public Health	(4) PPNA
Migrants	-0.00191	0.00398	0.00398***	-0.00855**
	(0.00145)	(0.00335)	(0.00133)	(0.00377)
year = 2014	-0.0101	0.0264	0.225	-0.664
	(0.322)	(0.745)	(0.296)	(1.016)
year = 2015	0.0223	0.0857	0.394	-1.672
	(0.322)	(0.745)	(0.296)	(1.016)
year = 2016	0.0310	0.128	-0.242	-1.797*
	(0.322)	(0.745)	(0.296)	(1.016)
year = 2017	0.222	0.131	0.221	-1.131
	(0.322)	(0.746)	(0.297)	(1.164)
year = 2018	0.228	0.157	-0.105	-1.704
	(0.324)	(0.750)	(0.298)	(1.172)
year = 2019	0.707**	1.263	-0.471	-2.163*
	(0.330)	(0.763)	(0.304)	(1.193)
2014*affiliated with subsidized regime	-6.42e-08	-2.93e-08	-4.09e-07	2.24e-07
	(3.31e-07)	(7.66e-07)	(3.05e-07)	(8.76e-07)
2015*affiliated with subsidized regime	-8.28e-08	-4.86e-08	-6.30e-08	2.03e-07
	(3.31e-07)	(7.67e-07)	(3.05e-07)	(8.76e-07)
2016*affiliated with subsidized regime	-2.26e-08	-1.08e-07	-1.84e-07	6.49e-07
	(3.33e-07)	(7.70e-07)	(3.06e-07)	(8.80e-07)
2017*affiliated with subsidized regime	-1.43e-07	-2.94e-07	-8.43e-07***	1.08e-06
	(3.41e-07)	(7.90e-07)	(3.14e-07)	(9.04e-07)
2018*affiliated with subsidized regime	1.72e-07	-6.80e-07	-1.15e-06***	2.32e-06**
	(3.96e-07)	(9.16e-07)	(3.64e-07)	(1.04e-06)
2019*affiliated with subsidized regime	3.23e-07	-1.96e-06*	-1.73e-06***	3.67e-06***
	(5.00e-07)	(1.16e-06)	(4.60e-07)	(1.30e-06)
2014*MPI	0.000629	-0.000163	-0.00220	0.00782
	(0.00644)	(0.0149)	(0.00593)	(0.0214)
2015*MPI	0.00229	0.000802	-0.00636	0.0253
	(0.00644)	(0.0149)	(0.00593)	(0.0214)
2016*MPI	0.00162	0.000187	0.00250	0.0277
	(0.00644)	(0.0149)	(0.00593)	(0.0214)
2017*MPI	-0.000685	0.00105	-0.00218	0.00997
	(0.00645)	(0.0149)	(0.00593)	(0.0259)
2018*MPI	-0.00105	0.00197	0.00808	0.0198
	(0.00652)	(0.0151)	(0.00600)	(0.0261)
2019*MPI	-0.0293***	-0.0438***	0.000483	0.0134
	(0.00672)	(0.0155)	(0.00619)	(0.0267)
Constant	12.77***	12.62***	9.547***	9.337***
	(0.0563)	(0.130)	(0.0519)	(0.159)
Observations	161	161	161	124
R-squared	0.593	0.393	0.606	0.329
Number of cities	23	23	23	19
City FE	yes	yes	yes	yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2.5. Effects of migration on health expenditures per capita in Colombia (2SLS)

	(1)	(2)	(3)	(4)
VARIABLES	Total Health Expenditure	Subsidized Regime	Public Health	PPNA
Migrants	0.0105**	0.00757	0.00612**	-0.000668
	(0.00415)	(0.00758)	(0.00304)	(0.00649)
year = 2014	-0.000952	0.0290	0.227	-0.653
	(0.410)	(0.749)	(0.300)	(1.041)
year = 2015	0.0145	0.0834	0.393	-1.670
	(0.410)	(0.749)	(0.300)	(1.041)
year = 2016	0.00680	0.121	-0.246	-1.792*
	(0.410)	(0.749)	(0.300)	(1.041)
year = 2017	0.134	0.105	0.206	-1.141
	(0.411)	(0.751)	(0.300)	(1.193)
year = 2018	-0.0827	0.0663	-0.158	-1.989
	(0.423)	(0.773)	(0.309)	(1.216)
year = 2019	0.0934	1.085	-0.577*	-2.710**
	(0.458)	(0.838)	(0.335)	(1.275)
2014*affiliated with subsidized regime	-1.38e-07	-5.08e-08	-4.22e-07	1.73e-07
	(4.22e-07)	(7.71e-07)	(3.09e-07)	(8.99e-07)
2015*affiliated with subsidized regime	-1.87e-07	-7.89e-08	-8.10e-08	1.35e-07
	(4.23e-07)	(7.73e-07)	(3.09e-07)	(8.99e-07)
2016*affiliated with subsidized regime	-2.96e-07	-1.87e-07	-2.31e-07	4.72e-07
	(4.31e-07)	(7.88e-07)	(3.15e-07)	(9.09e-07)
2017*affiliated with subsidized regime	-8.50e-07*	-4.99e-07	-9.65e-07***	6.26e-07
	(4.83e-07)	(8.83e-07)	(3.53e-07)	(9.75e-07)
2018*affiliated with subsidized regime	-1.69e-06**	-1.22e-06	-1.47e-06***	1.15e-06
	(7.51e-07)	(1.37e-06)	(5.50e-07)	(1.32e-06)
2019*affiliated with subsidized regime	-2.88e-06**	-2.89e-06	-2.28e-06***	1.66e-06
	(1.15e-06)	(2.11e-06)	(8.44e-07)	(1.88e-06)
2014*MPI	0.000632	-0.000162	-0.00220	0.00771
	(0.00819)	(0.0150)	(0.00599)	(0.0219)
2015*MPI	0.00250	0.000863	-0.00632	0.0253
	(0.00819)	(0.0150)	(0.00599)	(0.0219)
2016*MPI	0.00208	0.000320	0.00258	0.0274
	(0.00819)	(0.0150)	(0.00599)	(0.0219)
2017*MPI	0.00152	0.00170	-0.00180	0.0101
	(0.00822)	(0.0150)	(0.00602)	(0.0265)
2018*MPI	0.00760	0.00448	0.00958	0.0271
	(0.00869)	(0.0159)	(0.00636)	(0.0272)
2019*MPI	-0.0129	-0.0390**	0.00332	0.0272
	(0.00986)	(0.0180)	(0.00722)	(0.0288)
Constant	12.75***	12.62***	9.543***	9.316***
	(0.0720)	(0.132)	(0.0527)	(0.163)
Observations	161	161	161	124
Number of cities	23	23	23	19
City FE	yes	yes	yes	yes

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

2.6. Concluding Remarks

We examined the impacts of the recent Venezuelan migration on Colombia's health expenditures for 23 main cities between 2013 and 2019. Migration from Venezuela increased significantly in August 2016 when Colombia's government re-opened the border, after one year of being closed. We found that total health expenditures, and public health expenditures specifically, increased with the number of migrants coming from Venezuela (Colombian returnees and Venezuelans). An increase in the number of migrants by 1,000 increased total health expenditures for the municipalities by 1.05%, and public health expenditures by 0.61%.

This result suggests that local governments made efforts to contain the negative externalities in terms of public health produced by the migration shock. Public health programs at the local government level include actions to prevent increases in the incidence of vaccine-preventable diseases, as well as sexually transmitted diseases, and promoting food safety, and mental health. Also, notice that the migration effect on the total health expenditures is larger than the one on public health expenditures. Recall that total health expenditure includes four subaccounts: subsidized regime, public health, PPNA, and other expenses. Therefore, the difference in those coefficients could be capturing the migration effect on other health components, such as infrastructure investments and fiscal clearing programs of the public hospital networks.

The estimated effects of the Venezuelan migration are coherent with the documented evidence of the Colombian government's financial effort to attend to the need for medical care of migrants. In 2019 hospitals had invoiced services worth USD 163.9 million on account of the care provided to the migrants (Ministerio de Salud y Protección Social, 2023). Between 2017 and 2019, the government spent 26,430 million COP on vaccination (7.7 Mill. USD), and around 1.8 million doses of vaccines were supplied to migrants.

Additionally, we found that migration did not significantly affect expenditures related to the subsidized health insurance that has been granted to regular migrants (subsidized regime), which is compatible with the fact that many of them might not be insured yet. As of 2019, only 4.36% of Venezuelans living in Colombia have joined the subsidized regime. Lack of information could be one of the reasons they did not seek out insurance. In Colombia, local governments are responsible for identifying potential beneficiaries of the subsidized health insurance. Therefore, these should focus on reaching the uninsured population and provide pertinent information to obtain health care access.

Even though we did not find any significant effect in the subsidized regime expenditures if the subsidized population grows, so will the Colombian Government's budgetary pressures. In 2022 each subsidized enrolled cost the government $964.807 COP (Ministerio de Salud y Protección Social, 2021). If the 1.7 million Venezuelans living in Colombia get subsidized health insurance, it would cost the country around 401 million USD annually. To put that figure in context, Colombia's capital (Bogota), health expenditure was 532 million USD in 2019 (Departamento Nacional de Planeación, 2023). Notice that we are not counting the Colombian returnees, the 4.9 million pendulum migrants, or the 832 thousand migrants in transit to another country (Ministerio de Salud y Protección Social, 2023). To alleviate the potential budgetary pressures the country would need to facilitate the inclusion of Venezuelan migrants in the formal labor market since formal workers in Colombia must fund their own health insurance.

Finally, migration did not significantly affect expenditures in the subaccount that covers the attention of the uninsured population (PPNA). There is evidence that local governments have not fully paid the hospitals for the services provided to the uninsured migrants. In November 2019, 76.7% of the invoiced services on account of the care provided to the migrants had not been paid (Ministry of Health and Social Protection in Colombia, 2019). Therefore, these expenses were not registered in the municipalities' budget during the period considered in this study. Moreover, departments (or states) administer the budget for PPNA expenses of some municipalities. This implies that variations in the expenses on the services provided to the uninsured population are not observed for some municipalities in our sample, which is a limitation of this analysis. Therefore, studying the effects of migration at the department level could complement the analysis presented here.

Another limitation is our small sample and short study period (7 years total and only 4 years after the migration shock). We are bound to the 23 cities included in the GEIH, which have migration information. To include all the Colombian municipalities in our estimations, additional migration data would be needed. Still, even with the data available, we were able to provide considerable insight into the migration effects on health expenditures at the local level: Facing the migration shock from Venezuela, in the short run local authorities responded with efforts to contain the negative externalities in terms of public health. Therefore, as the migration from Venezuela continues, local governments might need to secure resources to grant public health programs continuity.

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CHAPTER 3: ACCOUNTS RECEIVABLE AND QUALITY OF PATIENT CARE

This paper evaluates the association between the accounts receivable and some healthcare quality indicators. Accounts receivable is an indicator of a hospital´s liquidity, which refers to its ability to fulfill cash obligations (Barnes et al., 2017). Protecting liquidity is one of the most important challenges for healthcare providers, especially during an economic slowdown (Davis & Robinson, 2010). Liquidity is closely related to other aspects of financial performance. There is evidence that having an accounts receivable problem is a strong predictor of financial distress (Kim, 2018). A study of 34 healthcare companies in the U.S. found that between 2005 and 2020 liquidity significantly influenced companies' performance measured by profitability indicators (Batrancea, 2021). That positive relationship between profitability and liquidity was also found in 15% of all public hospitals in Poland (Bem et al., 2014), and in 1,397 not-for-profit U.S hospitals (Rauscher et al, 2012). They also found a negative correlation between liquidity and debt. Liquidity is also positively related to investment. In California, high–cash–flow hospitals invested more than low–cash–flow hospitals during the 2007 recession (Choi, 2017).

Hospitals without liquidity might not be able to cover their operating expenses or make investments that improve the hospital infrastructure. If the hospital is not able to collect enough money, it would not be able to pay the payroll, which would reduce the number of medical personnel available for consultations or in the emergency department, increasing waiting times. Also, it could limit the purchase of inputs. Delays in assigning appointments with specialists, or diagnostic tests, and in the delivery of medications, can affect patient satisfaction.

Evidence has shown that an improvement in the financial performance of hospitals is associated with better quality of care. Both financial performance and quality of care indicators are measured with a variety of indicators. Higher levels of funding per enrollee were associated with better patient satisfaction in 94 U.S. military healthcare facilities with 1999-2003 data (Beauvais et al., 2007). Between 1995 and 2000, improved financial performance led to greater U.S. hospital investments in plant and equipment (Bazzoli et al., 2007). During the same period, for a sample of 1,544 acute care hospitals operating in eleven U.S states, it was found that hospitals with the lowest cash flow to total revenues ratio had significantly higher rates of in-hospital mortality and nursing-related patient incidents (Bazzoli et al., 2008). Also, for acute care hospitals in the U.S., the quality of treatment for cardiovascular patients rises in the year following an increase in hospital profitability, financial leverage, and labor costs (Dong, 2015). Here, the quality of treatment was a composite measure constructed based on many quality scores for clinical conditions of heart attack and heart failure. Akinleye et al. (2019) also developed a composite quality performance score, and a composite financial performance score for 108 New York State acute care facilities using 2014 data, finding a positive relationship between those variables.

This paper focuses on evaluating the effects of the accounts receivables to sales ratio on six quality of care indicators: waiting time for getting an appointment with a General Doctor, waiting time for emergency care, hospital readmission rate, satisfaction rate, number of General Doctors, and number of nurses. I will present evidence using official information reported by public hospitals to the Health Ministry of Colombia from 2009 to 2019. Public hospitals in Colombia are very relevant because they are mostly located in small cities where it is less likely to have private providers. Therefore, an important percentage of the population in those areas depends on public hospitals to access health care (Bernal & Barbosa, 2015; Guzmán-Finol, 2017). In 2019, 29% of the municipalities had only public providers.

Despite their importance, public hospitals in Colombia have not managed to be financially sustainable or efficient (Asociación Colombiana de Hospitales y Clínicas, 2020, 2017; Fedesarrollo & Fundación Suramericana, 2012; Cubides, 2019; Orozco, 2014). As the Organization for Economic Cooperation and Development (2015) pointed out, part of their financial struggle has been precisely attributed to the delays by the health insurers and the local governments in the payment of services provided, or accounts receivable (Gutiérrez, 2018).

Accounts receivable of public hospitals in Colombia went from 3.09 billion COP in 2007 to 9.95 billion COP in 2019 (Ministerio de Salud y Protección Social, 2023d)[32]. The longer an account receivable goes unpaid, the less likely healthcare providers will receive payment. Receivables over 360 days past due have been the most predominant and its participation in the total of accounts receivable has increased. It went from 32.34% in 2007 to 49.94% in 2019 (SIHO, 2023). Moreover, receivables have worsened after the recent migration shock from Venezuela in 2016. Public hospitals in Colombia have attended to the healthcare needs of foreigners and Colombian returnees without health insurance. In November 2019, 76.7% of the invoiced services on account of the care provided to migrants from Venezuela had not been paid (Ministerio de Salud y Protección Social, 2020)[33].

[32] In real terms of 2020.
[33] In Colombia, accounts receivables are not a public hospital issue only. According to the Colombian Association of Hospitals and Clinics, which analyzed information from 205 public and private providers, their receivables were 12.7

As the receivables increase, the number of public hospitals at high risk of breakdown also does. In many cases, hospital closures have been avoided through financial rescue operations by the national and local governments (OCDE, 2015)". The accounts receivable explosion in Colombia has occurred as the quality of care has improved: staffing levels and patient satisfaction have increased while waiting times and readmission rates have decreased. Therefore, some of the questions that arise are: What would happen with these indicators if the receivables had not increased the way they did? Would the quality have improved more? In other words, Is there any causal effect of the accounts receivable on the quality of care?

This paper makes the following four-fold contributions. First, this study extends the limited research on the relationship between financial performance and quality of care by using a liquidity measure of high relevance in the context of a developing country, where healthcare providers might face more budget constraints than their peers in developed ones. Notice that most of the evidence is found in U.S. hospitals. Previous literature reviews on the subject have concluded that there is a need for additional studies that analyze the association between quality and financial performance in a hospital setting (Beauvais & Wells, 2006; Barnes et al. 2017).

The second contribution is that this paper deals with the potential endogeneity between the financial performance indicator and the quality outcomes. Most of the papers in this literature explained their relationship using correlations, without considering the potential feedback and endogeneities between these variables (Barnes et al, 2017). I use a 2SLS approach with a shift-share type instrument that exploits the liquidation of Saludcoop, a health insurance company that had the highest share of the insured population in Colombia. Saludcoop liquidation in 2015 affected the accounts receivable of the public hospitals located in regions with a high percentage of their population enrolled by this insurance company.

The third contribution is that I investigate the relationship of the quality of care with short-term and long-term receivables separately. Finally, I evaluate the relationship of accounts receivable with other liquidity indicators such as the percentage of assets in cash, the current liquidity ratio, and the cash ratio. Their relationship with the quality of care is analyzed as well.

No previous study, to the best of my knowledge and through search in peer-reviewed databases, has evaluated in Colombia how the financial challenges faced by public hospitals could

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billion pesos as of June 2021. They increased by 2 billion, compared to December 2020. (Asociación Colombiana de Hospitales y Clínicas, 2021).

affect some aspects of the quality of care that the patients experience. This paper goes beyond evaluating a problem that in principle is of a financial and political nature, to analyzing its implications on the quality of services. The rest of the paper is organized as follows. Section 3.1 presents the quality indicators considered in this study. Section 3.2 describes the data and shows some descriptive statistics. Sections 3.3 and 3.4 present the empirical strategy and results, and the last section provides some concluding remarks.

3.1. Healthcare Quality Indicators

Quality of care has been measured in different ways. According to Fischer (2015), “quality indicators are measurement tools, screens, or flags that are used as guides to monitor, evaluate, and improve the quality of patient care, clinical support services, and organizational functions that affect patient outcomes”. Indicators have been classified in dimensions. These dimensions are measurable attributes of a health system that are related to the maintenance, restoration, or improvement of health. The OECD (2021, 2023) focuses on the dimensions of accessibility, effectiveness, cost, efficiency, governance, and patient-centeredness (Arah, et al., 2006, Carinci et al., 2015), while Colombia considers effectiveness, safety, and experience of care (Ministerio de Salud y Protección Social de Colombia, 2016). Donabedian’s framework classified quality indicators into three types: structure, process, and outcome (Fischer, 2015; Grupo de Trabajo SEMES- Insalud, 2001; Stelfox & Straus 2013; Mainz, 2003). There is a large body of literature that studies the factors associated with quality of care (Table C1).

In this study, the choice of outcome indicators was based on the data availability and their broad use in the literature. The dependent variables used consisted of six measures of quality of care: waiting time for getting an appointment with a General Doctor, waiting time for emergency care, hospital readmission rate, satisfaction rate, number of General Doctors, and number of nurses. (Table 3.1).

Table 3.1. Healthcare Quality Indicators

Variable	Definition
Waiting time for getting an appointment (days) with a General Doctor	Ratio between the sum of the difference between the date on which the first-time appointment was assigned and the date on which the patient requested it (in calendar days) and the total number of first-time appointments assigned.
Waiting time for emergency care (minutes)	Ratio between the sum of the number of minutes elapsed since the patient is classified as Triage II to the moment in which he is seen in the Emergency Department by a doctor and the total number of patients classified as Triage II.
Hospital readmissions rate (%)	Ratio between the total number of patients readmitted to the hospitalization service within 20 days (for the same diagnosis) and the total discharged alived patients (multiplied by 100).
Patient satisfaction rate (%)	Ratio between the number of patients who answered "very good" or "good" to the question: How would you rate your global experience regarding the health services you have received? and the total of patients who answer the question (multiplied by 100).
Number of General Doctors	Average number of General Doctors who work eight hours available per day
Number of nurses	Average number of nurses who work eight hours available per day

Source: Ministerio de Salud y Protección Social de Colombia (2017). Note: The Ministry of Health in Colombia defined the first four indicators and established how they must be calculated. Triage is a system for selecting and classifying patients in emergency services, based on their therapeutic needs and the resources available to attend to them. There are five categories of triage (Ministerio de Salud y Protección Social de Colombia. (2021b). About the patients' satisfaction rate: I did not observe the number of patients who responded good or very good, but the total of patients who answered any of them.

The waiting times measurements (to getting an appointment with a General Doctor, and to receive emergency care), and patient satisfaction indicators evaluate the experience of care. Indicators in this dimension of quality measure the timeliness and acceptability of the service provision. Timeliness refers to the opportunity for which the services were provided, while acceptability refers to how the expectations and desires of the users and their families were met (Ministerio de Salud y Protección Social de Colombia, 2016, 2006). Appointments with the general practitioner are the gateway to the system. The general practitioner guides the patient and rationalizes the demand for services at higher levels of complexity and specialty. Moreover, a rapid response in emergency care contributes to the reduction of mortality, disability, sequelae, and risks inherent to the pathological process that originates the demand for care and reduces congestion in emergency services. The opportunity both in the appointment with a general practitioner and in emergency care reflects how capable is the hospital of meeting its demand and could be an indicator of the access to services (Angelis et al., 2021; Anderson et al., 2007; Sundmacher & Kopetsch, 2013; Mustafa et al., 2018; Roll et al., 2012; Sauerland et al., 2009). On the other hand, the patient satisfaction rate is a subjective measure of quality (Acuna et al., 2022, Brockett et al., 2021, Peng et al., 2020). It could be related not only to the effectiveness of the treatment received, but also to the duration of the consultation, or whether the patient felt cared for. Health insurers in Colombia might take this indicator into consideration when selecting the hospitals that they will contract with to provide health services.

The hospital readmissions rate is a measure of safety in the service provision. Safety is a quality dimension where the hospital provides services in ways that prevent harm to the user, -e.g., the percentage of patients that fall while staying in the emergency department (Ministerio de la Protección Social de Colombia, 2006). The readmission of patients to hospitalization services frequently occurs because of a deficient approach and solution to the problem that generated the consultation or failures in the quality of the information given to the user. High readmission may indicate inadequate treatment of a patient's needs during their admission, incorrect prescriptions, poor care coordination after discharge, disengagement, non-compliance of the patient, and poor follow-up care. (Pai et al., 2022; Jamalabadi et al., 2020; Sundmacher & Kopetsch, 2013; Berry et al., 2013; Mustafa et al., 2018). Non-public U.S. hospitals with higher operating margins exhibited lower readmission rates (Ly et al., 2011).

I also consider two indicators of staffing levels: the number of general doctors and the number of nurses. Staffing levels are a structure indicator, that helps define the characteristics of the hospital in which the care is provided (Fischer, 2015). "Recruiting and retaining quality staff remains the top healthcare issue consuming operational energies and capital" (Colosi, 2020). Moreover, there is evidence of a negative association between increases in registered nurses' staffing and mortality rates in English (Griffiths et al., 2016) and Californian hospitals (Harless & Mark, 2010).

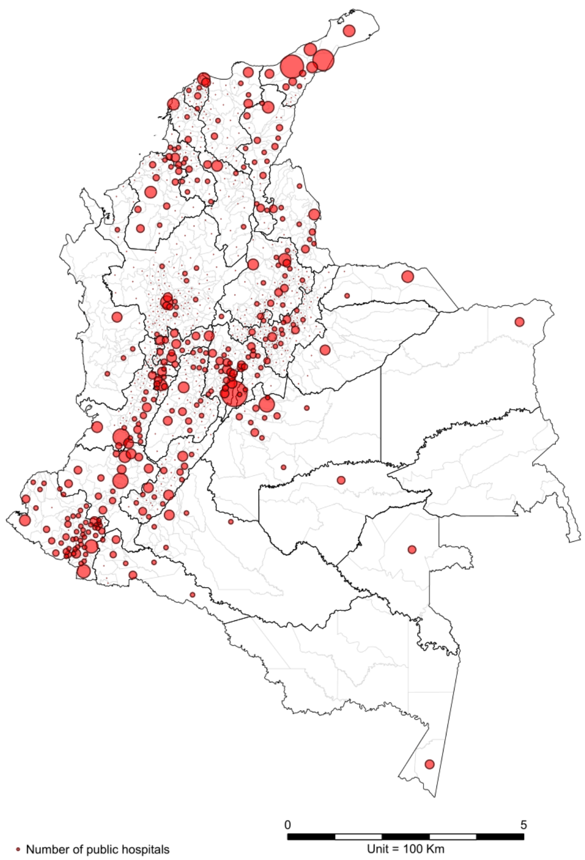
These measures by themselves do not control for differences in the socioeconomic status of patients across hospitals or hospital sizes. For example, hospitals that tend to see sicker patients might have good quality care, but they also might have higher readmission rates, or hospitals with more beds might have more nurses available. However, as I explain in the Empirical Strategy section (Section 3.3), estimations include independent variables and hospital fixed effects that control for both factors are included in the estimations.

3.2. Data and Descriptive Statistics

I used hospital-annual data from 2009 to 2019 to conduct the empirical analysis. Financial data and quality of care indicators at the hospital level come from the Hospital Information System -SIHO[34]. For public hospitals is mandatory to report their financial information and quality of care indicators to the Ministry of Health and Social Protection of Colombia.

Information on the number of healthcare providers per municipality comes from the Special Registry of Providers -REPS-. Additionally, I use the Unique Enrollees Database -which contains information on the population insured in the Colombian health security system and the companies providing the plans. SIHO, REPS, and BDUA are datasets managed by the Ministry of Health and Social Protection of Colombia.

Figure 3.1. Public Hospitals in Colombia 2019



[34] This data is not public. I requested them from the Department of Provision of Services and Primary Care in the Health Ministry. There is a manual that can be consulted online, which describes the content and scope of the datasets (https://prestadores.minsalud.gov.co/siho/ayudas/ManualUsuarioSIHO.pdf).

Professionals of the Ministry of Health and Social Protection in Colombia provided insights about what could be considered an outlier in the data, and a potential error in the information. For example, they aimed that waiting times for emergency care longer than 45 minutes and readmission rates equal to 100% could reflect a mistake in the registration of the information[35]. Therefore, I deleted the observations with a waiting time for emergency care higher than 45 minutes (3% from the original number of observations) and with a readmission rate equal to 100% (0.32% from the original number of observations)[36]. The result of this cleaning process is a dataset with information for 931 public hospitals located throughout almost the entire national territory of Colombia, covering 31 departments (out of 32) and 845 municipalities (out of 1,122) (Figure 3.1).

Table 3.2 shows descriptive statistics for the dependent and independent variables used in the analysis[37]. Comparing hospitals based on their accounts receivable only is inappropriate because hospitals that bill more might have higher accounts receivable. Therefore, the main explanatory variable is the accounts receivable to sales ratio (AR). Notice that the numerator in this ratio, accounts receivable, includes debts over 365 days, while the denominators refer to the billed services provided in a particular year. For this reason, accounts receivable could be higher than the total sales, causing their ratio to be higher than 1.

[35] This was more evident when the number of patients readmitted was high. It is very unlikely that more than one thousand patients would have come back to a hospital after being discharged.
[36] Waiting times for emergency care higher than 45 minutes were observed during the whole study period. Those observations did not exhibit a geographical pattern. Observations with a readmission rate equal to 100% were before 2016 and located mainly in small municipalities of the departments Narino, Santander, and Atlántico. The number of observations varies with the outcome considered.
[37] See the distributions of the main explanatory variable and outcomes in Figures C1 and C2.

Table 3.2. Descriptive Statistics 2009-2019

Variable	Average	Std. Dev.	Min	Max	Observations
Financial Performance indicator					
Accounts receivable to sales ratio	0.40	0.28	0	2.98	10,136
Accounts receivable (million COP of 2020)	7,205	26,425	1	454,099	10,143
Total sales (million COP of 2020)	11,330	27,896	11	426,157	10,140
Quality of care indicators					
Waiting time for getting an appointment with a General Doctor (days)	1.45	1.11	0	12.56	9,538
Waiting time for emergency care (minutes)	13.68	9.83	0	45	8,818
Hospital readmissions rate (%)	1.26	4.89	0	97	8,311
Patient satisfaction rate (%)	90.82	8.99	0	100	9,889
Staffing levels					
Number of General Doctors	6	12.50	0	327	8,932
Number of nurses	3	9.18	0	161	10,143
Controls					
Share of contracts with insurers in the contributory regime	0.08	0.13	0	1	10,143
Outpatient care rooms	10	21.119	0	459	10,143
Examination rooms in the emergency department	2.12	13.89	0	1,375	10,143
Number of beds	34	75.50	0	1,278	10,143
Delivery beds	1	1.46	0	29	10,143
Number of providers in the same municipality where the hospital is located*	74.58	329.21	1	4,126	8,300
Instrument					
Share of contracts with insurers in the subsidized regime	0.78	0.25	0	1	10,143
Market share of Saludcoop in 2010	0.11	0.15	0	0.82	10,143

*Information available since 2011

Between 2007 to 2019 accounts receivable increased faster than sales. AR went from 0.45 in 2007 to 0.76 in 2019 (Figure 3.2). However, most of the quality indicators considered experienced small changes during the same period. The average waiting time for getting an appointment with a general Doctor went from 1.1 days to 1.7 days while the average waiting time for emergency care increased by 4 minutes (Figure 3.3). While the waiting times barely increased, the number of general doctors and nurses expanded. They increased 37% and 33%, respectively. Doctors went from 3,823 to 5,233, while nurses went from 2,163 to 2,868 (Figure 3.4). The hospital readmission and patient satisfaction rates also improved. The first one went from 1.6% to 0.92%, while the second one went from 89.4% to 92.3% (Figure 3.5).

Figure 3.2. Accounts receivable to sales ratio (Real COP of 2020)

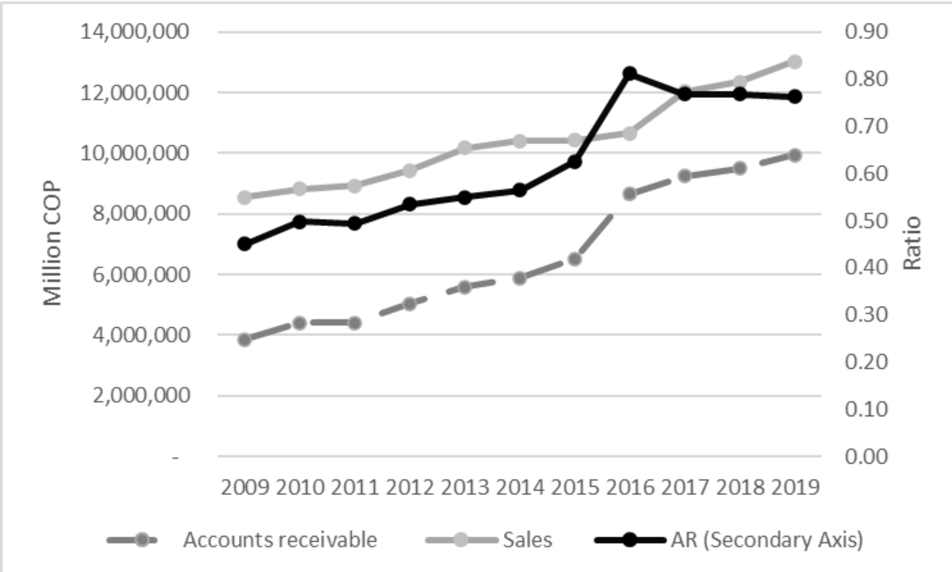
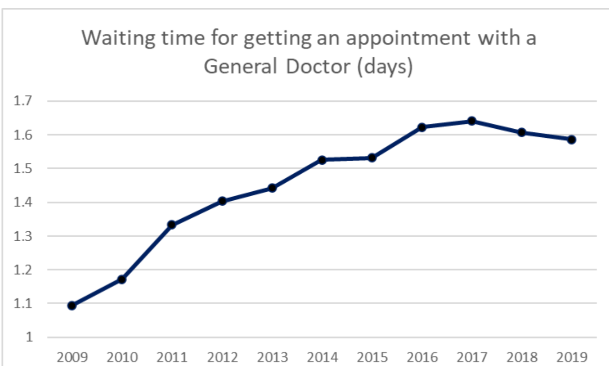


Figure 3.3. Average waiting time to schedule an appointment with a General Doctor (left) and receiving emergency care (right)



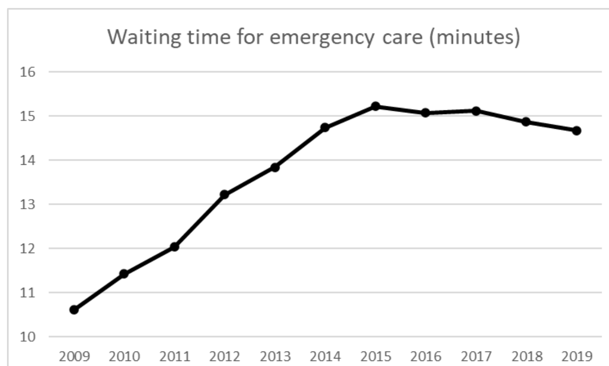
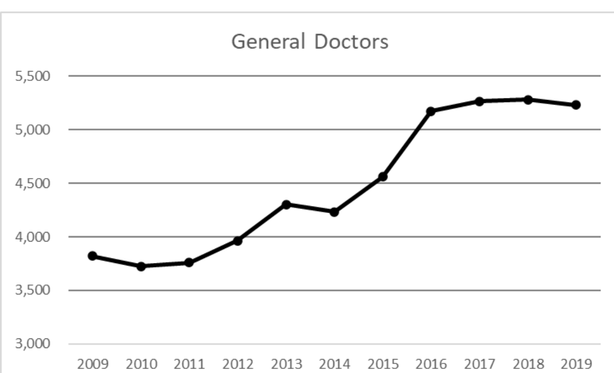


Figure 3.4. Staffing levels: Total number of General Doctors (left) and Nurses (right)



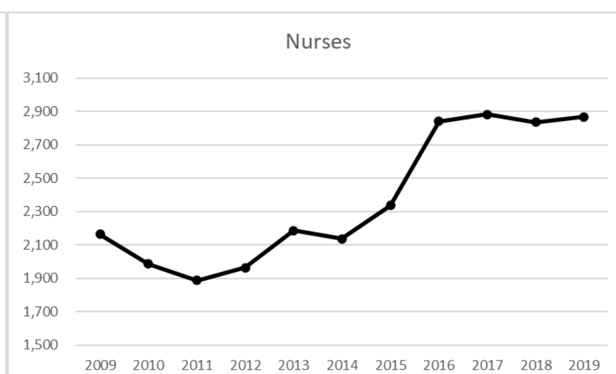
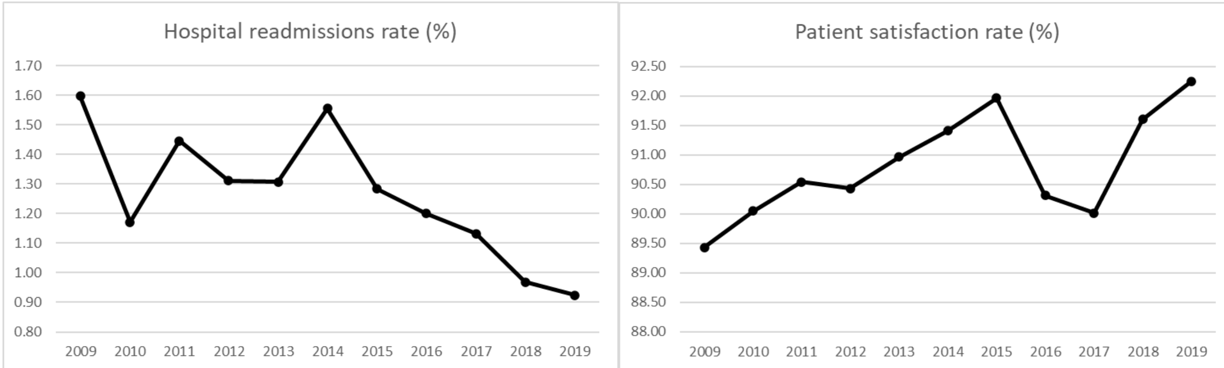


Figure 3.5. Average hospital readmissions rate (left) and patient satisfaction rate (right)



In summary, between 2009 and 2019 public hospitals were providing more services, which translated into pilling accounts receivable. But in general, the quality of care measured in terms of the indicators considered improved. I will explain the empirical strategy used to disentangle this causal relationship in the next section.

3.3. Empirical Strategy

To empirically investigate whether account receivables have an impact on the quality of care in Colombia, I estimate the following model:

$$Quality_{it} = \alpha + \beta ARS_{it} + \gamma X_{it} + \mu_i + \delta_t + \epsilon_{it} \quad (3.1)$$

The dependent variable is one of the six healthcare quality indicators considered for hospital i, at year t (Table 3.1). The main explanatory variable is ARS_{it}, accounts receivable to sales ratio. I applied a log transformation to this one and each dependent variable to ease the interpretation of the results[38]. The estimates for β represent the average effect of one percentage point increase of ARS on the health care quality indicator. The period of study is from 2009 to 2019. Each model is estimated with an unbalanced panel because some hospitals have no measurements for the ARS and the quality indicators in all periods.

Some of the hospital characteristics included in X_{it} control for the hospital size. These are the number of outpatient care rooms, examination rooms in the emergency department, beds, and delivery beds. I also include the share of contracts with insurers in the contributory regime and the share of contracts with insurers in the subsidized regime to control for the type of contractual relationship that

[38] I replaced ARS_{it} and the dependent variables with their natural log transformation: log (1+x).

the hospital has with the two types of health insurance companies in Colombia, as well as hospitals' main payers[39]. Other control variables include μ_i (hospital fixed effects), which accounts for all the time-invariant characteristics of the hospitals, and δ_t, which controls for the time-fixed effects or all the shocks common to the hospitals in the sample[40].

The main challenge in investigating the relationship between financial performance and healthcare quality indicators is that the financial performance indicator, ARS, may be potentially endogenous. Identifying the impact of ARS on quality indicators could be biased if there are unobservable variables that affect the accounts receivables that also affect the quality of care provided by the hospitals. For instance, hospitals that have skilled staff that can quickly collect accounts receivable may also be able to schedule appointments more quickly. Also, current realizations of quality of care will likely affect future contracts, and therefore future financial performance. This is because insurers evaluate hospitals in terms of production goals and quality standards. The contracts might change based on these evaluations and the negotiation between them. Additionally, hospital financial and quality of care data may have missing information and elements subject to measurement error.

I account for the potential endogeneity and measurement error problems using a Bartik-type or shift-share instrumental variable approach (Bartik,1991, Goldsmith-Pinkham et al., 2018, Jaeger et al., 2018, Mckenzie, 2018, Byrne et al., 2021). To construct the instrument, I will exploit the intervention and later liquidation of one of the most important health insurance companies in Colombia, called Saludcoop. In 2011 the Colombian government intervened Saludcoop after allegations were made that funds had been diverted for the benefit of some of its managers. Saludcoop was the health insurance company with the largest number of affiliates in the country and had a presence in all the departments. By that time, around 10% of Colombians (over four million) were insured by it. Saludcoop was liquidated in 2015. The government transferred the population Saludcoop had insured to another insurance company (Fernandez & Suarez, 2019). This process

[39] In Colombia's system of universal health insurance, people participate in one of two regimes depending on income: the Contributory Regime or the Subsidized Regime. Insurance companies in the contributory Regime serve formal sector employees (Miller et al., 2013). Insurance companies in the Subsidized Regime cover the unemployed population or low-income citizens.

[40] Patient characteristics (age, gender) have been included in previous literature that also intends to estimate the relationship between financial performance and quality of care. Unfortunately, I do not observe those variables. However, if the average characteristics of patients have not changed, their correlation with the quality indicators will be captured by the hospital's fixed effects.

might have delayed the payment to the providers with a contractual relationship with Saludcoop. Providers in municipalities where Saludcoop had a higher number of insured would have been more affected. Saludcoop had enrollees in both the subsidized and the contributory regimes. The instrument -I_{it}- is the interaction of three variables (See Equation 3.2, 3.3, and 3.4):

$$I_{it} = \underbrace{S_{2010} * TCVS_{it}}_{\text{Share}} * \underbrace{Post[= 1\ if\ t \geq 2015]}_{\text{Shift}} \qquad (3.2)$$

where:

$$S_{m2010} = \left(\frac{Population\ insured\ by\ Saludcoop_m}{Total\ insured\ population_m}\right)_{2010} \qquad (3.3)$$

$$TVCS_{it} = \left(\frac{Total\ Contract\ Value\ with\ insurers\ in\ the\ subsidized\ regime}{Total\ Contract\ Value}\right)_{it} \qquad (3.4)$$

Ideally, the "share" part of the instrument would be the percentage of contracts with Saludcoop in total contracts by the hospital in 2010. However, I do not observe that. Instead, I construct the "share" part of the instrument with the interaction of two variables. The first variable -S_{2010}- is the share of Saludcoop in the total insured population in municipality *m*, in 2010, which is one year before the Colombian government intervened in this company. Even though the liquidation of the company was announced in 2015, it is possible that as soon as the Saludcoop intervention occurred in 2011, some of its insured chose to move to another insurer. This is why the share of Saludcoop in the total insured population in municipality *m* -S_{2010}- is measured in 2010, before the intervention.

The second variable -$TVCS_{it}$ -is the share of contracts made by public hospital *i* in year *t* with insurers that serve the subsidized population (insurers in the subsidized regime). By law insurers that serve the population with subsidized health insurance must contract at least 60% of their health expenses with public hospitals (Corte Constitucional de Colombia, 2010). Therefore, public hospitals are tied to insurers in the subsidized regimen, which makes hospitals that have a higher percentage of their contracts with the subsidized regime insurers, more vulnerable to their financial performance. If these insurers do well financially, public hospitals contracted by them might have an easier time collecting their payments. $TVCS_{it}$ represent the shift or expansion in subsidized health insurance. It reflects the increase in the subsidized population in the municipality where the hospital is located and of the services provided to this segment of the population.

There might be concerns about the potential bias that could be generated by the fact that I am using the interaction of the market share of Saludcoop at the municipality level in 2010 and the percentage of contracts with the subsidized regimen (in hospital *i* and year *t*), as a proxy for the percentage of contracts with Saludcoop in 2010. With this interaction I am assuming that Saludcoop's participation in the contracts of each hospital is proportional to the participation of the subsidized regimen in the contracts. This implies that hospitals with a higher participation of the subsidized regimen in their sales had more contracts with Saludcoop. If in real life, this assumption did not hold for some of the hospitals in my sample, this could cause a potential biased. However, this potential biased would be present in the first stage of the estimations, and not the second.

The third variable in the instrument, $Post[= 1\ if\ t \geq 2015]$, is capturing the years after Saludcoop was liquidated. The first stage of the estimation is given by:

$$ARS_{it} = \alpha + \theta I_{it} + \gamma X_{it} + \mu_i + \delta_t + \epsilon_{it} \quad (3.5)$$

Goldsmith-Pinkham et al. (2018) and Jaeger et al. (2018) review how the Bartik instruments work and what assumptions should hold for the instrument to be valid. One condition that should be held is that the shift is not serially correlated. Here, the national shift is not serially correlated because the liquidation of Saludcoop was a one-time event. On the other hand, the exclusion restriction in this case requires that the instrument only affects quality indicators through the accounts receivable to sales ratio. I argue that this is the case in this study, because there is no evidence of Saludcoop's liquidation affecting quality of care of public hospitals through a different channel. One of the potential channels through which the instrument could have affected quality is creating a potential demand shock for services in public hospitals: Let´s consider a situation where Saludcoop owned clinics that were competing with the public hospitals in this sample during the study period. If after Saludcoop's liquidation, some of its clinics went out of bussiness too, the population that used to attend those places could have started to demand services (such as appointments with the general doctor) in the public hospitals. If the public hospitals could not cope with the demand shock, it is possible that some of their quality indicators could have been affected. This is not likely to be the case. Although I found that Saludcoop owned some clinics (Fernandez, C., & Suarez, 2019), there was no evidence that they stopped working after or because of Saludcoop's liquidation. Another potential channel for the violation of the exclusion restriction would be that Saludcoop's enrollees transferred to another insurance company that provided better access to health services, creating again a demand shock for public hospitals services. This was not the case, since Saludcoop's enrollees were later transfer to another insurance company of similar quality that faced its own intervention process due to its financial struggles (Fernandez and Suarez, 2019).

There is a first-stage regression for each quality indicator since the number of observations varies for each of those. These regressions measure the strength of the relationship between accounts receivable and Saludcoop's liquidation. The identification strategy requires the instrument to predict the explanatory variable. The first-stage regressions of our main specification confirm that this is the case (Table 3.3). The estimated coefficients indicate a significant positive correlation between the two variables. Accounts receivable increased substantially after Saludcoop's liquidation in hospitals with a higher percentage of contracts with insurers of the subsidized regime, located in municipalities with a stronger presence of Saludcoop. The F-test rules out the possibility of a weak instrument problem. Also, the Kleibergen-Paap LM statistics verify that the models are not underidentified.

Table 3.3. First-stage estimates.

Dependent variable: Accounts receivable to sales ratio

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
$S_{2010} * TCVS_{it} * Post[= 1\ if\ t \geq 2015]$	0.113***	0.117***	0.109***	0.128***	0.118***	0.129***
	(0.0265)	(0.0278)	(0.0288)	(0.0268)	(0.0280)	(0.0266)
Share of contracts with insurers in the subsidized regime	-0.0295***	-0.0246**	-0.0147	-0.00997	-0.0186*	-0.0110
	(0.00988)	(0.00969)	(0.0109)	(0.00989)	(0.0102)	(0.00980)
Share of contracts with insurers in the contributory regime	-0.0495***	-0.0466**	-0.0376*	-0.0416**	-0.0430**	-0.0405**
	(0.0188)	(0.0182)	(0.0193)	(0.0183)	(0.0193)	(0.0180)
Number of beds	-0.000210	0.000112	-1.69e-05	-1.75e-05	-6.25e-05	-5.34e-06
	(0.000165)	(0.000151)	(0.000157)	(0.000142)	(0.000144)	(0.000142)
Outpatient care rooms	7.64e-05	-0.000136	-0.000299	-0.000148	-0.000163	-0.000184
	(0.000262)	(0.000302)	(0.000284)	(0.000252)	(0.000250)	(0.000250)
Examination rooms in the emergency department	5.97e-05***	0.00220	-0.000150	5.96e-05***	5.62e-05***	5.77e-05***
	(7.41e-06)	(0.00257)	(0.00290)	(8.03e-06)	(8.12e-06)	(8.21e-06)
Delivery beds	0.00535	0.00698*	0.00730*	0.00389	0.00429	0.00402
	(0.00389)	(0.00411)	(0.00386)	(0.00385)	(0.00385)	(0.00381)
year=2010	0.0127***	0.0145***	0.0153***	0.0130***	0.0147***	0.0131***
	(0.00337)	(0.00346)	(0.00362)	(0.00329)	(0.00348)	(0.00324)
year=2011	0.0136***	0.0147***	0.0163***	0.0145***	0.0114**	0.0134***
	(0.00432)	(0.00425)	(0.00456)	(0.00418)	(0.00454)	(0.00414)
year=2012	0.0243***	0.0272***	0.0321***	0.0292***	0.0237***	0.0266***
	(0.00448)	(0.00464)	(0.00477)	(0.00446)	(0.00474)	(0.00434)
year=2013	0.0311***	0.0352***	0.0407***	0.0353***	0.0336***	0.0335***
	(0.00510)	(0.00517)	(0.00540)	(0.00506)	(0.00536)	(0.00494)
year=2014	0.0463***	0.0503***	0.0571***	0.0510***	0.0501***	0.0493***
	(0.00560)	(0.00581)	(0.00606)	(0.00554)	(0.00596)	(0.00546)
year=2015	0.0491***	0.0528***	0.0624***	0.0544***	0.0530***	0.0530***
	(0.00603)	(0.00642)	(0.00683)	(0.00602)	(0.00637)	(0.00593)
year=2016	0.0770***	0.0853***	0.0974***	0.0853***	0.0841***	0.0836***
	(0.00628)	(0.00675)	(0.00718)	(0.00638)	(0.00660)	(0.00625)
year=2017	0.0857***	0.0928***	0.108***	0.0954***	0.0934***	0.0930***
	(0.00652)	(0.00697)	(0.00734)	(0.00653)	(0.00680)	(0.00648)
year=2018	0.0953***	0.102***	0.118***	0.105***	0.104***	0.103***
	(0.00699)	(0.00749)	(0.00778)	(0.00692)	(0.00724)	(0.00687)
year=2019	0.0948***	0.105***	0.121***	0.105***	0.103***	0.103***
	(0.00718)	(0.00767)	(0.00800)	(0.00714)	(0.00745)	(0.00707)
Constant	0.277***	0.274***	0.279***	0.269***	0.279***	0.271***
	(0.00975)	(0.0118)	(0.0117)	(0.00990)	(0.0101)	(0.00987)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,535	8,816	8,307	9,883	8,928	10,136
R-squared	0.127	0.146	0.175	0.151	0.144	0.147
Number of hospitals	893	878	843	931	884	931
F statistic	25.02	26.37	28.00	28.85	27.3	28.94
Kleibergen-Paap LM (p-value)	0.000	0.000	0.000	0.000	0.000	0.000

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Note: Columns (1) to (6) present the results for the estimations without missings in each of the quality-of-care indicators. In this order: waiting time for getting an appointment with a General Doctor, waiting time for emergency care, readmission rate, patient satisfaction rate, number of General Doctors, and number of nurses.

3.3.1. Results

I present the OLS estimates in Table 3.4. This shows a negative correlation between the accounts receivable to sales ratio and the number of General Doctors, and no correlation between that ratio and the rest of the quality indicators[41]. On the other hand, Table 3.5 shows the estimated LATE

[41] In most cases, the variables that control for the hospital size are not correlated with the quality-of-care indicators. This might be because the variables that control for the hospital size do not usually undergo important changes much over time and their effects might be absorbed by the fixed effects.

(local average treatment effect) of the accounts receivable ratio on the quality-of-care indicators. In other words, it presents the effects of the receivables for those hospitals affected by the instrument (the ones whose accounts receivable increased because of Saludcoop's liquidation).

Results of the 2SLS estimations show that accounts receivable on sales ratio did not have a significant effect on any of the quality-of-care indicators considered, except for the number of General Doctors and nurses available. For those hospitals whose accounts receivable increased because of Saludcoop's liquidation, the accounts receivable to sales ratio had a positive effect on the number of general doctors and nurses on their staff. Columns (5) and (6) show that an increase of 1% in the accounts receivable to sales ratio increased the number of General Doctors in 34.14% and the number of Nurses in 23.6%.[42]

Notice that the coefficients for these two outcomes were negative in the OLS regressions. The reason for this switch is signs is that while the OLS estimations are likely biased due to the potential endogeneity of the accounts receivable explanatory variable, the 2SLS estimation is correcting this endogeneity through the instrument proposed. Hospitals with liquidity constraints caused by a high accounts receivable to sales ratio might find other sources of funding, and partner with other organizations to get financial support. Also, they could negotiate with the insurance companies to get a higher percentage of their contracts with the capitation payment method. With capitation, hospitals receive their payment at the beginning of each month and would be expected to provide a minimum number of services to the population assigned by the contract. This could increase their demand for general doctors and nurses.

Results suggest that even though public hospitals have faced severe delays in collecting payments they have assigned appointments with General Doctors and provide care for users at the emergency department in acceptable time windows. This implies that public hospitals have been able to count on the necessary staff (medical and administrative) to provide those services. This might indicate that their budget has allowed them to cover their regular expenses, which can include salaries and facilities maintenance costs. Moreover, it is possible that hospitals have had the ability to offset their accounts receivable issues through other sources of revenue (Bazzoli et al, 2008).

[42]These results are robust to dropping the 1% of the observations in the top tale of the distributions of the main explanatory variable and the quality-of-care indicators. See Tables C2 and C3.

Table 3.4. OLS estimations

VARIABLES	(1) Waiting time General Doctor	(2) Waiting time Emergency	(3) Readmissions	(4) Patient satisfaction	(5) General Doctors	(6) Nurses
Accounts receivable to sales ratio	-0.0683	0.417	-0.356	-0.537	-1.165**	0.0625
	(0.0496)	(0.953)	(0.643)	(0.964)	(0.552)	(0.619)
Share of contracts with insurers in the subsidized regime	-0.0468**	-0.442	0.0654	0.456	0.235	0.682*
	(0.0227)	(0.539)	(0.324)	(0.577)	(0.222)	(0.357)
Share of contracts with insurers in the contributory regime	-0.0347	-0.761	0.438	0.632	0.0842	0.378
	(0.0473)	(1.208)	(0.501)	(1.077)	(0.731)	(1.191)
Number of beds	-0.000307	0.00898	0.00116	-0.00121	0.00864	0.0244
	(0.000411)	(0.0107)	(0.00212)	(0.00543)	(0.0119)	(0.0181)
Outpatient care rooms	-0.000635	-0.00919	-0.0152	-0.000332	0.0877*	0.0111
	(0.000599)	(0.0186)	(0.0113)	(0.0106)	(0.0513)	(0.0226)
Examination rooms in the emergency department	4.17e-05**	0.0683	0.0357	-0.0110***	0.000712	-0.000125
	(1.89e-05)	(0.144)	(0.0563)	(0.000554)	(0.000676)	(0.000695)
Delivery beds	0.00353	0.0212	0.0680	-0.172	-0.492	-0.296
	(0.00926)	(0.184)	(0.101)	(0.177)	(0.336)	(0.273)
year=2010	0.0690***	0.863***	-0.411**	0.549	-0.136**	-0.207
	(0.0123)	(0.260)	(0.196)	(0.359)	(0.0601)	(0.158)
year=2011	0.146***	1.301***	-0.152	1.060**	-0.127	-0.377**
	(0.0140)	(0.290)	(0.282)	(0.423)	(0.0824)	(0.159)
year=2012	0.194***	2.397***	-0.219	0.965**	0.111	-0.310*
	(0.0151)	(0.334)	(0.239)	(0.397)	(0.123)	(0.169)
year=2013	0.226***	2.958***	-0.191	1.496***	0.470**	-0.130
	(0.0162)	(0.339)	(0.241)	(0.418)	(0.186)	(0.252)
year=2014	0.268***	3.819***	0.0276	1.982***	0.331**	-0.202
	(0.0166)	(0.364)	(0.302)	(0.424)	(0.149)	(0.200)
year=2015	0.276***	4.318***	-0.233	2.502***	0.735***	-0.00321
	(0.0167)	(0.358)	(0.269)	(0.400)	(0.167)	(0.233)
year=2016	0.270***	3.936***	-0.316	0.875*	1.012***	0.149
	(0.0182)	(0.412)	(0.265)	(0.465)	(0.167)	(0.244)
year=2017	0.280***	3.897***	-0.430	0.621	1.034***	0.162
	(0.0188)	(0.411)	(0.299)	(0.482)	(0.176)	(0.250)
year=2018	0.275***	3.648***	-0.553**	2.219***	1.074***	0.118
	(0.0189)	(0.415)	(0.275)	(0.430)	(0.200)	(0.254)
year=2019	0.279***	3.356***	-0.557**	2.880***	1.005***	0.140
	(0.0194)	(0.408)	(0.269)	(0.443)	(0.204)	(0.272)
Constant	0.675***	11.82***	1.498***	89.50***	5.693***	2.507***
	(0.0289)	(0.740)	(0.270)	(0.635)	(0.514)	(0.639)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,535	8,816	8,307	9,883	8,928	10,136
R-squared	0.094	0.046	0.003	0.014	0.056	0.017
Number of hospitals	893	878	843	931	884	931

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.5. Effects of accounts receivable on health care quality (2SLS estimates)

VARIABLES	(1) Waiting time General Doctor	(2) Waiting time Emergency	(3) Readmissions	(4) Patient satisfaction	(5) General Doctors	(6) Nurses
Accounts receivable to sales ratio	-0.275	-22.03	6.743	0.484	34.14**	23.60*
	(0.694)	(19.12)	(8.606)	(14.01)	(15.66)	(12.25)
Share of contracts with insurers in the subsidized regime	-0.0513*	-0.810	0.107	0.456	0.580	0.711*
	(0.0276)	(0.685)	(0.318)	(0.577)	(0.450)	(0.419)
Share of contracts with insurers in the contributory regime	-0.0441	-1.707	0.673	0.668	1.437	1.203
	(0.0576)	(1.464)	(0.690)	(1.181)	(1.179)	(1.377)
Number of beds	-0.000345	0.0119	0.00122	-0.00122	0.0102	0.0240
	(0.000423)	(0.0121)	(0.00234)	(0.00541)	(0.0126)	(0.0179)
Outpatient care rooms	-0.000613	-0.0117	-0.0131	-0.000216	0.0923*	0.0146
	(0.000609)	(0.0204)	(0.0113)	(0.0107)	(0.0544)	(0.0244)
Examination rooms in the emergency department	5.50e-05	0.132	0.0333	-0.0110***	-0.00145	-0.00162
	(4.79e-05)	(0.170)	(0.0575)	(0.00105)	(0.00103)	(0.00118)
Delivery beds	0.00456	0.172	0.0196	-0.175	-0.635	-0.383
	(0.00977)	(0.257)	(0.115)	(0.182)	(0.389)	(0.290)
year=2010	0.0716***	1.188***	-0.519**	0.536	-0.650**	-0.513**
	(0.0151)	(0.393)	(0.220)	(0.402)	(0.271)	(0.238)
year=2011	0.149***	1.625***	-0.265	1.045**	-0.518**	-0.685***
	(0.0171)	(0.408)	(0.305)	(0.464)	(0.256)	(0.244)
year=2012	0.199***	2.994***	-0.442	0.935*	-0.705*	-0.923**
	(0.0223)	(0.624)	(0.353)	(0.559)	(0.415)	(0.376)
year=2013	0.233***	3.723***	-0.470	1.461**	-0.681	-0.893**
	(0.0268)	(0.745)	(0.390)	(0.627)	(0.538)	(0.422)
year=2014	0.277***	4.923***	-0.369	1.931**	-1.402*	-1.338**
	(0.0363)	(1.011)	(0.531)	(0.817)	(0.798)	(0.649)
year=2015	0.288***	5.700***	-0.741	2.437**	-1.453	-1.481*
	(0.0438)	(1.223)	(0.675)	(0.987)	(0.970)	(0.757)
year=2016	0.288***	6.048***	-1.070	0.778	-2.267	-2.046*
	(0.0620)	(1.822)	(0.964)	(1.411)	(1.432)	(1.059)
year=2017	0.300***	6.178***	-1.260	0.514	-2.577	-2.256*
	(0.0687)	(1.948)	(1.001)	(1.580)	(1.597)	(1.168)
year=2018	0.296***	6.136***	-1.456	2.102	-2.926*	-2.528**
	(0.0753)	(2.139)	(1.163)	(1.676)	(1.734)	(1.281)
year=2019	0.301***	5.924***	-1.481	2.763*	-2.940*	-2.517**
	(0.0749)	(2.195)	(1.158)	(1.679)	(1.724)	(1.283)
Constant	0.731***	17.79***	-0.433	89.23***	-3.892	-3.687
	(0.190)	(5.208)	(2.360)	(3.713)	(4.273)	(3.429)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,535	8,816	8,307	9,883	8,928	10,136
Number of hospitals	893	878	843	931	884	931

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Another factor that could help explain the results is the predominant payment mechanism in the sample. In half of the observations, the share of the capitated contracts in the total contracts was higher than 0.91. With capitated contracts, hospitals receive payment in advance, which could have allowed them to pay salaries and have enough staff to meet their demand for general practitioner appointments and emergency care. Although it is documented in the literature that capitation payments imply a risk transfer to providers that may contribute to lower quality (Castaño, 2014), in Colombia, there is evidence that capitation contracts are associated with lower rates of return to the emergency room and with lower relapse rates than fee-for-service contracts (Carranza et al., 2015). Therefore, results in this paper might suggest that the potential negative effects of capitation on quality are being offset by its benefits through providing financial liquidity to the public hospitals.

On the other hand, even if a low receivables turnover leads to an increase in their liabilities (such as salaries), healthcare professionals (and other members of the staff) may not quit their jobs because of relocation costs. Therefore, they wait for the hospitals to pay them and continue offering their services. A final factor to consider is that in Colombia there is a mandatory social service program for doctors who have recently graduated in medicine. In this program, they are assigned to provide their services for one year in rural and difficult-to-access areas. Through this program, the State helps guarantee the supply of health services in dispersed or dangerous areas, where doctors would not normally work.

3.3.2. The role of competition

Previous literature also included a measure that assesses whether a hospital has nearby competitors as a control variable in estimations that assess the relationship between financial performance and quality of care. I have access to a variable that measures how many other healthcare providers (public and private) are in each Colombian municipality. I did not observe this variable for the whole period of study (2009-2019), but for 2011-2019. Notice that private providers are mostly located in the capitals of the country (Figure 3.6). According to Table 3.6, hospitals without competition (hospitals in municipalities where there is no other provider), exhibit smaller waiting times to get an appointment with a General Doctor and emergency care, higher patient satisfaction rates, and have a smaller number of General Doctors and nurses, with respect to hospitals located in municipalities with more than one provider. Moreover, the difference in readmission rates is not statistically significant (Table 3.6). The first stage and 2SLS estimations results are very similar to the ones with the whole sample (Table C4 and Table 3.7). 2SLS estimations results show that the accounts receivable to sales ratio have a positive effect on the number of general doctors and nurses, after controlling for competition.

Figure 3.6. Private providers in Colombia 2019

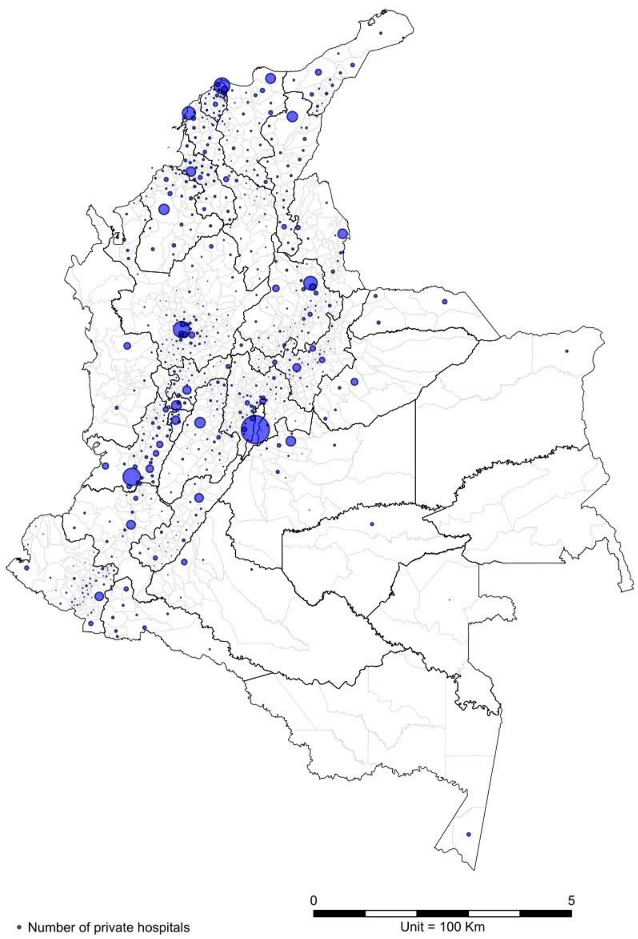


Table 3.6. Two-sample t test with equal variances 2011-2019

Variable		Mean	Std. Dev.	Observations
Accounts receivable to sales ratio	Without competition	0.33	0.206	1,968
	With competition	0.44	0.305	6,325
	t	-15.717		
	p-value	0.000		
Waiting time for getting an appointment with a General Doctor (days)	Without competition	1.26	0.743	1,966
	With competition	1.61	1.161	5,831
	t	-12.694		
	p-value	0.000		
Waiting time for emergency care (minutes)	Without competition	9.90	7.258	1,500
	With competition	15.45	9.948	5,669
	t	-20.228		
	p-value	0.000		
Hospital readmissions rate (%)	Without competition	1.35	5.942	1,321
	With competition	1.20	4.793	5,470
	t	0.963		
	p-value	0.335		
Patient satisfaction rate (%)	Without competition	91.95	8.467	1,922
	With competition	90.78	8.977	6,210
	t	5.046		
	p-value	0.000		
Number of General Doctors	Without competition	2.30	1.579	1,723
	With competition	6.75	14.802	5,606
	t	-12.457		
	p-value	0.000		
Number of nurses	Without competition	0.61	0.633	1,968
	With competition	3.28	10.869	6,332
	t	-10.873		
	p-value	0.000		

Table 3.7. 2SLS estimates controlling for competition (2011-2019)

VARIABLES	(1) Waiting time General Doctor	(2) Waiting time Emergency	(3) Readmissions	(4) Patient satisfaction	(5) General Doctors	(6) Nurses
Accounts receivable to sales ratio	0.362	-26.64	15.11	-11.68	29.12*	21.96*
	(0.679)	(21.27)	(11.40)	(15.48)	(15.77)	(11.76)
Share of contracts with insurers in the subsidized regime	-0.0156	-1.135	0.427	0.221	0.675	0.595
	(0.0299)	(0.874)	(0.445)	(0.695)	(0.515)	(0.383)
Share of contracts with insurers in the contributory regim	0.0140	-1.788	0.891	0.599	1.199	0.447
	(0.0544)	(1.541)	(0.920)	(1.340)	(1.184)	(1.249)
Number of beds	-7.84e-05	0.00313	0.00220	-0.00221	0.00916	0.0252
	(0.000369)	(0.0127)	(0.00339)	(0.00709)	(0.0122)	(0.0172)
Outpatient care rooms	0.000339	0.000326	-0.00289	-0.0143	0.0743	0.0114
	(0.000686)	(0.0243)	(0.00812)	(0.0110)	(0.0485)	(0.0202)
Examination rooms in the emergency department	-1.05e-05	0.199	0.0160	-0.0105***	-0.00211*	-0.00192
	(5.47e-05)	(0.209)	(0.0698)	(0.00123)	(0.00122)	(0.00124)
Delivery beds	0.00122	-0.0103	-0.0417	-0.0986	-0.468	-0.344
	(0.00861)	(0.240)	(0.121)	(0.212)	(0.336)	(0.316)
Number of providers in the same municipality	-0.000517	-0.00320	-0.00290	0.00810**	0.0121	0.00728
	(0.000354)	(0.00756)	(0.00229)	(0.00344)	(0.00779)	(0.00579)
year=2012	0.0426***	1.432***	-0.314	0.0379	-0.187	-0.242
	(0.0130)	(0.364)	(0.308)	(0.412)	(0.241)	(0.186)
year=2013	0.0724***	2.251***	-0.430	0.609	-0.141	-0.216
	(0.0176)	(0.522)	(0.375)	(0.488)	(0.399)	(0.258)
year=2014	0.108***	3.544***	-0.458	1.276*	-0.811	-0.661
	(0.0269)	(0.814)	(0.535)	(0.678)	(0.634)	(0.475)
year=2015	0.113***	4.386***	-0.959	1.912**	-0.827	-0.809
	(0.0340)	(1.043)	(0.710)	(0.856)	(0.801)	(0.587)
year=2016	0.0958*	4.869***	-1.576	0.619	-1.517	-1.350
	(0.0519)	(1.702)	(1.100)	(1.320)	(1.253)	(0.878)
year=2017	0.103*	5.012***	-1.821	0.437	-1.792	-1.562
	(0.0582)	(1.829)	(1.160)	(1.484)	(1.408)	(0.982)
year=2018	0.0928	5.071**	-2.096	2.133	-2.113	-1.835*
	(0.0643)	(2.049)	(1.344)	(1.598)	(1.554)	(1.097)
year=2019	0.0990	4.855**	-2.155	2.760*	-2.170	-1.842*
	(0.0642)	(2.102)	(1.346)	(1.596)	(1.535)	(1.101)
Constant	0.688***	21.51***	-3.169	93.38***	-3.771	-4.248
	(0.204)	(6.303)	(3.398)	(4.413)	(4.642)	(3.653)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	7,794	7,167	6,787	8,126	7,325	8,293
Number of hospitals	888	869	833	931	877	931

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3.3.3. Failure to pay staff

It is possible that hospitals with higher accounts receivable find it harder to pay their staff. Delaying the payment to clinical and administrative staff could be one of the hospital responses to the funding pressures (Robertson et al., 2017). In Colombia, it is very often seeing in the news that hospitals delay the payment of the salaries, which sometimes cause the staff to protest and cease working. To test this hypothesis, I have considered as another outcome an indicator of failure to pay staff, which is calculated as the ratio between the unpaid wages and the total payroll of the hospital. Table 3.8 shows descriptives statistics for this variable[43]. OLS estimations show a positive correlation between the accounts receivable to sales ratio and failure to pay for public hospitals in Colombia (Table 3.9). The first stage is still valid when using the sample with observations without missing in

[43] See the histogram of the distribution of this variable in Figure C3.

this variable (Table C5). However, the 2SLS estimations show that the accounts receivable to sales ratio did not influence the failure to pay staff in those hospitals affected by the instrument (Table 3.10).

Table 3.8. Failure to pay staff (Descriptive statistics)

Variable	Average	Std. Dev.	Min	Max	Observations
Failure to pay staff= Unpaid wages to total payroll ratio	0.10	0.16	0	4	10,143
Unpaid wages (in million COP of 2020)	607	3,638	0	181,938	10,143
Total payroll (in million COP of 2020)	6,389	15,503	168	255,284	10,143

Table 3.9. Failure to pay staff (OLS estimates)

VARIABLES	Failure to pay
Accounts receivable to sales ratio	0.0918***
	(0.0133)
Share of contracts with insurers in the subsidized regime	0.00263
	(0.00588)
Share of contracts with insurers in the contributory regime	-0.0186*
	(0.0113)
Number of beds	-0.000144
	(0.000175)
Outpatient care rooms	5.84e-05
	(0.000249)
Examination rooms in the emergency department	1.05e-05
	(1.04e-05)
Delivery beds	-0.00167
	(0.00261)
year=2010	-0.00338*
	(0.00199)
year=2011	-0.00149
	(0.00260)
year=2012	-0.00174
	(0.00296)
year=2013	-0.0130***
	(0.00306)
year=2014	-0.0214***
	(0.00344)
year=2015	-0.0207***
	(0.00378)
year=2016	-0.0158***
	(0.00415)
year=2017	0.0128***
	(0.00451)
year=2018	0.0120***
	(0.00459)
year=2019	0.0143***
	(0.00506)
Constant	0.0639***
	(0.00734)
Year FE	yes
Hospital FE	yes
Observations	10,136
R-squared	0.062
Number of hospitals	931

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.10. Failure to pay staff (2SLS estimates)

VARIABLES	Failure to pay
Accounts receivable to sales ratio	0.0178
	(0.141)
Share of contracts with insurers in the subsidized regime	0.00254
	(0.00598)
Share of contracts with insurers in the contributory regime	-0.0212
	(0.0134)
Number of beds	-0.000143
	(0.000174)
Outpatient care rooms	4.75e-05
	(0.000254)
Examination rooms in the emergency department	1.52e-05
	(1.28e-05)
Delivery beds	-0.00140
	(0.00266)
year=2010	-0.00242
	(0.00269)
year=2011	-0.000525
	(0.00310)
year=2012	0.000188
	(0.00473)
year=2013	-0.0106*
	(0.00572)
year=2014	-0.0178**
	(0.00810)
year=2015	-0.0161
	(0.0103)
year=2016	-0.00887
	(0.0145)
year=2017	0.0204
	(0.0158)
year=2018	0.0203
	(0.0173)
year=2019	0.0227
	(0.0174)
Constant	0.0834**
	(0.0375)
Year FE	yes
Hospital FE	yes
Observations	10,136
Number of hospitals	931

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

I will now turn my attention to robustness checks that involve alternative definitions of liquidity, and I evaluate the relationship between those variables and the same quality of care indicators considered above. In section 3.3.4, I consider the percentage of accounts receivable past due over 360 days, as a measure of the values of receivables that the hospital might find harder to collect or does not expect to collect at all; while in section 3.3.5, I look at other liquidity indicators broadly used in the literature that analyze financial performance, such as, the percentage of assets in cash, the current liquidity ratio and the cash ratio.

3.3.4. The delay length (Over 360 days past due accounts receivable)

As I mentioned, accounts receivable (AR) in year *t* include debts for services that the hospitals provided the same year and debts for services that were provided more than one year ago. In this section, I evaluate the relationship between the quality-of-care indicators considered and the percentage of accounts receivable past due over 360 days, calculated as in Equation (3.6). I present the summary statistics for these variables in Table 3.11.

$$\text{Percentage of AR over 360 days}_{it} = \frac{\text{Over 360 AR}}{Total\ AR} * 100 \quad (3.6)$$

Table 3.11. Percentage of accounts receivable past due over 360 days (Descriptive Statistics)[44]

Variable	Average	Std. Dev.	Min	Max	Observations
Percentage of accounts receivable over 360 days %	36	22	0	100	10,143
Accounts receivable over 360 days (in million COP of 2020)	3,139	13,186	0	251,664	10,143

I estimated Equation (3.1) using as the main explanatory variable the percentage of accounts receivable past due over 360 days, instead of the accounts receivable to sales ratio. The results are presented in Table 3.12. According to the OLS estimations, a higher percentage of accounts receivable past due over 360 days is associated with a higher readmission rate, a lower patient satisfaction rate, and a lower number of General Doctors. These results suggest that long-term accounts receivable might be negatively affecting the quality of care. I estimated Equation (3.5) using the percentage of accounts receivable past due over 360 days as the dependent variable. Results show that the instrument in Equation (3.2) is not statistically significant in the first stage regression (Table C6), implying that the 2SLS estimates are likely to be biased. Therefore, I would not be able to make a causal inference.

[44] See the histogram of the distribution of this variable in Figure C4.

Table 3.12. Over 360 days accounts receivable (OLS estimates)

VARIABLES	(1) Waiting time General Doctor	(2) Waiting time Emergency	(3) Readmissions	(4) Patient satisfaction	(5) General Doctors	(6) Nurses
Percentage of accounts receivable over 360 days	0.000173	0.00936	0.00964*	-0.0172***	-0.00648*	-0.00404
	(0.000246)	(0.00574)	(0.00570)	(0.00631)	(0.00381)	(0.00270)
Share of contracts with insurers in the subsidized regime	-0.0472**	-0.456	0.0722	0.462	0.221	0.666*
	(0.0227)	(0.539)	(0.325)	(0.577)	(0.223)	(0.354)
Share of contracts with insurers in the contributory regime	-0.0317	-0.740	0.496	0.568	0.0890	0.342
	(0.0473)	(1.206)	(0.507)	(1.069)	(0.731)	(1.198)
Number of beds	-0.000271	0.00972	0.00140	-0.00224	0.00787	0.0239
	(0.000411)	(0.0108)	(0.00209)	(0.00537)	(0.0119)	(0.0179)
Outpatient care rooms	-0.000662	-0.00871	-0.0140	-0.00205	0.0919*	0.0112
	(0.000589)	(0.0186)	(0.0110)	(0.0107)	(0.0501)	(0.0221)
Examination rooms in the emergency department	3.61e-05*	0.0689	0.0364	-0.0109***	0.000682	-8.80e-05
	(1.90e-05)	(0.144)	(0.0561)	(0.000549)	(0.000670)	(0.000691)
Delivery beds	0.00281	0.0176	0.0567	-0.155	-0.483	-0.288
	(0.00929)	(0.183)	(0.101)	(0.177)	(0.336)	(0.271)
year=2010	0.0676***	0.841***	-0.443**	0.598*	-0.135**	-0.193
	(0.0122)	(0.262)	(0.194)	(0.359)	(0.0629)	(0.158)
year=2011	0.144***	1.214***	-0.248	1.226***	-0.0747	-0.331**
	(0.0143)	(0.296)	(0.279)	(0.424)	(0.0985)	(0.163)
year=2012	0.189***	2.268***	-0.368	1.223***	0.182	-0.245
	(0.0157)	(0.347)	(0.231)	(0.404)	(0.151)	(0.177)
year=2013	0.221***	2.818***	-0.351	1.782***	0.541**	-0.0552
	(0.0168)	(0.354)	(0.248)	(0.426)	(0.210)	(0.278)
year=2014	0.261***	3.672***	-0.162	2.291***	0.399**	-0.119
	(0.0173)	(0.385)	(0.300)	(0.438)	(0.170)	(0.218)
year=2015	0.268***	4.157***	-0.444*	2.824***	0.795***	0.0872
	(0.0174)	(0.382)	(0.263)	(0.414)	(0.192)	(0.272)
year=2016	0.259***	3.727***	-0.594**	1.282***	1.093***	0.266
	(0.0190)	(0.438)	(0.286)	(0.471)	(0.204)	(0.307)
year=2017	0.270***	3.715***	-0.701**	1.003**	1.064***	0.272
	(0.0194)	(0.437)	(0.315)	(0.489)	(0.211)	(0.314)
year=2018	0.263***	3.434***	-0.869***	2.668***	1.117***	0.248
	(0.0197)	(0.453)	(0.316)	(0.445)	(0.237)	(0.327)
year=2019	0.267***	3.142***	-0.873***	3.333***	1.052***	0.272
	(0.0202)	(0.437)	(0.302)	(0.465)	(0.241)	(0.342)
Constant	0.655***	11.74***	1.193***	89.70***	5.500***	2.621***
	(0.0261)	(0.692)	(0.356)	(0.579)	(0.503)	(0.547)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,538	8,818	8,311	9,889	8,932	10,143
R-squared	0.094	0.046	0.004	0.015	0.058	0.017
Number of hospitals	893	878	843	931	884	931

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3.3.5. Percentage of assets in cash, current liquidity ratio, and cash ratio.

In this section, I analyze the relationship between the accounts receivable to sales ratio, a liquidity indicator, and other indicators of liquidity. Also, I evaluate the relationship between these ones and the quality-of-care indicators. I consider three additional liquidity indicators broadly used in the literature: percentage of cash in assets, current liquidity ratio, and cash ratio (Batrancea, 2021; Upadhyay & Smith, 2016; Bem et., 2014; Richards & Laughlin, 1980). I present the summary statistics for these variables in Table 3.13. They are calculated based on three variables: cash, assets, and liabilities, as in the following equations:

$$\text{Percentage of assets in cash (\%)} = \frac{Cash}{Assets} * 100 \qquad (3.7)$$

$$\text{Current liquidity ratio} = \frac{Assets}{Liabilities} \qquad (3.8)$$

$$\text{Cash ratio} = \frac{Cash}{Liabitlities} \qquad (3.9)$$

Table 3.13. Alternative Liquidity Indicators (Descriptive Statistics)[45]

Variable	Average	Std. Dev.	Min	Max	Observations
Liquidity (%) =(Cash/Assets)*100	6	8.04	0.00	77.44	10,142
Cash (million COP of 2020)	1,103	5,124	0.00	174,469	10,142
Assets (million COP of 2020)	15,827	49,473	68.64	941,838	10,141
Current liquidity ratio = (Assets/Liabilities)	82	5,116	0.15	512,038	10,082
Liabilities (million COP of 2020)	4,063	15,015	0.00	359,925	10,097
Cash ratio=(Cash/Liabilities)	17	1,373	0.00	137,609	10,083

I estimated Equation (3.1) using cash, liabilities, and cash ratio as the dependent variables. Notice that accounts receivable is part of the hospital assets. Therefore, assets should not be on both the left and the right side of the estimation equation. According to the results, a higher accounts receivable to sales ratio is associated with lower cash, higher liabilities, and a lower cash ratio (Table 3.14).

To evaluate the correlation between the alternative liquidity indicators (Eq. 3.7 to 3.9) and the quality of care, I estimated Equation (3.1) using each of the liquidity indicators as the main

[45] See the histograms of the distributions of these variables in Figure C5.

explanatory variable (instead of ARS). Results show that, first, the higher the percentage of assets in cash the lower the waiting time for getting an appointment with a General Doctor (Table 3.15). Second, the current liquidity ratio is positively correlated with patient satisfaction and negatively correlated with the number of General Doctors available (Table 3.16). Third, hospitals with better cash ratio also exhibit longer waiting times for emergency care (Table 3.17).

Table 3.14. Accounts receivable and other financial indicators (OLS estimates)

VARIABLES	(1) Cash	(2) Liabilities	(3) Cash ratio
Accounts receivable to sales ratio	-0.580**	1.853***	-0.718***
	(0.261)	(0.142)	(0.0783)
Share of contracts with insurers in the subsidized regime	0.127	0.0208	0.0393
	(0.116)	(0.0636)	(0.0351)
Share of contracts with insurers in the contributory regime	-0.246	0.102	-0.105
	(0.204)	(0.132)	(0.0795)
Number of beds	-0.00146	0.00256***	-0.00128**
	(0.00123)	(0.000938)	(0.000512)
Outpatient care rooms	0.000553	-0.00226	0.00196**
	(0.00251)	(0.00168)	(0.000887)
Examination rooms in the emergency department	-0.000549***	0.00116***	-0.00159***
	(9.60e-05)	(0.000144)	(5.66e-05)
Delivery beds	0.0821*	-0.0428	0.0297
	(0.0445)	(0.0273)	(0.0189)
year=2010	0.130*	0.167***	0.0266
	(0.0772)	(0.0425)	(0.0203)
year=2011	-0.0711	0.215***	-0.00174
	(0.0801)	(0.0455)	(0.0211)
year=2012	-0.0441	0.304***	-0.0196
	(0.0994)	(0.0459)	(0.0200)
year=2013	0.442***	0.239***	0.142***
	(0.104)	(0.0500)	(0.0265)
year=2014	0.466***	0.132**	0.186***
	(0.102)	(0.0536)	(0.0292)
year=2015	0.341***	0.180***	0.146***
	(0.106)	(0.0569)	(0.0288)
year=2016	0.403***	0.243***	0.0759**
	(0.0924)	(0.0712)	(0.0310)
year=2017	0.953***	0.431***	0.105***
	(0.0892)	(0.0669)	(0.0307)
year=2018	0.934***	0.381***	0.144***
	(0.0914)	(0.0738)	(0.0331)
year=2019	0.967***	0.479***	0.150***
	(0.0943)	(0.0687)	(0.0343)
Constant	17.86***	19.27***	0.555***
	(0.138)	(0.0882)	(0.0423)
Year FE	yes	yes	yes
Hospital FE	yes	yes	yes
Observations	10,134	10,089	10,074
R-squared	0.039	0.077	0.031
Number of hospitals	931	931	931

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.15. Percentage of assets in cash and quality of care (OLS estimates)

VARIABLES	(1) Waiting time General Doctor	(2) Waiting time Emergency	(3) Readmissions	(4) Patient satisfaction	(5) General Doctors	(6) Nurses
(Cash/Assets)*100	-0.00152***	-0.0106	0.00449	0.00364	0.00268	-0.00967
	(0.000504)	(0.0142)	(0.00788)	(0.0135)	(0.0105)	(0.00736)
Share of contracts with insurers in the subsidized regime	-0.0461**	-0.443	0.0654	0.453	0.218	0.669*
	(0.0227)	(0.538)	(0.324)	(0.575)	(0.223)	(0.355)
Share of contracts with insurers in the contributory regime	-0.0314	-0.783	0.435	0.644	0.118	0.360
	(0.0472)	(1.208)	(0.506)	(1.076)	(0.734)	(1.196)
Number of beds	-0.000301	0.00921	0.00123	-0.00161	0.00811	0.0239
	(0.000417)	(0.0107)	(0.00206)	(0.00535)	(0.0120)	(0.0179)
Outpatient care rooms	-0.000649	-0.00902	-0.0147	-0.00144	0.0921*	0.0115
	(0.000584)	(0.0186)	(0.0111)	(0.0106)	(0.0504)	(0.0222)
Examination rooms in the emergency department	1.55e-05	0.0663	0.0358	-0.0109***	0.000683	-0.000249
	(2.06e-05)	(0.144)	(0.0563)	(0.000582)	(0.000667)	(0.000660)
Delivery beds	0.00294	0.0186	0.0659	-0.168	-0.487	-0.290
	(0.00937)	(0.184)	(0.101)	(0.176)	(0.338)	(0.271)
year=2010	0.0682***	0.871***	-0.417**	0.542	-0.153**	-0.204
	(0.0122)	(0.260)	(0.194)	(0.360)	(0.0599)	(0.158)
year=2011	0.144***	1.297***	-0.154	1.055**	-0.135*	-0.382**
	(0.0140)	(0.290)	(0.278)	(0.422)	(0.0818)	(0.160)
year=2012	0.190***	2.398***	-0.226	0.955**	0.0881	-0.318*
	(0.0151)	(0.333)	(0.231)	(0.395)	(0.125)	(0.170)
year=2013	0.226***	2.981***	-0.209	1.477***	0.431**	-0.115
	(0.0160)	(0.339)	(0.237)	(0.417)	(0.187)	(0.254)
year=2014	0.265***	3.846***	0.00454	1.956***	0.274*	-0.190
	(0.0163)	(0.361)	(0.293)	(0.423)	(0.145)	(0.202)
year=2015	0.271***	4.337***	-0.256	2.473***	0.663***	-0.000615
	(0.0165)	(0.355)	(0.252)	(0.397)	(0.159)	(0.242)
year=2016	0.261***	3.941***	-0.345	0.838*	0.929***	0.145
	(0.0176)	(0.410)	(0.245)	(0.453)	(0.155)	(0.260)
year=2017	0.273***	3.932***	-0.471*	0.573	0.907***	0.167
	(0.0182)	(0.408)	(0.274)	(0.469)	(0.168)	(0.268)
year=2018	0.267***	3.686***	-0.597**	2.175***	0.934***	0.126
	(0.0181)	(0.406)	(0.244)	(0.419)	(0.183)	(0.272)
year=2019	0.271***	3.394***	-0.595**	2.843***	0.867***	0.153
	(0.0186)	(0.399)	(0.239)	(0.436)	(0.198)	(0.289)
Constant	0.669***	12.01***	1.363***	89.35***	5.350***	2.617***
	(0.0262)	(0.701)	(0.312)	(0.552)	(0.504)	(0.523)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,536	8,816	8,310	9,887	8,930	10,141
R-squared	0.094	0.046	0.003	0.014	0.057	0.017
Number of hospitals	893	878	843	931	884	931

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.16. Current liquidity ratio and quality of care (OLS estimates)

VARIABLES	(1) Waiting time General Doctor	(2) Waiting time Emergency	(3) Readmissions	(4) Patient satisfaction	(5) General Doctors	(6) Nurses
Current liquidity ratio = (Assets/Liabilities)	0.00451	0.0148	0.0319	0.460***	-0.108***	-0.0501
	(0.00536)	(0.131)	(0.0842)	(0.139)	(0.0399)	(0.0362)
Share of contracts with insurers in the subsidized regime	-0.0460**	-0.483	0.0648	0.468	0.224	0.675*
	(0.0226)	(0.540)	(0.325)	(0.576)	(0.223)	(0.354)
Share of contracts with insurers in the contributory regime	-0.0216	-0.764	0.458	0.544	0.121	0.358
	(0.0473)	(1.227)	(0.514)	(1.079)	(0.735)	(1.216)
Number of beds	-0.000266	0.00990	0.00122	-0.00106	0.00799	0.0240
	(0.000411)	(0.0108)	(0.00207)	(0.00529)	(0.0119)	(0.0179)
Outpatient care rooms	-0.000683	-0.00934	-0.0147	-0.00246	0.0925*	0.0115
	(0.000588)	(0.0187)	(0.0111)	(0.0104)	(0.0503)	(0.0222)
Examination rooms in the emergency department	4.17e-05**	0.0645	0.0356	-0.0104***	0.000511	-0.000173
	(2.03e-05)	(0.145)	(0.0561)	(0.000594)	(0.000670)	(0.000695)
Delivery beds	0.00250	0.00998	0.0634	-0.207	-0.482	-0.289
	(0.00930)	(0.184)	(0.101)	(0.175)	(0.339)	(0.272)
year=2010	0.0673***	0.881***	-0.417**	0.516	-0.149**	-0.212
	(0.0123)	(0.262)	(0.196)	(0.362)	(0.0604)	(0.159)
year=2011	0.147***	1.299***	-0.160	0.999**	-0.137*	-0.377**
	(0.0141)	(0.292)	(0.282)	(0.425)	(0.0831)	(0.159)
year=2012	0.192***	2.405***	-0.232	0.936**	0.0857	-0.310*
	(0.0152)	(0.335)	(0.233)	(0.397)	(0.125)	(0.169)
year=2013	0.224***	2.989***	-0.210	1.408***	0.451**	-0.120
	(0.0161)	(0.341)	(0.236)	(0.418)	(0.184)	(0.257)
year=2014	0.263***	3.843***	-1.72e-05	1.801***	0.306**	-0.185
	(0.0165)	(0.365)	(0.294)	(0.424)	(0.146)	(0.205)
year=2015	0.269***	4.311***	-0.288	2.303***	0.699***	0.0179
	(0.0166)	(0.355)	(0.254)	(0.399)	(0.165)	(0.246)
year=2016	0.264***	3.943***	-0.358	0.755*	0.958***	0.172
	(0.0177)	(0.409)	(0.245)	(0.453)	(0.159)	(0.266)
year=2017	0.272***	3.925***	-0.477*	0.476	0.929***	0.180
	(0.0183)	(0.408)	(0.275)	(0.471)	(0.171)	(0.273)
year=2018	0.265***	3.705***	-0.604**	2.035***	0.965***	0.143
	(0.0183)	(0.408)	(0.243)	(0.423)	(0.186)	(0.277)
year=2019	0.270***	3.395***	-0.606**	2.692***	0.899***	0.170
	(0.0187)	(0.400)	(0.241)	(0.438)	(0.200)	(0.293)
Constant	0.649***	11.94***	1.342***	88.54***	5.585***	2.641***
	(0.0274)	(0.741)	(0.351)	(0.599)	(0.488)	(0.548)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,475	8,780	8,275	9,827	8,878	10,080
R-squared	0.093	0.045	0.003	0.016	0.058	0.017
Number of hospitals	893	878	843	931	884	931

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.17. Cash ratio and quality of care (OLS estimates)

VARIABLES	(1) Waiting time General Doctor	(2) Waiting time Emergency	(3) Readmissions	(4) Patient satisfaction	(5) General Doctors	(6) Nurses
Cash ratio=(Cash/Liabilities)	-3.68e-06	0.000847*	-2.27e-05	0.000774	4.69e-05	-1.50e-05
	(1.17e-05)	(0.000492)	(6.08e-05)	(0.000528)	(4.21e-05)	(4.53e-05)
Share of contracts with insurers in the subsidized regime	-0.0468**	-0.476	0.0646	0.469	0.220	0.666*
	(0.0226)	(0.539)	(0.325)	(0.575)	(0.223)	(0.354)
Share of contracts with insurers in the contributory regime	-0.0220	-0.760	0.457	0.545	0.120	0.354
	(0.0473)	(1.227)	(0.513)	(1.081)	(0.735)	(1.215)
Number of beds	-0.000273	0.00985	0.00120	-0.00156	0.00809	0.0241
	(0.000413)	(0.0107)	(0.00208)	(0.00535)	(0.0119)	(0.0179)
Outpatient care rooms	-0.000669	-0.00933	-0.0146	-0.00107	0.0922*	0.0113
	(0.000588)	(0.0187)	(0.0111)	(0.0106)	(0.0503)	(0.0222)
Examination rooms in the emergency department	3.60e-05*	0.0647	0.0353	-0.0110***	0.000646	-0.000112
	(1.93e-05)	(0.144)	(0.0561)	(0.000550)	(0.000667)	(0.000688)
Delivery beds	0.00274	0.0113	0.0649	-0.183	-0.488	-0.292
	(0.00930)	(0.184)	(0.101)	(0.176)	(0.338)	(0.272)
year=2010	0.0676***	0.868***	-0.418**	0.494	-0.148**	-0.206
	(0.0123)	(0.262)	(0.196)	(0.363)	(0.0602)	(0.159)
year=2011	0.147***	1.298***	-0.161	0.992**	-0.138*	-0.377**
	(0.0141)	(0.291)	(0.282)	(0.425)	(0.0831)	(0.159)
year=2012	0.192***	2.406***	-0.233	0.927**	0.0841	-0.308*
	(0.0152)	(0.335)	(0.233)	(0.398)	(0.125)	(0.169)
year=2013	0.224***	2.991***	-0.208	1.463***	0.433**	-0.126
	(0.0161)	(0.341)	(0.237)	(0.419)	(0.185)	(0.257)
year=2014	0.264***	3.846***	0.00604	1.922***	0.272*	-0.198
	(0.0165)	(0.363)	(0.294)	(0.425)	(0.145)	(0.204)
year=2015	0.271***	4.315***	-0.282	2.437***	0.661***	0.00283
	(0.0165)	(0.354)	(0.254)	(0.400)	(0.162)	(0.245)
year=2016	0.265***	3.945***	-0.355	0.844*	0.932***	0.162
	(0.0177)	(0.409)	(0.246)	(0.454)	(0.157)	(0.264)
year=2017	0.272***	3.928***	-0.477*	0.546	0.908***	0.172
	(0.0184)	(0.408)	(0.276)	(0.473)	(0.169)	(0.272)
year=2018	0.267***	3.708***	-0.601**	2.136***	0.938***	0.132
	(0.0182)	(0.408)	(0.245)	(0.423)	(0.183)	(0.275)
year=2019	0.271***	3.397***	-0.602**	2.796***	0.869***	0.158
	(0.0187)	(0.401)	(0.241)	(0.439)	(0.197)	(0.292)
Constant	0.658***	11.96***	1.403***	89.41***	5.390***	2.553***
	(0.0256)	(0.690)	(0.308)	(0.555)	(0.502)	(0.552)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,476	8,781	8,276	9,828	8,879	10,081
R-squared	0.093	0.046	0.003	0.014	0.057	0.017
Number of hospitals	893	878	843	931	884	931

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

I estimated the first stage as in Equation (3.5) using the alternative liquidity indicators as the dependent variables. Results in Table C7 show that the instrument in Equation (3.2) is not statistically significant, implying that the liquidation of Saludcoop does not explain the percentage of cash in assets for the public hospitals and the 2SLS estimates are likely to be biased. Therefore, I would not be able to make a causal inference of the effects of this liquidity indicator on the quality of care.

On the other hand, Table C8 presents the results of the estimation of the first stage using the cash ratio as the dependent variable. According to the F-test, the instrument is weak for the models in columns (2) and (3). Also, the Kleibergen-Paap LM statistics suggest that the models in columns (1), (4), (5) and (6) are underidentified. Therefore, the 2SLS estimates are also likely to be biased in this case. Hence, I am not able to make a causal inference of the cash ratio effects on the quality of care.

On the contrary, results in Table C9 show that the instrument is statistically significant when the dependent variable is the current liquidity ratio. The estimated coefficients indicate a significant negative correlation between the two variables. The current liquidity ratio decreased substantially after Saludcoop's liquidation in hospitals with a higher percentage of contracts with insurers of the subsidized regime, located in municipalities with a stronger presence of Saludcoop. The F-test rules out the possibility of a weak instrument problem, except for the estimations in columns (2) and (3). Also, the Kleibergen-Paap LM statistics verify that the models are not underidentified.

Table 3.18 presents the results of the 2SLS estimations of the current liquidity ratio effects on the quality of care. Results show that the current liquidity ratio did not have a significant effect on any of the quality-of-care indicators considered, except for the number of General Doctors and nurses available. For those hospitals whose current liquidity ratio decreased because of Saludcoop's liquidation, current liquidity ratio had a negative effect on the number of general doctors and nurses on their staff. Columns (5) and (6) show that an increase of 1% in the current liquidity ratio decreased the number of General Doctors in 5.90% and the number of Nurses in 3.75%. This means that the main findings presented in section 3.3.1 are robust. A decrease in liquidity, measure as the accounts receivable to sales ratio or as the current liquidity ratio increases the number of doctors and nurses in the hospital staff.

Table 3.18. Effects of the current liquidity ratio on health care quality (2SLS estimates)

VARIABLES	(1) Waiting time General Doctor	(2) Waiting time Emergency	(3) Readmissions	(4) Patient satisfaction	(5) General Doctors	(6) Nurses
Current liquidity ratio = (Assets/Liabilities)	0.0378	4.732	-1.671	-0.252	-5.898*	-3.746*
	(0.0926)	(3.944)	(2.458)	(2.281)	(3.022)	(2.090)
Share of contracts with insurers in the subsidized regime	-0.0469**	-0.637	0.0603	0.481	0.607	0.753*
	(0.0227)	(0.638)	(0.333)	(0.578)	(0.468)	(0.435)
Share of contracts with insurers in the contributory regime	-0.0217	-1.022	0.380	0.548	0.257	0.430
	(0.0474)	(1.391)	(0.505)	(1.083)	(1.001)	(1.325)
Number of beds	-0.000198	0.0173	0.000143	-0.00186	0.00251	0.0198
	(0.000445)	(0.0129)	(0.00281)	(0.00592)	(0.0134)	(0.0187)
Outpatient care rooms	-0.000795	-0.0320	-0.00980	-0.000226	0.107**	0.0228
	(0.000658)	(0.0277)	(0.0128)	(0.0129)	(0.0498)	(0.0224)
Examination rooms in the emergency department	8.23e-05	0.115	0.0178	-0.0113***	-0.00663*	-0.00475*
	(0.000114)	(0.165)	(0.0665)	(0.00287)	(0.00362)	(0.00289)
Delivery beds	0.000348	-0.234	0.144	-0.170	-0.140	-0.104
	(0.0110)	(0.281)	(0.163)	(0.217)	(0.358)	(0.303)
year=2010	0.0688***	1.074***	-0.483**	0.486	-0.314*	-0.339*
	(0.0130)	(0.329)	(0.210)	(0.375)	(0.174)	(0.195)
year=2011	0.147***	1.401***	-0.192	0.988**	-0.0676	-0.395**
	(0.0143)	(0.322)	(0.286)	(0.425)	(0.172)	(0.187)
year=2012	0.193***	2.497***	-0.295	0.920**	0.163	-0.367*
	(0.0153)	(0.365)	(0.255)	(0.400)	(0.204)	(0.202)
year=2013	0.219***	2.491***	-0.0707	1.492***	1.386**	0.357
	(0.0198)	(0.551)	(0.334)	(0.507)	(0.582)	(0.439)
year=2014	0.254***	2.715***	0.323	1.987***	2.112**	0.820
	(0.0301)	(1.037)	(0.585)	(0.738)	(0.979)	(0.609)
year=2015	0.259***	3.156***	0.0375	2.510***	2.726**	1.157
	(0.0337)	(1.062)	(0.534)	(0.773)	(1.117)	(0.760)
year=2016	0.256***	3.259***	-0.192	0.894	2.337***	0.960
	(0.0273)	(0.745)	(0.343)	(0.632)	(0.797)	(0.629)
year=2017	0.266***	3.450***	-0.428	0.582	2.062***	0.778
	(0.0240)	(0.623)	(0.308)	(0.563)	(0.666)	(0.541)
year=2018	0.257***	2.960***	-0.437	2.190***	2.410***	0.986
	(0.0284)	(0.796)	(0.327)	(0.638)	(0.853)	(0.669)
year=2019	0.261***	2.518***	-0.400	2.855***	2.464***	1.064
	(0.0295)	(0.892)	(0.382)	(0.675)	(0.901)	(0.704)
Constant	0.586***	3.210	4.561	89.89***	15.85***	9.564**
	(0.175)	(7.266)	(4.663)	(4.342)	(5.424)	(3.801)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,475	8,780	8,275	9,827	8,878	10,080
Number of hospitals	893	878	843	931	884	931

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3.4. Conclusions

During the last decade, accounts receivable growth has been one of the most important threats to the financial sustainability of public hospitals in Colombia. I study the effects of accounts receivable on six indicators of health care quality: waiting time to schedule an appointment with the general doctor and to receive care in the emergency department, patient satisfaction, readmission rate, and number of General Doctors and nurses. For this purpose, I use a 2SLS methodology, where the first stage exploits the intervention and liquidation of the most important health insurance company in Colombia during the study period (2009-2019). In those hospitals whose accounts receivable increased with Saludcoop's liquidation, the accounts receivable to sales ratio had a positive effect on the number of General Doctors and nurses.

At first, this result might be rather counterintuitive because one might expect a negative effect of the accounts receivable on the hospital's ability to hire more staff. There are some plausible explanations for this result. Hospitals with liquidity constraints caused by a high accounts receivable to sales ratio might find other sources of funding, and partner with other organizations to get financial support. Also, they could negotiate with the insurance companies to get a higher percentage of their contracts with the capitation payment method. With capitation, hospitals receive their payment at the beginning of each month and would be expected to provide a minimum number of services to the population assigned by the contract, which in turn would increase their demand for general doctors and nurses. Finally, hospitals that face higher receivables could be hiring more General Doctor and nurses instead of other specialists whose expected salary would be higher, like an Internal Medicine specialist or an Oncologist. An exploration of hospital decisions to hire generalists vs. specialists when they face liquidity constraints is an area for future research. A potential limitation for testing this hypothesis would be the sample size, since the number of the public hospitals in Colombia that offer appointments with specialists might not be enough to conduct an econometric analysis.

Additionally, results suggest that even though public hospitals have faced severe delays in collecting payments they have assigned appointments with General Doctors and provided care for users at the emergency department in acceptable time windows. This implies that public hospitals have been able to count on the necessary staff (medical and administrative) to provide those services. This might indicate that their budget has allowed them to cover their regular expenses, which can include salaries and facilities maintenance costs. Accounts receivable did not influence the readmission rates and patient satisfaction either. These results are robust after using a shorter study period (2011-2019) while controlling for competition, dropping potential outliers from the sample, and using an alternative measure of liquidity, such as the current liquidity ratio.

The methodology used had some limitations. First, I did not have access to information about the characteristics of the patients that each hospital served. Therefore, I was not able to control for time-varying variables, like changes in the age distribution of the patients or in the distribution of the illnesses of the patients over time. But the hospital's fixed effects should have had control for some of that. Second, ideally, the instrument would have included the percentage of contracts with Saludcoop as the “share”, but I did not observe that. I was able to construct the “share” part of the instrument using the interaction of the market share of Saludcoop in each municipality prior its intervention and the percentage of contracts of each hospital with the insurers that cover the segment of the Colombian population with subsidized health insurance (that varies in time). The instrument was able to explain the accounts receivable, but it was not statistically significant when the outcomes in the first stage were the percentage of receivables past due over 360 days and the percentage of assets in cash. Also, the instrument was weak and the model underidentified when the outcome in the first stage was the cash ratio.

Despite the limitations of the data and the instrument, I was able to provide new information about the relationship between accounts receivable and other important financial indicators, such as cash, assets, and cash ratio, another liquidity metric. Accounts receivable is significantly correlated with them. Moreover, I showed that alternative liquidity indicators are significantly correlated with some of the quality indicators considered. The percentage of assets in cash is negatively correlated with the waiting time for getting an appointment with a General Doctor, and hospitals with better cash ratio also exhibit longer waiting times for emergency care. Even though I was not able to find an effect of accounts receivable on the failure to pay staff (for those hospitals affected by the instrument), I found a significant negative correlation between them, which implies that hospitals with a more severe receivables issue experience more difficulties to pay their staff in a timely manner.

Some policy recommendations follow from these results. The government must continue making efforts to ensure the payment of the debt to the hospitals and prevent it from accumulating in the future. Even if the accounts receivable does not affect the quality of care during the same year, it might lead to the hospital bankruptcy in the long term, which might affect the welfare of the population served by those hospitals, especially in municipalities where there are not private hospitals.

In this study, I focused on the quality of care of basic services of a health system (consultation with a general practitioner, emergency care, and hospitalization). Therefore, it is necessary to expand the analysis of the financial performance effects to other aspects of the quality of care (e.g., staffing ratios, staffing turnover given the number of beds, or hospital mortality rates). An interesting case is given by more specialized services because their provision might rely more on the hospital's solvency. The validity of this type of analysis depends on the rigor and transparency with which hospitals report quality indicators and financial information. Therefore, the government should also make efforts to ensure data quality, considering the incentives that hospitals might be subject to considering national policies like waiting time targets and other indicators that insurers use to evaluate their performance and renegotiate their contracts.

3.5. References

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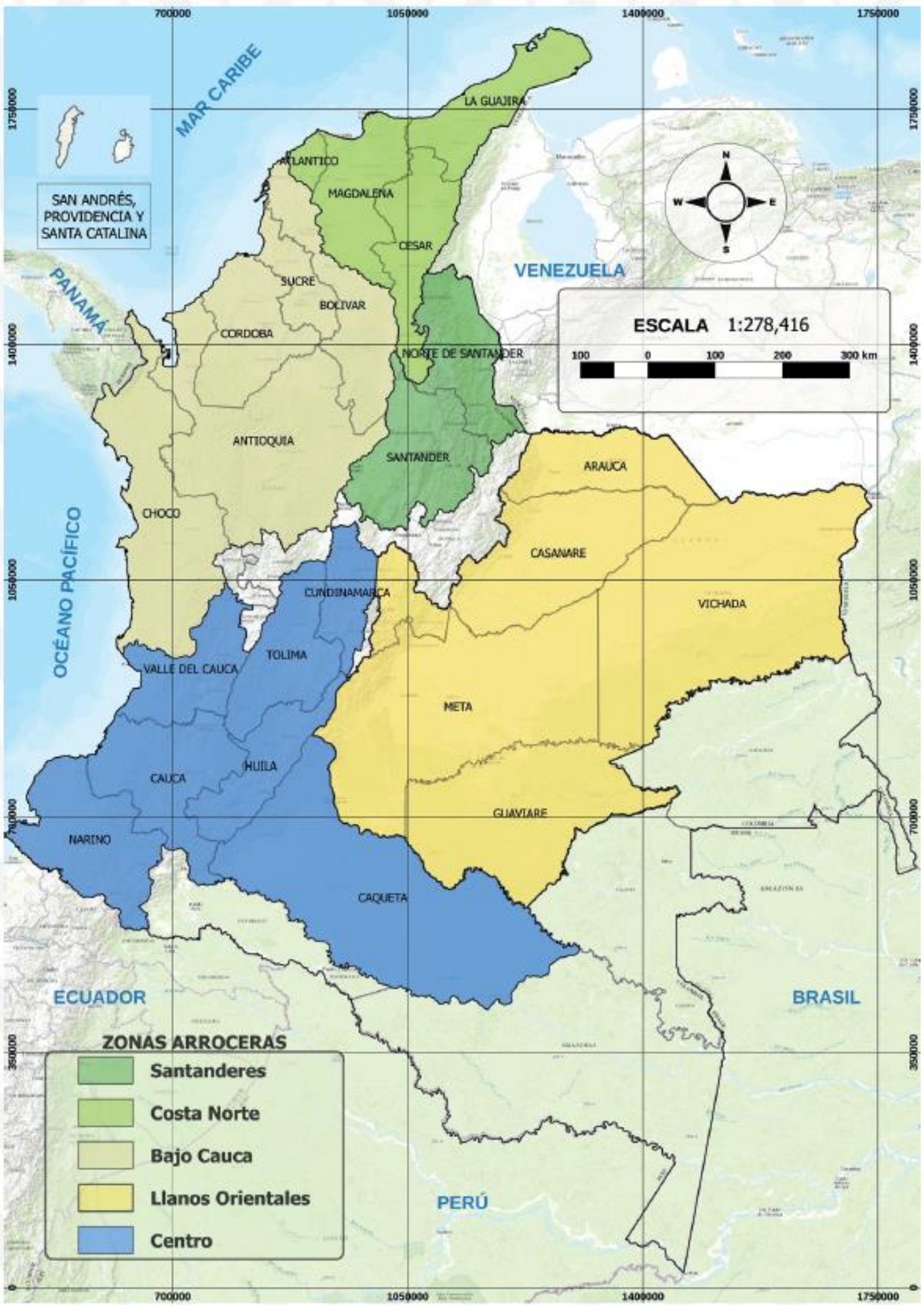
APPENDIX A: SUPPLEMENTARY MATERIAL FOR CHAPTER 1

Figure A1: Rice regions in Colombia (2016)



Source: FEDEARROZ (2017)

Table A2. Confidence intervals for the yield projections under the scenario RCP 4.5
Period 2046- 2065

Department	Yield (2046-2065)	Standard Deviation	Confidence Interval Lower bound	Confidence Interval Upper bound
Antioquia	5.37	0.21	4.96	5.79
Atlántico	2.73	0.80	1.17	4.30
Bolívar	5.44	0.17	5.10	5.78
Caquetá	5.80	0.21	5.38	6.21
Cauca	5.53	0.26	5.02	6.04
Cesar	5.65	0.18	5.31	6.00
Córdoba	5.53	0.18	5.17	5.89
Cundinamarca	5.04	0.23	4.58	5.49
Huila	5.37	0.25	4.89	5.85
La Guajira	5.70	0.22	5.26	6.13
Magdalena	5.60	0.18	5.25	5.95
Meta	5.73	0.22	5.30	6.16
Norte de Santander	5.52	0.16	5.20	5.84
Santander	5.22	0.18	4.86	5.57
Sucre	5.48	0.19	5.10	5.86
Tolima	5.33	0.27	4.80	5.86
Valle del Cauca	4.88	0.26	4.37	5.40
Arauca	5.72	0.21	5.31	6.13
Casanare	5.72	0.24	5.26	6.19
Guaviare	5.80	0.20	5.40	6.20

Period 2081- 2100

Department	Yield (2081-2100)	Standard Deviation	Confidence Interval Lower bound	Confidence Interval Upper bound
Antioquia	5.38	0.21	4.97	5.79
Atlántico	2.73	0.81	1.14	4.32
Bolívar	5.45	0.17	5.11	5.79
Caquetá	5.80	0.21	5.39	6.20
Cauca	5.57	0.26	5.06	6.07
Cesar	5.66	0.18	5.31	6.00
Córdoba	5.52	0.19	5.15	5.89
Cundinamarca	5.10	0.22	4.66	5.53
Huila	5.42	0.24	4.95	5.88
La Guajira	5.71	0.22	5.28	6.13
Magdalena	5.59	0.18	5.23	5.96
Meta	5.76	0.21	5.34	6.17
Norte de Santander	5.53	0.16	5.21	5.85
Santander	5.27	0.18	4.92	5.62
Sucre	5.46	0.21	5.06	5.87
Tolima	5.38	0.26	4.87	5.90
Valle del Cauca	4.91	0.26	4.40	5.42
Arauca	5.74	0.20	5.34	6.13
Casanare	5.74	0.23	5.28	6.19
Guaviare	5.80	0.20	5.41	6.19

APPENDIX B: SUPPLEMENTARY MATERIAL FOR CHAPTER 2

Table B1. Two-sample t test with equal variances

		Mean	Std. Dev.
Migrants	No frontera	16.38	3.871
	Frontera	15.83	4.850
	t	0.063	
	p-value	0.950	
Health expenditure	No frontera	12.73	0.042
	Frontera	12.84	0.085
	t	-1.057	
	p-value	0.292	
Subsidized regime	No frontera	12.55	0.074
	Frontera	12.77	0.091
	t	-1.355	
	p-value	0.177	
Public Health	No frontera	9.48	0.042
	Frontera	9.43	0.071
	t	0.502	
	p-value	0.617	
PPNA	No frontera	8.83	0.104
	Frontera	8.39	0.215
	t	1.457	
	p-value	0.148	

Table B2. First-Stage estimates using an alternative instrument

	(1)
Migration network (*alternative measure*) * CPI	3.045***
	(0.551)
year = 2014	-0.737
	(18.22)
year = 2015	0.626
	(18.22)
year = 2016	1.950
	(18.22)
year = 2017	7.065
	(18.22)
year = 2018	25.08
	(18.22)
year = 2019	47.92***
	(18.22)
2014*affiliated with subsidized regime	5.98e-06
	(1.87e-05)
2015*affiliated with subsidized regime	8.42e-06
	(1.87e-05)
2016*affiliated with subsidized regime	2.20e-05
	(1.87e-05)
2017*affiliated with subsidized regime	5.71e-05***
	(1.87e-05)
2018*affiliated with subsidized regime	0.000150***
	(1.87e-05)
2019*affiliated with subsidized regime	0.000255***
	(1.87e-05)
2014*MPI	-0.000312
	(0.364)
2015*MPI	-0.0172
	(0.364)
2016*MPI	-0.0372
	(0.364)
2017*MPI	-0.178
	(0.364)
2018*MPI	-0.701*
	(0.364)
2019*MPI	-1.667***
	(0.369)
Constant	2.039
	(3.182)
City FE	yes
Observations	161
Number of cities	23
Adjusted R-squared	0.79
F statistic	34.38
Kleibergen-Paap LM (*p-value*)	0.000

*** p<0.01, ** p<0.05, * p<0.1

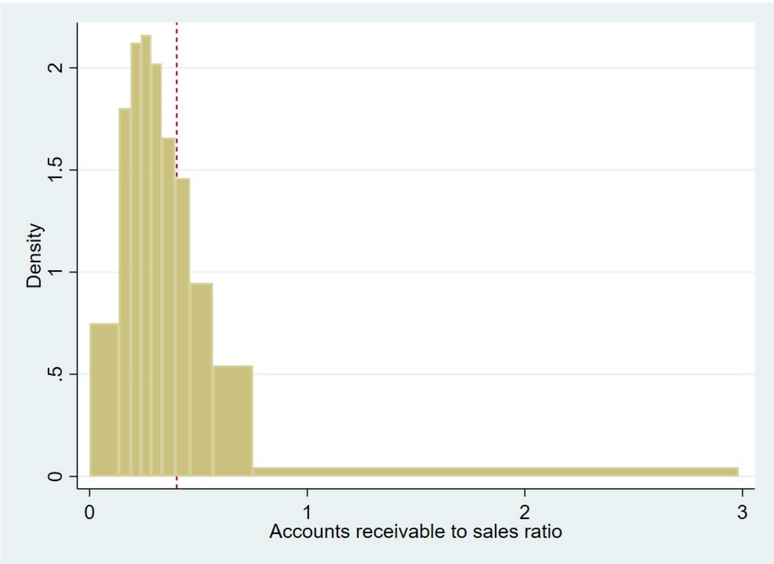
Table B3. 2SLS estimates of the effects of migration on health expenditure per capita in Colombia using an alternative instrument

	(1)	(2)	(3)	(4)
VARIABLES	Total Health Expenditure	Subsidized Regime	Public Health	PPNA
Migrants	0.0122***	0.0139*	0.00537*	-0.00285
	(0.00429)	(0.00767)	(0.00296)	(0.00628)
year = 2014	0.000312	0.0337	0.226	-0.656
	(0.432)	(0.772)	(0.298)	(1.029)
year = 2015	0.0135	0.0795	0.393	-1.671
	(0.432)	(0.772)	(0.298)	(1.029)
year = 2016	0.00346	0.109	-0.245	-1.793*
	(0.432)	(0.772)	(0.298)	(1.029)
year = 2017	0.122	0.0609	0.211	-1.139
	(0.433)	(0.774)	(0.299)	(1.179)
year = 2018	-0.126	-0.0918	-0.140	-1.910
	(0.445)	(0.796)	(0.307)	(1.201)
year = 2019	0.00848	0.774	-0.540	-2.559**
	(0.481)	(0.860)	(0.332)	(1.257)
2014*affiliated with subsidized regime	-1.49e-07	-8.86e-08	-4.17e-07	1.87e-07
	(4.45e-07)	(7.95e-07)	(3.07e-07)	(8.88e-07)
2015*affiliated with subsidized regime	-2.02e-07	-1.32e-07	-7.47e-08	1.54e-07
	(4.46e-07)	(7.96e-07)	(3.07e-07)	(8.89e-07)
2016*affiliated with subsidized regime	-3.34e-07	-3.26e-07	-2.15e-07	5.21e-07
	(4.54e-07)	(8.12e-07)	(3.13e-07)	(8.98e-07)
2017*affiliated with subsidized regime	-9.48e-07*	-8.59e-07	-9.22e-07***	7.51e-07
	(5.07e-07)	(9.07e-07)	(3.50e-07)	(9.60e-07)
2018*affiliated with subsidized regime	-1.94e-06**	-2.16e-06	-1.36e-06**	1.48e-06
	(7.82e-07)	(1.40e-06)	(5.39e-07)	(1.29e-06)
2019*affiliated with subsidized regime	-3.33e-06***	-4.53e-06**	-2.09e-06**	2.21e-06
	(1.20e-06)	(2.14e-06)	(8.24e-07)	(1.83e-06)
2014*MPI	0.000633	-0.000160	-0.00220	0.00774
	(0.00864)	(0.0154)	(0.00596)	(0.0217)
2015*MPI	0.00253	0.000971	-0.00633	0.0253
	(0.00864)	(0.0154)	(0.00596)	(0.0217)
2016*MPI	0.00214	0.000555	0.00255	0.0275
	(0.00864)	(0.0154)	(0.00596)	(0.0217)
2017*MPI	0.00183	0.00282	-0.00193	0.0100
	(0.00867)	(0.0155)	(0.00598)	(0.0262)
2018*MPI	0.00879	0.00888	0.00905	0.0251
	(0.00914)	(0.0163)	(0.00630)	(0.0268)
2019*MPI	-0.0106	-0.0307*	0.00232	0.0234
	(0.0103)	(0.0185)	(0.00713)	(0.0284)
Constant	12.74***	12.60***	9.545***	9.322***
	(0.0760)	(0.136)	(0.0524)	(0.161)
Observations	161	161	161	124
Number of coddep	23	23	23	19
City FE	yes	yes	yes	yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

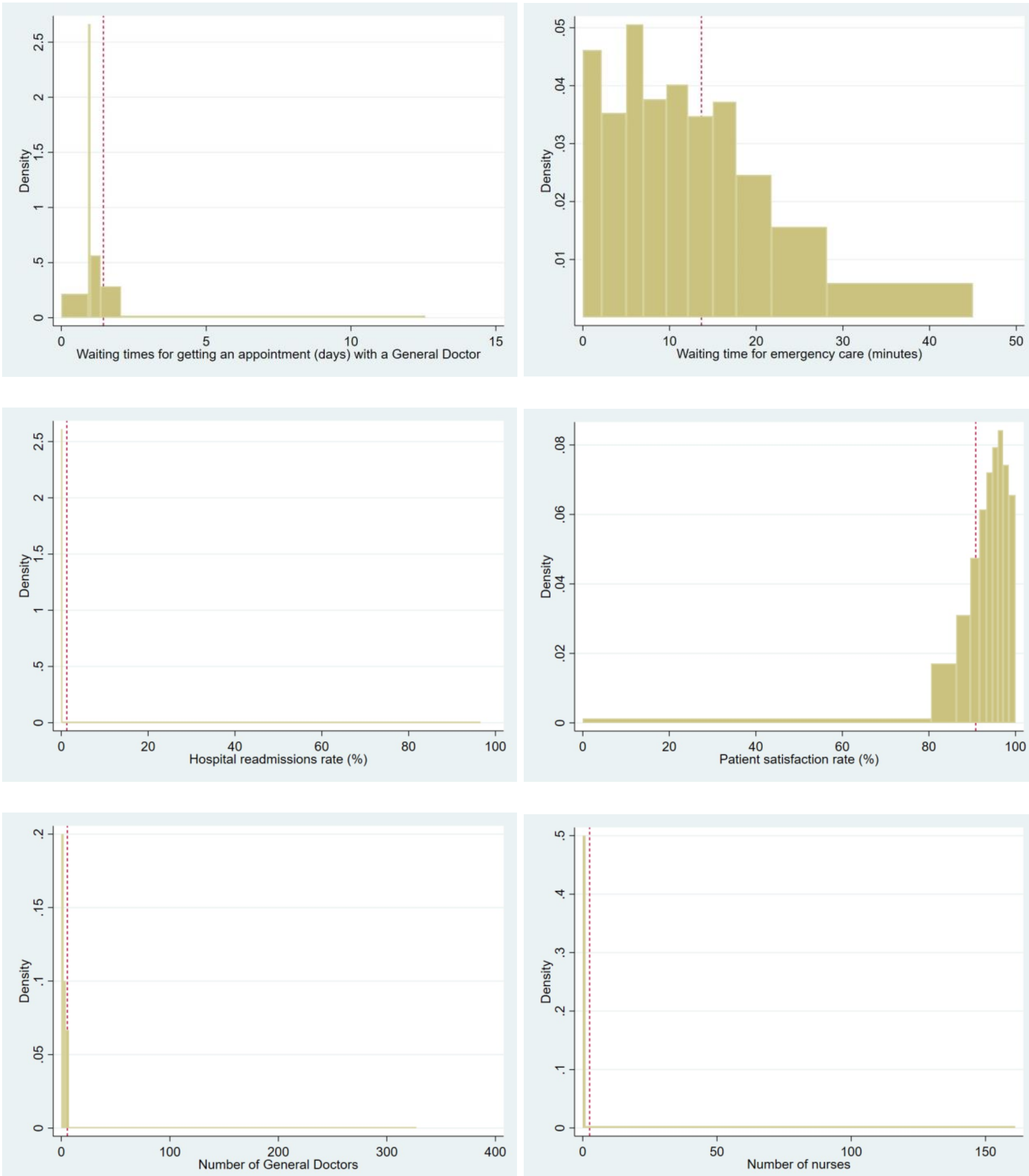
APPENDIX C: SUPPLEMENTARY MATERIAL FOR CHAPTER 3

Figure C1. Histogram of the distribution of the variable accounts receivable to sales ratio



Note: the red line shows the mean of the variable.

Figure C2. Histograms of the distributions of the quality of care variables



Note: the red line shows the mean of the variable.

Figure C3. Histogram of the distribution of the failure to pay staff variable

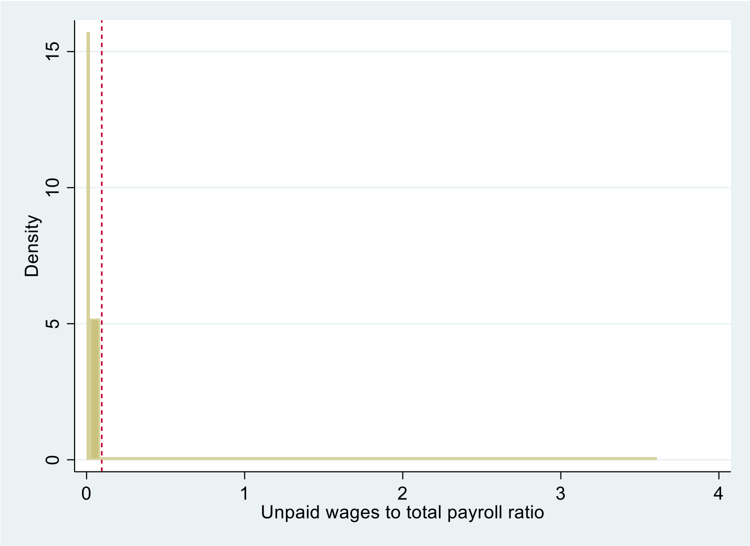


Figure C4. Histogram of the distribution of the percentage of accounts receivable past due over 360 days

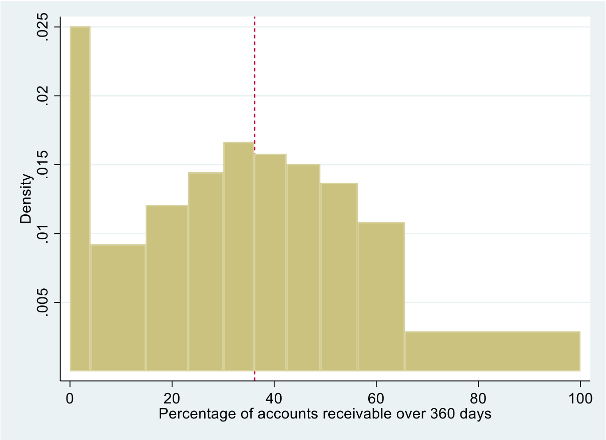


Figure C5. Histogram of the distributions of the alternative measures of liquidity

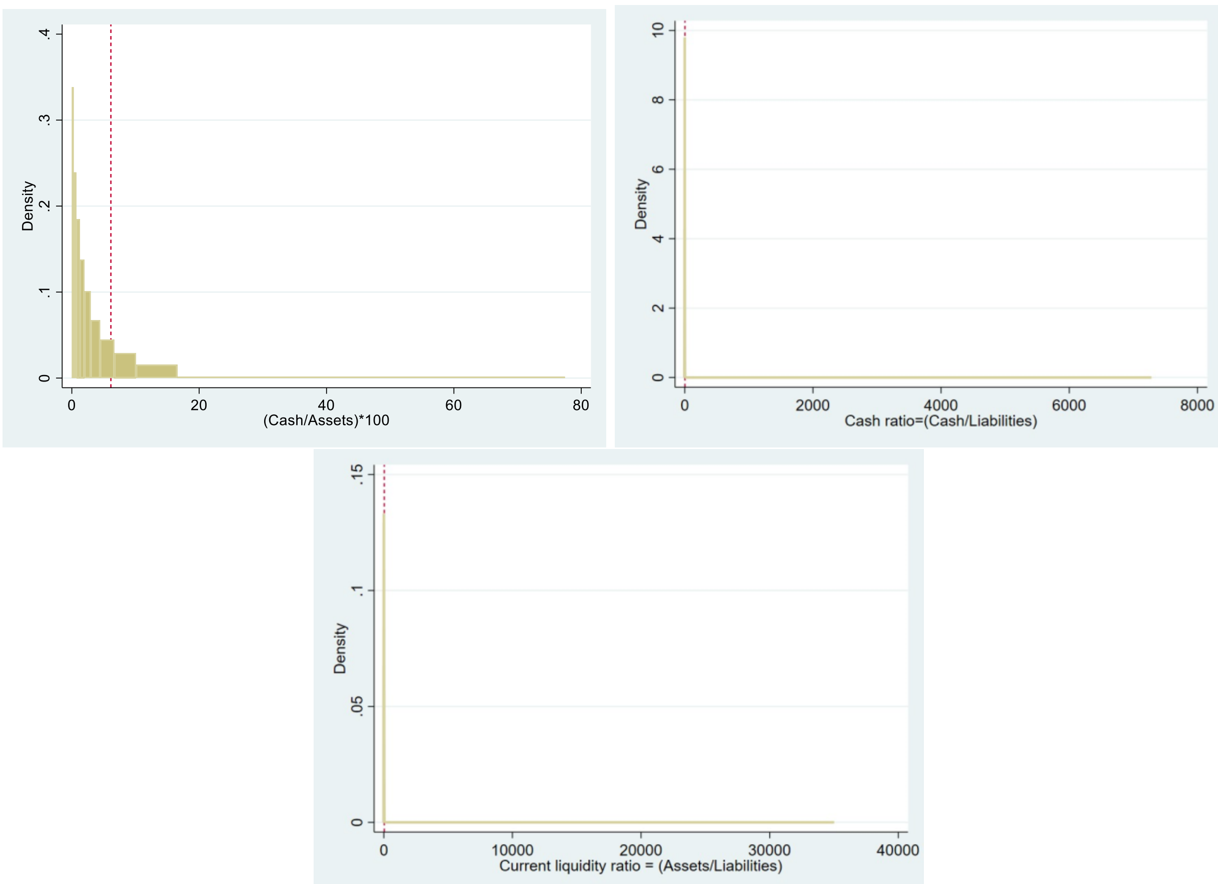


Table C1. Examples of quality indicators according to Donabedian's classification

Donabedian's classification		
Structure indicators	**Process indicators**	**Outcome indicators**
Number or proportions of admissions: Romano & Choi (2016); Grupo de Trabajo SEMES- Insalud (2001); Pronovost et al. (2003); Giuffrida, et al. (1999)	**Average time (in treatments, ventilator days, waiting lists/times):** Pronovost et al. (2003); Grupo de Trabajo SEMES- Insalud (2001); Romano & Choi (2016); Berenholtz et al. (2002); de Vos et al. (2007); Krammers (2003).	**Readmission**: Fischer (2015); Weiss, et al. (2021); Grupo de Trabajo SEMES- Insalud (2001); Giuffrida, et al. (1999); Mainz (2004)
Availability of staff (per hour): de Vos, et al. (2007)	**Disease prevention:** Romano & Choi (2016); Krammers (2003); Mattke et al. (2006); Pronovost et al. (2003).	**Relapse:** Fischer (2015).
Staffing levels: Romano & Choi (2016); Krammers (2003); Mainz (2004); de Vos et al. (2007); Pronovost, et al. (2002); Zacca, et al. (2006); Fischer (2015); Grupo de Trabajo SEMES- Insalud (2001).	**Subjective indicators (Perception of the health system):** Grupo de Trabajo SEMES- Insalud (2001); Krammers (2003); Zacca, et al. (2006).	**Complications:** Fischer (2015); Saluja, et al. (2018); Berenholtz et al. (2002); de Vos, et al. (2007); Zacca, et al. (2006)
Medicine use/medical aids: Krammers (2003); Rios et al. (2019); Romano & Choi (2016).	**In-patient care utilization (Beddays; occupancy rates; average length of stay; discharges):** Krammers (2003); Saluja et al. (2018); Pronovost et al. (2003); de Vos et al.	**Mortality:** Fischer (2015); Grupo de Trabajo SEMES- Insalud (2001); Mattke et al. (2006); Saluja et al. (2018); Pronovost et al. (2003); Mainz et al.
	Proportion of patients with different treatments or interventions: Mainz et al. (2004); Berenholtz et al. (2002); Saluja et al. (2018); Krammers (2003).	**Length of stay**: Pronovost et al. (2003); Pronovost et al. (2002); Grupo de Trabajo SEMES- Insalud (2001); Saluja et al. (2018); Berenholtz et al. (2002)
	Disease-specific indicators: Mainz (2004); Mainz et al. (2004)	

Table C2. First stage estimates after dropping potential outliers

Dependent variable: Accounts receivable to sales ratio

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
$S_{2010} * TCVS_{it} * Post[= 1\ if\ t \geq 2015]$	0.113***	0.117***	0.109***	0.128***	0.118***	0.129***
	(0.0265)	(0.0278)	(0.0288)	(0.0268)	(0.0280)	(0.0266)
Share of contracts with insurers in the subsidized regime	-0.0295***	-0.0246**	-0.0147	-0.00997	-0.0186*	-0.0110
	(0.00988)	(0.00969)	(0.0109)	(0.00989)	(0.0102)	(0.00980)
Share of contracts with insurers in the contributory regime	-0.0495***	-0.0466**	-0.0376*	-0.0416**	-0.0430**	-0.0405**
	(0.0188)	(0.0182)	(0.0193)	(0.0183)	(0.0193)	(0.0180)
Number of beds	-0.000210	0.000112	-1.69e-05	-1.75e-05	-6.25e-05	-5.34e-06
	(0.000165)	(0.000151)	(0.000157)	(0.000142)	(0.000144)	(0.000142)
Outpatient care rooms	7.64e-05	-0.000136	-0.000299	-0.000148	-0.000163	-0.000184
	(0.000262)	(0.000302)	(0.000284)	(0.000252)	(0.000250)	(0.000250)
Examination rooms in the emergency department	5.97e-05***	0.00220	-0.000150	5.96e-05***	5.62e-05***	5.77e-05***
	(7.41e-06)	(0.00257)	(0.00290)	(8.03e-06)	(8.12e-06)	(8.21e-06)
Delivery beds	0.00535	0.00698*	0.00730*	0.00389	0.00429	0.00402
	(0.00389)	(0.00411)	(0.00386)	(0.00385)	(0.00385)	(0.00381)
year=2010	0.0127***	0.0145***	0.0153***	0.0130***	0.0147***	0.0131***
	(0.00337)	(0.00346)	(0.00362)	(0.00329)	(0.00348)	(0.00324)
year=2011	0.0136***	0.0147***	0.0163***	0.0145***	0.0114**	0.0134***
	(0.00432)	(0.00425)	(0.00456)	(0.00418)	(0.00454)	(0.00414)
year=2012	0.0243***	0.0272***	0.0321***	0.0292***	0.0237***	0.0266***
	(0.00448)	(0.00464)	(0.00477)	(0.00446)	(0.00474)	(0.00434)
year=2013	0.0311***	0.0352***	0.0407***	0.0353***	0.0336***	0.0335***
	(0.00510)	(0.00517)	(0.00540)	(0.00506)	(0.00536)	(0.00494)
year=2014	0.0463***	0.0503***	0.0571***	0.0510***	0.0501***	0.0493***
	(0.00560)	(0.00581)	(0.00606)	(0.00554)	(0.00596)	(0.00546)
year=2015	0.0491***	0.0528***	0.0624***	0.0544***	0.0530***	0.0530***
	(0.00603)	(0.00642)	(0.00683)	(0.00602)	(0.00637)	(0.00593)
year=2016	0.0770***	0.0853***	0.0974***	0.0853***	0.0841***	0.0836***
	(0.00628)	(0.00675)	(0.00718)	(0.00638)	(0.00660)	(0.00625)
year=2017	0.0857***	0.0928***	0.108***	0.0954***	0.0934***	0.0930***
	(0.00652)	(0.00697)	(0.00734)	(0.00653)	(0.00680)	(0.00648)
year=2018	0.0953***	0.102***	0.118***	0.105***	0.104***	0.103***
	(0.00699)	(0.00749)	(0.00778)	(0.00692)	(0.00724)	(0.00687)
year=2019	0.0948***	0.105***	0.121***	0.105***	0.103***	0.103***
	(0.00718)	(0.00767)	(0.00800)	(0.00714)	(0.00745)	(0.00707)
Constant	0.277***	0.274***	0.279***	0.269***	0.279***	0.271***
	(0.00975)	(0.0118)	(0.0117)	(0.00990)	(0.0101)	(0.00987)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,535	8,816	8,307	9,883	8,928	10,136
R-squared	0.127	0.146	0.175	0.151	0.144	0.147
Number of hospitals	893	878	843	931	884	931
F statistic	25.02	26.37	28.00	28.85	27.3	28.94
Kleibergen-Paap LM (p-value)	0.000	0.000	0.000	0.000	0.000	0.000

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Columns (1) to (6) present the results for the estimations without missings in each of the quality-of-care indicators. In this order: waiting time for getting an appointment with a General Doctor, waiting time for emergency care, readmission rate, patient satisfaction rate, number of General Doctors, and number of nurses.

Table C3. 2SLS estimates after dropping potential outliers

VARIABLES	(1) Waiting time General Doctor	(2) Waiting time Emergency	(3) Readmissions	(4) Patient satisfaction	(5) General Doctors	(6) Nurses
Accounts receivable to sales ratio	-0.275	-22.03	6.743	0.484	34.14**	23.60*
	(0.694)	(19.12)	(8.606)	(14.01)	(15.66)	(12.25)
Share of contracts with insurers in the subsidized regime	-0.0513*	-0.810	0.107	0.456	0.580	0.711*
	(0.0276)	(0.685)	(0.318)	(0.577)	(0.450)	(0.419)
Share of contracts with insurers in the contributory regime	-0.0441	-1.707	0.673	0.668	1.437	1.203
	(0.0576)	(1.464)	(0.690)	(1.181)	(1.179)	(1.377)
Number of beds	-0.000345	0.0119	0.00122	-0.00122	0.0102	0.0240
	(0.000423)	(0.0121)	(0.00234)	(0.00541)	(0.0126)	(0.0179)
Outpatient care rooms	-0.000613	-0.0117	-0.0131	-0.000216	0.0923*	0.0146
	(0.000609)	(0.0204)	(0.0113)	(0.0107)	(0.0544)	(0.0244)
Examination rooms in the emergency department	5.50e-05	0.132	0.0333	-0.0110***	-0.00145	-0.00162
	(4.79e-05)	(0.170)	(0.0575)	(0.00105)	(0.00103)	(0.00118)
Delivery beds	0.00456	0.172	0.0196	-0.175	-0.635	-0.383
	(0.00977)	(0.257)	(0.115)	(0.182)	(0.389)	(0.290)
year=2010	0.0716***	1.188***	-0.519**	0.536	-0.650**	-0.513**
	(0.0151)	(0.393)	(0.220)	(0.402)	(0.271)	(0.238)
year=2011	0.149***	1.625***	-0.265	1.045**	-0.518**	-0.685***
	(0.0171)	(0.408)	(0.305)	(0.464)	(0.256)	(0.244)
year=2012	0.199***	2.994***	-0.442	0.935*	-0.705*	-0.923**
	(0.0223)	(0.624)	(0.353)	(0.559)	(0.415)	(0.376)
year=2013	0.233***	3.723***	-0.470	1.461**	-0.681	-0.893**
	(0.0268)	(0.745)	(0.390)	(0.627)	(0.538)	(0.422)
year=2014	0.277***	4.923***	-0.369	1.931**	-1.402*	-1.338**
	(0.0363)	(1.011)	(0.531)	(0.817)	(0.798)	(0.649)
year=2015	0.288***	5.700***	-0.741	2.437**	-1.453	-1.481*
	(0.0438)	(1.223)	(0.675)	(0.987)	(0.970)	(0.757)
year=2016	0.288***	6.048***	-1.070	0.778	-2.267	-2.046*
	(0.0620)	(1.822)	(0.964)	(1.411)	(1.432)	(1.059)
year=2017	0.300***	6.178***	-1.260	0.514	-2.577	-2.256*
	(0.0687)	(1.948)	(1.001)	(1.580)	(1.597)	(1.168)
year=2018	0.296***	6.136***	-1.456	2.102	-2.926*	-2.528**
	(0.0753)	(2.139)	(1.163)	(1.676)	(1.734)	(1.281)
year=2019	0.301***	5.924***	-1.481	2.763*	-2.940*	-2.517**
	(0.0749)	(2.195)	(1.158)	(1.679)	(1.724)	(1.283)
Constant	0.731***	17.79***	-0.433	89.23***	-3.892	-3.687
	(0.190)	(5.208)	(2.360)	(3.713)	(4.273)	(3.429)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,535	8,816	8,307	9,883	8,928	10,136
Number of hospitals	893	878	843	931	884	931

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table C4. First-stage estimates controlling for competition (2011-2019)

Dependent variable: Accounts receivable to sales ratio

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
$S_{2010} * TCVS_{it} * Post[= 1\ if\ t \geq 2015]$	0.108***	0.106***	0.0922***	0.113***	0.107***	0.114***
	(0.0254)	(0.0266)	(0.0273)	(0.0253)	(0.0272)	(0.0252)
Share of contracts with insurers in the subsidized regime	-0.0357***	-0.0349***	-0.0324***	-0.0260***	-0.0314***	-0.0267***
	(0.00950)	(0.00944)	(0.0103)	(0.00927)	(0.00981)	(0.00916)
Share of contracts with insurers in the contributory regime	-0.0535***	-0.0503***	-0.0421**	-0.0503***	-0.0475***	-0.0491***
	(0.0179)	(0.0177)	(0.0185)	(0.0174)	(0.0182)	(0.0171)
Number of beds	-0.000264	9.80e-05	-1.39e-05	-2.57e-05	-4.25e-05	-1.08e-05
	(0.000162)	(0.000164)	(0.000162)	(0.000140)	(0.000138)	(0.000140)
Outpatient care rooms	0.000367	2.09e-06	-0.000273	-0.000104	-8.42e-05	-0.000110
	(0.000275)	(0.000322)	(0.000297)	(0.000264)	(0.000255)	(0.000263)
Examination rooms in the emergency department	7.06e-05***	0.00239	-0.000148	7.17e-05***	6.87e-05***	6.89e-05***
	(6.21e-06)	(0.00297)	(0.00298)	(6.86e-06)	(6.61e-06)	(6.55e-06)
Delivery beds	0.00198	0.00374	0.00512	0.00214	0.00186	0.00175
	(0.00419)	(0.00451)	(0.00380)	(0.00384)	(0.00387)	(0.00386)
Number of providers in the same municipality	-0.000126	5.91e-05	0.000144	0.000123	4.48e-05	0.000122
	(0.000163)	(9.77e-05)	(9.38e-05)	(8.37e-05)	(9.18e-05)	(8.36e-05)
year=2012	0.0109***	0.0123***	0.0160***	0.0143***	0.0124***	0.0130***
	(0.00366)	(0.00368)	(0.00394)	(0.00361)	(0.00393)	(0.00352)
year=2013	0.0182***	0.0206***	0.0247***	0.0208***	0.0227***	0.0202***
	(0.00453)	(0.00461)	(0.00493)	(0.00438)	(0.00487)	(0.00437)
year=2014	0.0335***	0.0355***	0.0404***	0.0359***	0.0386***	0.0353***
	(0.00537)	(0.00547)	(0.00599)	(0.00531)	(0.00580)	(0.00522)
year=2015	0.0365***	0.0384***	0.0463***	0.0396***	0.0419***	0.0392***
	(0.00596)	(0.00627)	(0.00685)	(0.00595)	(0.00642)	(0.00587)
year=2016	0.0644***	0.0705***	0.0814***	0.0703***	0.0731***	0.0698***
	(0.00618)	(0.00661)	(0.00729)	(0.00632)	(0.00671)	(0.00619)
year=2017	0.0730***	0.0773***	0.0904***	0.0791***	0.0818***	0.0782***
	(0.00635)	(0.00677)	(0.00730)	(0.00636)	(0.00684)	(0.00629)
year=2018	0.0828***	0.0868***	0.101***	0.0883***	0.0927***	0.0877***
	(0.00673)	(0.00720)	(0.00759)	(0.00669)	(0.00714)	(0.00660)
year=2019	0.0825***	0.0899***	0.103***	0.0883***	0.0908***	0.0876***
	(0.00707)	(0.00754)	(0.00799)	(0.00698)	(0.00749)	(0.00688)
Constant	0.305***	0.298***	0.303***	0.292***	0.300***	0.293***
	(0.0116)	(0.0128)	(0.0129)	(0.0111)	(0.0116)	(0.0109)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	7,794	7,167	6,787	8,126	7,325	8,293
R-squared	0.120	0.138	0.163	0.139	0.138	0.139
Number of hospitals	888	869	833	931	877	931
F statistic	26.22	24.4	26.26	29.2	27.73	30.38
Kleibergen-Paap LM (*p-value*)	0.000	0.000	0.000	0.000	0.000	0.000

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Columns (1) to (6) present the results for the estimations without missings in each of the quality-of-care indicators. In this order: waiting time for getting an appointment with a General Doctor, waiting time for emergency care, readmission rate, patient satisfaction rate, number of General Doctors, and number of nurses.

Table C5. Failure to pay staff (First-stage estimates)

Dependent variable: Accounts receivable to sales ratio	
VARIABLES	
$S_{2010} * TCVS_{it} * Post[= 1\ if\ t \geq 2015]$	0.129***
	(0.0266)
Share of contracts with insurers in the subsidized regime	-0.0110
	(0.00980)
Share of contracts with insurers in the contributory regime	-0.0405**
	(0.0180)
Number of beds	-5.34e-06
	(0.000142)
Outpatient care rooms	-0.000184
	(0.000250)
Examination rooms in the emergency department	5.77e-05***
	(8.21e-06)
Delivery beds	0.00402
	(0.00381)
year=2010	0.0131***
	(0.00324)
year=2011	0.0134***
	(0.00414)
year=2012	0.0266***
	(0.00434)
year=2013	0.0335***
	(0.00494)
year=2014	0.0493***
	(0.00546)
year=2015	0.0530***
	(0.00593)
year=2016	0.0836***
	(0.00625)
year=2017	0.0930***
	(0.00648)
year=2018	0.103***
	(0.00687)
year=2019	0.103***
	(0.00707)
Constant	0.271***
	(0.00987)
Year FE	yes
Hospital FE	yes
Observations	10,136
R-squared	0.147
Number of hospitals	931
F statistic	28.94
Kleibergen-Paap LM (p-value)	0.000

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table C6. Over 360 days accounts receivable (First Stage estimates)

Dependent variable: Percentage of accounts receivable over 360 days %

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
$S_{2010} * TCVS_{it} * Post[= 1\ if\ t \geq 2015]$	0.0893	4.608	1.508	-0.0444	-2.209	-0.164
	(3.869)	(3.885)	(3.850)	(3.747)	(3.891)	(3.726)
Share of contracts with insurers in the subsidized regime	0.953	0.166	-0.715	0.577	0.369	0.378
	(1.277)	(1.268)	(1.279)	(1.215)	(1.287)	(1.215)
Share of contracts with insurers in the contributory regime	-5.844**	-4.564**	-4.922**	-5.301**	-4.404*	-5.787**
	(2.518)	(2.241)	(2.290)	(2.407)	(2.358)	(2.344)
Number of beds	-0.0350	-0.0320**	-0.0234*	-0.0341**	-0.0300*	-0.0320**
	(0.0216)	(0.0155)	(0.0138)	(0.0145)	(0.0156)	(0.0147)
Outpatient care rooms	-0.0462	-0.0539	-0.0575	-0.0398	-0.0479	-0.0419
	(0.0439)	(0.0512)	(0.0429)	(0.0424)	(0.0424)	(0.0418)
Examination rooms in the emergency department	0.00551***	-0.156	-0.132	0.00558***	0.00587***	0.00572***
	(0.00157)	(0.292)	(0.273)	(0.00153)	(0.00164)	(0.00159)
Delivery beds	0.777*	0.328	0.930**	0.768*	0.596	0.646
	(0.459)	(0.463)	(0.461)	(0.459)	(0.463)	(0.454)
year=2010	3.126***	3.043***	2.707***	3.212***	2.822***	3.018***
	(0.521)	(0.545)	(0.553)	(0.517)	(0.537)	(0.502)
year=2011	10.19***	10.06***	9.358***	10.20***	9.709***	10.06***
	(0.676)	(0.699)	(0.710)	(0.670)	(0.699)	(0.650)
year=2012	15.96***	15.02***	14.24***	15.83***	14.90***	15.42***
	(0.787)	(0.801)	(0.830)	(0.770)	(0.811)	(0.757)
year=2013	17.77***	16.48***	15.21***	17.57***	16.61***	17.37***
	(0.797)	(0.818)	(0.849)	(0.785)	(0.819)	(0.769)
year=2014	19.45***	17.88***	17.60***	19.36***	19.00***	19.19***
	(0.825)	(0.831)	(0.858)	(0.812)	(0.862)	(0.796)
year=2015	20.87***	19.53***	19.05***	20.54***	20.70***	20.61***
	(0.884)	(0.917)	(0.935)	(0.870)	(0.925)	(0.860)
year=2016	26.49***	24.50***	24.79***	26.16***	26.06***	26.07***
	(0.904)	(0.923)	(0.946)	(0.901)	(0.939)	(0.882)
year=2017	25.35***	23.35***	23.53***	25.16***	24.61***	25.01***
	(0.905)	(0.916)	(0.932)	(0.904)	(0.930)	(0.880)
year=2018	29.15***	27.24***	27.78***	28.86***	28.58***	28.82***
	(0.934)	(0.945)	(0.967)	(0.928)	(0.973)	(0.911)
year=2019	29.57***	27.34***	27.56***	29.36***	28.94***	29.10***
	(0.967)	(0.976)	(1.005)	(0.954)	(0.998)	(0.940)
Constant	18.09***	20.64***	21.33***	18.92***	19.83***	19.26***
	(1.391)	(1.501)	(1.384)	(1.304)	(1.389)	(1.297)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,538	8,818	8,311	9,889	8,932	10,143
R-squared	0.265	0.250	0.264	0.265	0.262	0.265
Number of hospitals	893	878	843	931	884	931
F statistic	89.96	80.01	76.24	90.47	79.37	93.29
Kleibergen-Paap LM (*p-value*)	0.000	0.000	0.000	0.000	0.000	0.000

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Columns (1) to (6) present the results for the estimations without missings in each of the quality-of-care indicators. In this order: waiting time for getting an appointment with a General Doctor, waiting time for emergency care, readmission rate, patient satisfaction rate, number of General Doctors, and number of nurses.

Table C7. Percentage of assets in cash and quality of care (First stage estimates)

Dependent variable: Liquidity=(Cash/Assets)*100

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
$S_{2010} * TCVS_{it} * Post[= 1\ if\ t \geq 2015]$	1.052	0.167	0.414	0.379	0.638	0.298
	(1.712)	(1.720)	(1.763)	(1.680)	(1.784)	(1.654)
Share of contracts with insurers in the subsidized regime	0.623	0.810*	0.551	0.299	0.598	0.375
	(0.470)	(0.457)	(0.507)	(0.476)	(0.480)	(0.461)
Share of contracts with insurers in the contributory regime	0.388	0.126	-0.403	-0.164	-0.262	-0.225
	(0.896)	(0.875)	(0.944)	(0.884)	(0.891)	(0.879)
Number of beds	-0.0162**	-0.0206***	-0.0135**	-0.0155***	-0.0161***	-0.0159***
	(0.00824)	(0.00734)	(0.00596)	(0.00572)	(0.00613)	(0.00571)
Outpatient care rooms	0.0125	0.0167	0.0182	0.0117	0.0131	0.0123
	(0.0154)	(0.0153)	(0.0160)	(0.0146)	(0.0146)	(0.0144)
Examination rooms in the emergency department	-0.0142***	-0.142	-0.144	-0.0143***	-0.0144***	-0.0143***
	(0.000409)	(0.149)	(0.131)	(0.000449)	(0.000450)	(0.000504)
Delivery beds	0.0321	-0.158	0.0613	0.0115	0.0228	0.0312
	(0.199)	(0.192)	(0.203)	(0.189)	(0.199)	(0.192)
year=2010	0.0323	0.135	0.0378	0.200	-0.0446	0.165
	(0.271)	(0.276)	(0.279)	(0.267)	(0.277)	(0.260)
year=2011	-1.177***	-0.938***	-0.896***	-0.929***	-1.112***	-0.992***
	(0.312)	(0.305)	(0.319)	(0.308)	(0.328)	(0.298)
year=2012	-1.252***	-0.964***	-0.869**	-1.081***	-1.146***	-1.158***
	(0.323)	(0.321)	(0.338)	(0.320)	(0.344)	(0.310)
year=2013	0.959**	0.979**	0.985**	1.122***	0.788*	1.039***
	(0.411)	(0.401)	(0.429)	(0.405)	(0.426)	(0.395)
year=2014	0.545	0.650*	0.690*	0.664*	0.528	0.625*
	(0.383)	(0.383)	(0.403)	(0.377)	(0.405)	(0.369)
year=2015	-0.601	-0.556	-0.534	-0.483	-0.636	-0.500
	(0.407)	(0.400)	(0.429)	(0.402)	(0.426)	(0.392)
year=2016	-1.789***	-1.757***	-1.800***	-1.627***	-1.685***	-1.675***
	(0.377)	(0.358)	(0.388)	(0.373)	(0.400)	(0.363)
year=2017	-0.558	-0.469	-0.570	-0.539	-0.543	-0.501
	(0.381)	(0.362)	(0.385)	(0.374)	(0.400)	(0.366)
year=2018	-0.761*	-0.516	-0.631	-0.675*	-0.750*	-0.663*
	(0.391)	(0.385)	(0.408)	(0.386)	(0.410)	(0.378)
year=2019	-0.615	-0.224	-0.372	-0.440	-0.561	-0.443
	(0.419)	(0.422)	(0.438)	(0.414)	(0.439)	(0.404)
Constant	7.329***	7.656***	7.575***	7.725***	7.565***	7.630***
	(0.530)	(0.577)	(0.598)	(0.532)	(0.549)	(0.513)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,536	8,816	8,310	9,887	8,930	10,141
R-squared	0.016	0.018	0.017	0.016	0.015	0.016
Number of hospitals	893	878	843	931	884	931
F statistic	100.82	10.32	9.35	84.32	81.59	67.84
Kleibergen-Paap LM (p-value)	0.000	0.002	0.009	0.004	0.006	0.003

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Columns (1) to (6) present the results for the estimations without missings in each of the quality-of-care indicators. In this order: waiting time for getting an appointment with a General Doctor, waiting time for emergency care, readmission rate, patient satisfaction rate, number of General Doctors, and number of nurses.

Table C8. Cash ratio and quality of care (First stage estimates)

Dependent variable: Cash ratio

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
$S_{2010} * TCVS_{it} * Post[= 1\ if\ t \geq 2015]$	-0.350**	-0.258	-0.143	-0.368**	-0.325*	-0.379**
	(0.167)	(0.172)	(0.171)	(0.165)	(0.167)	(0.161)
Share of contracts with insurers in the subsidized regime	0.0852**	0.0870**	0.0461	0.0672*	0.107***	0.0703*
	(0.0401)	(0.0400)	(0.0411)	(0.0384)	(0.0398)	(0.0374)
Share of contracts with insurers in the contributory regime	-0.0330	-0.0288	-0.117*	-0.0598	-0.0155	-0.0633
	(0.0844)	(0.0834)	(0.0706)	(0.0823)	(0.0817)	(0.0802)
Number of beds	-0.00169**	-0.00158***	-0.000881*	-0.00121**	-0.00104*	-0.00121**
	(0.000776)	(0.000584)	(0.000507)	(0.000513)	(0.000531)	(0.000508)
Outpatient care rooms	0.00242**	0.00296***	0.00226**	0.00214**	0.00182**	0.00215**
	(0.000998)	(0.00105)	(0.000951)	(0.000878)	(0.000836)	(0.000865)
Examination rooms in the emergency department	-0.00161***	-0.0102	-0.00946	-0.00162***	-0.00162***	-0.00162***
	(4.59e-05)	(0.00949)	(0.00805)	(5.06e-05)	(4.61e-05)	(5.34e-05)
Delivery beds	0.0321	0.0183	0.0250	0.0274	0.0301	0.0259
	(0.0209)	(0.0231)	(0.0206)	(0.0191)	(0.0192)	(0.0188)
year=2010	0.0107	0.0158	0.0107	0.0176	0.0128	0.0171
	(0.0217)	(0.0223)	(0.0231)	(0.0216)	(0.0186)	(0.0206)
year=2011	-0.0273	-0.0168	-0.00502	-0.0147	-0.00824	-0.0122
	(0.0221)	(0.0223)	(0.0241)	(0.0220)	(0.0209)	(0.0211)
year=2012	-0.0469**	-0.0343*	-0.0335	-0.0397*	-0.0237	-0.0399**
	(0.0210)	(0.0205)	(0.0219)	(0.0209)	(0.0204)	(0.0200)
year=2013	0.109***	0.0957***	0.0916***	0.117***	0.119***	0.116***
	(0.0274)	(0.0265)	(0.0275)	(0.0274)	(0.0278)	(0.0264)
year=2014	0.144***	0.129***	0.106***	0.149***	0.162***	0.148***
	(0.0298)	(0.0306)	(0.0311)	(0.0297)	(0.0302)	(0.0286)
year=2015	0.125***	0.0737**	0.0476	0.123***	0.135***	0.129***
	(0.0318)	(0.0300)	(0.0316)	(0.0319)	(0.0325)	(0.0308)
year=2016	0.0336	-0.0162	-0.0416	0.0310	0.0528	0.0369
	(0.0336)	(0.0332)	(0.0337)	(0.0334)	(0.0348)	(0.0325)
year=2017	0.0590*	0.0262	-0.0187	0.0538	0.0755**	0.0591*
	(0.0330)	(0.0329)	(0.0329)	(0.0329)	(0.0333)	(0.0317)
year=2018	0.0926***	0.0532	0.0196	0.0874**	0.103***	0.0917***
	(0.0352)	(0.0347)	(0.0342)	(0.0348)	(0.0355)	(0.0338)
year=2019	0.0911**	0.0592	0.0226	0.0935**	0.110***	0.0974***
	(0.0367)	(0.0362)	(0.0354)	(0.0366)	(0.0376)	(0.0353)
Constant	0.323***	0.341***	0.369***	0.348***	0.274***	0.340***
	(0.0447)	(0.0499)	(0.0435)	(0.0410)	(0.0403)	(0.0400)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,476	8,781	8,276	9,828	8,879	10,081
R-squared	0.016	0.013	0.012	0.015	0.017	0.015
Number of hospitals	893	878	843	931	884	931
F statistic	97.89	6.28	5.50	80.53	99.91	72.59
Kleibergen-Paap LM (p-value)	0.048	0.051	0.045	0.227	0.515	0.134

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Columns (1) to (6) present the results for the estimations without missings in each of the quality-of-care indicators. In this order: waiting time for getting an appointment with a General Doctor, waiting time for emergency care, readmission rate, patient satisfaction rate, number of General Doctors, and number of nurses.

Table C9. Current liquidity ratio and quality of care (First stage estimates)

Dependent variable: Current liquidity ratio

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
$S_{2010} * TCVS_{it} * Post[= 1\ if\ t \geq 2015]$	-0.854***	-0.621***	-0.425*	-0.794***	-0.682***	-0.824***
	(0.233)	(0.240)	(0.237)	(0.227)	(0.226)	(0.224)
Share of contracts with insurers in the subsidized regime	0.0857	0.0759	0.0323	0.0793	0.117**	0.0833
	(0.0590)	(0.0582)	(0.0583)	(0.0572)	(0.0585)	(0.0560)
Share of contracts with insurers in the contributory regime	0.0330	0.0780	-0.0281	0.0407	0.0503	0.0539
	(0.117)	(0.113)	(0.108)	(0.117)	(0.113)	(0.114)
Number of beds	-0.00183*	-0.00148*	-0.000601	-0.000992	-0.000833	-0.000992
	(0.000988)	(0.000756)	(0.000688)	(0.000691)	(0.000737)	(0.000684)
Outpatient care rooms	0.00356**	0.00493***	0.00290**	0.00335**	0.00260**	0.00327**
	(0.00144)	(0.00149)	(0.00123)	(0.00137)	(0.00131)	(0.00133)
Examination rooms in the emergency department	-0.00118***	-0.00733	-0.00853	-0.00121***	-0.00120***	-0.00120***
	(7.38e-05)	(0.0132)	(0.0110)	(8.78e-05)	(7.86e-05)	(8.44e-05)
Delivery beds	0.0615**	0.0503*	0.0457*	0.0501**	0.0576**	0.0481**
	(0.0252)	(0.0270)	(0.0240)	(0.0231)	(0.0232)	(0.0228)
year=2010	-0.0465*	-0.0412*	-0.0390	-0.0412*	-0.0294	-0.0351
	(0.0244)	(0.0250)	(0.0267)	(0.0246)	(0.0223)	(0.0232)
year=2011	-0.0217	-0.0231	-0.0200	-0.0161	0.0100	-0.00644
	(0.0268)	(0.0275)	(0.0288)	(0.0274)	(0.0257)	(0.0261)
year=2012	-0.0251	-0.0228	-0.0400	-0.0259	0.00991	-0.0195
	(0.0284)	(0.0292)	(0.0304)	(0.0288)	(0.0274)	(0.0274)
year=2013	0.121***	0.0995***	0.0770**	0.112***	0.156***	0.122***
	(0.0343)	(0.0349)	(0.0349)	(0.0345)	(0.0341)	(0.0332)
year=2014	0.274***	0.233***	0.185***	0.257***	0.306***	0.265***
	(0.0391)	(0.0410)	(0.0397)	(0.0390)	(0.0388)	(0.0376)
year=2015	0.386***	0.291***	0.226***	0.352***	0.401***	0.371***
	(0.0451)	(0.0460)	(0.0452)	(0.0447)	(0.0457)	(0.0438)
year=2016	0.289***	0.192***	0.132***	0.255***	0.289***	0.275***
	(0.0467)	(0.0481)	(0.0484)	(0.0464)	(0.0479)	(0.0455)
year=2017	0.240***	0.147***	0.0635	0.211***	0.247***	0.224***
	(0.0482)	(0.0502)	(0.0482)	(0.0479)	(0.0483)	(0.0466)
year=2018	0.309***	0.205***	0.133***	0.279***	0.301***	0.291***
	(0.0502)	(0.0519)	(0.0507)	(0.0499)	(0.0505)	(0.0486)
year=2019	0.316***	0.233***	0.156***	0.291***	0.322***	0.304***
	(0.0509)	(0.0524)	(0.0516)	(0.0508)	(0.0516)	(0.0492)
Constant	1.820***	1.809***	1.862***	1.842***	1.730***	1.821***
	(0.0596)	(0.0678)	(0.0570)	(0.0555)	(0.0546)	(0.0540)
Year FE	yes	yes	yes	yes	yes	yes
Hospital FE	yes	yes	yes	yes	yes	yes
Observations	9,475	8,780	8,275	9,827	8,878	10,080
R-squared	0.040	0.026	0.018	0.034	0.041	0.036
Number of hospitals	893	878	843	931	884	931
F statistic	32.18	7.97	6.97	25.1	29.19	26.6
Kleibergen-Paap LM (p-value)	0.000	0.000	0.000	0.001	0.001	0.000

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Note: Columns (1) to (6) present the results for the estimations without missings in each of the quality-of-care indicators. In this order: waiting time for getting an appointment with a General Doctor, waiting time for emergency care, readmission rate, patient satisfaction rate, number of General Doctors, and number of nurses.