Essays on Economic Development and Political Economy: Evidence from Latin America

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Declaration

I certify that the thesis I have presented for examination for the PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others. The first chapter draws on work that was carried out jointly with equal share by Juan Pablo Rud and me.

Fernando Martín Aragón Sánchez

Abstract

This thesis presents three papers that contribute to our understanding of economic development. In particular, I explore the role of natural resources and political actors on economic development and provide empirical evidence from Latin America.

Chapter 1 draws on joint work with Juan Pablo Rud. In this chapter we study the impact of a large Peruvian gold mine on the local population. Using annual household data from 1997 to 2006, we find evidence of a positive effect of the mine's demand of local inputs on real income, household welfare and poverty reduction. The effects are only present in the mine's supply market and surrounding areas. We examine and rule out that the results are driven by the fiscal revenue windfall from mining levies. Using a spatial general equilibrium model, we interpret these results as evidence of welfare gains generated by the mine's backward linkages.

Chapter 2 explores empirically the effect of party nomination procedures on political selection and governance. Using a new data set of Latin American parties, I find evidence of a positive relationship between primaries, electoral performance and quality of government. I interpret these results as evidence of primaries improving political selection. To address relevant identification concerns, I use an instrumental variable approach based on determinants suggested by a model of endogenous primaries, which I test on the data.

Chapter 3 studies the role of costly taxation as an explanation of the flypaper effect: the observed greater response of public spending to grants than to increments of the tax base. I develop a model of local spending with costly taxation and test the model using data from Peruvian municipalities. I find that differences in tax collection costs explain almost one third of the flypaper effect.

Para mis padres Mina e Ismael, por todo.

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Preface

A recurrent element of economic development is that accumulation of factors of production is not always sufficient. Institutions, technology and political actors, among other factors, also play a vital role by shaping societies' ability to use their existing resources to improve their living conditions. Without this ability, societies may simply fail to exploit their development opportunities and remain trapped in a vicious circle of poverty. For example, they may fail to exploit their abundance of natural resources to promote development, to use democratic institutions to improve governance, or to spend a fiscal revenue windfall to provide public goods.

In this thesis, I study these phenomena in the context of Latin America. First, I study whether access to natural resources benefit local communities and the mechanisms for this to happen. Second, I explore the role of party institutions, in particular nomination procedures, on political selection and quality of government. Finally, I investigate how tax collection costs shape the responsiveness of local governments' spending to grants from the central government.

Developing countries have an abundance of natural resources. They are among the largest producers of oil, gas and minerals like iron, copper, gold and aluminium and account for most of the recent growth on mining production (Humphreys, 2009). They attract a significant, and increasing, proportion of the exploration spending, a good indicator of future production. For example, Latin America attracts 29 percent of the global exploration budget and Africa, around 14 percent (World Bank, 2002b).

A main question, however, is how to transform this resource abundance into economic wealth. A body of theoretical and empirical literature suggests that natural resources may fail to benefit societies and may even hinder development (Sachs and Warner, 1999; Sachs and Warner, 2001; Caselli and Michaels, 2009) These results contrast with historical experiences of resource-rich countries such as United States, Canada, United Kingdom and Sweden, now among the most developed ones.

There are two main explanations for this "curse of natural resources": the crowding out of a productive sector with better long-term prospects (also called the "Dutch disease"), or some political economy factors such as conflict, rent-seeking, or ineffective government. We know less, however, about alternative mechanisms linking natural resources and development such as the linkages between extractive industries and the rest of the economy. Moreover, the available empirical evidence uses aggregated country-level data. While informative of broader economic phenomena, this evidence cannot address relevant questions about the effects at local level, where most of the negative effects of natural resources, such as pollution or population displacement, occur.

The first chapter of this thesis explores these issues using the case of Yanacocha, a large gold mine in Peru.[1] In particular, we study the effect of the mine expansion on

[1] This chapter draws on joint work with Juan Pablo Rud.

the income and welfare of the local population. We focus on the general equilibrium effects of the mine demand for local inputs and study the role of backward linkages as a mechanism to generate positive effects in a local economy.

We first develop an economic geography model that provides testable predictions about the effect of the demand shock from the mine on real income and relative prices at different locations. Then, we use household data to study the effect of the mine on local conditions. The identification strategy exploits variation on the mine's local procurement and distance from the household to the city where the mine buys local inputs.

We find evidence that the expansion of the mine has a positive effect on the income and welfare of the local population. The benefits accrue to both residents of the city and of the surrounding rural areas, but decrease with distance. We also document increments on the relative price of locally produced food crops such as potatoes and maize. This phenomenon explains the increase of real income in the rural areas, not directly providing goods or services to the mine.

Overall, the evidence is consistent with the demand shock from the mine creating a multiplier effect in the region that is transferred from the city to the rural area via trade of agricultural products. We also discuss and rule out that the effects are driven by the fiscal revenue windfall associated to the mine activities.

These results highlight the importance of backward linkages as a mechanism for natural resources to benefit a society. In the Peruvian case, this mechanism seems to be more important, at least in the short run, than the expansion of public spending. Moreover, these findings suggest a possible reason for the failure of natural resources: the lack of linkages between extractive industries and local economies.

A second theme in this thesis is the importance of political actors and institutions for development. Politicians play a crucial role in economic life. They implement policies, participate in the provision of public goods and contribute to enforcing the rule of law. In sum, they play a key role in setting the environment in which economic activity, and growth, takes place.

The extent to which politicians actions are aligned to the public interest is shaped, however, by the institutional setup. For example, contestable electoral processes may create incentives for self-interested politicians to act on the benefit of the majority in order to be re-elected (Besley and Case, 1995) or for parties to enhance quality of politicians to attract swing voters (Besley et al., forthcoming).

Most of the literature studying the effect of institutions on economic performance considers institutions as predetermined factors. An alternative view, however, considers that societies can choose institutions, and hence institutions are endogenous (Barbera and Jackson, 2004; Alesina and Trebbi, 2004). This endogeneity may confound the identification of the effects of institutions and suggests the importance to understand also the determinants of institutional adoption.

In the second chapter of the thesis I explore this issue in the context of Latin

American political parties. I focus on a specific party institution: the candidate nomination procedure, and explore both its determinants and the effect on political selection.

Parties play an important role in politics. They create the bridge between voters and politicians and provide the organizational support to participate in political life. By selecting politicians to run in elections, parties effectively become the gatekeepers of the political arena (Hazan and Rahat, 2006; White, 2006).

Parties use a variety of nomination procedures ranging from nomination by party leaders to more democratic procedures such as primaries (Gallagher and Marsh, eds, 1988; Hazan and Rahat, 2006). In the last 25 years, for example, around 15 percent of major Latin American parties have used primaries while the rest used less participative procedures.

Given this institutional heterogeneity, a relevant question is how nomination procedures affects political selection. This question is particularly important in contexts with weak democratic checks and balances. In those cases, existing institutions may not be enough to shape politicians incentives and societies must rely on selecting good, honest politicians to improve the quality of government (Besley, 2005).

The main problem to answer this question is that, in most cases, parties choose their internal procedures (Serra, 2007). The endogeneity of candidate selection methods has long been noted by political scientists who consider it one of the most important party decisions, even more than writing the manifesto, and a main feature to understand the internal balance of power (Katz, 2001; Lundell, 2004). I address this concern by exploring some of the determinants of institutional adoption. To do so, I first develop a model of endogenous primaries which relates its adoption to political competition and the incumbency advantage of the party leader. Then, I test the model predictions on the data. Finally, I use these determinants as instruments to identify the effect of primaries on quality of government.

Consistent with the model predictions, I find a positive and significant relationship between measures of political competition and the likelihood of primary adoption. This effect becomes insignificant when the candidate is also the party founder, a measure of strong incumbency advantage.

More importantly, I find evidence that primaries improve quality of government. In particular, during the mandate of primary-nominated presidents there is an improvement of more than one standard deviation in the measures of government efficiency (such as corruption and bureaucracy quality) as well as an increase of government size and real income per capita. I also observe that primary-nominated candidates obtain a larger vote share. The vote premium is decreasing in the size of the party -measured as the seat share obtained in legislative elections. These findings suggest that primaries improve the candidate's quality and attract non-partisan voters.

The final theme I explore is the performance of local governments in the context of fiscal decentralization. In recent years, there has been a significant increase in devolution of responsibilities, and financial resources, to sub-national governments (USAID, 2000). This process of fiscal decentralization involves allocation of tax responsibilities to local governments, but also increase of transfers from the central government. These phenomena raise the need to understand how local governments react to additional fiscal resources. Do they increase spending and provide better public goods? or do they simply replace local taxes by grants? These are relevant questions specially when the political success of decentralization requires that local governance improves.

In the last chapter of this thesis I explore a particular phenomenon associated to local governments' response to transfers: the flypaper effect. This effect refers to the greater responsiveness of public spending to grants than to increments of the local tax base. This empirical regularity has been widely reported in the fiscal federalism literature (Hines and Thaler, 1995; Gamkhar and Shah, 2007).[2] This result, however, is paradoxical in the standard grants-in-aid theoretical framework (Oates, 1999).

I develop a model that emphasizes the role of costly taxation as an explanation of the flypaper effect, a mechanism first proposed by Hamilton (1986). The model provides testable predictions about the effect of grants on local spending and taxation and relates them to tax collection costs and tax rate. Then, I test the model predictions using data from Peruvian local governments and the tenure of administrative tools as measures of tax collection costs.

I find that the spending of local governments with lower tax collection costs is less responsive to additional grants: a result consistent with a smaller flypaper effect. In particular, differences on tax collection costs explain almost one third of the observed flypaper effect. The model also predicts substitution of local taxes by grants. I find evidence of this phenomenon among local governments with lower tax collection costs. Overall, these findings support the argument that costly taxation plays a relevant role on the response of local governments to intergovernmental transfers.

[2] A similar phenomenon has been document in the aid literature and refers, more broadly, to the lack of fungibility of grants.

1 Natural Resources and Local Development

Access to natural resources has hardly been associated with development. A body of theoretical and empirical literature suggests that natural resources may not translate into better living standards or may even hinder development (Sachs and Warner, 1999; Sachs and Warner, 2001; Caselli and Michaels, 2009). The current explanations for this "natural resource curse" focus on conflict, bad institutions, ineffective government or displacement of other productive sectors like in the Dutch disease (Benjamin et al., 1989; Torvik, 2002; Caselli, 2006). The available evidence, however, tells us little about alternative channels such as the backward linkages between the extractive industry and the rest of the economy, or the consequences at local level where many of the negative effects, such as pollution or population displacement, occur.

This chapter fills this gap in the literature by investigating whether natural resources benefit local communities and exploring the economic mechanisms for this to happen. We use the case of Yanacocha, a large gold mine in Peru, as a testing ground and evaluate the effect of the expansion of the mine on the income and welfare of the local population. In contrast to the existing literature, we focus on the general equilibrium effects of the mine's demand of local inputs as the main transmission channel.

To inform the empirical exercise, we first develop a spatial general equilibrium model based on Fujita and Krugman (1995). In this setup, there is a single city surrounded by a rural hinterland. The city specializes in the production of manufactured goods while the rural area produces food. Both areas engage in costly intra-regional trade and are also able to import goods from other regions. The model treats the expansion of the mine as a demand shock on local labor in the city and delivers two testable predictions. First, if the mine expansion increases city's real income, then the agricultural real income also increases. The effect wanes the longest the distance to the mine's input market due to transportation costs. Second, there is an increase in the relative price of locally produced food due to the relative larger demand. The increase in agricultural prices transmits the income gains to the rural population, not directly supplying goods or services to the mine.

We test these predictions using household data from repeated cross sections. The data comes from household surveys -representative of the region where the mine is located- for the period 1997 to 2006. We exploit two sources of variation to identify the effects of the mine expansion. First, we use the significant increase in Yanacocha's local purchases and wage bill since 2000. This phenomenon was driven by the increment on gold extraction and the implementation of a corporate policy directed at increasing local procurement and employment. Second, we use the distance from the household location to Cajamarca city -the mine's local supplying market- as a source of heterogeneous exposure to the mine's expansion.

We find a positive effect of the mine's activities on real income in the city and surrounding areas. The effect decreases monotonically with distance and becomes insignificant beyond 100 km from the city. Our estimates suggest that a 10 percent increase in the mine's local purchases and wage bill is associated with an increase in real income of 1.7 percent. We also observe increments on the relative price of local food crops, such as potatoes and maize. This is consistent with the effect on real income being driven by a market mechanism and explains how the rural population benefitted from the demand shock in the city markets.

Nonetheless, in the presence of locational externalities associated to the mine (such as pollution or crime), increments on real income do not imply an increase in welfare. Similarly, the average increase in income may hide negative re-distributional effects, for example if poor households are unable to benefit from the mine expansion. To explore these questions, we first follow Roback (1982) who suggests using house prices as a measure of welfare.[3] We find evidence of increments on house rental prices, in line with the observed increase in real income, which we interpret as evidence of net welfare gains due to the mine expansion. Second, we test for changes in self-reported measures of health and crime, but we do not find evidence that they have worsened with the expansion of the mine. Thirdly, we analyze the re-distributional impacts of the mine expansion. Using quantile regressions, we find that the average household income at the bottom of the income distribution has experienced an increase of real income similar to that observed for richer households. We also find evidence of poverty reduction associated to the mine expansion.

Finally, we investigate whether the observed phenomena is driven by the revenue windfall to local governments or by the mine's backward linkages. This is a relevant question because of the importance attached to the increment on public expenditure as one of the main benefits from natural resource exploitation. We show that local public spending increases due to the expansion of the mine. However, we find no evidence that this expansion of the public sector contributes to the observed increase in real income or welfare.[4] Instead, the observed phenomena seems to be driven entirely by the expansion of the mine's local purchases and employment. To the best of our knowledge, there is not previous empirical work contrasting the relative importance of these two mechanisms.

In sum, our empirical results suggest that the expansion of the mine increased real income and welfare of the local population. The effect seems to be driven by the demand shock and its multiplier effect, associated to the mine's backward linkages

[3]For an example of an empirical application, see Greenstone and Moretti (2003).

[4]Using the case of Brazil, Caselli and Michaels (2009) also find evidence suggesting that the oil revenue windfall to municipalities did not translate to increases in local income.

not to the fiscal revenue windfall. The gains are transmitted to residents in the rural area, not directly selling inputs to the mine, due to the existence of trade within the economic region. The increase in the relative price of locally produced food crops is evidence of this transmission channel.

A main policy implication of our findings is that, even in the presence of weak governments, natural resources can benefit local populations if backward linkages between the extractive industry and the rest of the economy are strong enough. This recommendation, however, hinges on the existence of economic integration in the regional economy (labor mobility and trade) as well as the existence of goods and labor markets able to supply local inputs to the extractive industry.

The lessons to be drawn from this case study are not exclusive to extractive industries: they could apply to any business venture that creates a strong demand shock in a relatively poor area. There are, however, at least two features that make large-scale mining a different and interesting case to study. First, mining is a relevant industry for developing countries.[5] According to the World Bank, around 60 countries in the world have a mining sector large enough, in terms of GDP or exports, to be a main driver of economic growth and poverty reduction (World Bank, 2002a). Nonetheless, understanding how to transform mining wealth into better living standards still remains an unsolved policy question. Second, there are well-documented negative local effects associated to mining. These negative side effects increase the need to assess both direct and indirect benefits on local communities to inform industrial and development policies.

The remainder of the chapter is organized as follows. Section 1.1 briefly reviews the relevant literature. Section 1.2 develops the analytical framework we use to explore the effect of the mine on a regional economy. Section 1.3 presents background information about Yanacocha and the relevant geographic area. Section 1.4 describes the data and identification strategy. Section 1.5 presents the main empirical results related to the model predictions. Section 1.6 explores alternative explanations of the observed phenomena. Section 1.7 presents robustness checks and section 1.8 concludes.

1.1 Related Literature

The findings in this chapter contribute to the literature studying the effect of natural resources on economic development and to the literature examining how regional markets respond to demand shocks.

There is not conclusive evidence of the effect of natural resources on development. Earlier studies use cross country data and find negative effects (Sachs and Warner, 1995; Sachs and Warner, 2001). Other papers, however, use alternative measures of

[5] Developing countries play an important role in global mining. They are the largest producers of key minerals like iron, copper and aluminium, and have almost three quarters of the world mineral resources. They account for most of the recent growth on mining production and attract an even increasing proportion of exploration spending (Humphreys, 2009).

resource abundance and fail to find a negative relation (Lederman and Maloney, 2003; Sala-i-Martin et al., 2004). Using a microeconomic approach, Michaels (2006) finds that oil abundance in U.S. counties increased specialization in primary industries, but that these costs were offset by population growth and better education. In balance, oil-rich counties enjoyed higher income per capita without increments in inequality. Black et al. (2005) explore the effect of a coal boom in U.S. counties and find modest positive spillover effects on employment. More recently, Caselli and Michaels (2009) find no evidence of positive effect of oil extraction on income in Brazilian municipalities.

In contrast, the literature on the impact of demand shocks (such as large industrial plants, construction works, casinos or military bases) find some evidence of positive regional effects on wage bill and employment (Carrington, 1996; Hooker and Knetter, 2001; Evans and Topoleski, 2002), and resident's welfare (Greenstone and Moretti, 2003).

Three features distinguish our research from previous work. First, we use a microeconomic approach where the household is the unit of observation, as opposed to counties or districts. The comprehensiveness of the data allows us to explore in more detail the mechanisms generating the spillover effects and to assess the net impact on resident's welfare. Second, we show the importance of backward linkages as a channel to improve local conditions. The mechanism we uncover hints at an alternative explanation for the failure of natural resources to promote development: few linkages with local markets. This explanation relates to a technological feature of extractive industries and complements the political economy argument used to explain the natural resource curse. Finally, we embed the study of natural resources (and local demand shocks) in the analytical framework of a new economic geography model. This allows us to explicitly explore general equilibrium effects and to introduce transportation costs, agglomeration economies and migration which are relevant factors when studying a regional economy.

1.2 Analytical framework

In this section we present a stylized model to shed light on the general equilibrium effects of the expansion of a mine on a regional economy. We use the mono-centric city model developed by Fujita and Krugman (1995) and extend it by including an export sector and interregional trade. In this framework, the mine is a foreign-owned net exporter that uses local labor as a production factor but sells all its output in international markets.[6]

We treat the expansion of the mine as a shock in the demand for local labor and explore the effect on factor and good prices, and ultimately on real income. The model allows us to analyze the spatial distribution of the effects as well as the interaction of different economic sectors.

[6]This setup resembles the characteristics of the mining activities of Yanacocha and other large modern mines.

The model stresses the role of backward linkages, rather than alternative channels such as forward linkages, agglomeration economies, public spending or technology spillovers.

1.2.1 Environment

We consider a mono-centric spatial structure à la von Thünen, as depicted in Figure 1.1. In this spatial configuration, the regional economy is a long narrow line with a single city surrounded by a rural hinterland that extends from $-f$ to f, where f represents the endogenously determined agricultural frontier. The land is of homogenous quality with one unit of land per unit of distance. Each location along the line is denoted by r. For simplicity, we drop it when referring to the city ($r = 0$).

The economy has three productive sectors: manufacturing, agriculture and an export sector. The manufacturing sector produces a large number of varieties with an increasing returns to scale technology and has a monopolistic competition structure. In contrast, the agricultural sector is perfectly competitive and produces a single homogeneous good, namely food. The export sector produces two goods: a manufactured commodity and the natural resource, which are not consumed locally. Consumers in the region can import consumption goods from other regions. Import and export goods are homogenous and their prices are set in external markets.

All manufacturing, production of the export goods and import activity takes place in the city, while the rural hinterland specializes in food production. We take this spatial system as given.[7] There are (potentially) different factor and good prices in each location r, since we assume trade within the region is costly. We use an iceberg transportation cost such that if 1 unit is transported over a distance d, only $e^{-\tau d}$ units arrive. The parameter τ represents the transportation cost and is the same for all types of goods.[8]

The region has a given population of N workers who supply inelastically one unit of labor.[9] Intra-regional migration is costless and workers can freely move among locations. They live where they work, so we rule out the possibility of commuting. The free mobility assumption implies that the population allocation within the region is endogenous. In particular, the size of the city L will depend on the spatial distribution of real wages.

[7]Fujita and Krugman (1995) show that this configuration can be an equilibrium outcome, if some conditions are met. In particular, if the population is relatively small, if manufacturing goods represent a large enough proportion of consumers' expenditure or if consumers have a sufficiently strong preference for varieties.

[8]The model predictions are similar if we assume different transportation costs for agricultural, manufactured and import goods.

[9]This assumption is very important since it precludes the possibility of inter-regional migration. However, the assumption is not a very strong one, if we take into account evidence in the next section that shows very low levels of inter-regional migration flows in Cajamarca over the analyzed period.

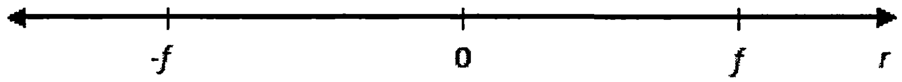

Figure 1.1: The monocentric economy

Consumers All consumers share the same homothetic preferences $U = X^{\mu}A^{\alpha}M^{1-\alpha-\mu}$, where X is a composite index of the domestically produced manufactured goods, A is the agricultural good or food and M is the import good. The quantity index X is a CES function of the consumption of each available variety:

$$X = \left(\int_0^v c_i^{\rho} di\right)^{\frac{1}{\rho}}, \ 0 < \rho < 1,$$

where c_i is the consumption of each individual variety and v is the range of varieties. The parameter ρ denotes the taste for variety and $\sigma = \frac{1}{1-\rho}$, the elasticity of substitution between varieties.

The representative consumer's budget constraint in location r is given by

$$Y(r) = p_a(r)A(r) + p_m(r)M(r) + \int_0^v p_i(r)c_i(r)di,$$

where Y is the consumer's income, p_a is the price of food, p_m is the price of the import good and p_i is the price of variety i. Note that, due to transport costs, prices and quantities are location-specific.

Consumers maximize their utility given the budget constraint. We can solve the problem in two steps.[10] First, we minimize the cost of attaining X and obtain the compensated demands for each variety $c_i(r) = \left(\frac{p_i(r)}{G(r)}\right)^{-\sigma} X$ where $G(r) = \left[\int_0^v p_i(r)^{1-\sigma} di\right]^{\frac{1}{1-\sigma}}$ is the price index for the manufacturing composite. Then, we allocate the available budget between A, M and X using the utility function parameters α and μ. The demand for the agricultural and import goods are $\alpha\dfrac{Y(r)}{p_a(r)}$ and $(1-\alpha-\mu)\dfrac{Y(r)}{p_m(r)}$ respectively, while the demand of the composite X is $\mu\dfrac{Y(r)}{G(r)}$. Combining this expression with the compensated demand we obtain the uncompensated demand for each variety:

$$c_i(r) = \mu Y(r)\frac{p_i(r)^{-\sigma}}{G(r)^{-(\sigma-1)}}. \tag{1.1}$$

Furthermore, from the indirect utility function we can obtain the cost of living in a specific location r:

$$P(r) = G(r)^{\mu}p_a(r)^{\alpha}p_m(r)^{1-\alpha-\mu}. \tag{1.2}$$

[10] For a detailed exposition see Fujita et al. (1999, pp. 46-48).

Manufacture producers The local manufacturing industry uses an increasing returns to scale technology with labor as the only production factor. In particular, a firm requires $l_i = F + \beta x_i$ units of labor to produce x_i units of a variety of the manufacturing good. The presence of increasing returns to scale implies that each variety is produced by a single firm. There is free entry and exit to the industry, hence in equilibrium manufacturing firms make zero profits.

A firm's profit is equal to $p_i x_i - w l_i$, where $x_i = c_i$ as in equation (1.1) and w is the wage in the city.[11] The resulting profit-maximization price is

$$p_i = \frac{\sigma}{\sigma - 1}\beta w. \tag{1.3}$$

Note that this result implies $p_i = p$, i.e. all varieties have the same price, since they all share the same marginal cost β. It follows that the manufacturing price index becomes $G = p v^{\frac{1}{1-\sigma}}$ and the location-specific individual demand for each variety (1.1) as

$$c(r) = \frac{\mu Y(r)}{p(r) v}. \tag{1.4}$$

From the zero-profit condition we obtain a firm's individual supply $x = \dfrac{F(\sigma - 1)}{\beta}$ and its labor demand $l = F\sigma$.

Agricultural production and rural hinterland Farming uses a fixed proportion technology. It requires one unit of land and c_a units of labor to produce one unit of food. Food is consumed locally and the surplus, a proportion $1-\alpha$, is sold to the city.[12] Landlords live in their landholdings, hence all the agricultural income is consumed locally. For a given frontier f, the total demand of labor from the agricultural sector is $2c_a f$ and total food supply to the city is $2\,(1-\alpha)\int_0^f e^{-\tau r} d$.

Food is traded in the city at a price p_a. However, due to transportation costs, the price of food received by farmers decreases with distance to the city, i.e. a farmer in location r receives $p_a(r) = p_a\, e^{-\tau|r|}$ where $|r|$ measures the distance to the city. This means that the opportunity cost of consuming food is lower the greater the distance to the city.

In contrast, since the manufactured goods and import need to be shipped from the city to rural areas for their consumption, the corresponding prices increase with distance. In particular, in location r the price of the manufacture composite is $G(r) = Ge^{\tau|r|}$ and the price of imports, $p_m(r) = p_m e^{\tau|r|}$. Taken together, these results imply that the price index in location r is

$$P(r) = Pe^{(1-2\alpha)\tau|r|}. \tag{1.5}$$

[11]In the city, given the manufacturing sector zero-profit condition, the wage w is also the average income.

[12]This follows from the representative consumer's maximizing food consumption.

Since landlords use c_a units of labor to produce one unit of food, their rents are $R(r) = p_a\ e^{-\tau|r|} - c_a w(r)$, where $w(r)$ is the wage rate in location r. The hinterland extends around the city up to the point where rents are zero, or $w(f) = \frac{p_a e^{-\tau f}}{c_a}$. Costless migration implies that in equilibrium the real wage is the same in all locations. In particular, we compare the real wage in the city and in the agricultural frontier to obtain the following wage equalization condition:[13]

$$w = \frac{p_a e^{-2(1-\alpha)\tau f}}{c_a}. \tag{1.6}$$

Finally, we derive total demand for manufactures and import goods from the rural hinterland. Note that a proportion μ of the local income is consumed in the manufactured good while the remaining $1-\alpha-\mu$ is spent on imports. In the rural hinterland, the total income -distributed between landlord and workers- corresponds to the price of the agricultural output $p_{a(r)}$. Since landlords and agricultural workers share the same homothetic preferences, we can treat their demand as the one of a representative consumer. Replacing the values of local prices and income, we obtain the total demand of each manufactured good variety and import goods from the rural hinterland:

$$\text{Manufactured goods:} \quad 2\mu\frac{p_a}{pv}\int_0^f e^{-2\tau r}dr \tag{1.7}$$

$$\text{Imported goods:} \quad 2(1-\alpha-\mu)\frac{p_a}{p_m}\int_0^f e^{-2\tau r}dr. \tag{1.8}$$

Export sector There are two types of firms in the export sector: producers of a tradeable commodity and a mine that extracts the natural resource. Both use labor as their input and sell their output in perfectly competitive external markets.

In contrast to the manufacturers supplying the domestic market, the commodity producers face decreasing returns to scale. In particular, their production function is $E\left(L_e\right) = L_e^{\varepsilon}$, where E is the amount produced of the commodity, L_e is the size of the workforce employed in the industry and $\varepsilon < 1$. The industry profit is $p_e E\left(L_e\right) - wL_e$, where p_e is the price of the commodity. Solving for the profit maximization problem we obtain the unconditional labor demand function:

$$\text{Labor demand: } L_e\left(w\right) = \left(\frac{\varepsilon p_e}{w}\right)^{\frac{1}{1-\varepsilon}}. \tag{1.9}$$

Note that $\varepsilon p_e E$ is paid, as wages, to local workers; while the industry profits $\pi_e = \left(1-\varepsilon\right)p_e E$ are distributed among the firms' shareholders. For simplicity we assume that all shareholders reside in the city and have similar preferences than workers.

The mine uses a fixed proportion of local labor in its production process. The

[13]Real wage equalization and the price index defined in (1.5), give us a nominal wage in location r equal to $w(r) = we^{(1-2\alpha)\tau|r|}$.

demand of local labor is θS, where S is the mine's production and $\theta < 1$ is exogenously determined. Note that θ captures the extent of backward linkages between the mine and the local economy. The mine is foreign-owned and there are no taxes, hence all the profits are remitted abroad.

1.2.2 Equilibrium

The instantaneous equilibrium is given by the solution of the following system of non-linear equations:

$$\begin{aligned}
\frac{F(\sigma-1)}{\beta} &= \frac{\mu}{pv}\left(Lw + 2p_a\int_0^f e^{-2\tau r}dr + \pi_e\right) && (1.10)\\
2(1-\alpha)\int_0^f e^{-\tau r}dr &= \frac{\alpha}{p_a}(Lw+\pi_e) && (1.11)\\
L &= vF\sigma + L_e(w) + \theta S && (1.12)\\
w &= \frac{p_a e^{-2(1-\alpha)\tau f}}{c_a} && (1.13)\\
p_e E(w) + w\theta S &= (1-\alpha-\mu)\left(Lw + 2p_a\int_0^f e^{-2\tau r}dr + \pi_e\right) && (1.14)\\
p &= \beta w\frac{\sigma}{\sigma-1} && (1.15)\\
N &= L + 2c_a f. && (1.16)
\end{aligned}$$

Equation (1.10) represents the market equilibrium of each variety of the local manufacture. The total demand on the right hand side is proportional to the regional income which is composed by the wages paid to city workers, agricultural income and the profits from the commodity export firms. Equation (1.11) is the food market equilibrium condition while equation (1.12) represents the equilibrium in the city's labor market. Note that the labor demand in the city comes from local manufacturers, commodity export firms and the mine.

Equation (1.13) is the wage equalization condition (1.6) obtained from the assumption of costless migration. Equation (1.14) represents the current account's balance: in equilibrium the value of exports minus the net factor payments should be the same as the value of total imports.[14] Equation (1.15) is the manufacturers' profit maximization condition (1.3). Finally, equation (1.16) represents the population constraint, where the size of the regional population equals the number of workers in the city and in the agricultural sector.

We solve the system analytically. First note that, using (1.12) and (1.16), we can write the number of manufacturing firms, v, as:

$$v(w,f) = \frac{N - 2c_a f - L_e(w) - \theta S}{F\sigma}. \qquad (1.17)$$

[14] We assume a fixed exchange rate equal to one.

Using this result, replacing (1.14) into (1.10) and re-arranging, we obtain:

$$N - 2c_a f - \frac{(1-\alpha-\mu)\,\varepsilon + \mu}{(1-\alpha-\mu)\,\varepsilon} L_e(w) - \frac{1-\alpha}{1-\alpha-\mu}\theta S = 0. \tag{AA}$$

Note that expression (AA) defines an upward sloping curve in the space (f, w). This curve has a positive intercept and also an upper bound $\overline{f}$ on the values that f can adopt.[15]

Second, using (1.9), (1.13) and (1.16), solving for the integral over f and rearranging, we can rewrite the equilibrium condition in the food market (1.11) as:

$$2c_a[\frac{(1-\alpha)(1-e^{-\tau f})}{\alpha e^{-2(1-\alpha)\tau f}} + f] - N - \frac{(1-\varepsilon)}{\varepsilon} L_e(w) = 0. \tag{BB}$$

This expression defines a downward sloping curve in the space (f, w), with a lower bound $\underline{f}$ on the values of f.[16]

Intuitively, the curve AA is upward sloping because with a larger rural hinterland (higher f), the city has a smaller population and hence the labor supply is smaller. This translates into higher wages in the city. In contrast, curve BB is downward sloping because higher wages in the city increase agricultural wages (due to costless intra-regional migration). In turn, this means that the marginal farmer makes losses and hence the agricultural frontier shrinks (smaller f).

To solve the model we plot curves AA and BB (see Figure 1.2). The intersection of both curves at point Q provides the unique pair (f^*, w^*) that solves the system and defines the equilibrium.[17]

1.2.3 The Effects of the Mine's Expansion

We are now ready to use the model to perform a thought experiment and analyze the effect of the mine's expansion on the regional economy. We simulate the expansion of the mine as an increase in S, the amount of natural resources extracted by the mine. The immediate effect of this shock is to increase demand of labor and shift the curve AA upwards as depicted in Figure 1.3. To understand this shift, note that f defines the distribution of people between city and rural countryside, and thus the labor supply in each area. Hence, keeping the labor supply fixed, increments on the demand for labor in the city due to the mine expansion would increase local wages.

As we see in Figure 1.3, the equilibrium moves from point Q to $Q\prime$ with a higher wage in the city but smaller f. The reduction on f implies a smaller extension of agricultural frontier and a larger city population. Since N is assumed to be fixed,

[15]To see this, note that $\overline{f} \equiv \lim_{w\to\infty} f = \frac{1}{2c_a}\left(N - \frac{1-\alpha}{1-\alpha-\mu}\theta S\right)$ and that $\lim_{f\to 0} w = L_e^{-1}\left(2c_a\overline{f}\frac{(1-\alpha-\mu)\varepsilon+\mu}{(1-\alpha-\mu)\varepsilon}\right)$, where L_e^{-1} is the inverse function of $L_e(w)$.

[16]Note that $\underline{f} \equiv \lim_{w\to\infty} f = g^{-1}(N)$, where $g^{-1}(\cdot)$ is the inverse function of $g(f) \equiv 2c_a[\frac{(1-\alpha)(1-e^{-\tau f})}{\alpha e^{-2(1-\alpha)\tau f}} + f]$.

[17]See Appendix A.1 for a formal proof.

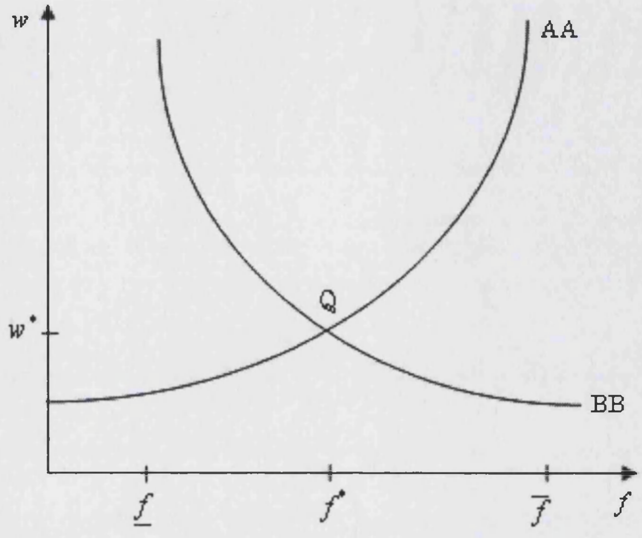

Figure 1.2: Model equilibrium

the grow of the city requires migration of agricultural workers to the city.[18] In this model, the increase in wages -triggered by the mine expansion- is partially offset by migration to the city.

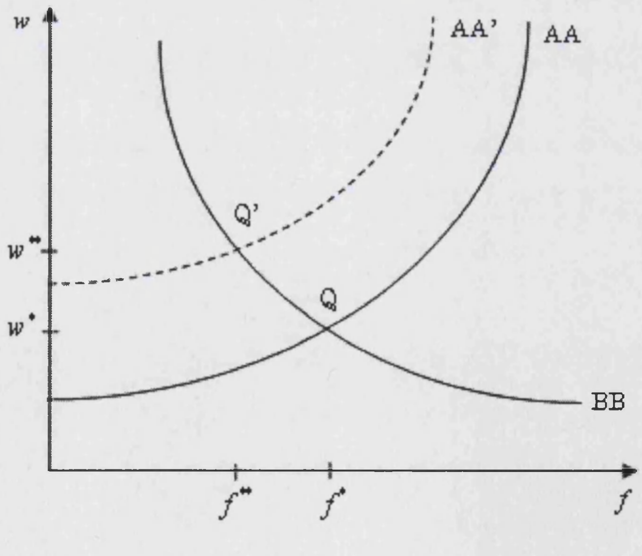

Figure 1.3: The expansion of the mine

Crowding out The expansion of the mine, and the subsequent wage increment, displaces other economic activities. First, the reduction on the agricultural frontier

[18] The assumption of a fixed N is important to obtain the model predictions. If we assume instead costless inter-regional migration, the effect of the mine expansion on real income would be zero.

implies a smaller agricultural production. Second, the higher wage reduces the employment, output and profits of the export sector which uses labor as its only production factor. This result is similar in flavor to the "Dutch disease", commonly found in macroeconomic models of resource boom (Corden and Neary, 1982). In this case, the crowding out is driven by increase in the relative price of a production factor.

Nonetheless, the effect on the local manufacturing industry could be either positive or negative. On the one hand, the growth of the city population favors the increase in the number of firms, v, due to the increasing returns to scale. On the other hand, this positive effect is offset by the expansion of the mine's labor demand, which reduces the labor available for manufacturing firms. The net effect depends on the extent of the mine's backward linkages, θ. In particular, if it is sufficiently high, v would increase, because the multiplier effect would make the city population grow enough to satisfy the additional labor demand from the mine without harming the manufacturing industry.[19]

Effect on real wages From (1.2), we can obtain an expression for the real wage in the city:

$$\omega = \frac{w}{P} = \left(\frac{w}{G}\right)^{\mu} \left(\frac{w}{p_a}\right)^{\alpha} \left(\frac{w}{p_m}\right)^{1-\alpha-\mu}, \tag{1.18}$$

where $G = pv^{\frac{1}{1-\sigma}}$ and $\sigma > 1$.

Note that the wage relative to the price of food and import goods ($\frac{w}{p_a}$ and $\frac{w}{p_m}$) increases as a consequence of the expansion of the mine.[20] These results highlights two sources for real wages to increase: the increase in the payments to labor relative to land rents, due to the additional demand; and the access to relatively cheaper import goods. However, the effect on real wages is ambiguous, because these gains may be offset by higher price of manufactured goods (G), if the number of firms reduces.[21]

1.2.4 Testable Predictions

The previous results provide the basis for the two testable predictions of the model regarding the effect of the mine expansion on real income and relative prices.

Effect on real income The income of households located in the city and rural hinterland comes from different sources. In the city, the households' income is composed by wages and the dividends from export firms. In contrast, in the rural hinterland the income is proportional to the value of the agricultural output $p_a(r)$. Taking that into

[19]See Appendix A.2 for a formal derivation of the condition.

[20]To see this note, from (1.13), that $\frac{w}{p_a}$ is decreasing on f and hence increases with S. Additionally, given that the price of imports p_m is exogenously determined and w increases, $\frac{w}{p_m}$ also increases.

[21] We can, however, identify two plausible cases in which the real wage increases: when v increases, and when v decreases but local manufactures represent a small proportion of the budget (small μ). See Appendix A.3 for a formal derivation of these conditions.

account, we can write the average real income in location r as:

$$y(r) = \begin{cases} \omega + \frac{\pi_e}{PL} & \text{if } r = 0 \\ \frac{1}{k}\frac{p_a}{P}\, e^{-2(1-\alpha)\tau|r|} & \text{if } r \neq 0, \end{cases} \tag{1.19}$$

where $y(r)$ is the average real income, P is the general price index in the city, and k is the unknown, but constant, population size in each rural locality.[22]

The effect of the mine expansion on the income of city residents is, a priori, unclear and remains an empirical question. On the one hand, it increases due to higher wages. On the other hand, it decreases due to reduction on the profit of export firms, crowded out by the mining sector, and the (potential) increase in the price of the manufactured good due to the smaller number of firms.

We focus on the case in which the real income in the city increases with the mine expansion. In this case, the model provides clear testable predictions regarding the relation between income in the city and rural hinterland and relative prices.

Proposition 1 *If the real income of city residents increases, then the real income of rural inhabitants must also increase.*

Intuitively, the growth of urban income combined with the larger city population increases the demand for food. This shift of demand, combined with the reduction on food supply due to the smaller agricultural frontier, necessarily results on an increase in the price of food and on higher income in rural locations.

To explore the effects on welfare, note that the indirect utility of a household in location r is $V(r) = \mu^\mu \alpha^\alpha (1-\mu-\alpha)^{1-\mu-\alpha} y(r)$. Hence, the real income becomes a sufficient statistic for welfare. This result, however, does not hold in presence of externalities from the mine. For that reason, in the empirical section we explore different measures of welfare in addition to real income.

In this model, the shock of demand created by the mine expansion directly affects the city's labor and goods markets. The effect is transmitted to the surrounding rural areas due to the trade links between the city and its rural hinterland. Since intra-regional trade is limited by the existence of transportation costs, a relevant question is how the effects of the mine expansion are distributed spatially in the economic region.

Proposition 2 *When the mine expansion increases real income, the effect decreases monotonically with distance to the city.*

The model predicts heterogeneous effects by distance, because transportation costs reduce the land rents for farmers in farther locations and absorb part of the gains on real income. In the extreme, beyond the agricultural frontier, the effect is nil since there is no trade with the city. In the empirical section, we use this insight as a key

[22] Recall that in each farm there are c_a workers and a landlord, but the total population is not $1+c_a$ since a landlord can also be a worker.

element of the identification strategy. In particular, we obtain the distance from a locality to the city, and use it as a measure of different exposure of households to the mine expansion.

Effect on relative prices The increase of real income, and its transmission to agents not directly employed by the mine, are driven by changes in the relative prices of labor and food. To explore this mechanism further, we use the model to obtain predictions regarding the effect of the mine expansion on relative prices within the economic region. We focus on two types of goods that are possible to identify in the data: the agricultural good and the import good.

Proposition 3 *If the real income of city residents increases due to the mine expansion, then* $\frac{p_a(r)}{P(r)}$ *also increases. The effect on* $\frac{p_m(r)}{P(r)}$ *is ambiguous.*

The relative price of food in the region increases because it is proportional to the real agricultural income. In contrast, the effect on the relative price of the import good is ambiguous since G, one of the components of the price index may increase or decrease. However, if local manufactures represent a small proportion of the consumption basket, then the relative price of imports would actually decrease due to the increase in price of food. A corollary of this result is:

Proposition 4 *if the real income of city residents increases due to the mine expansion, then the increase in* $y(r)$ *is greater than the increase in* $\frac{Y(r)}{p_a(r)}$*, where* $Y(r)$ *is the nominal income in location* r*.*

Note that $\frac{Y(r)}{p_a(r)} = \frac{y(r)}{p_a(r)/P(r)}$. It is straightforward to see that the change on $\frac{Y(r)}{p_a(r)}$ is smaller than the change on $y(r)$ since $\frac{p_a(r)}{P(r)}$ also increases due to the mine expansion.

This result sheds light on the transmission channel of the effect from the city to the rural hinterland. Since rural income increments are driven for higher food prices, the income relative to the price of food should not vary as consequence of the mine expansion. In the city, the increment may be positive, but still smaller than the increase in y.

1.3 The Case of Yanacocha Gold Mine

Peru has a long tradition as a mining country and ranks among the top producers of minerals in the world.[23] In the late 1990s it experienced a mining boom and the sector expanded significantly. In the relevant period for our analysis, from 1997 to 2006, the mining product grew at an average annual rate of 7.4 percent while the economy's growth rate was around 3.5 percent. As a consequence, the share of the mining sector in GDP went from 3.8 to 5.2 percent (Banco Central de Reserva del Perú, 2009). The

[23] In 2006 it was the first producer of gold, zinc, silver, lead and tin in Latin America and among the top five producers of those minerals in the world (Ministerio de Energía y Minas, 2006).

mining growth has been mostly driven by the opening and expansion of large mining operations in gold, copper and silver.[24]

One of the largest new mines is Yanacocha. The mine is privately owned and none of the investors resides in the locality.[25] Yanacocha is the second largest gold mine in the world, representing around 45 percent of the total Peruvian gold production, and the most profitable. The mine extracts gold from open pits and uses a very capital intensive technology. All production is exported as gold bars, with no other processing or added value. This feature precludes the creation of forward linkages.

The mine is located in the department of Cajamarca in the North Highlands of Peru. The department of Cajamarca is mostly rural and relatively poor. In 2006, Cajamarca was the eighth department (among 24) in terms of incidence of poverty, with 63.8 percent of the population living below the poverty line (INEI, 2007). The mine is located less than 50 km away from Cajamarca city, the department's capital and largest urban settlement (see Figure 1.4 for a map of the spatial configuration). Due to the proximity to the city, most workers and local suppliers live there. This feature facilitates our analysis, because the city becomes the geographical market where the mine purchases local goods and services.[26] There are other three major cities in the surrounding regions (Trujillo, Chiclayo and Chachapoyas) and some small and medium mines in the south of Cajamarca.[27]

Local procurement Yanacocha started operations in 1993, and its production increased steadily over time. In 2001, it expanded its production due to the opening of new gold deposits Figure 1.5 shows the expansion of the mine production since 1997 and the change of trend since 2001 associated to the expansion of the production capacity.

The growth on the mine size has required a steady increase in the purchase of production inputs such as explosives, machinery, oil, laboratory services, limestone, etc. As we will see below, the mine expansion coupled with a shift in procurement policies has increased Yanacocha's local purchases and employment.

Yanacocha procures its inputs in three ways: purchasing goods to suppliers, directly hiring workers and contracting out services. In terms of origin, Yanacocha classifies the supplying firms as local and non-local depending of where they are registered for tax purposes and the origin of their shareholders.[28] In particular, for a firm to be considered local it has to pay taxes in Cajamarca and have at least 50 percent

[24] Some of the new mines are Yanacocha (gold), Pierina (gold) and Antamina (silver and copper).

[25] The mine shareholders are: Newmont Mining Co., with more than 50 percent of the shares, Compañia de Minas Buenaventura (more than 40 percent of the shares) and the World Bank (around 5 percent of the shares). Newmont Mining Co. is a U.S. based company, while Compañia de Minas Buenaventura has its headquarters in Lima, Peru's capital city.

[26] Yanacocha classifies its purchases by origin as local (sourced in Cajamarca), national (bought from the rest of the country, mostly Lima) and foreign.

[27] These mines use more traditional technologies, have smaller scale and are more labor intensive than Yanacocha.

[28] The non-local category includes Lima, rest of Peru, and other countries.

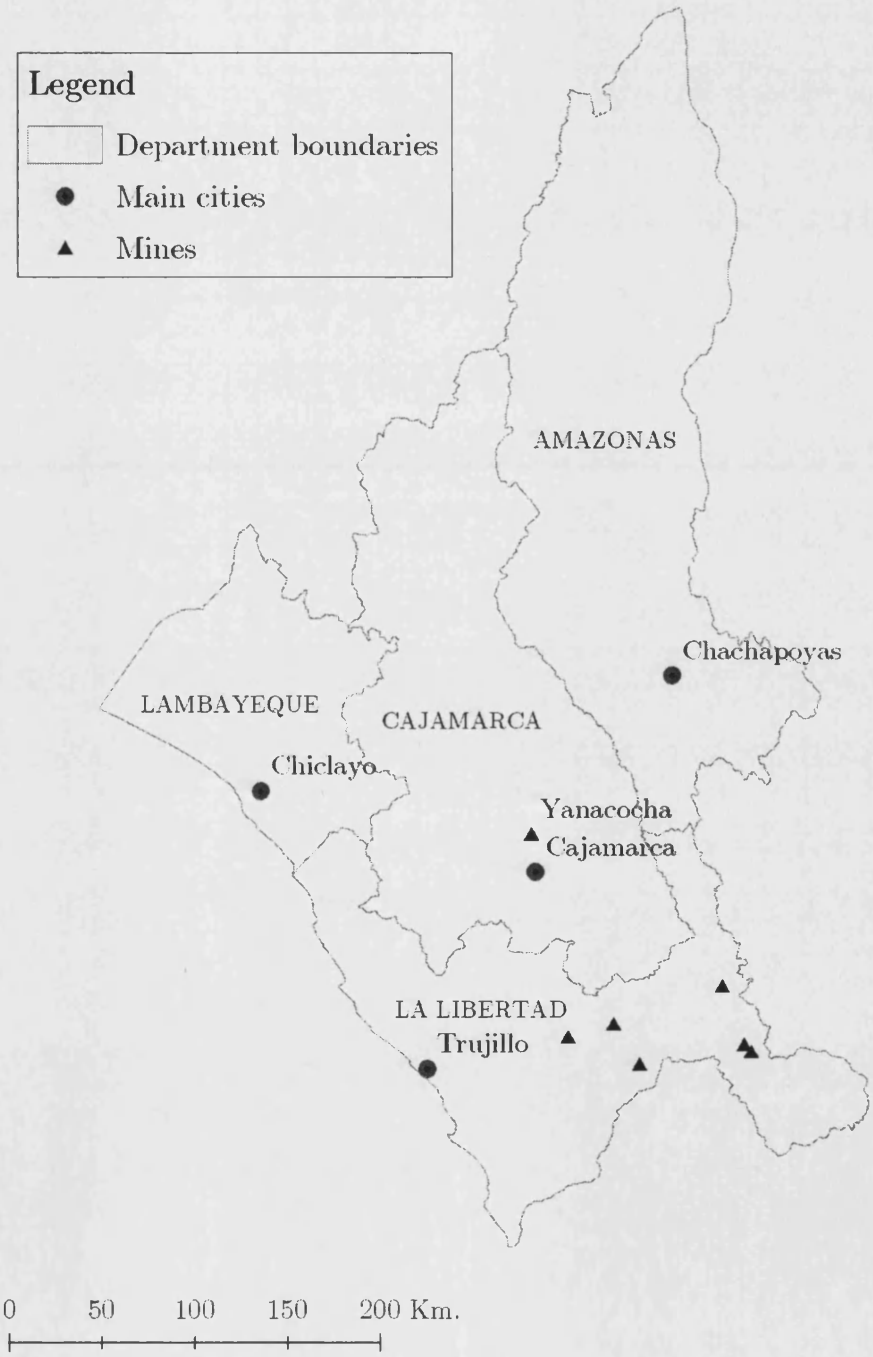

Figure 1.4: Location of mine and main cities

of Cajamarquinos among their shareholders. For individuals, the requirement is to be born in Cajamarca or to demonstrate continuous residence for at least five years in Cajamarca.[29]

In the first years of operation, Yanacocha had little economic interaction with the city of Cajamarca and its surroundings, with only a very small proportion of inputs bought locally (Kuramoto, 1999). For example, in 1998 the value of purchases from Cajamarca represented 3 percent of total good purchases and 15.5 percent of services. In contrast, purchases from Lima were 77.5 percent and 72.6 percent of goods and services respectively. The rest was bought abroad or in the rest of the country. There were also very few local firms among the top mine suppliers.[30]

A shift in procurement policy Since late 1990s, the mine started a shift in its procurement and employment policies aimed to increase the participation of local firms and workers. The policy change was promoted by the International Finance Corporation (IFC), one of Yanacocha's shareholders and Newmont's main lender, as a way to increase the economic impact of the mine in the region and minimize the risk of conflict with the local population (Jenkins et al., 2007).[31]

The most important feature of the mine procurement policy was to give priority to local suppliers and workers in competitive bids and recruitment.[32] For example, a 2006 policy memorandum by the mine aiming at outsourcing services such as cleaning, waste management or transport, establishes that "in competitive bids with non-local companies, the Company has to prioritize the hiring of local small and medium enterprizes". Similarly, the memorandum specifies that the mine should ensure that at least 60 percent of personnel of the mine contractors reside in Cajamarca. This shift in policy becomes apparent in the evolution of local purchases and wage bill (including bonuses) that show a significant increase since 2000 (see Figure 1.5).

What does the mine buy locally? The local purchases consist of relatively simple services and goods, with low quality requirements and not considered vital to the mine operations. The expenditure on services is larger that the expenditure on goods.[33] The main local services contracted locally include demolition, haulage and transport of material to leach pads, and cleaning and reforestation activities. More specialized services such as transport of dangerous materials, consulting, engineering, laboratory

[29]This information was obtained from internal memorandums and interviews with Yanacocha representatives.

[30] Among the top 20 suppliers, there was only one local firm. In the case of service providers, there were four local firms among the top contractors.

[31] The IFC is promoting policies to increase supply chain linkages in other mining, oil and gas projects. For example, a similar approach is being development in a new mine operated by Newmont in Ghana.

[32]Yanacocha has also promoted quality certification among its suppliers, but it has not engaged in direct transfer of technology or training.

[33]For example, in 2004 the expenditure on services was around nine times greater than the expenditure on goods.

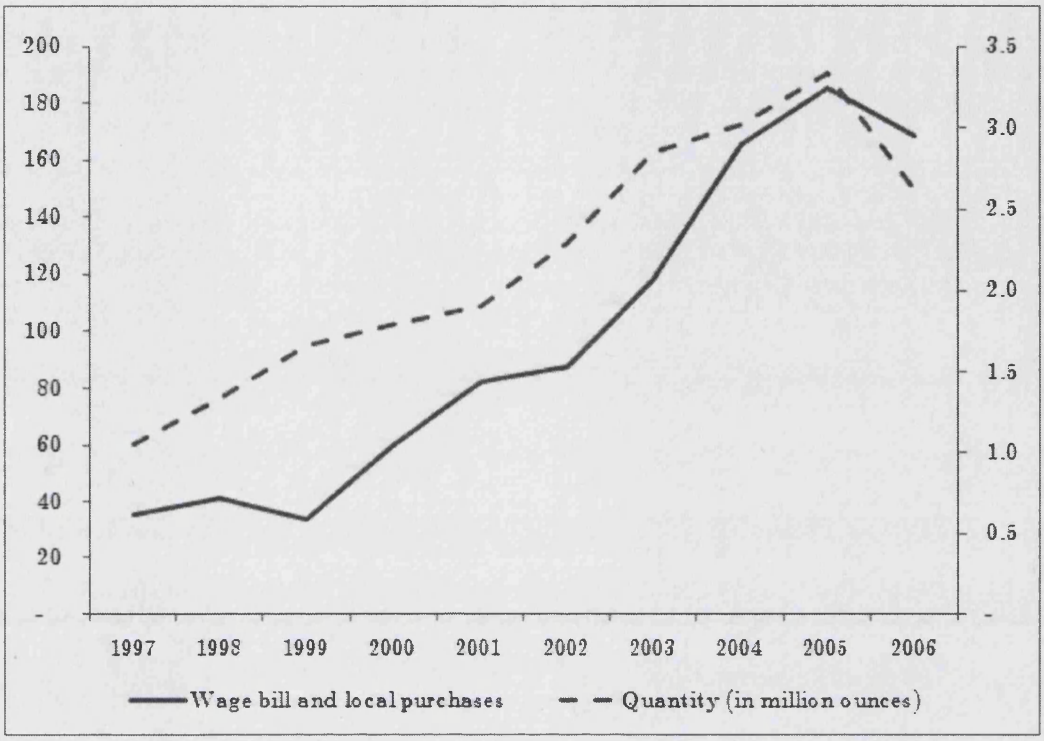

Figure 1.5: Evolution of Yanacocha's local procurement and production

analysis, etc., are supplied by firms located in Lima or abroad. In the case of goods, local purchases consists mostly of construction materials, basic hardware, cleaning materials, vehicles spare parts, chemical products, office furniture, etc.

Even though local purchases and wages would imply different channels through which the activity of the mine affects household incomes (e.g. direct effect of wages or development of backward linkages), the distinction is not as clear-cut as it seems. The mine hires some workers directly; however, most workers located in the mine site are employed by contractors who provide services to the mine.

Figure 1.6 shows the evolution of the number of workers in the mine, directly employed by Yanacocha or indirectly through contractors. In the period 1997-2006 the number of total workers increases from 4,000 to 14,000, a substantial proportion of the active population of Cajamarca. To put this numbers in context, the mine's workforce represented around 12 percent of the active population of the city of Cajamarca in 2001 and 20 percent in 2005. Consistent with the mine policies, 60 percent of the workers are locals and almost all of them live in Cajamarca (Minera Yanacocha, 2006)

The increase of mine employment occurred in 2000 and was driven mainly by workers indirectly hired through contractors. Contractor workers represent a significant proportion of the mine's workforce. In average they represent 78.5 percent of the total mine workers. Workers that are hired directly by Yanacocha, tend to be skilled (engineers, accountants, technicians, secretaries, assistants, supervisors) as opposed to low-skilled workers employed through contractors.

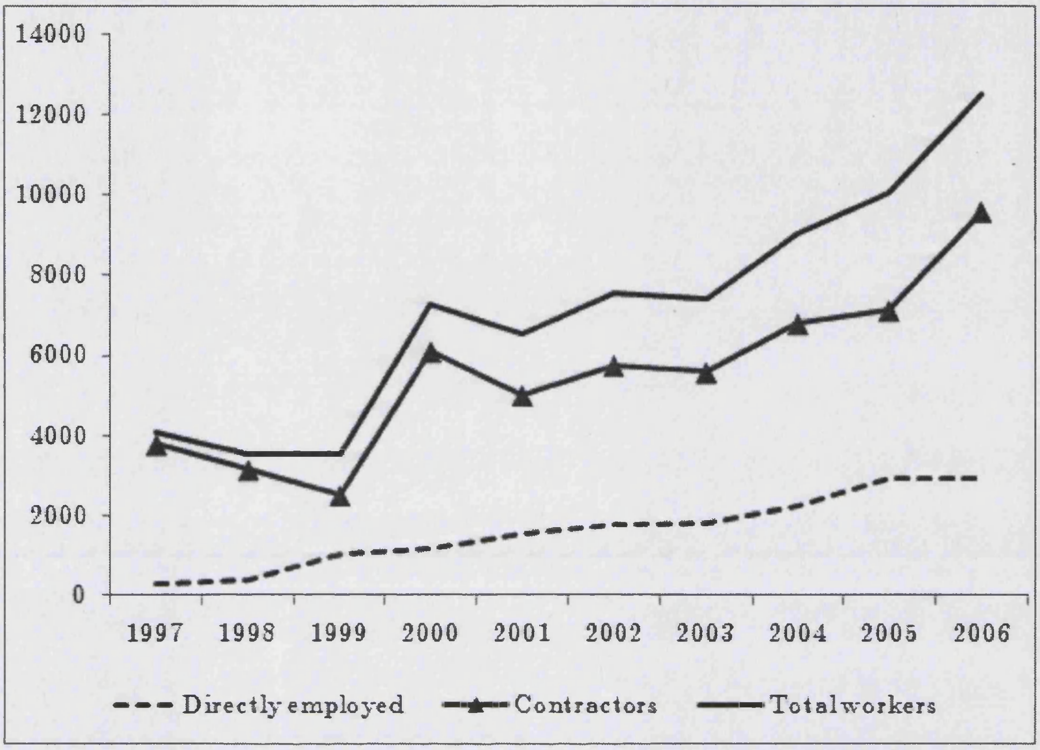

Figure 1.6: Direct and indirect employment

1.4 Data and Identification Strategy

Household data The empirical analysis uses data from repeated cross sections of the Peruvian Living Standards Survey, an annual household survey collected by the the National Statistics Office (INEI).[34]

The survey consists of a stratified household sample representative at regional level. The regions are defined for statistical purposes and consider both environmental conditions (coast, highlands and forest) and geographical location (north, center and south).[35] We focus on the North Highlands statistical region, where the mine is located. The data set covers 10 years, between 1997 and 2006, and includes more than 7700 households.[36]

Figure 1.7 shows the area of study and the spatial distribution of the sample. The area covers a surface of almost 40,000 square kilometers and had an estimated population of 1.2 million inhabitants in 2005.[37] The darker shaded areas correspond

[34]The name of the survey is *Encuesta Nacional de Hogares* or ENAHO.

[35]In general, these statistical regions are larger than departments and do not necessarily share the same boundaries.

[36] In line with the model, we restrict attention only to household with an employed household head. This filter reduces the sample by just 46 observations and does not affect the results.

[37]The population estimates are obtained from the ENAHO survey.

to districts sampled at least one year, while lighter shaded ones are districts for which there are not available observations. We can see that the sample is evenly distributed over the area of study.

The main purpose of the survey is to measure poverty and living standards. The survey contains detailed information on income, expenditure, socio-demographics (such as gender, age and educational attainment), composition of the household, housing characteristics like access to public utilities and construction materials, and self-reported incidence of health problems and exposure to crime. The data set also has extensive information on prices and agricultural activity at household level.

Additionally, we obtain the distance from the household's location to the city. We measure distance as the length of the shortest path between the main town of the household's district and Cajamarca city using the existing road network. We performed the calculation using the ArcGIS software and maps produced by the Ministry of Transport of Peru. The road map corresponds to the network available in 2001 and includes only tracks usable by motorized vehicles. In terms of the model, this variable is the empirical counterpart of r and relates to the total transportation cost from one location to the city markets. As suggested by the model, the effect of the mine expansion should decrease with distance to the mine's supplying market. As described below, we exploit this heterogenous effects by distance to identify the effect of the mine on the regional economy.

Table 3.2 shows the estimated mean of the main variables at household level. Since we are using an stratified sample, the means are estimated using sampling weights. In the second column we report the standard errors of the mean estimates, which are calculated using sampling weights and clustering by primary sampling unit.

Poverty line as a price deflator The survey provides estimates at household level of nominal income and prices. However, the model provides predictions of the effect of the mine on $y(r)$ and $pa(r)/P(r)$, the real income and relative price of food in a given location. To construct these variables we need a measure of $P(r)$, the general price index in location r.

We use the value of the poverty line as a proxy for $P(r)$. The poverty line is estimated by the National Statistics Office as the value of the minimum consumption basket that guarantees an adequate living standard. It is calculated using local prices and varies within region and over time.[38]

A concern with using poverty line as a price index is that it may not be representative of the average consumption basket. Two reasons suggest that this may not be a relevant concern. First, the proportion of households with a consumption below the poverty line is 65 percent. This implies that the median household is poor and hence the consumption basket used to calculate the the poverty line may not be too different

[38]Ideally we would like to construct a price index for each locality; however, we are limited by the lack of representativeness of the sample at more local level.

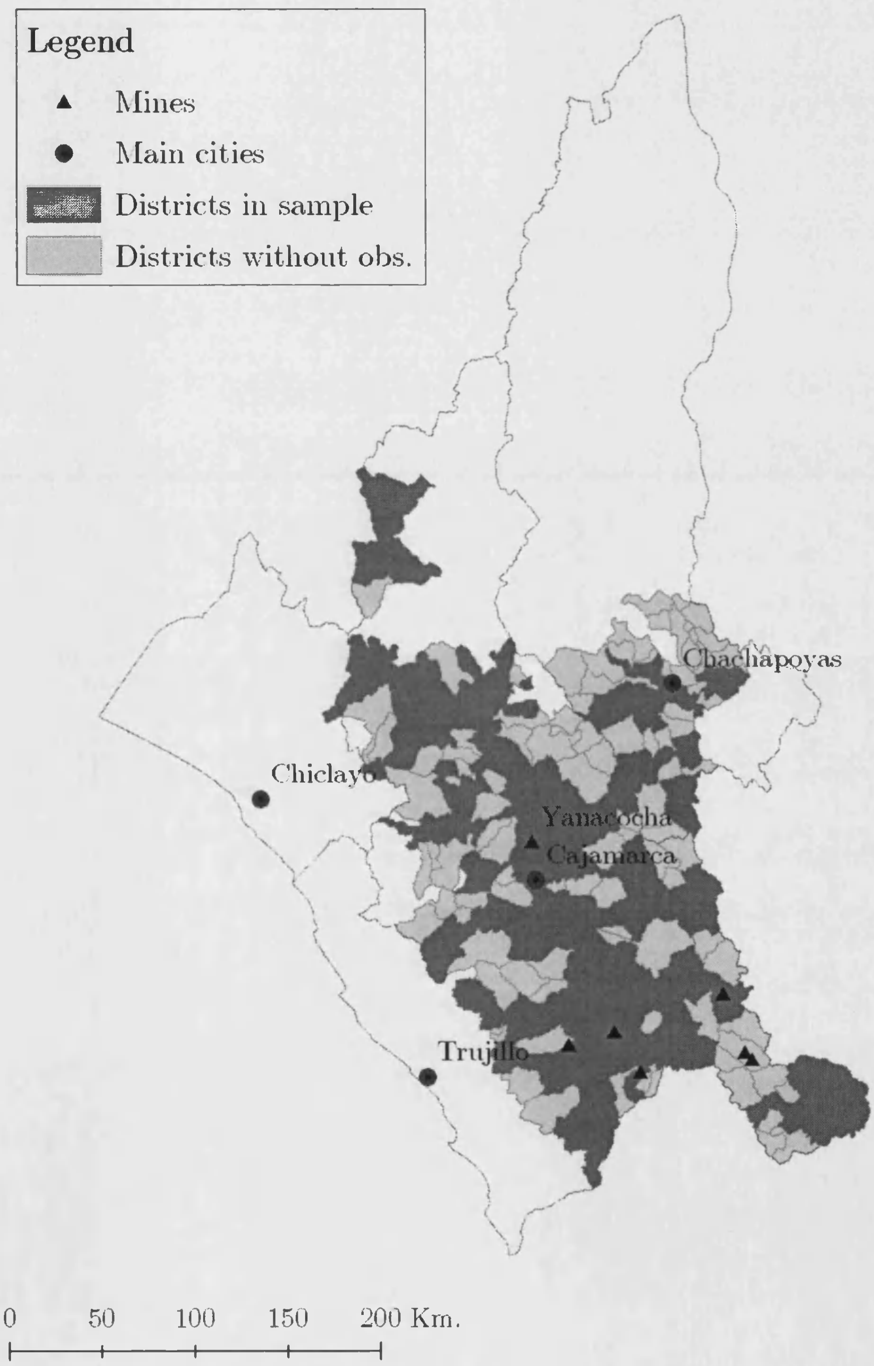

Figure 1.7: Area of study and spatial distribution of sample

Table 1.1: Summary statistics of household data

Variables	Mean N=7738	Standard error
Household head		
Years of education	4.1	0.2
Age	48.4	0.7
% female	0.129	0.021
All individuals		
% health problems	0.208	0.012
Household		
Income per capita	143.7	10.8
Expenditure per capita	149.0	8.8
Poverty line	155.9	1.6
% poor	0.651	0.048
% extreme poor	0.374	0.040
% access to electricity	0.163	0.031
% access to water	0.616	0.054
% victim of crime	0.014	0.005
Nr. Household members	4.8	0.2
Nr. Income earners	2.0	0.1
Distance to Cajamarca city (km)	108.2	7.9

Note: The mean and its standard error are calculated using sample weights and clustering by primary sampling unit.

from its actual consumption. Second, we compare the evolution of the poverty line in Cajamarca city with an index of consumer prices calculated by the National Statistics Office. This price index is only available at city level and it is used to calculate city inflation. Figure 1.8 depicts both variables, normalized to be equal to 100 in year 1997. Note that the poverty line has a similar trend until 2000 and then grows *faster* than the consumer price index.[39] Thus, if anything, the use of the poverty line as a deflator may lead to an *underestimation* of the actual increase in real income or relative prices.

Firm data To measure the expansion of the mine activities, we collect data from the Yanacocha reports on the mine wage bill, value of local purchases and quantity of gold produced (Minera Yanacocha, 2006). The frequency of this data is annual and covers the period 1993 to 2006.

Local purchases include goods and services bought to local suppliers and contractors. The wages of workers indirectly employed in the mine, through contractors, are also included in this variable. A supplier or contractor is classified as local if it is reg-

[39] This pattern is consistent with the model predictions. In particular, recall that the relative price of locally produced food may increase with mine expansion. Then if the poverty consumption basket has a larger proportion of local food than the basket used to calculate the consumer price index, we could expect the value of the poverty line to increase faster.

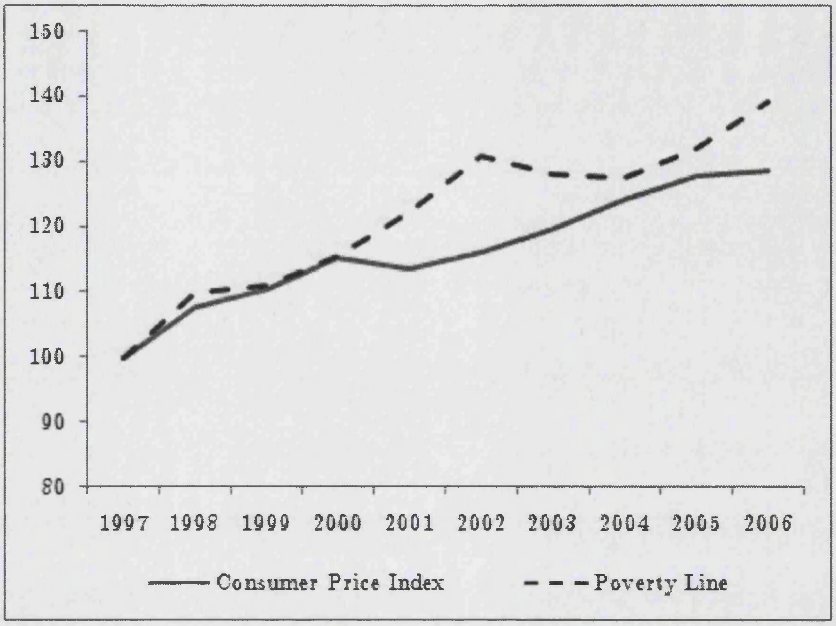

Figure 1.8: Consumer price index and poverty line for Cajamarca city

istered for tax purposes in the department of Cajamarca and the main shareholders are also locals or with permanent residence in the department. The wage bill includes net wages and bonuses paid to workers directly employed by Yanacocha. The data on wages do not separate workers by location; however, almost all the mine's workforce lives in Cajamarca city.

Panel A in Table 1.2 presents summary statistics for the firm level data over the period 1997 to 2006. The value of wage bill and local purchases is measured in million of U.S. dollars while the quantity produced is measured in million of ounces.

Municipality data We complement the household and firm data with data at municipality level.[40] Municipalities are the lowest tier of autonomous local government with jurisdiction over districts. We use this administrative unit to calculate the distance from the city to the households.

We obtain annual data about revenues and expenditures for each municipality in the North Highlands region and within 400 km from Cajamarca city. This geographical scope corresponds to the distance range observed in the household data. The dataset includes information on 179 municipalities over the period 1998 to 2006.

Our dataset contains detailed information about the sources of revenue, including the amount of mining transfers received. This information provides a reliable measure of the magnitude of the revenue windfall experienced by each local government. The expenditure is also divided between capital and current expenditures. This is a

[40]We use this data in Section 1.6.1 to evaluate the role of the fiscal revenue windfall as an alternative explanation of the observed phenomena.

relevant distinction since the mining transfers are earmarked to capital expenditures, and hence we can expect a relative increase of this category of expenditure.[41]

Panel B in Table 1.2 displays some summary statistics. The average municipality has an annual budget of 3.5 million of Nuevos Soles, but a slightly smaller expenditure. The difference is kept by the local government and rolled forward to next periods. In the period of analysis, capital expenditures represented around 40 percent of total expenditures, while mining transfers were around 12 percent of total revenue.

Table 1.2: Summary statistics of firm and municipality data

Variables	Mean	Standard deviation
A. Firm data		
Wage bill	55.5	33.9
Local purchases	42.3	27.7
Gold production	2.18	0.76
local purchases / total purchases	0.12	0.05
B. Municipality data		
Total revenue	3.53	8.20
Mining transfer	0.41	2.08
Total expenditure	2.96	6.52
Capital expenditure	1.26	2.42

Note: The value of wage bill and local purchases is measured in million of US$ while the quantity produced is measured in million of ounces. The municipal data is measured in million of Nuevos Soles.

Identification strategy The aim of the empirical exercise is to evaluate the effect of the mine expansion on real income, relative prices and measures of welfare.[42] To do that, we exploit two sources of variation. First, we use the significant increase in Yanacocha's wage bill and local purchases started in 2000. As previously mentioned, this growth was driven by the increment on gold extraction and implementation of mine's policies directed at increasing local procurement and employment.

Second, we use distance to the city as a measure of heterogeneous exposure to the mine expansion. As predicted by the model, we expect the effect on real income, if positive, to decrease with distance to the city due to transportation costs. At a large enough distance, the effect should become insignificant because there is no economic interaction between those locations and the city. This prediction suggests that we could use households living in areas farther from the city as a control group of households living in areas closer to it. In the sample, the distance ranges from 0 to

[41]Capital expenditures include mainly the investment on infrastructure projects.

[42]We provide more details about the measures of welfare and the rationale for using them in the next section.

400 km with an average value of around 100 km. We use this threshold to divide the districts in two categories: far and closer to the city.[43]

Our identification strategy is basically a difference in difference, with the expansion of the mine being the treatment and the distance to the city defining treated and control groups. The underlying identification assumption is that the evolution of the outcome variables in areas close and far from the city would have been similar in the absence of the mine expansion.

Figure 1.9 illustrates the basic idea behind the identification strategy. It plots the conditional mean of real income per capita for households located in districts within 100 km from the city and farther away.[44] Note that until 2001 the real income follows similar trends in both locations. After that, it diverges and increases in areas located closer to the city relative to areas located farther away.

The similarity of trends in both areas before the expansion of the mine is a necessary condition for the validity of our difference in difference strategy. There may be, however, other unobserved time-varying factors correlated with the expansion of the mine and affecting differently areas closer and farther from the city, which would invalidate our identification assumption.

In Section 1.7, we explore the possibility of confounding factors by including heterogenous non-parametric trends based on observable characteristics (such as urbanization, density, type of economic activity or proximity to a city) and by performing a falsification test using other cities in the north of Peru that do not have a nearby mine. In all cases, the results are similar to the baseline regressions and provide suggestive evidence that our estimates capture the effect of the mine expansion.

To formally evaluate the effect of the mine expansion on real income, relative prices and measures of welfare, we estimate the following regression:

$$\ln y_{hdt} = \alpha_d + \eta_t + \beta(\ln M_t \times D_d) + \mathbf{X}_{hdt}\gamma + \varepsilon_{hdt}, \tag{1.20}$$

where y_{hdt} is the outcome variable of household h in district d in year t. The outcome variables could be real income, relative price or a measure of welfare. M_t is a measure of the mine activity, lagged two periods to allow adjustments in market prices.[45] In the baseline specification we use the value of the mine's wage bill and local purchases, but we also check the robustness of the results using alternative measures such as the value of local purchases or quantity of gold produced. D_d is a dummy equal to 1 if the district where the household lives is within 100 km of Cajamarca city, and 0 otherwise. This dummy identifies households living close and far to the city and thus defines the treated and control group (see Figure 1.10 for a map of the spatial distribution of

[43] In Section 1.7.3 we check the robustness of the results using alternative definitions of proximity and distance.

[44] The mean is conditional on schooling, age and gender of the household head, access to water and electricity, number of household members and number of income earners.

[45] The results are similar using other time lags.

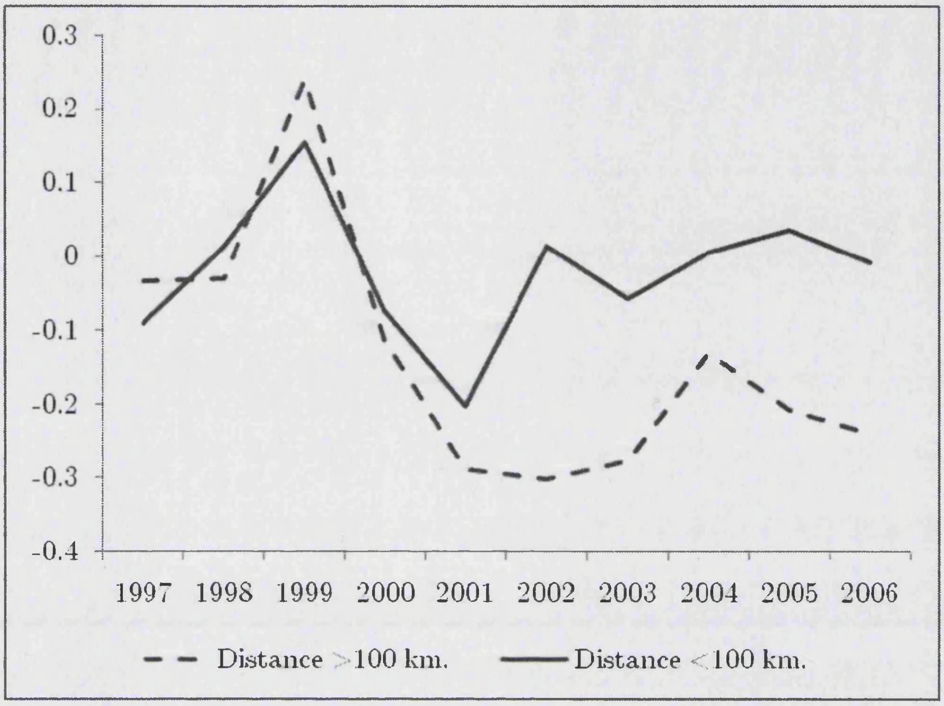

Figure 1.9: Conditional mean of real income

both groups). $\mathbf{X}_{hdt}$ is a vector of time-varying control variables. In this specification, the parameter of interest is β which captures the effect of the mine expansion.

All regressions include year (η_t) and district (α_d) fixed effects to account for common regional shocks and unobserved time-invariant district characteristics. The regressions are estimated using sample weights and clustering the standard errors at the level of the primary sampling unit. The primary sampling unit is a geographical unit smaller than districts and defined for sampling purposes. The estimation procedure takes into account that the sample is not a random draw of the region's population but an stratified sample.[46] The reason for clustering is to account for spatial correlation of households exposed to similar shocks and market conditions, or surveyed simultaneously.

1.5 Main Results

The model highlights a market channel for the extractive industry to affect a regional economy. In this story, the mine expansion increases the demand for local labor. This demand shock increases wages in the city, but it is partially offset by migration of rural workers. The net effect on city income is ambiguous due to the crowding out of other sectors, that may reduce alternative sources of income such as dividends from export firms. However, if city income increases, the price of local food crops also increase due to the lower supply. In turn, this translates into higher income in rural locations,

[46]See Magee et al. (1998) for a discussion on the use of sample weights with complex survey data.

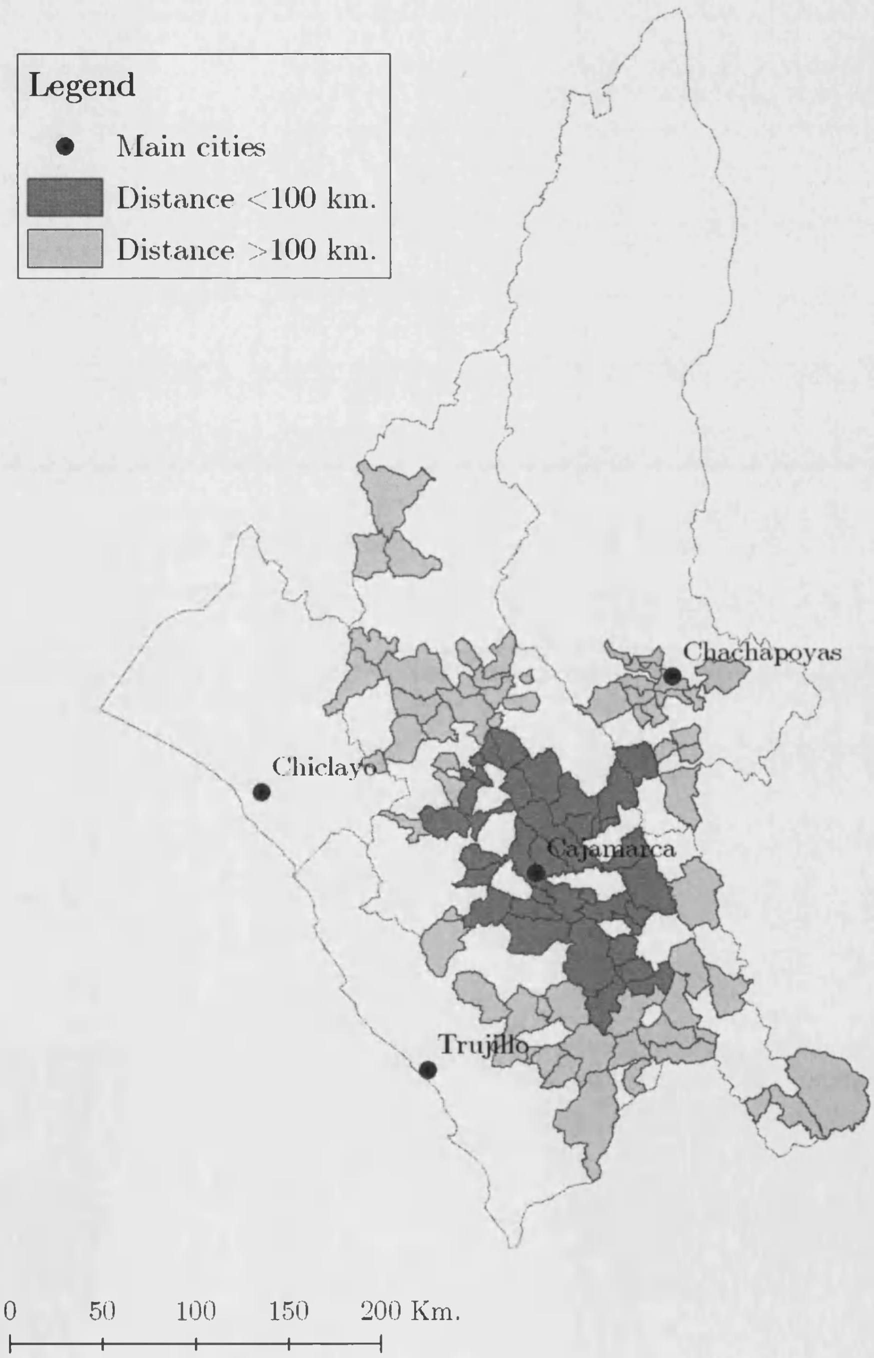

Figure 1.10: District closer and farther than 100 km from Cajamarca city

but the effect decreases with distance due to transportation costs. In the absence of externalities, the increase in real income also represents increase in welfare.

This mechanism resembles the multiplier effect with growth in the mining industry creating ripple effects in other sectors of the economy. The magnitude of the effect depends on the extent of backward linkages connecting the extractive industry to the rest of the economy.[47] The benefits accrue to all residents of the regional economy -not only to the ones directly employed in the mine or living in the city- due to mobility of goods and labor, but do not reach households living outside the city hinterland.

In this section we first evaluate the model predictions regarding the effect on real income and relative price of local food crops. Then, we explore the effect on welfare and the re-distributional effects of the mine expansion.

1.5.1 Effect on Real Income

Columns (1) and (2) of Table 1.3 show the estimates of β using the baseline specification (1.20) with different measures of the mine activity. Panel A uses the value of the mine wage bill and local purchases as a measure of mine activity while panels B and C use the value of the mine local purchases and the quantity of gold produced, respectively. All regressions include year and district fixed effects and a vector of control variables. In column (1) we use the full set of control variables including characteristics of the household head such as education, age, gender and dummies indicating the occupation industry and type of job (e.g. independent worker, employee, wage worker, etc.). It also includes household characteristics like access to water, electricity and number of household members and income earners. In column (2) we use a more parsimonious specification with only the household head's schooling, age and occupation industry dummies.

In all the cases, the estimates of β -the change on real income associated to the mine expansion- are positive and significant. The similarity of results shows that the results are not sensitive to different measures of the mine activity or alternative set of control variables.[48] In what follows, we use the mine wage bill and local purchases as our preferred measure of the mine activity because it relates, more closely, to the mine's demand of local inputs.[49]

The positive relation between the mine expansion and real income suggests that the crowding out of local firms (and the subsequent reduction of their profits) does not affect the income of the average household. This is not surprising since most people

[47] The model suggests that if the mine does not buy local inputs, its expansion would not have any effect on the regional economy.

[48] We also use real expenditure per capita as a dependent variable. The results, not reported, are similar.

[49] Note that the quantity of gold produced can be used as an instrument for the mine wage bill and local purchases. In that case, the results in Panel C would correspond to the reduced form estimates. We run a 2SLS regression using the quantity of gold as an instrument for the mine's wage bill and local purchases, and find an estimate for $\beta = 0.306$, significant at five percent.

in the sample are wage workers or farmers, and hence less likely to be affected by reduction on firm profits.[50]

Under the assumption that the evolution of income in locations far and closer to the city would have been similar in the absence of Yanacocha, we can interpret these results as the evidence of a positive effect of the mine on real income. The magnitude of the effect is economically significant: the smallest estimate using the full specification suggests that a 10 percent increase in the mine's activity is associated to an increase of 1.7 percent in the real income of households located closer to the city. Note that the evolution of Yanacocha implies large changes in household incomes since, by any measure, the activity of the mine has multiplied by at least a factor of two.

The model predicts that the effect of the mine expansion on real income decreases with distance. This heterogenous response justifies the use of households far from the city as controls for households closer to the city. To explore this hypothesis further we present two additional specifications. First, we use a flexible specification for the measure of distance. In particular, we divide the households in six groups according to the distance to the city and create dummies corresponding to each category. The categories start with households living in Cajamarca city and then group them in blocks of up to 50 km, with the last category containing all households located at least 200 km from the city. Then we estimate the baseline regression (1.20) with the full set of controls, using the mine wage bill and local purchases as measure of the mine activity interacted with each of the distance dummies. The omitted category is the group of households living farther than 200 km.

Figure 1.11 shows the estimates of β for households located at each of the distance brackets, as well as the 95 percent confidence interval. The estimates are positive and significant for households located within 100 km of Cajamarca city, but become insignificant for households located in farther locations. These results provide the basis for using a dummy variable of distance and reduces concerns about the observed average effect being driven exclusively by city residents.[51]

Second, we run a regression on the interaction of the measure of the mine's activity and the *continuous* measure of distance, expressed in hundreds of kilometers. The results are displayed in columns (3) and (4) of Table 1.3. Note that in almost all the cases, the estimated parameter is negative and significant. Taken together, these results are consistent with the prediction of the model that the effects decrease with distance.[52]

[50] In the sample, 95 percent of individuals work as independent workers, laborers, employees or family workers.

[51] For example if the distribution of household income improvements was only concentrated in Cajamarca city, the reduced form estimates would be just averaging out large positive effects in the city and negative or zero effects in the vicinity.

[52] In section 1.7.3 we evaluate the robustness of the results to the use of alternative measures of distance and non-linear functional forms.

Table 1.3: Effect of Yanacocha's expansion on real income per capita

	Ln(real income per capita)			
	(1)	(2)	(3)	(4)
A. Measure of mine activity = mine's wage bill and local purchases				
Mine activity	0.174**	0.161*		
× distance < 100 km	(0.078)	(0.088)		
Mine activity			-0.128**	-0.102
× continuous distance			(0.062)	(0.064)
R-squared	0.521	0.349	0.521	0.348
B. Measure of mine activity = mine's local purchases				
Mine activity	0.215**	0.188*		
× distance < 100 km	(0.091)	(0.101)		
Mine activity			-0.151**	-0.119*
× continuous distance			(0.060)	(0.064)
R-squared	0.523	0.35	0.522	0.349
C. Measure of mine activity = mine's gold production				
Mine activity	0.313**	0.316**		
× distance < 100 km	(0.131)	(0.154)		
Mine activity			-0.207**	-0.185*
× continuous distance			(0.100)	(0.106)
R-squared	0.523	0.35	0.522	0.349
Observations	7738	7738	7738	7738
Full set of controls	yes	no	yes	no

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects. The full set of control variables includes: household head's education, age, gender and dummies indicating her industry of occupation and type of job, plus household access to water, electricity and number of household members and income earners. Columns (2) and (4) use a smaller set of controls: household heads' schooling, age and dummies of her industry of occupation. Columns (3) and (4) use a measure of continuous distance, expressed in hundreds of kilometers.

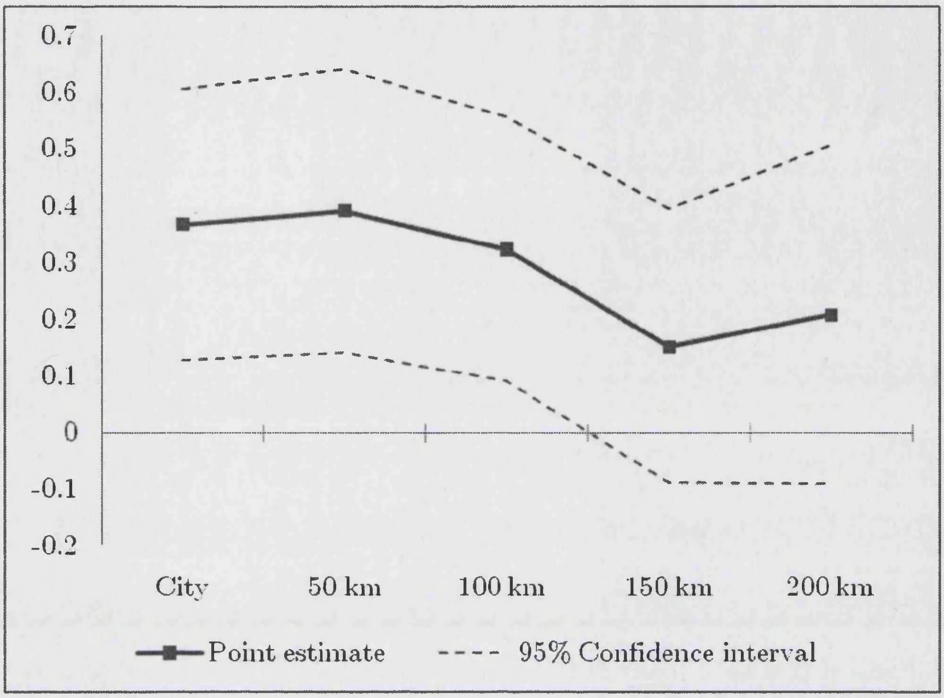

Figure 1.11: Effect of Yanacocha's wage bill and local purchases on household income, by distance to Cajamarca city

1.5.2 Effect on Relative Prices

The model predicts an increase in the relative price of locally produced goods -such as foodstuff- as a consequence of the demand shock initiated by the mine activities. This price increment is responsible for transmitting the effect among rural agricultural producers, who do not participate directly in the city's labor market. In contrast, the model is mute regarding the effect on the relative price of imported goods. Their relative price may increase or decrease (see Proposition 3).

To test these predictions, we start by identifying the main crops in the area of study. We use information from the household survey about agricultural production and rank the crops according to its contribution to the regional agricultural gross product.[53] In our sample, the two most important crops are potatoes and maize. Together they account for almost half of the agricultural gross product.[54] These results are consistent with the data from the 1994 Agricultural Census. According to the census, potatoes and maize were the most widespread crops in the highlands of Cajamarca representing more than 50 percent of the land cultivated with annual crops.

For each crop we obtain the farm gate price received by the producer based on

[53]The survey has detailed information about the production and value of individual crops at producer level.

[54]In the period 1997 to 2006, they represented 30 percent and 16 percent of the value of agricultural production, respectively. Their contribution remained relatively constant over the period of analysis.

reported quantity and value of production. In addition, we calculate the unit value paid by consumers using information about total expenditure and quantity purchased. These variables do not correspond exactly to market prices because they are also affected by the household's quality choice. The producer prices and unit values are then divided by the value of the poverty line to obtain measures of relative prices.

To explore the effect of the mine expansion, we estimate the baseline regression (1.20) using as dependent variable the logarithm of the measure of relative prices. When using unit values, we include as an additional control variable the logarithm of the household real income to account for quality choices (Deaton, 1997).[55] In the case of prices at producer level, we do not include any additional control. The reason is that the inclusion of income or expenditure as controls would bias the results since the income of agricultural producers also depends on crop prices.

Table 1.4 presents the estimates using the measures of prices at producer and consumer level. In most cases, the estimates suggest that the relative prices of local crops in areas closer to the city increase relative to prices in markets located in farther locations. The use of year fixed effects reduce concerns that this relation is driven by an underlying common trend. There is no significant change of the price of price received by producers (Column 2), though there is a positive and significant effect on the price paid by consumers. The lack of effect in the case of the farm gate price of maize may be due to the poor development of the maize market. According to the survey, only 40 percent of the maize production was sold, while the proportion of potatoes sold was 63 percent. In contrast, around of 63 percent of the potatoes were sold.

Table 1.4: Effect of mine expansion on price of local goods

	Ln relative price of:			
	Potatoes		Maize	
	(1)	(2)	(3)	(4)
Mine's wage bill and local purchases × distance < 100 km	0.128*	0.084*	-0.026	0.110***
	(0.074)	(0.050)	(0.082)	(0.038)
Prices reported by:	producer	consumer	producer	consumer
Real income per capita	no	yes	no	yes
Observations	3407	4072	4253	4000
R-squared	0.417	0.524	0.374	0.19

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects. Columns (1) and (3) do not include any additional control variable. Columns (2) and (4) include ln(real income per capita) as control variable.

[55] The underlying assumption is that quality is correlated with income.

As a second step, we replicate the same empirical exercise using unit values of commodities consumed by a large number of households and less likely to be locally produced such as rice, sugar, cooking oil and canned fish.[56] In the model, these goods correspond to the import good. Similar to the previous regressions, we use the baseline specification (1.20) and include the log of real income per capita as an additional control variable. The results are shown in Table 1.5. In contrast to the case of local crops, the effect of the mine on relative prices is negative or insignificant. This result reduces concerns that the observed increase in relative price of locally produced food is driven by a general increase of food stuff.

Table 1.5: Effect of mine expansion on price of non-local goods

	Ln relative price of:			
	Rice	Sugar	Cooking oil	Canned fish
	(1)	(2)	(3)	(4)
Mine's wage bill and local purchases × distance < 100 km	0.021 (0.033)	0.037 (0.029)	0.020 (0.028)	-0.111* (0.064)
Prices reported by:	consumer	consumer	consumer	consumer
Real income per capita	yes	yes	yes	yes
Observations	5174	5520	2349	925
R-squared	0.416	0.349	0.591	0.486

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects, and ln(real income per capita) as control variable.

We can go further and explore the changes on income relative to the price of local food. As predicted by the model, we expect the increase in income deflated using the price of local crops to be smaller than the increase in income deflated by a more general price index (Proposition 4). The main reason is that the increase in rural income is mostly driven by higher food prices, hence the effect of the mine expansion on income deflated by food price should be negligible.

To test this prediction we re-estimate the baseline regression (1.20), using alternative measures of prices to deflate the nominal income. In particular, we use the unit value of potatoes and maize. In both cases, we take the average value by primary sampling unit to reduce measurement errors and obtain better proxies of the underlying prices.

Table 1.6 displays the results. Columns (1) and (2) use as explained variable the log of the income divided by the unit value of potatoes or maize. Column (3) displays

[56]For example, rice represents only 1.6 percent of the agricultural product in the sample, while sugar and cooking oil are processed food stuff traded at national level. Of particular interest is canned fished (sardine), because the region is landlocked and thus the production is certainly not local.

the baseline result using the poverty line as deflator. Note that the estimated effect of the mine expansion is positive but insignificant when using the unit values of local crops as deflators. The point estimates are also smaller than the ones obtained using poverty line as a deflator.

Table 1.6: Effect of mine expansion on real income, using alternative price deflators

	Ln(relative income per capita)		
	(1)	(2)	(3)
Mine's wage bill and local purchases × distance <100 km	0.137 (0.091)	0.115 (0.091)	0.174** (0.078)
Deflator of nominal income	unit value of potatoes	unit value of maize	poverty line
Observations	7132	7089	7738
R-squared	0.562	0.525	0.521

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects, and control variables.

1.5.3 Effect on Welfare

We have shown that the mine has had a positive effect on real income. In the context of the model, this increase of real income translates into higher household utility. However, in the presence of negative externalities this is not necessarily the case. The negative effects of the mine may offset the benefits of having a higher income and leave households neither better or worse off. In that case, higher wages would just compensate for the mine negative externalities.

For example, the mine may have increased the actual, or expected, levels of pollution or environmental degradation with negative effects on health. Similarly, the influx of new population and growth of the city may be linked to increase in criminal activity or anti-social behavior. There is anecdotal evidence of concerns among the population about the risk of water pollution due to the use of highly toxic chemicals in the mine, and discomfort associated to the perceived increase in prostitution and crime (Pascó-Font et al., 2001, p. 156).

To evaluate the effect on welfare, we proceed in the following way. We first treat the mine as an "amenity" and apply the analytical framework developed by Roback (1982) that suggests using changes on housing prices as a measure of net welfare effects. Then, we evaluate changes on indicators of negative spillovers -such as incidence of health problems and crime.

1.5.4 The Mine as an Amenity

Using the simplest version of the model in Roback (1982), the mine can be studied as an amenity that generates locational externalities (positive or negative) in a region with perfect labor mobility and a fixed supply of housing. If the mine generates negative externalities to workers (e.g. pollution), there is an outflow of people from that particular location. This emigration increases wages but *decreases* property prices. Alternatively, if the mine creates positive externalities to producers (e.g. due to agglomeration economies) there is an increase in labor demand and wages.[57] The higher wages attract immigrant workers and *increase* the price of housing. If both forces are at play, wage unequivocally increases but the effect on rent is ambiguous and depends of the relative magnitude of both externalities.

A particularly useful implication of this model is that changes on property values reflect the net effects on welfare (for an empirical application see Greenstone and Moretti (2003)). In particular, lower property prices would suggest that the increase in real income is just compensating workers for negative externalities. In contrast, an increase in house prices would provide evidence of a net positive effect.

To evaluate this hypothesis, we use data from the household survey on self-reported house rents. This variable was obtained asking home owners about the minimum price they would require for renting their property.[58] We calculate a proxy for relative price of property dividing the reported house rents by the value of the poverty line.

Then, we estimate the baseline regression (1.20) with the logarithm of the relative house rent as dependant variable. In addition to year and fixed effects, the regression includes controls for observable house characteristics that may affect the property value such as type of urban settlement, construction materials (walls and floor), number of rooms and access to utilities (water, sewage, electricity and phone landline). In addition, we also include household socioeconomic variables -like schooling, age and gender of the household head and number of members and income earners- to account for systematic biases in the report of rental price. This empirical specification corresponds to the hedonic regression, a widely used method to assess the value of environmental amenities.[59]

Table 1.7 displays the results using different sets of control variables. Column (1) includes only house characteristics while column (2) runs the complete specification with socio-economic controls. In both cases, we find evidence of a positive relation between the mine activity and house rents. The magnitude of the effect is significant, with an estimated elasticity of 0.24. This evidence is consistent with the mine activities having a positive net effect on household's welfare.

[57] This effect is similar to the one emphasized in our model in Section 1.2

[58] We did no use actual rent prices due to the small number of observations. In the sample, only 6 percent of households live in rented accommodation.

[59] See Black (1999) and Greenstone and Gallagher (2008) for examples of empirical applications.

Table 1.7: Effect of mine expansion on house rents

	Ln (relative value of house rent)	
	(1)	(2)
Mine's wage bill and local purchases × distance < 100 km	0.250**	0.238**
	(0.095)	(0.092)
House characteristics	yes	yes
Socio-economic controls	no	yes
Observations	7699	7696
R-squared	0.635	0.650

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects. Column (1) include as additional controls only house characteristics such as type of urban settlement, construction materials (walls and floor), number of rooms and access to utilities (water, sewage, electricity and phone landline). Column (2) adds socio-economic characteristics of the household such as schooling, age and gender of the household head and number of household members and income earners.

1.5.5 Health and Crime

A main limitation of the previous analysis is that the self-reported rental prices may fail to fully capture the net effect on household welfare. This may happen, for example, if housing markets are incomplete, if self-reported rental prices are biased or if individuals lack information regarding the negative effects associated to the mine.

To address this issue, we test directly for the presence of some negative effects associated to the expansion of the mine. In particular, we use data from the household survey to construct dummy variables to indicate whether an individual had a health problem, and whether a household member was victim of a criminal activity.[60] Then, we use these dummies as the dependent variables in the baseline regression (1.20) and estimate it using a linear probability model. As control variables we use an indicator of whether the household lives in a urban or rural area, access to water, sanitation and electricity, number of household members and income earners, and individual's sex and age.[61]

Table 1.8 shows the results. Column (1) uses the whole sample of individuals, including children, while in column (2) we restrict the sample to children under the age of five, who may be more vulnerable to negative health spillovers. Note that in both cases the incidence of self-reported health problems has actually decreased with the expansion of the mine. Column (3) shows that there is no apparent increase in

[60] The survey questions are "In the last four months, have you felt sick, suffered a chronic disease or an accident?" and "In the last 12 months, has any member of the household been affected by a criminal act?".

[61] The results are robust to the exclusion of the control variables.

crime associated with the expansion of the mine.

Nonetheless, we need to interpret these results with caution. They only suggest that there is no evidence that individuals in the area of influence of the mine have suffered more occasional illnesses, that could result from a more polluted environment. But, we cannot say anything about long run effects, such as general deterioration in health or chronic afflictions that could result from exposure to the activities of the mine. Similarly, the measure of crime only informs us about the perceived level of crime but may fail to account for other forms of social disorder or crimes within the household. Moreover, it may reflect changing perceptions of crime.

Taken together, these results do not rule out the presence of negative externalities. They suggest, however, that their magnitude, at least as perceived by the residents, may not be too important. This finding is consistent with the observed net improvements on household welfare discussed previously.

Table 1.8: Yanacocha's expansion and measures of health and crime

	Health problems		Crime
	(1)	(2)	(3)
Mine's wage bill and local purchases × distance < 100 km	-0.087*** (0.039)	-0.008 (0.057)	0.001 (0.008)
Sample	All individuals	Children under 5 years	Households
Observations	39674	4189	6663
R-squared	0.076	0.157	0.048

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. *Health problems* is a self-reported measure of whether an individual was sick in the recent past, while *Crime* is a self-reported measure of anyone in the household being victim of a crime in the recent past. All regressions are estimated using a linear probability model. Columns (1) and (2) include as control variables an indicator of the house being in a urban area, access to water, sanitation and electricity, number of household members and income earners, and individual's sex and age. Column (3) use similar controls but exclude individuals' age and sex.

1.5.6 Distributional Impacts

The previous results are only informative of the effect of the mine expansion on the income and welfare of the average household. They do not tell us, however, whether the operations of the mine have reduced poverty or whether the effects were distributed evenly across different income groups. The increase in average income may hide negative re-distributional effects with only the richer benefitting from the mine expansion. Even if equally distributed, the income increase may have been insufficient to close the poverty gap.

We address these questions in two steps. First, we evaluate the effect of the mine expansion on measures of poverty. To do so, we estimate the baseline regression (1.20) using as dependent variables dummies indicating whether a household is poor or extreme poor. The difference between these two categories is the definition of the minimum consumption basket, which is more restrictive for the case of extreme poor.[62] We estimate the regression using a linear probability model and interpret the coefficients as the change on the probability of being poor or extreme poor. Table 1.9 displays the results. Note that the mine expansion is associated to reductions on the probability of being poor or extreme poor.

Table 1.9: Yanacocha's expansion and poverty

	Poor (1)	Extreme poor (2)
Mine's wage bill and local purchases × distance < 100 km	-0.107***	-0.075**
	(0.036)	(0.056)
Observations	7738	7738
R-squared	0.406	0.3572

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions are estimated using a linear probability model.

Second, we explore the distributional impact of the mine expansion estimating the the effect of the mine on real income at different points of the conditional income distribution using quantile regressions.[63] The model specification is the same as the baseline regression (1.20), but the estimator does not use the sampling weights nor cluster the errors by primary sampling unit.

Figure 1.12 plots the estimates of β -the effect of the mine expansion on real income- (on the vertical axis) and the confidence interval at 95 percent at different quantile values. The estimated parameter is positive and significant for all quantiles except for the top 20 percent. These results mean that households with income below the 80th percentile, conditional on the control variables, experienced an increase of real income associated to the mine expansion in areas within 100 km from Cajamarca city. We cannot conclude from this result that inequality has not increased, but we can claim that the positive effects were evenly distributed across income groups, even among the poorer households.

In this section we have provided evidence that the increase in income that followed

[62] In the sample, 65.2 percent of households are poor, while 37.4 percent are classified as extreme poor.

[63] See Koenker and Hallock (2001) for a survey of the literature on quantile regressions.

the expansion of local purchases by Yanacocha is also associated with a positive net welfare effect. There is no evidence of short run negative externalities, poverty has decreased and even the poorest of the poor in Cajamarca city and surroundings have obtained an increase in income relative to households in other surrounding areas.

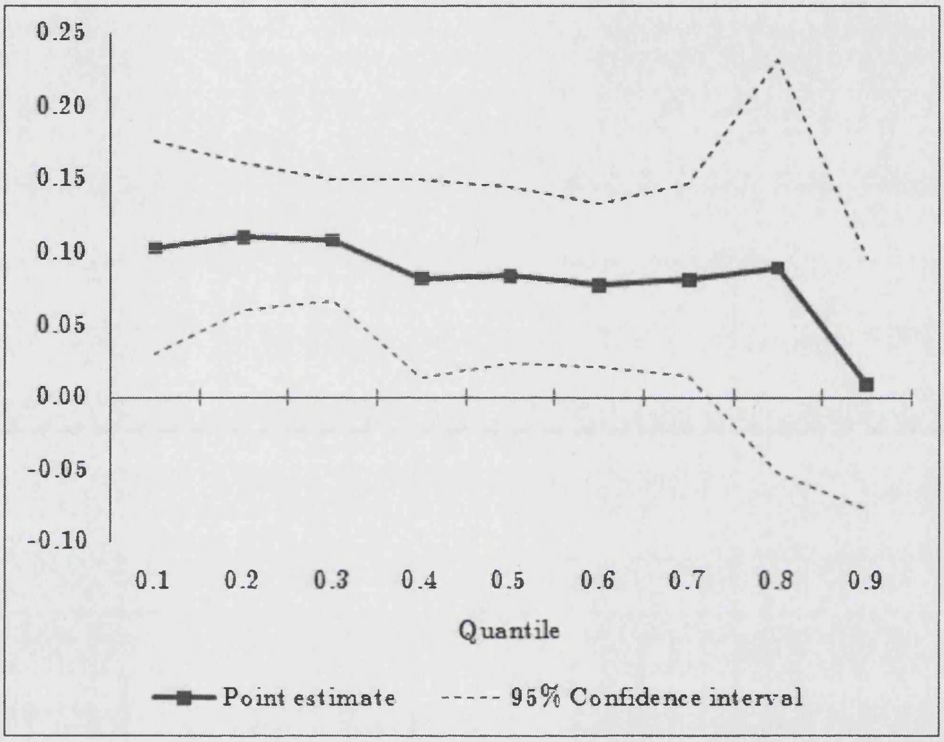

Figure 1.12: Effect of Yanacocha's wage bill and local purchases on household income, by quantile

1.6 Alternative Explanations

In addition to local purchases and employment, there are at least two other channels through which Yanacocha's activities might have affected the regional economy: a revenue windfall to local governments and direct transfers to local groups, through higher wages or local development projects.

1.6.1 Fiscal Revenue Windfall

Local governments receive a transfer from the central government, funded with the taxes paid by the mine. In particular, 50 percent of the corporate tax paid by the mine is distributed to local governments in the region.[64] This mining transfer (called *canon minero*) is allocated according to a formula established by law, that takes into

[64]Mining firms also pay fees for operational rights (derecho de vigencia) which is distributed to the local government where the mine pits are. The total fee is proportional to the extension of the mining operation, regardless of actual production. Its magnitude is much smaller than the *canon minero*.

account location of the mine pits, population, density and poverty incidence.[65]

This source of local revenue grew in the last years following the expansion of the mine operations and represented a substantial revenue windfall for local governments. For example, between 1998 and 2006 the total amount of mining transfers in the area multiplied by a factor of 7 and its contribution to the municipal budget increased from 8 percent to 25 percent.

This revenue windfall may explain the observed relation between the mine expansion and real income. For example, the additional revenue could have increased public spending and demand of local inputs. Similarly, better public good provision could have enhanced household welfare, and contributed to the increase in housing rents.

In order to understand the mechanism driving the results, we evaluate whether the effects on real income and welfare are driven by a fiscal channel (additional public spending) or by a market channel (mine's demand of local inputs). We address this question in two steps. First, we evaluate the effect of the revenue windfall on municipal total revenue and spending. Second, we evaluate the effect of real income and welfare using both the measure of the mine local demand and the revenue windfall received by the local government where the household resides.

Effect on municipal revenue and spending As a first step, we check whether the revenue windfall from the mining transfer translated into higher revenue and expenditure for local governments. To do that, we estimate the following regression:

$$y_{it} = \alpha_i + \eta_t + \beta x_{it} + \epsilon_{it}, \tag{1.21}$$

where y_{it} is a revenue or expenditure outcome of municipality i in year t, such as the logarithm of total revenue or the share of capital expenditure while x_{it} is the logarithm of the amount of mining transfer received. This specification includes year and municipality fixed effects, and exploits within municipality variation. The standard errors are clustered at municipality level to address possible serial autocorrelation.

Table 1.10 displays the results using different dependent variables. All the variables, except the share of capital expenditures, are expressed as logarithms. In all the cases the estimates of β are positive and significant. This result supports the claim that the revenue windfall associated to the mining transfer increased both the available budget and actual spending. Capital expenditure increased even faster that other expenditures, as the increase of its share in total expenditure indicates. This result is expected since, by law, the revenues from the mining transfer should be used only for capital expenditures.

[65] More specifically, 10 percent of the tax collected goes to the district where the mine is located, 25 percent goes to other districts in the province, 40 percent to the province government and the remaining 25 percent to the departmental government (Minera Yanacocha, 2006).

Table 1.10: Effect of mining transfers on municipal revenue and expenditure

	Total revenue	Total expenditure	Capital expenditure	Share of capital expenditure
	(1)	(2)	(3)	(4)
Mining transfer	0.034***	0.030***	0.047***	0.007***
	(0.004)	(0.003)	(0.005)	(0.001)
Observations	1414	1414	1414	1414
Nr. Municipalities	179	179	179	179
R-squared	0.738	0.733	0.476	0.156

Notes: Robust standard errors in parentheses. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects. All the variables, except the share of capital expenditure, are expressed as logarithms.

Effect on real income and welfare As a second step, we re-estimate the baseline results on the effect on real income and relative rental prices including, as an additional control, the logarithm of the municipal revenue or expenditure of the district where the household resides. To address possible heterogenous impact of public spending by location, we also estimate the baseline regressions including the measure of municipal revenue or expenditure *interacted* with our measure of proximity to the city (an indicator of the household living less than 100 km to the city or not). If the effect was driven by the revenue windfall, and subsequent public spending, we could expect the parameter associated to the effect of the mine expansion to become insignificant.

Tables 1.11 and 1.12 report the results using the logarithms of real income and relative house rents as dependant variables, respectively. These regressions explore the effect of the mine expansion on real income and household welfare and use the same set of control variables as in the baseline results (see notes in Tables 1.3 and 1.7 for further details). In both tables, the regressions in panel A include as additional control variable a measure of municipal revenue or expenditure, while Panel B includes this variable interacted with the dummy of proximity to the city. Columns (1) and (2) use two measures of municipal revenue: the amount received as mining transfer and the total revenue. Columns (3) and (4) uses instead measures of total expenditure and capital expenditures. The difference in the sample size respect to the baseline regressions is due to the lack of observations on municipal budgets for 1997.

Note that in all cases the effect of the mine expansion on real income and house rents remains positive and significant. The estimates are similar in magnitude to the results without municipality control variables. In contrast, the effect of municipality's revenue or expenditure is insignificant or even negative.[66] These results reduce concerns that the observed effect is driven by the revenue windfall to local governments.

[66] We also replicate this exercise dropping the measure of mine expansion interacted with distance and keeping only the municipal variables. The results, not reported, are similar.

Moreover, they suggest that the market mechanism may have been more effective on enhancing household income and welfare than public spending.

The lack of a positive effect of public spending is surprising. A first explanation is the need of a longer period for public projects to mature. We replicate the results lagging the variables one and two periods, but the estimates remain insignificant.[67] An alternative explanation is that public spending increased well being (through better public good provision) but did not affect income. The lack of positive effect on house rents, however, does not support this argument. Finally, it could be that the additional public spending had very small economic returns.[68] A similar phenomenon is reported by Caselli and Michaels (2009) in the context of oil-rich Brazilian municipalities. They find that municipalities increased significantly their expenditure using the revenue windfall associated to the oil operations. But they find no evidence of a positive effect on local income. They interpret this result as suggestive that the additional revenue was wasted if not stolen.

1.6.2 Direct Beneficiaries

There are three groups of individuals that might have benefited directly from the mine expansion: residents of communities located around the mine pits, mine workers, and public sector workers.

In the first case, inhabitants of local communities may have benefited from the development projects started and financed by Yanacocha. These projects are aimed to rural communities adjacent to the mine pits and focus mostly on construction and staffing of schools and health centers, provision of electricity and sanitation, and maintenance of local transport infrastructure.[69] Similar to the expansion of mining transfers, the expenditure on local development projects increased significantly in the period of analysis from around US$ 4 million in 1997 to US$ 34 million in 2006.

In the case of mine workers, the benefit may be explained by the higher wages paid by the mine. For example, in 1997 the average salary for a Yanacocha employee was almost three times the salary for a similar job in Cajamarca city (Pascó-Font et al., 2001, p.165).[70] In the case of public workers, their income would have increased if the revenue windfall associated to mining transfers was redistributed in the form of higher wages or in-kind benefits.

A relevant concern is that the observed effect on the average real income may be just driven by the positive effect of local development projects or higher wages

[67] We cannot explore longer lags since we only have budgetary data from 1998. Additionally, the use of lags reduces the number of observations in the period before the mine expansion and may attenuate the results.

[68] Anecdotal evidence suggests that some recipients of mining transfers embarked in unproductive projects such as refurbishing the town main square or erecting monuments.

[69] Yanacocha considers as potential beneficiaries the inhabitants of 65 villages adjacent to the mine pits with a population of around 28,000 inhabitants (Minera Yanacocha, 2002, p. 24).

[70] The higher wages may be a compensation for the (potentially) more dangerous working environment or efficiency wages paid for roles deemed as vital for the mine's normal operation.

Table 1.11: Effect of the mine on real income, controlling for municipal revenue or expenditure

	Ln(real income per capita)			
	(1)	(2)	(3)	(4)
Panel A: Adding municipal revenue or expenditure				
Mine's wage bill and local purchases × distance < 100 km	0.175**	0.180*	0.164*	0.164*
	(0.083)	(0.094)	(0.089)	(0.089)
Municipal revenue or expenditure	-0.025	-0.142	0.045	0.045
	(0.209)	(0.093)	(0.126)	(0.126)
Observations	7738	6305	6305	6305
R-squared	0.521	0.536	0.536	0.536
Panel B: Adding municipal revenue or expenditure × proximity to city				
Mine's wage bill and local purchases × distance < 100 km	0.250*	0.295*	0.361**	0.169
	(0.129)	(0.172)	(0.152)	(0.123)
Municipal revenue or expenditure × distance < 100 km	-0.081	-0.178	-0.346*	-0.015
	(0.056)	(0.184)	(0.185)	(0.144)
Observations	7138	6305	6305	6305
R-squared	0.524	0.536	0.536	0.536
Municipal revenue or expenditure	Mining transfers	Total revenue	Total expenditure	Capital expenditure

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects and the same control variables of the baseline regressions (see notes of Table 1.3). The measures of municipal expenditure or revenue and mine wage bill and local purchases are expressed as logarithms of the total amount.

Table 1.12: Effect of the mine on house rents, controlling for municipal revenue or expenditure

	Ln (relative value of house rent)			
	(1)	(2)	(3)	(4)
Panel A: Adding municipal expenditure or revenue				
Mine's wage bill and local purchases × distance < 100 km	0.239**	0.360***	0.353***	0.353***
	(0.096)	(0.102)	(0.101)	(0.101)
Municipal revenue or expenditure	-0.016	-0.230**	-0.194*	-0.194*
	(0.242)	(0.097)	(0.106)	(0.106)
Observations	7696	6365	6365	6365
R-squared	0.650	0.667	0.666	0.666
Panel B: Adding municipal expenditure or revenue × proximity to city				
Mine's wage bill and local purchases × distance < 100 km	0.286**	0.472**	0.447**	0.381**
	(0.131)	(0.206)	(0.176)	(0.159)
Municipal revenue or expenditure × distance < 100 km	-0.055	-0.182	-0.171	-0.059
	(0.056)	(0.218)	(0.191)	(0.164)
Observations	7696	6365	6365	6365
R-squared	0.650	0.667	0.667	0.667
Municipal revenue or expenditure	Mining transfers	Total revenue	Total expenditure	Capital expenditure

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects and the same control variables of the baseline regressions (see notes of Table 1.7). The measures of municipal expenditure or revenue and mine wage bill and local purchases are expressed as logarithms of the total amount.

received by mine workers or public servants, not by the multiplier effect highlighted in the model.

To check for this possibility, we use data on the industry of occupation reported by employed individuals and identify workers in the mining industry and public service.[71] We classify education workers as part of the public sector given that most teachers are in the government payroll. Additionally, we identify households living in the same districts where the towns targeted by Yanacocha's development projects are located. We consider these groups to be a broader definition of potential direct beneficiaries of the mine activities. In our sample, these households represent around 15 percent of total observations. Then we re-estimate the regressions of the effect on real income and welfare excluding these three groups of households.

Table 1.13 displays the results. Panel A uses real income as dependant variable, while panel B uses the relative house rental price,. Column (1) presents the baseline results with the whole sample. Columns (2) to (4) gradually reduce the sample excluding public sector workers, mining workers and households living adjacent to the mine. Note that in all the cases the results are similar to the obtained with the whole sample. This evidence suggests that the observed effects on income and welfare are not driven by groups that may receive direct benefits from the mine, and supports the claim that the main driver is the multiplier effect from the mine's demand shock.[72]

1.7 Additional Checks

In this section we present additional checks on the validity of the previous results. We are particularly interested on confounding factors that may violate the identification assumption, compositional effects driven by migration within the region and the sensitivity of the results to alternative measures of distance.

We focus on the baseline regression exploring the effect of the mine on real income. We also perform similar checks on the set of results on local crop prices and house rents and reach similar conclusions. These additional checks are not reported, but are available from the authors upon request.

1.7.1 Confounding Factors

A main concern is that, in parallel to the expansion of the mine, there are other phenomena happening in the region that affected differently areas close and far from the city. This would violate our identification assumption and imply that the estimated effect on real income could not be attributed to the mine expansion.

We are particularly concerned with changes on the survey sampling framework in 2001, heterogenous trends driven by different initial conditions or by proximity to a

[71] The survey reports the two digit International Standard Industry Code of the main activity of working individuals.

[72] We are unable to evaluate in a reliable manner the effect among direct beneficiaries due to the small size of the sample.

Table 1.13: Effect on households not directly employed by public sector, mining industry or living adjacent to the mine

	(1)	(2)	(3)	(4)
Panel A: dependent variable is Ln(real income per capita)				
Mine's wage bill and local purchases × distance < 100 km	0.174**	0.198**	0.186**	0.187**
	(0.078)	(0.085)	(0.086)	(0.087)
Observations	7738	6796	6668	6570
R-squared	0.521	0.484	0.478	0.479
Panel B: dependent variable is Ln(relative value of house rent)				
Mine's wage bill and local purchases × distance < 100 km	0.238***	0.240**	0.255***	0.256***
	(0.092)	(0.096)	(0.096)	(0.097)
Observations	7696	6829	6718	6613
R-squared	0.65	0.595	0.583	0.583
Public sector workers	yes	no	no	no
Mining workers	yes	yes	no	no
Live in district adjacent to mine pits	yes	yes	yes	no

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects and the same control variables of the baseline regressions (see notes of Tables 1.3 and 1.7).

city.

Methodological change In 2001 some changes were introduced to the sampling framework of the household survey to include newly developed urban areas and improve the estimates of the poverty line (INEI, 2006). Our concern is that the change in methodology may have affected differently areas close and far to the mine and that our results are simply reflecting the change on the survey methodology and not the effects of the mine.

To address this issue, we include in our baseline regression a dummy equal to one for all years from 2001interacted with our measure of distance, to capture any shift in the average income level after 2001 for households closer to Cajamarca due to the re-sampling. Column (1) in Table 1.14 shows that our main result is not affected, suggesting that the income of adjacent households does not just suffer a jump in levels (as a change only due to the methodology would suggest) but follows the variation in mine's activity. If anything, accounting for this change in methodology increases the magnitude of our coefficient, suggesting that the bias was towards zero, rather than positive.

Heterogenous trends There are some systematic differences between areas close and far to Cajamarca. Areas closer to the city are relatively more urbanized, more densely populated and less agricultural. In the main specification, this is dealt with by using district fixed effects and controlling for household characteristics. However, these different initial conditions may also lead to different trends of income or prices which we may be mistakenly attributing to the mine expansion. For example, farmers' income may be diverging from non-farmers, or there may be an overall decline of rural areas or possibly densely populated areas are growing faster.

To address this concern we include a non-parametric trend interacted with dummies related to observable characteristics. In particular we use an indicator of urbanization (a dummy equal to one if the household is located in an urban area), agricultural activity (one if the household reports any agricultural production), population density (one if the population density of the district where the household lives is above the median).

Columns (2) to (4) in Table 1.14 shows the results of this robustness check using real income as dependant variable.[73] The estimates of the effect of the mine on real income are similar to those found in the baseline regression.

Proximity to a city The previous checks suggest that our results are not driven by different trends based on some observable characteristics. There may be, however, unobservable shocks contemporaneous to the mine expansion that affect differently areas close or far from the city. For example, there may be a general process of

[73]The results are similar using other dependant variables studied in the main results.

Table 1.14: Effect of the mine on real income, controlling by methodological change and heterogenous trends

	Ln (real income per capita)			
	(1)	(2)	(3)	(4)
Mine's wage bill and local purchases × distance < 100 km	0.238** (0.109)	0.168** (0.079)	0.177** (0.080)	0.184** (0.075)
Post 2001 × distance < 100 km	yes	no	no	no
Year dummies × urban	no	yes	yes	yes
Year dummies × farmer	no	no	yes	yes
Year dummies × high density	no	no	no	yes
Observations	7738	7738	7738	7738
R-squared	0.522	0.526	0.532	0.537

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects and control variables. Post 2001 is a dummy equal to 1 if year is 2001 or later. Urban is a dummy equal to 1 if household resides in an urban area. Farmer is equal to 1 if household reports agricultural production. High density is equal to 1 if density of the district of residence is above the median in the sample.

divergence between cities and their rural hinterland due to agglomeration economies, different vulnerability to climatic shocks or targeting of public projects to main cities.

We address this concern in two steps. First, we include as additional control to the baseline regression the measure of mine activity interacted with distance to other cities, to rule out that proximity to other city centers is driving the results. Second, we perform a falsification test replicating the estimates of the effect of the mine on real income but using as reference points other cities instead of Cajamarca. Finding a similar effect of the mine expansion on other cities would suggest that the observed effect on real income observed in areas closer to Cajamarca city is just reflecting a broader city-rural phenomenon and would raise concerns about the validity of the identification assumption

We select the other main cities around the North Highlands region: Chachapoyas, Chiclayo and Trujillo (see Figure 1.4 for a localization map of the cities). All these cities are department's capitals, as Cajamarca, and have a similar governmental status. Chachapoyas is located in the highlands and have a similar size as Cajamarca. In contrast, Chiclayo and Trujillo are much larger cities located on the coast. For each city, we calculate distance by road using the shortest path and construct a distance dummy variable equal to one if the distance is less than 100 km and zero otherwise. The algorithm is the same used to calculate distance to Cajamarca city.

Table 1.15 presents the estimates of the baseline regression with real income as the dependant variable and including the mine wage bill and local purchases interacted with distance to other cities. In all cases, the mine expansion only affects areas closer to Cajamarca city, not to other urban centers.

Table 1.15: Effect of the mine on real income, controlling by proximity to other cities

	Ln(real income per capita)		
	(1)	(2)	(3)
Mine's wage bill and local purchases ×			
distance to Cajamarca	0.160*	0.160*	0.144*
< 100 km	(0.083)	(0.083)	(0.082)
distance to Chachapoyas	-0.088	-0.088	-0.103
< 100 km	(0.154)	(0.155)	(0.153)
distance to Chiclayo		0.014	0.001
< 100 km		(0.179)	(0.179)
distance to Trujillo			-0.042
< 100 km			(0.170)
Observations	7738	7738	7738
R-squared	0.520	0.520	0.520

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects and control variables. Distance to all cities is calculated as the shortest path between the main town in the district where the household lives and the city.

Table 1.16 displays the results of the falsification test estimating the baseline regression with distance to the alternative city instead of Cajamarca and using two alternative samples. Panel A uses the same sample as in the baseline results: households in the North Highland region. Panel B includes households within 200 km of the cities, regardless of the geographical region.[74] In all cases the effect of the mine's wage bill and local purchases becomes insignificant or even negative. The lack of effect on this falsification exercise weakens the case for some confounding factor driving the results.

1.7.2 Migration and Compositional Effects

The model predicts an increase in city size due to intra-regional migration. In the model, the increase in labor demand and wages in the city attracts agricultural workers. To explore this model prediction, we use data from two most recent population

[74]The results are similar using larger areas of influence, e.g. 400 km

Table 1.16: Falsification test using distance to other cities

	Ln(real income per capita)		
	(1)	(2)	(3)
Panel A: North Highlands sample			
Mine's wage bill and local purchases × distance < 100 km	-0.188 (0.142)	-0.066 (0.169)	-0.136 (0.157)
Observations	7738	7738	7738
R-squared	0.521	0.521	0.521
Panel B: Households within 200 km			
Mine's wage bill and local purchases × distance < 100 km	-0.058 (0.063)	0.000 (0.050)	-0.077* (0.044)
Observations	6978	10801	12073
R-squared	0.552	0.536	0.604
City	Chachapoyas	Chiclayo	Trujillo

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects and control variables.

censuses (1993 and 2007) and calculate the intercensal population growth rate in Cajamarca city and surrounding areas, up to 400 km.[75]

Figure 1.13 plots the population growth rates for areas at different distance from the city. In the period between the two censuses, the region grew at an annual rate of 0.7 percent, below the national average of 2 percent. In contrast, Cajamarca city experienced a significant growth, with population increasing at a rate of 3.4 percent per year and became the second fastest growing city in Peru (INEI, 2008).[76] In contrast, the surrounding areas grew at a much slower pace, below the regional average. Interestingly, the growth rate decreases with distance to the city.[77]

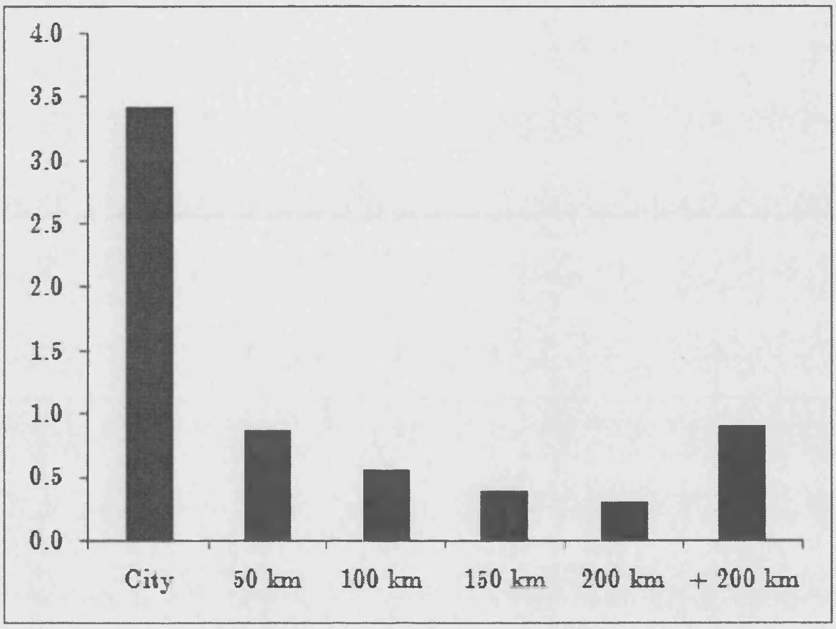

Figure 1.13: Intercensal annual population growth rate: Cajamarca city and surroundings

Taken together, this evidence is suggestive of migration from the rural hinterland to the city, as predicted by the model.[78] Empirically, a main concern with migration is that the observed increment on real income may be just reflecting compositional changes on the labor force. For example, if only the most productive agricultural workers migrate to the city, the increase in real income would be driven by higher productivity not by the demand shock from the mine.

We address this concern indirectly by evaluating whether the expansion of the mine

[75]This extension corresponds to the range of distances observed in the data.

[76] In the period between 1993 and 2007, Cajamarca city increased its population from 117,000 to almost 190,000.

[77] A possible explanation consistent with this observation is that migration costs are increasing with distance.

[78]Nonetheless, we cannot interpret it as evidence of the mine expansion *causing* migration because, among other reasons, we do not know whether migration occurred before or after the expansion of the mine.

has lead to changes on observable characteristics of the labor force in areas closer and farther from the city.[79] In particular we focus on different measures of human capital such as: years of education, indicators of having completed primary school or attended a private school (a proxy for quality of education).[80] We also consider demographics such as age, gender and number of household members to evaluate selective migration of young adult males. Finally, we explore characteristics of the agricultural unit such as proportion of production sold, number and concentration of crops, to account for changes on the type of farmers. In all cases, we estimate the baseline regression (1.20) with year and district fixed effect as the only control variables.

Table 1.17 shows the results. The parameter associated to the interaction term captures the changes on the measure of human capital, demographics or agricultural activity in areas closer to the city associated to the expansion of the mine. Note that all the measures of education (columns 1 to 3) worsen in areas closer to the city, while the rest of characteristics remain unchanged. If we take into account that educational attainment in areas far from the city was *lower* before the mine expansion, these results suggest a reduction on the gap between both areas due to the migration of relatively less educated workers from the rural hinterland to the city.[81] Taken together, these results reduce concerns that the increase in real income is driven by migration of more productive workers to the city.

1.7.3 Alternative Measures of Distance

In this section we check that our results are not sensitive to our measure of distance. So far, we have used the shortest path by road and the average (i.e. 100 km) as the threshold. In column 1 of Table 1.18 we show that results hold when the threshold is defined by the median, i.e. 90 km.

Additionally, we obtain two alternative measures of distance: a topographic and a straight line. The topographic measure is calculated using the ArcGIS package by minimizing the sum of the normalized values of altitude and gradient, regardless of the existence of a road. It can be interpreted as a proxy for where a road may be located or alternative transportation routes in the absence of roads. The straight line measure is calculated as the Euclidian distance between the district capital town and the city of Cajamarca. In order to distinguish district closer and farther from the city, we use as a threshold the median value of the measure of distance. Columns 2 and 3 show that the effects are similar, irrespective of the measure of distance used to tell apart districts that are far and close to Cajamarca.

[79]Ideally we would like to identify migrants in the sample and check whether the results are driven by this sub-population. Unfortunately, that information is not available.

[80]In the baseline regressions we control for education. However, this control may be insufficient to account for compositional changes in the presence of human capital spillovers or complementarities.

[81] In 1997 the average worker located more than 100 km from the city had 3 years of education while the average worker closer to the city had 3.6 years of education. In 2006, the years of education of both type of workers were 4.6 and 4.7, respectively

Table 1.17: Changes on characteristics of labor force and agricultural activity

	Human capital			Demographics		Agricultural activity		
	Years of education	Complete primary	Private school	Age	Is female	% prod. sold	Number of crops	Crop HH index
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Mine's wage bill and local purchases × distance < 100 km	-0.684**	-0.059*	-0.019***	-0.648	0.011	-0.094*	-0.153	0.015
	(0.322)	(0.031)	(0.007)	(0.835)	(0.017)	(0.050)	(0.287)	(0.036)
Observations	31255	31255	25473	34507	34159	5582	5582	5582
R-squared	0.106	0.064	0.177	0.023	0.011	0.309	0.311	0.228

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects. Regressions in Columns 1 to 5 use the sample of individuals in working age, while columns 6 to 8 use the sample of households with some agricultural production. Complete primary is a dummy equal to 1 if individual completed primary school, private school is a dummy equal to 1 if individual assisted to private school. Is female is a dummy equal to 1 if individual is a female. Crop concentration is the Herfindahl-Hirschman concentration index calculated as the sum of squares of the contribution of a crop to total agricultural production.

Table 1.18: Alternative measures of distance

	Ln(real income per capita)		
	(1)	(2)	(3)
Mine's wage bill and local purchases × distance < median	0.137*	0.150**	0.134*
	(0.077)	(0.075)	(0.074)
Measure of distance	Shortest path by road	Topographic	Straight line
Median distance (km)	90	75	65
Observations	7738	7738	7738
R-squared	0.521	0.521	0.521

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects and control variables. Topographic distance is calculated as the length of the shortest path that minimizes the normalized sum of altitude and gradient. Straight line distance is the Euclidean distance between two points.

Finally, we explore in more detail the monotonic decline of the effect by distance, which is a crucial feature of our identification strategy. To do that we estimate the baseline regression including the interaction between the mine's wage bill and local purchases and different functions of distance. Column 1 in Table 1.19 displays the results with the linear measure of distance as a benchmark. Columns 2 and 3 allow for non-linearities by including the logarithm and inverse of distance. In all cases, the results support the claim that the effect of the mine expansion on real income declines with distance to the city.

1.8 Conclusion

This chapter investigates the effect of a large mine on a regional economy using the analytical framework provided by a spatial general equilibrium model. We find robust evidence that the mine has generated positive income and net welfare gains for residents in the city and in the surrounding rural hinterland.

The main contribution of the paper is to improve the understanding of the mechanisms through which natural resource extraction can foster local development. In particular it shows that, in the presence of backward linkages, the expansion of extractive industries can generate a positive demand shock and increase the real return to local factors of production, such as land and labor. In turn, this translates into better living conditions for local residents.

A main limitation of the paper is that we only observe events occurring over the span of a decade during the mine operation. This means that we are unable to explore whether the welfare gains are a short-term effect or part of sustainable development

Table 1.19: Exploring the decrease of the effect by distance

	Ln(real income per capita)		
	(1)	(2)	(3)
Mine's wage bill and local purchases x			
distance	-0.128**		
	(0.062)		
Ln(distance)		-0.034**	
		(0.016)	
distance^{-1}			0.002*
			(0.001)
Observations	7738	7738	7738
R-squared	0.521	0.521	0.521

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at primary sampling unit level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include year and district fixed effects. Distance is equal to the length of the shortest path by road from the main town of the district where the household lives to Cajamarca city, expressed in hundreds kilometers.

that would persist after the mine closure. For the same reason, we can say little about relevant long-run phenomena such as specialization, technological progress, or city formation (such as San Francisco after the Gold Rush). Though beyond the scope of this thesis, these phenomena warrants further research.

In the case we study, the positive effects come from a market channel rather than from the revenue windfall to local governments. This suggests that, in a context of weak governments, policies that promote local procurement and employment could be more beneficial to local residents than increased public spending, at least in the short run.

This policy implication, however, depends of the existence of goods and labor markets able to supply local inputs to the mine, and the extent of economic integration of the region where the mine is located. In the absence of inter-regional trade, the benefits would disappear since the increase in prices could offset the gains on nominal income. Similarly, lack of intra-regional trade or labor mobility would restrict the benefit to the place where the mine suppliers are located and might lead to negative re-distributional effects.

The availability of natural resources in the developing world is often seen as a hindrance to economic development. In most cases, institutional failure (e.g. conflict, mismanagement or corruption) is at the heart of this inability to transform natural wealth into better standards of living. However, as this paper suggests, in the presence of strong enough backward linkages natural resources can be more a blessing than a curse.

A Appendix

A.1 Existence of equilibrium

Assumption 5 $N > \frac{1-\alpha}{1-\alpha-\mu}\theta S$

This assumption means that the share of employment from the mine is small enough relative to the total population in the region. To check how reasonable this assumption is, note that we can re-write it as $\mu < (1-\alpha)\left(1-\frac{\theta S}{N}\right)$, where α is the consumer's budget share of locally produced food, μ is the budget share of local manufactures and $\frac{\theta S}{N}$ is the relative size of the mine's workforce.

We calculate the budget share on food using the ENAHO survey and use it as a proxy for α.The estimated budget share is 0.6, however note that this measure may overestimate the true value of α since some of the food is not locally produced. Regarding $\frac{\theta S}{N}$, recall from Section 1.3 that Yanacocha's direct and indirect employment in the analyzed period was between 12 percent and 20 percent of the active population of the city of Cajamarca. This proportion would be significantly lower if we include working population in the rest of the region. These figures imply that for Assumption 1 to be violated μ should be, at least, greater than 0.32 or 0.35. In turn this implies a very small budget share of imported goods $(1-\alpha-\mu)$, with values at most between 0.05-0.08.[82]

Proposition 6 *Under Assumption 5, there is a unique and positive pair* $(f^*; w^*)$ *that solves* (AA) *and* (BB).

Proof. To see this, first note that we can re-write equilibrium condition (BB) as a function of $L_e(w)$ and plug it in equilibrium condition (AA). We then obtain an expression of f only that can be expressed as

$$H(f) = N - 2c_a f - \frac{1-\alpha}{1-\alpha-\mu}\theta S - A(f)$$

,where $A(f) = (1+\frac{\mu}{1-\alpha-\mu}\frac{1}{\varepsilon})\frac{\varepsilon}{1-\varepsilon}\{2c_a[\frac{(1-\alpha)(1-e^{-\tau f})}{\alpha e^{-2(1-\alpha)\tau f}}+f]-N\}$, $A'(f) > 0$ and $H'(f) < 0$. To find the equilibrium, we look for a value f^* such that $H(f^*) = 0$.

First, recall that the values that f can adopt in equation (AA) have an upper bound $\overline{f} = \frac{1}{2c_a}\left(N - \frac{1-\alpha}{1-\alpha-\mu}\theta S\right)$ with $0 < \overline{f} < \dfrac{N}{2c_a}$ under Assumption 5. Note that $H(\overline{f}) = -A(\overline{f})$, which is negative only if $2c_a[\frac{(1-\alpha)(1-e^{-\tau\overline{f}})}{\alpha e^{-2(1-\alpha)\tau\overline{f}}} + \overline{f}] - N > 0$. From definition of $\overline{f}$, (1.11) and (1.16), this condition can be re-written as $\frac{1-\alpha}{1-\alpha-\mu}\theta S + \dfrac{\pi_e}{w} > \frac{1-\alpha}{1-\alpha-\mu}\dfrac{\theta S}{2c_a}$, which is satisfied under Assumption 5, hence $H(\overline{f}) < 0$.

[82]Note that the overestimation of α and $\frac{\theta S}{N}$ mean that the threshold that μ should exceed to violate assumption 1 are understated. Hence, violation of assumption 1 requires an even higher μ, and smaller budget share of imported goods.

Second, recall that the values of f in equation (BB) have a lower bound $\underline{f} \equiv \lim_{w\to\infty} f = g^{-1}(N)$, where $g^{-1}(\cdot)$ is the inverse function of $g(f) \equiv 2c_a[\frac{(1-\alpha)(1-e^{-\tau f})}{\alpha e^{-2(1-\alpha)\tau f}} + f]$. from this definition follows that $A(\underline{f}) = 0$. Combining this result with the previous observations that $A(\overline{f}) > 0$ and $A'(f) > 0$, it follows that $0 < \underline{f} < \overline{f} < \dfrac{N}{2c_a}$ and therefore $H(\underline{f}) = N - 2c_a\underline{f} - \frac{1-\alpha}{1-\alpha-\mu}\theta S > 0$.

Finally, since $H(f)$ monotonically decreases in f, $H(\underline{f}) > 0$ and $H(\overline{f}) < 0$ imply that there is a unique positive value $f^* \in (\underline{f}, \overline{f})$, such that $H(f^*) = 0$. From inspection of either (1.11) or (1.16), values of $f^* \in (\underline{f}, \overline{f})$ imply a value of $L_e(w) > 0$ and thus that the equilibrium wage, namely w^*, is also unique and positive. ■

A.2 Effect on number of manufacturing firms

Proposition 7 *the number of manufacturing firms, v increases with the expansion of the mine, $\frac{dv}{dS} > 0$, if and only if $\theta > -\dfrac{1}{\varepsilon}\dfrac{dL_e}{dw}\dfrac{dw}{dS}$.*

Proof. Taking total derivatives to (AA) we obtain that:

$$-2c_a\frac{df}{dS} - \frac{(1-\alpha-\mu)\,\varepsilon + \mu}{(1-\alpha-\mu)\,\varepsilon}\frac{dL_e}{dw}\frac{dw}{dS} = \frac{1-\alpha}{1-\alpha-\mu}\theta. \tag{1.22}$$

Similarly taking total derivatives to (1.17) we obtain

$$\frac{dv}{dS} = -2c_a\frac{df}{dS} - \frac{dL_e}{dw}\frac{dw}{dS} - \theta \tag{1.23}$$

and thus $\frac{dv}{dS} > 0$ if and only if:

$$-2c_a\frac{df}{dS} - \frac{dL_e}{dw}\frac{dw}{dS} > \theta. \tag{1.24}$$

Using (1.22) and (1.9) we can re-write condition (1.24) as $\theta > -\dfrac{1}{\varepsilon}\dfrac{dL_e}{dw}\dfrac{dw}{dS}$. ■

A.3 Effect on real wage

Proposition 8 *if the number of manufacturing firms increase with expansion of the mine, then $\frac{d\omega}{dS} > 0$. Otherwise, the effect is more likely to be positive for low values of μ, θ or high values of ε.*

Proof. Taking total derivatives to (1.18) and using (1.13) we obtain:

$$\begin{aligned}\frac{d\omega}{dS} = \frac{\mu}{\sigma-1}(\frac{w}{G})^{\mu}v^{-1}\frac{dv}{dS} + 2(1-\alpha)\alpha\tau(\frac{w}{p_a})^{\alpha}(-\frac{df}{dS}) + \\ (1-\alpha-\mu)(\frac{w}{p_a})^{1-\alpha-\mu}w^{-1}\frac{dw}{dS},\end{aligned} \tag{1.25}$$

which is positive if $\dfrac{dv}{dS} > 0$.

To study the conditions for $\dfrac{d\omega}{dS} > 0$ when $\dfrac{dv}{dS} < 0$, we first re-write (1.25) replacing $\dfrac{dv}{dS}$ using expression (1.23):

$$\frac{d\omega}{dS} = C - \frac{dL_e}{dw}\frac{dw}{dS} - \theta,$$

where

$$C \equiv -\{2(1-\alpha)\alpha\tau(\frac{w}{p_a})^{\alpha}\frac{\sigma-1}{\mu}(\frac{w}{G})^{-\mu}v + c_a\}\frac{df}{dS} +$$
$$(1-\alpha-\mu)(\frac{w}{p_a})^{1-\alpha-\mu}w^{-1}\frac{\sigma-1}{\mu}(\frac{w}{G})^{-\mu}v\frac{dw}{dS}.$$

Hence the condition for $\dfrac{d\omega}{dS} > 0$ when $\dfrac{dv}{dS} < 0$ is:

$$C - \frac{dL_e}{dw}\frac{dw}{dS} > \theta.$$

Note, from Proposition 7, that $\dfrac{dv}{dS} < 0$ implies $-\dfrac{dL_e}{dw}\dfrac{dw}{dS} > \varepsilon\theta$. That means that a sufficient condition for $\dfrac{d\omega}{dS} > 0$ when $\dfrac{dv}{dS} < 0$ is:

$$C > \theta(1-\varepsilon).$$

This condition is more likely to be satisfied for high values of ε or low values of μ and θ. ■

A.4 Proof of Propositions 1 and 2

Using the definition of real income from (1.19) and re-arranging, we can re-write the food market equilibrium condition (1.11) as:

$$\frac{p_a}{P} = \left[2\left(1-\alpha\right)\int_0^f e^{-\tau r}dr\right]^{-1}\alpha L y,$$

where y is the real income in the city. Note that $\frac{dy}{dS} > 0$ implies $\frac{dp_a/P}{dS} > 0$, because $\frac{df}{dS} < 0$ and $\frac{dL}{dS} > 0$. However if $\frac{dy}{dS} > 0$ the sign of $\frac{dp_a/P}{dS}$ is ambiguous.

Recall that real income in the rural hinterland is:

$$y(r) = \frac{1}{k}\frac{p_a}{P}e^{-2(1-\alpha)\tau|r|}.$$

It is immediate to see that $\frac{dy(r)}{dS} > 0$ and $\frac{d^2y(r)}{dSdr} < 0$.

A.5 Proof of Proposition 3

Using (1.2) and (1.5), we can write the relative prices of food and the import good as:

$$\begin{aligned} \frac{p_a(r)}{P(r)} &= \frac{p_a}{P} e^{-2(1-\alpha)\tau|r|} \\ \frac{p_m(r)}{P(r)} &= \frac{p_m}{P} e^{2\alpha\tau|r|}. \end{aligned}$$

By proposition 1, we know that if $\frac{dy}{dS} > 0$, then $\frac{dp_a/P}{dS} > 0$ which also implies that $\frac{dp_a(r)/P(r)}{dS} > 0$ Since $\frac{dP}{dS} \lesseqgtr 0$ and $\frac{dp_m}{dS} = 0$, it follows that $\frac{dp_m(r)/P(r)}{dS} \lesseqgtr 0$.

2 Nomination Procedures and Political Selection

Political parties are considered one of the key political actors in modern democracies. They create a link between voters and politicians and provide the organizational infrastructure needed to enter and participate in political life (Hazan and Rahat, 2006; White, 2006). Nonetheless, despite their role as gatekeepers of the political arena, little is known about the effect of party institutions on political selection and the implications for economic and policy outcomes (Besley, 2005).

This chapter explores empirically the relationship between internal party nomination procedures and the quality of politicians. It uses a new data set of Latin American political parties containing detailed information on the procedures used to select presidential candidates, electoral outcomes and politicians' characteristics. This data is complemented with several measures of quality of government at country level.

The main empirical challenge in addressing the research question is the presence of omitted variables which might drive both policy outcomes and parties' institutional decisions. In most countries, parties are free to choose a nomination procedure and hence it may be endogenous to the political process (Katz, 2001; Serra, 2007). To address this concern, I first develop a model to understand a party's decision to adopt a particular nomination procedure. Then I test the model predictions on the data and use the suggested institutional determinants as instruments for the observed candidate nomination procedure.

In the model, more democratic nomination procedures -such as party primaries- provide party members with the option of replacing the incumbent candidate with a better politician and enhance the party's electoral performance. They can do it because they have inside information and observe the quality of the politicians. The cost of adopting primaries comes from the possibility of replacing the incumbent leader, to whom party members may have a loyalty attachment.[83]

The model predicts that primary-nominated candidates will obtain higher vote shares and have a better expected quality than candidates selected in less contested procedures, like nomination by a party leader. Regarding primary determinants, the model predicts that inter-party political competition increases the likelihood of adopting primaries. The effect of political competition, however, is attenuated by the incumbency advantage, which in the model comes from the loyalty bias of party members.

[83]The model stresses the role of primaries as selection devices in presence of perfect information within the party. Complementary explanations focus on the signalling or screening role of primaries. For example Meirowitz (2005) develops a model in which primaries offer voters an early opportunity to signal their preferences to candidates. Serra (2007) proposes a model of endogenous primary adoption in which parties use primaries as devices to obtain information about the campaigning skills of candidates.

I test the model predictions in three steps. First, I exploit within-party variation to evaluate the determinants of primary adoption. I find a positive and significant relationship between measures of political competition and the likelihood of primary adoption. This effect becomes insignificant when the candidate is also the party founder. I interpret this finding as evidence of the incumbency advantage offsetting the incentives created by political competition.

Second, I investigate the relationship between selection methods and quality of government using a sample of appointed presidents. The empirical strategy exploits between-party variation and uses the primary determinants identified in the first step as instruments. In particular, I use political competition, the status of a candidate as party founder and the interaction term as instruments for the nomination procedure used by the president's party. This approach reduces relevant identification concerns due to the endogeneity of primary adoption. I find that during the mandate of primary-nominated presidents there is an improvement of more than one standard deviation in the measures of government efficiency (such as corruption and bureaucracy quality) as well as an increase of government size and real income per capita.

Finally, I explore the relationship between nomination procedures and electoral performance. This allow us to explore the mechanism through which primaries affect quality of government: improvements of the political process or the type of politician. Exploiting within party variation, I find evidence that primary-nominated candidates obtain a larger vote share. On average, the increase in vote share is 6 percent -a sizeable gain considering that the average vote share is 33 percent. This result is similar to previous studies in Latin America (Carey and Polga-Hecimovich, 2006). More interestingly, the vote premium is decreasing in the size of the party -measured as the seat share obtained in legislative elections. I interpret these findings as evidence of primaries improving the candidate's quality and attracting non-partisan voters.

Taken together, these results support the claim that parties -through the choice of more democratic nomination procedures- can improve political selection. The quality differences do not only translate into better electoral performance, but seem also to affect government efficiency and economic outcomes.

The rest of the chapter proceeds as follows. Section 2.1 places the findings of this chapter in the context of the relevant literature. Section 2.2 presents some background on Latin America primaries and the data used in the empirical exercise. Section 2.3 develops the analytical framework. Section 2.5 explores the determinants of primary adoption. Section 2.6 uses the insights from the previous section to evaluate the effect of candidate selection methods on the quality of politicians. Section 2.7 provides some concluding remarks. All proofs are in the Appendix.

2.1 Related Literature

The research in this chapter contributes to the literature on political selection. This literature stresses the role of formal compensation as a factor to attract good politicians. For example, Caselli and Morelli (2004) argue that low rewards from office attract low-quality citizens and deteriorate the quality of the pool of available politicians. Ferraz and Finan (2009) exploit a quasi-experiment in Brazil and find evidence that increase in wages improves the observable quality of legislators and measures of performance. Besley et al. (forthcoming) find evidence in U.S. consistent with the argument that parties respond to political competition by improving the quality of their candidates. Nonetheless, to the best of my knowledge, there are not empirical studies relating party nomination procedures to the quality of politicians.

This chapter also contributes to the literature on primary adoption. Similar to the argument proposed in this chapter, this literature emphasizes the trade-off between the cost of increasing internal competition and the benefits of improving electoral performance. There are, however, very few empirical studies of primary determinants. For example, Castanheira et al. (forthcoming) develop a model in which the quality of the party platform depends on a candidate's effort. In their view, primaries provide a better signal to voters and enhance the pool of candidates the party can choose from, but they reduce candidates' incentives to improve the policy platform. The cost of adopting primaries is augmented by inter-party political competition and internal ideological polarization. Serra (2007) proposes a model in which primaries help party leaders to assess the candidates' campaigning skills but may be costly since they may induce candidates to adopt extreme ideological views. Lundell (2004) evaluates empirically the determinants of candidate selection methods using a cross section of political parties in developed countries. He finds that smaller parties -measured by the vote share in the previous election- tend to adopt more decentralized selection methods. This result is consistent with my empirical findings.

2.2 Primaries in Latin America

In recent democratic elections, Latin American political parties have used different methods to nominate presidential candidates. The nomination procedures range from nomination by the party leader to more democratic procedures such as party primaries (Alcántara Sáez, 2002). This institutional heterogeneity makes Latin America an interesting testing ground to study the effect of party institutions on political selection.

The use of primaries varies both between and within parties: there are several cases of parties switching nomination procedures between elections. For example, the Argentinean *Unión Cívica Radical* used primaries in the presidential elections of 1989, 1995 and 2003, but not in 1999. The Mexican *Partido Revolutionaries Institutional* started using primaries in 2000 after decades of nominations controlled by the incumbent president. As a rough measure of this heterogeneity I calculate the standard deviation of the use of primaries between and within parties. The values are 0.268 and 0.277 respectively. This suggests that within party variation is an important source of heterogeneity in the use of primaries.

Primaries in Latin America are not as widespread as in American politics. In the period 1978-2004, only 11 percent of presidential candidates was nominated in a party primary. The use of primaries, however, has increased over time specially during the second half of the 1990s (see Figure 2.1).

The use of primaries remains a party decision. In most countries there is no legal requirement to use primaries or any specific nomination procedure (Alcántara Sáez, 2002; Freidenberg, 2003). Only recently some countries like Uruguay, Paraguay and Panama included a legal obligation to use primaries in their electoral legislation. In practice, however, this requirement has not been fully enforced (see Table 2.1). Moreover, the adoption of primaries has been partial: not all parties in a given election used them (see Table 2.1). This suggests that the decision to use primaries is not entirely driven the by the electoral environment but also may be affected by party specific factors.

The endogeneity of primary adoption confounds the evaluation of the relationship between parties' nomination procedures and economic and electoral outcomes. In the next sections, I propose and test a simple model to understand some of the determinants of primary adoption. Then I use the suggested primary determinants as instruments of the nomination procedure and explore the effect of primaries on quality of government.

2.3 A Model of Endogenous Primaries

The aim of this section is to develop an simple analytical framework to understand some of the determinants of primary adoption and guide the empirical exercise. The model treats the candidate nomination procedure as endogenous and links its adoption to political competition and candidate characteristics.

The model stresses the following trade off of adopting primaries: increasing internal competition allows the party to choose a better candidate and may improve the party electoral performance. Primaries are costly, however, because they may replace the incumbent candidate, for whom some party members have a strong ideological attachment.

Consider a political party whose only role is to nominate a candidate to run in a presidential election. The party is composed of a rank and file and professional politicians, one of them acting as the party leader. In the status quo, the party leader is by default the party candidate.[84] The final decision, however, depends on the nomination procedure chosen by the party members.

[84] This status quo is equivalent to a situation with an office-seeking leader in charge of party nomination.

Figure 2.1: % primary-nominated candidates, by quinquennium

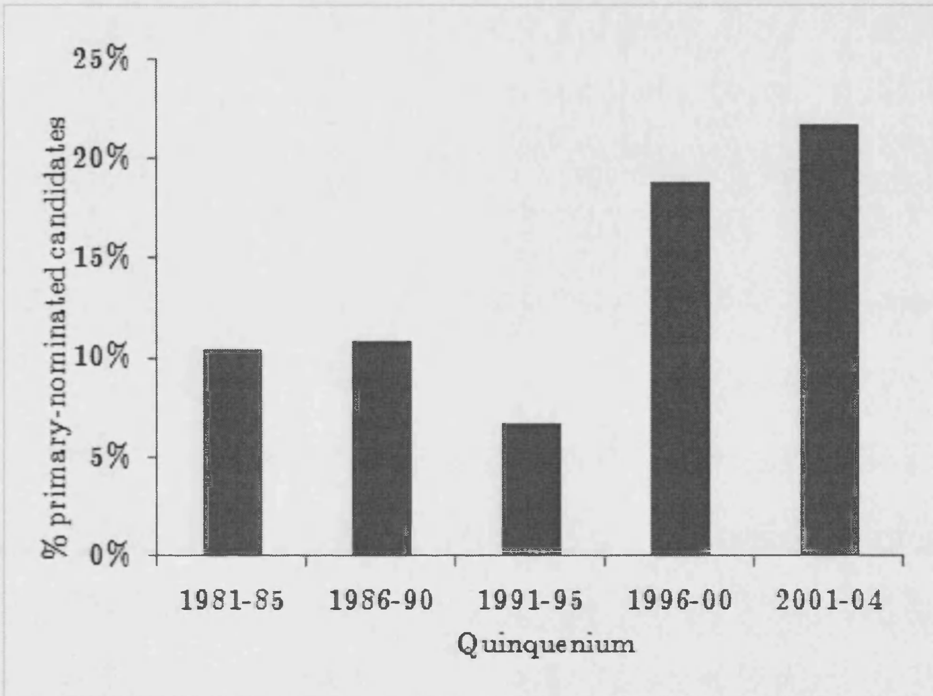

Table 2.1: Use of presidential primaries in Latin America

Country	Legal obligation	Use of primaries in practice
Argentina	No	Partial (1989, 1995, 1999, 2003)
Bolivia	Yes, since 1999	No
Brazil	No	Partial (2002)
Chile	No	Partial (1993, 1999)
Colombia	No	Partial (1978, 1986, 1990, 1994)
Costa Rica	Yes	Partial (1978, 1982, 1986, 1998, 2002)
Dominican Rep.	No	Partial (1982, 1986)
Ecuador	No	No
El Salvador	No	Partial (2004)
Guatemala	No	Partial (2003)
Honduras	Yes	Partial (2001)
Mexico	No	Partial (2000)
Nicaragua	No	Partial (1996, 2001)
Panama	Yes, since 1997	Partial (1999)
Paraguay	Yes, since 1996	Partial (1993, 1998, 2003)
Peru	No	No
Uruguay	Yes, since 1996	All parties (1999, 2004), partial (1989)
Venezuela	No	Partial (1978, 1993)

Notes: 'Partial' means that only some parties used primaries. The year of the presidential election in which primaries were used appears in parentheses. The sample considers presidential elections in Latin America during the period 1978-2004.

Sources: Alcántara Sáez (2002), Freidenberg (2003) and Carey and Polga-Hecimovich (2006).

The party members have two institutional choices: adopting a primary or maintaining the status quo. The main distinction between the two alternatives is the degree of internal competition. In the status quo the party leader runs uncontested and is ratified as party candidate. In a primary, in contrast, a random party politician challenges the leader's nomination and then the rank and file selects the party candidate from both contestants. In this context, primaries provide the option to the rank and file to challenge the status quo and to replace the incumbent candidate.[85]

Politicians behave as office seekers maximizing only their probability of holding office. This happens, for instance, if the benefits of holding office are sufficiently high. I abstract from enforceability concerns by assuming that all the politicians affiliated with a party can credibly commit to implementing the party's preferred ideology.[86]

Politicians are heterogenous and differ in terms of their quality q_i which is uniformly distributed on the support $[0, 1]$. The quality of the party leader q_l is exogenously determined. Following Caselli and Morelli (2004) and Besley (2005), I interpret quality as honesty or competence, but it can reflect any characteristic valued by all voters regardless of their political ideology.[87]

The rank and file is composed of heterogenous risk-neutral individuals. They have a common interest in maximizing the party candidate's vote share but differ on their degree of loyalty or attachment to the party leader. In particular, their utility is increasing in:

$$v + \sigma_i + \delta, \tag{2.1}$$

where v is the party vote share, σ_i is a party member's i individual attachment toward the leader and δ is a common popularity shock. I assume that both parameters are non-negative and $\sigma_i \sim U\left[0, \frac{1}{\psi}\right]$ while $\delta \sim U\left[0, \frac{1}{\phi}\right]$. In this model, the party leader enjoys an incumbency advantage since the rank and file has some degree of loyalty toward her. In turn, this feature makes it more difficult to replace her as party candidate.

Like Besley et al. (forthcoming), I introduce inter-party political competition by considering two types of voters: partisan and non-partisan. Partisan voters have a preference bias towards the party's ideological stance, although they do not participate in party decisions. For simplicity, I assume that the ideological bias is strong enough for partisan voter always to prefer voting for the party candidate. In contrast, non-partisan voters care only about the president's quality. The proportion of partisan voters is $\lambda \in (0, 1)$ and I define the political competition faced by the party as $(1 - \lambda)$.

Politician's types are perfectly observed inside the party, but only imperfectly observed by voters. The underlying assumption is that party members have inside in-

[85] These institutions resemble the procedures used in most Latin America cases. In particular, *primary* refers to closed primaries in which only party members can vote, while the status quo refers to the less inclusive methods in which the party leader (or group of leaders) decides the nomination.

[86] A possible motivation for this assumption is that politicians choose to join a party that shares their preferred ideology, as in Snyder Jr. and Ting (2002).

[87] In the political science literature, this concept of quality corresponds to valence.

formation due to more frequent social interaction or more personal contact with party politicians. During the electoral campaign voters observe the candidates' types with probability ρ. With complementary probability they remain completely uninformed about politicians' types and the party's selection method.

There are neither re-elections nor inter-temporal decisions in this model and all individuals live for one period. These assumptions diverge from previous models where parties are long-lived organizations (Alesina and Spear, 1988; Harrington, 1992), but they allow us to focus on the role of political competition and nomination procedures rather than reputation, re-election incentives or commitment devices.

The timing of the game is as follows:

1. (Party constitution) Both σ and δ are realized, the rank and file observe q_l and vote between adopting a primary or a caucus.

2. (Candidate selection) The party nominates its candidate using the chosen selection method. Simultaneously, the opposition party nominates a random politician to run in general elections.

3. (General election) Voters observe the types of both candidates with probability ρ and cast their votes.

The equilibrium concept is sub-game perfect Nash equilibrium and I solve the game using backward induction.

General election Let us denote the quality of the candidate from the party as q_p, and the quality of the opposition party' candidate as q_p^o. Due to the strong ideological bias, partisan voters will always vote in favor of the party, but non-partisan voters will only vote for the party if $q_p > q_p^o$. The tie-breaking rule is tossing a coin.

Given these responses, the expected vote share the party candidate can obtain conditional on q_p before the election is

$$v(q_p) = \rho\left[q_p + (1 - q_p)\lambda\right] + (1 - \rho)\left(\frac{1 + \lambda}{2}\right) \tag{2.2}$$

where I use the property that $\Pr\left(q_p^o < q_p\right) = q_p$. Note that the candidate's vote share is increasing in both q_p and λ, reflecting the two sources of votes: non-partisan voters attracted by a high quality candidate and the support of ideologically motivated voters.

Candidate selection When the party opts to maintain the status quo, the incumbent leader is the default candidate and thus $q_p = q_l$. In contrast, in a primary the incumbent leader faces a randomly drawn challenger with quality q_c and the nomination is decided by the rank and file.

From equation (2.1) we obtain the condition for a party member to prefer the challenger:

$$v(q_c) > v(q_l) + \sigma_i + \delta \tag{2.3}$$

where $\sigma_i + \delta \geq 0$. Since $v(\cdot)$ is increasing in q_p, condition (2.3) implies that $q_p \geq q_l$. Thus a party member will only vote to replace the leader as the party candidate if the quality of the challenger is sufficiently high.

In order to avoid a corner solution I assume that:

Assumption 1 $\frac{1}{2\psi} + \frac{1}{\phi} < \rho(1-\lambda)(1-q_l)$

This assumption states that the loyalty of party members towards the party leader is not too large. It guarantees that there is always a value of q_c such that even a leader with a maximum popularity shock can be replaced if a challenger of sufficiently high quality appears.

Let $\Delta q \equiv Eq_p - q_l$ represent the expected quality gains from using a primary. Then under assumption 1, we can prove that:

Proposition 2 *Primaries improve the expected quality of the party candidate ($\Delta q >$ 0). The expected gains in quality are decreasing in q_l.*

Proposition 3 *A primary-nominated candidate has a higher expected vote share. The expected vote premium is $\rho(1-\lambda)\Delta q$ which is decreasing in the size of partisan voters λ.*

These findings highlight the role of primaries as an option for party members to improve the quality of incumbent candidates. In this setup, the desire of the rank-and-file to appeal to non-partisan voters and increase the party's vote share creates incentives to enhance candidate selection. The expected electoral benefit from using primaries increases when the partisan support (λ) is smaller, since attracting non-partisan voters becomes more important for the party's success. The gains from political selection, however, are smaller when the incumbent leader is already of high quality.

Party constitution At the first stage, the rank and file vote between adopting a primary or maintain the status quo. A party member prefers a primary if:

$$v(Eq_p) > v(q_l) + \sigma_i + \delta. \tag{2.4}$$

Note that party members with a strong attachment to the party leader prefer not to adopt a primary because of the possibility that the leader will be replaced.

Replacing (3) in equation (2.4) we can identify the party member indifferent between a primary and the status quo:

$$\overline{\sigma} = \rho(1-\lambda)\Delta q - \delta > \sigma_i.$$

Given the distributional assumption about σ_i and δ, the proportion of party members preferring a primary is:

$$\pi_p = \psi\overline{\sigma},$$

while the probability of primary adoption p is:

$$p = \Pr\left(\pi_p > \frac{1}{2}\right) = \phi\left[\rho\left(1-\lambda\right)\Delta q - \frac{1}{2\psi}\right]. \tag{2.5}$$

Expression (2.5) reflects the cost and benefits of using a primary. On the one hand, the leader may be replaced by a better candidate. This is costly for party members who have an attachment or loyalty towards her. For that reason, the probability of primary adoption is decreasing in $\frac{1}{2\psi}$, the average loyalty towards the leader.

On the other hand, primaries provide the option of improving the quality of the party candidate and attracting non-partisan voters. In that case, the party obtains an electoral benefit $\rho\left(1-\lambda\right)\Delta q$, which increases with political competition but decreases with the quality of the party leader. Thus, primaries are more likely when the party faces high political competition or when the quality of the party leader is relatively low.

Both benefit and cost are scaled up by ϕ, the density of the popularity shock δ. We can interpret this parameter as an inverse measure of the incumbency advantage. To see this, note that the expected bias of the median party member towards the leader before the popularity shock is $\frac{1}{2\psi} + \frac{1}{2\phi}$. Thus everything else equal, the higher the values of ϕ, the smaller the leader's incumbency advantage.

Calculating comparative statics from (2.5), we can summarize the effect of political competition on primary adoption:

Proposition 4 *Political competition increases the probability of primary adoption. The effect of political competition is decreasing in the leader's incumbency advantage.*

Propositions 2, 3 and 4 summarize the model's main empirical predictions. They formalize the argument that political competition increases the need to attract non-partisan voters and also creates incentives to adopt quality-enhancing procedures such as contestable internal elections. A direct implication of this model is that primary-nominated candidates obtain larger vote shares and are of better quality. The incentives from political competition, however, are attenuated by the incumbency advantage, which in the model comes from the loyalty of party members towards the party leader.

2.4 Data and Main Variables

2.4.1 Data

I use a data set of presidential candidates from 17 Latin American countries. The data include all candidates from major parties running in presidential elections during the period 1978 to 2004. I restrict the universe of candidates only to candidates that obtained a vote share higher that five percent and who were among the four runners up.[88] I also exclude cases of presidents seeking immediate re-election because they may be abnormally popular or influential politicians.[89]

Based on the universe of candidates, I define two data sets: a data set of candidates and a data set of presidents. The first dataset includes candidates of parties that I observe for two or more elections. For each candidate I observe the procedure used to nominate her and the electoral outcome of her party in presidential and legislative elections. I complement this data with information about the candidate and party's characteristics. This dataset allows me to exploit within party variation on nomination procedures to explore both the determinants of primary adoption and the effect of primaries on electoral outcomes.

The second data set includes only candidate appointed as presidents. In addition to the information about the nomination procedure and electoral outcomes, I collect information about the quality of government during the mandate of the president.[90] I use this dataset to study the effect of nomination procedures on quality of government. The data on nomination procedures comes from Carey and Polga-Hecimovich (2006) while the electoral data is from the Political Database of the Americas and party websites. I obtain the data on quality of government from several sources: the International Country Risk Guide (ICRG), World Development Indicators database and Penn World Table.[91]

In total, the dataset of candidates comprises 176 candidates from 47 political parties, while the dataset of presidents includes 82 elected candidates. Table 2.2 presents some summary statistics for the dataset of candidates and presidents.

2.4.2 Main Variables

Nomination procedures I use an indicator variable *primary* equal to one if the candidate was nominated in a close or open primary.[92] The complementary category includes less democratic methods such as party conventions and nominations by party leaders. These two categories correspond to the *primary* and *status quo* institutions

[88]The rationale for this exclusion is to avoid very small parties that may not have an office-seeking motivation but may pursue other political objectives. The results including candidates from this parties, not reported, are qualitatively similar

[89]In Latin America presidential re-election is very rare and requires constitutional changes. In the period of analysis, there are four cases of incumbent presidents seeking re-election: Alberto Fujimori (Peru), Hugo Chávez (Venezuela), Carlos Mente (Argentina) and Henries Cardoso (Brazil). All four presidents were re-elected.

[90]The measures of quality of government have annual frequency. To link these variables to each president, I first identify the president ruling a country in any given year. In the case of two presidents in a year (i.e. transition years) I match the year to the president who held office for most of the time. Then I aggregate the measures of quality of government taking the average value during a given president's mandate.

[91] See Appendix B.4 for further details on data sources and variables' definitions.

[92]The main distinction between open and close primaries is than in open primaries the whole electorate can vote while in close primaries only registered party members can participate.

Table 2.2: Summary statistics

Variable	Obi.	Mean	Standard deviation
A. Dataset of candidates			
Primary	179	0.168	0.375
Primary in previous election	174	0.115	0.320
Primary any other	179	0.223	0.418
Seat share	179	0.335	0.152
Vote share	179	0.340	0.139
Political competition	179	-0.032	0.131
Founder	179	0.291	0.455
Number of candidates	179	9.587	4.835
B. Dataset of presidents			
Primary	82	0.390	0.491
Primary in previous election	82	0.122	0.329
Primary any other	82	0.220	0.416
Political competition	82	-0.095	0.120
Founder	82	0.293	0.458
Corruption	77	2.8	0.9
Bureaucracy quality	77	1.7	0.8
Government expense	43	18.1	6.3
Government revenue	43	18.8	5.7
Ln(GDP per capita)	76	8.6	0.4
Annual GDP growth	76	0.8	2.2

described in the model.

In addition, I construct indicator variables of whether the party used a primary in the previous presidential election (*primary in previous election*) and whether other parties used primaries in the same electoral process (*primary any other*).

Political competition As a measure of political competition faced by a party, I use the difference between a party's seat share and the second largest seat share. I calculate the seat share as the proportion of seats obtained by the candidate's party in the legislative election held simultaneously or immediately before the presidential election.[93]

Recall that in the model, the political competition faced by a party is $(1 - \lambda)$, where λ is the size of the partisan support or electoral advantage. Intuitively, a party with a relatively large partisan support faces less political competition because it can win the election relying only on the vote of partisan supporters.

The measure of political competition I use captures the same intuition and uses the party seat share as a proxy for partisan support.[94] The reason for comparing this partisan support to the second largest seat share is that under majority rule, a candidate needs at least as many votes as the second runner up to win the election. This measure can be easily derived from the model's definition of political competition.[95]

Incumbency advantage The model predicts that the effect of political competition of primary adoption decreases with the incumbent candidate's advantage. To measure the incumbency advantage, I use an indicator of the candidate also being a party founder (*founder*).

The rationale for using this variable is that party founders may have a particular charisma, popularity or reputation which facilitated the creation of a new party. These same characteristics may give them a political advantage inside the party.[96] In terms

[93] In the countries studied, the legislative and presidential elections are separated electoral events, even though both elections may occur simultaneously. The vote share obtained by the presidential candidate and the proportion of parliamentary seats obtained by a party (seat share) are highly correlated, but not identical. In the case of bi-cameral parliaments, I use the proportion of seats in the lower chamber (*Cámara de Diputados*)

[94] The proposed measure resembles the Ranney Index, a widely used index of political competition (King, 1989). In the empirical section I check the robustness of the results to alternative measures of political competition.

[95] For a formal derivation of the index of political competition, see Appendix C.

[96] There is anecdotal evidence suggesting that party founders enjoy a greater ability to influence party constitutions. For example, in the Dominican Republic, Joaquín Balaguer created the *Partido Reformista Social Cristiano* and controlled it throughout his lifetime, resisting internal pressures to democratized the party. In Peru, Alberto Fujimori changed his party's name several times and was able to control it even during his exile in Japan. In a more extreme case, a politician can create a party to support his own candidacy and accommodate party institutions to that purpose. That is the case of Hugo Chávez, who founded the party *Movimiento V República* in 1997 to back his presidential campaign. A similar case is the one of Álvaro Uribe, Colombia's current president, who first ran for president in 2002 with the *Colombia Democrática*, a party he created after separating from the *Partido Liberal*.

of the model, being a party founder would correspond to having a small ϕ and hence a higher cost of adopting primaries.

Quality of Government Following La Porta et al. (1999), I use several variables of government efficiency and size of the public sector as proxies of quality of government. As measures of government efficiency I use political risk assessments from the International Country Risk Guide (ICRG) related to corruption in government and the quality of a country's bureaucracy.[97] To measure the size of public sector, I use the value of government expense and revenues (excluding grants) as a proportion of GDP from the World Development Indicators database. In addition, I use indicators of economic performance such as real income per capita and economic growth rate from the Penn World Table.

2.5 First Stage: Primary Determinants

In this section, I explore empirically the determinants of adopting a particular nomination procedure using a data set of Latin American presidential candidates. Following the model's insights, I focus on the role of political competition and incumbency advantage as the main explanatory variables. In the next section I use these primary determinants as instruments to identify the effect of nomination procedures on the quality of politicians.

The model suggests that the likelihood of using a primary increases with political competition. Additionally, the model predicts a heterogenous effect with the effect of political competition decreasing in the leader's incumbency advantage (Proposition 4).

To test these hypotheses, I estimate the following model:

$$\begin{aligned} primary_{ij} = \alpha_1 X_{ij} + \alpha_2 (X_{ij} \times founder_{ij}) + \\ \alpha_3 founder_{ij} + \alpha_4 \mathbf{W}_j + \eta_i + \varepsilon_{ij}, \end{aligned} \tag{2.6}$$

where $primary_{ij}$ is the selection method used by the party i in the presidential election j, X_{ij} is the measure of political competition, $founder_{ij}$ is the proxy for the leader's incumbency advantage, $\mathbf{W}_j$ is a set of control variables and η_i is the party fixed effect. Note that the hypotheses stated in proposition 4 imply $\alpha_1 > 0$ and $\alpha_2 < 0$.

This specification exploits within-party variation and controls for time-invariant party characteristics. The identification of the effect of political competition on primary adoption comes from the comparison of the same party in different elections.

Table 2.3 presents the estimates of the baseline specification using a linear probability model. It includes as additional control variables a post-1990 dummy to capture

[97] These variables were previously used by Hall and Jones (1999) to construct an index of government anti-diversion policies. They find a relationship between this indicator and improvements in productivity. I replicate the empirical exercise of this section using this alternative index and obtain similar results.

the increased use of primaries and an indicator of other parties using primaries (*primary any other*). I cluster the standard errors by political party to correct for any serial correlation in the party use of a nomination procedure.

Column (1) shows the results without the interaction term. Consistent with the model predictions, there is a positive and significant correlation between political competition and primary adoption. This result highlights the importance of electoral incentives in the adoption of a candidate selection method. Column (2) explores the heterogenous effects of political competition by including the interaction term with $founder$. In this case, the estimate of α_2 is negative and significant, but the correlation with political competition alone (α_1) becomes insignificant. The differences on the effect of political competition by $founder$ are relevant. In particular, the effect of political competition is positive only when the candidate is *not* the party founder. This finding sheds light on the internal mechanism for adopting primaries and suggests that the incumbency advantage may attenuate the electoral incentives created by political competition.

Column (3) estimates the baseline model restricting the sample to parties older than 10 years. The results are similar to the ones using the full sample and reduce concerns that $founder$ is picking up other characteristics associated with young parties that may hinder their ability to implement primaries, such as lack of organizational infrastructure, knowledge or financial resources. In all the cases, the probability of using a primary is larger if other parties are also using it. This result may indicate some strategic complementarities between parties or the existence of common factors driving the party decisions.

A first identification concern is the presence of omitted variables. In particular, the model suggests that the quality of the leader (q_l) is positively correlated with primary adoption; however, q_l is unobserved and omitted in the regression.[98] This omission confounds the identification of the causal effect of political competition on primary adoption to the extent that q_l is correlated with the explanatory variables. To address this concern, the empirical specification includes party fixed effects. Under the assumption that any relevant omitted variable is time-invariant, the estimates would capture a causal relationship between political competition and primary adoption.

A second concern is reverse causality between primary adoption and the measure of political competition. For example, a party adopting a primary may increase its partisan support and obtain a larger seat share, in turn reducing the index of political competition. In this case, however, we could expect a downward bias on the estimates of α_1, which would make the results even more conservative.

Table 2.4 presents the estimates of the baseline regression using alternative measures of political competition. In columns (1) and (2), I use the value one as a threshold $\widehat{t}$ instead of the second highest seat share. The resulting index resembles more closely

[98]Other possible omitted variables stressed in the literature of primary determinants include party ideology and organization.

Table 2.3: Determinants of primary adoption

	(1)	(2)	(3)
	Primary	Primary	Primary
Political competition	0.453	0.714	0.901
	(0.261)*	(0.324)	(0.356)
Political competition × founder		-0.888	-1.008
		(0.344)**	(0.420)**
Founder	0.009	0.034	0.055
	(0.033)	(0.028)	(0.051)
Primary any other	0.237	0.249	0.232
	(0.099)**	(0.099)**	(0.103)**
Sample	Full	Full	Age>10 years
Observations	179	179	147
Number of parties	47	47	40
R-squared	0.09	0.11	0.12

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at party level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include a post-1990 dummy. The measure of political competition is the second highest seat share in an election minus the party seat share. Column (3) uses a sub-sample of parties older than 10 years.

the Ranney Index. In columns (3) and (4), in addition to changing the threshold, I replace the contemporaneous value of seat share with the value associated with the previous presidential election. In all the cases, the results are similar to the baseline regressions.

Table 2.5 presents the results of a falsification test. I use specification (2.6), replacing the dependant variable by its lagged value (*primary in previous election*). This variable adopts the value one if the party used a primary in the previous election, and zero otherwise. In contrast to the baseline results, the effect of political competition becomes insignificant.

2.6 Quality of Politicians

In this section, I explore the relationship between candidate nomination procedures and political selection in two steps. First, I explore the relationship between primary nomination and the quality of government using the dataset of presidents. A simple OLS regression would not be informative of this relationship due to the endogeneity of nomination procedures. To address this concern, I use the determinants of primary adoption identified in the previous section as instruments for the nomination procedure.

Second, I evaluate the effect of primaries on candidate's electoral performance. This allow us to explore the mechanism through which primaries affect quality of government: improvements of the political process or the type of politician. If primaries

Table 2.4: Alternative measures of political competition

	(1) Primary	(2) Primary	(3) Primary	(4) Primary
Political competition	0.481	0.754	0.358	0.607
	(0.253)*	(0.304)**	-0.221	(0.297)**
Political competition × founder		-0.860		-0.688
		(0.332)**		(0.323)**
Founder	0.016	0.636	-0.002	0.529
	(0.032)	(0.250)**	(0.046)	(0.251)**
Primary any other	0.242	0.250	0.275	0.284
	(0.099)**	(0.099)**	(0.111)**	(0.109)**
Measure of political competition	1 - party seat share		1 - party seat share in previous election	
Observations	179	179	158	158
Number of parties	47	47	47	47
R-squared	0.10	0.12	0.12	0.14

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at party level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include a post-1990 dummy.

Table 2.5: Determinants of primary adoption - falsification test

	(1) Primary in previous election	(2) Primary in previous election
Political competition	0.075	0.102
	(0.218)	(0.305)
Political competition × founder		-0.091
		(0.309)
Founder	0.026	0.029
	(0.030)	(0.033)
Primary any other	-0.021	-0.019
	(0.067)	(0.068)
Observations	174	174
Number of parties	47	47
R-squared	0.01	0.01

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at party level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include a post-1990 dummy.

improve political selection we expect primary-nominated candidates to attract voters and obtain a higher vote share.

2.6.1 Quality of Government

The analytical framework predicts that primaries may improve political selection (Proposition 2). If the role of the president is relevant enough to shape government policies, a corollary of this prediction is that a country will have a better government under a primary-nominated president.

To test this hypothesis, I estimate the following model:

$$y_{cm} = \gamma_1 primary\ president_{cm} + \gamma_2 \mathbf{W}_m + \varepsilon_{cm}, \qquad (2.7)$$

where y_{cm} is a measure of the quality of government of country c during the mandate of president m, $primary_{cm}$ is the method by which the ruling president was selected by his party and $\mathbf{W}_m$ is a vector of control variables including a post-1990 dummy and an annual trend. In all regressions, I use the values of y normalized to have mean zero and a standard deviation equal to one to facilitate comparison of results. In this specification, the parameter of interest is γ_1.

A simple inspection of equation (2.7) suggests that an OLS regression would lead to inconsistent estimates of γ_1. The main identification challenge is the presence of omitted variables that may drive both the quality of government and the nomination procedure used by the president's party. For example, the model suggests that parties with already good incumbent candidates will be less likely to adopt primaries. Since quality is unobservable and may positively affect the outcome variable, its omission may lead to a downward bias of the OLS estimates.

To address this identification concern, I use an instrumental variable approach based on the insights about the drivers of primary adoption identified in the analytical framework and tested in the previous empirical analysis (see Section 2.5). In particular, I instrument *primary* with the measure of political competition faced by the president's party, the variable $founder$ and the interaction term. The underlying identification assumption is that at least one of the instruments, including the interaction term, is uncorrelated to the error term.

Table 2.6 displays the estimates of equation (2.7) using different measures of government quality. As a benchmark, column (1) shows the estimates of an OLS regression. There is a positive correlation between primary-nominated presidents and all measures of government quality. However, with the exception of real income per capita, the correlation is not statistically significant.

Column (2) estimates the baseline regression using 2SLS. The estimates are larger than with OLS, which is consistent with the attenuation bias due to the omission of politician's quality in the regression. The results suggest that there are significant differences in the quality of government during the mandate of primary-nominated presidents. I find that having a primary-nominated president is associated with increments of more than one standard deviation in the perceptions of corruption, bureaucracy quality and size of government revenues. Countries with primary-nominated presidents also enjoyed higher levels of income, although I find no evidence of differences in the growth rate of the economy. Taken together, these results are consistent with the argument that parties enhance the quality of politicians by adopting more democratic selection methods.

Table 2.7 displays the first stage and reduced-form regressions. I only report the first stage of the model with *corruption* as the dependent variable. The results are similar when using other outcome variables, although the sample size varies. The results from the first stage (column 1) resemble the findings about primary determinants obtained using the sample of presidential candidates in section 2.5. The likelihood that a president was primary-nominated increases with political competition, but only for politicians who were not also party founders.[99] Columns (2) to (7) report the reduced form regressions. In all cases, the estimates are consistent with the 2SLS findings: the factors that increase the likelihood of primary adoption are also positively correlated with the measures of government quality. This evidence highlights the link between political competition, party institutions and political selection.

Discussion and main limitations There are at least to relevant concerns regarding the 2SLS estimates: the presence of weak instruments and the violation of the exclusion restriction. These issues need to be taken into account when interpreting the results. In particular, they could bias the results towards OLS or yield inconsistent estimates. In that case, we could not interpret the previous results as the effect of the president's nomination procedure on quality of government.

Regarding the first issue, note that the sample size used in the 2SLS regressions ranges from 43 to 77 observations, and the F-statistic of the excluded instruments is 6.87 (see Table 2.7). These evidence suggests that the instruments are weak. The presence of weak instruments may bias both the point estimates and the standard errors.[100]

To address this concern, I replicate the baseline regression using the Limited-Information Maximum Likelihood (LIML) estimator which is partially robust to weak instruments (Stock et al., 2002). In addition, I test significance using the Conditional Likelihood Ratio (CLR) test proposed by Moreira (2003). The CLR test provides a more reliable confidence interval and improves hypothesis testing in the presence of weak instruments (Andrews and Stock, 2005). Column (3) in Table 2.6 presents the estimates of γ_1 using the LIML estimator, while column (4) displays the p-values of the significance tests using the CLR. The pattern of results is consistent with

[99]The parameter associated to *founder* is negative and statistically significant as predicted by the model.

[100]A F-statistic above 10 is usually required to rule out weak instruments (Stock et al., 2002).

Table 2.6: Primaries and quality of government

Dependent variable	Nr. obi.	(1) OLS	(2) 2SLS	(3) LIML	(4) CLR test p-value	(5) Overid. test p-value
Government efficiency						
Corruption	77	0.119	1.223	1.427	0.036	0.291
		(0.239)	(0.624)*	(0.732)*		
Bureaucracy quality	77	0.416	1.296	1.3	0.058	0.936
		(0.209)*	(0.730)*	(0.714)*		
Size of public sector						
Government expense	43	0.215	1.655	1.999	0.023	0.447
		(0.332)	(1.084)	(1.338)		
Government revenue	43	0.436	1.83	1.991	0.019	0.638
		(0.344)	(0.933)*	(1.016)*		
Economic outcomes						
Ln(GDP per capita)	76	0.508	1.037	1.046	0.118	0.858
		(0.243)**	(0.498)**	(0.491)**		
GDP growth	76	0.036	-0.01	-0.013	0.982	0.663
		(0.230)	(0.670)	(0.683)		

Notes: Robust standard errors in parentheses. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. The estimates correspond to the parameter associated to variable *primary*. All regressions include a post-1990 dummy and a time trend. 2SLS and LIML regressions use *political competition*, *no founder*, and the interaction term as excluded instruments. 2SLS standard errors are corrected by small sample. Column (3) reports results using the Limited Information Maximum Likelihood (LIML). Column (4) shows the p-value of the LIML estimates using the Conditional Likelihood Ratio test. Column (5) shows the p-value of the Sargan-Hansen over-identification test.

Table 2.7: First stage and reduced-form regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
			Reduced-form regressions				
Excluded instruments	First stage	Corruption	Bureaucracy quality	Gov. expense	Gov. revenue	Ln(GDP per capita)	GDP growth
Political competition	0.757	2.128	1.053	1.402	2.063	0.981	0.635
	(0.427)*	(0.783)***	(1.260)	(1.800)	(1.634)	(0.825)	(1.309)
Political competition × founder	-2.188	-4.723	-3.269	-2.406	-3.366	-2.108	0.446
	(0.938)**	(1.531)***	(1.943)*	(2.626)	(2.677)	(1.732)	(1.874)
Founder	-0.479	-0.556	-0.615	-0.961	-0.947	-0.536	0.052
	(0.107)***	(0.248)**	(0.312)*	(0.406)**	(0.363)**	(0.266)**	(0.302)
Observations	77	77	77	43	43	76	76
F-statistic	6.87						
R-squared	0.149						

Notes: Robust standard errors in parentheses. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include a post-1990 dummy and year trend as included instruments. Column (1) reports the first stage of the 2SLS regression with *corruption* as the outcome variable and the F-statistic and R-squared of the excluded instruments.

the 2SLS findings, and suggests that weak instruments are not a serious concern in this application. Moreover, as shown by Stock et al. (2002), weak instruments may produce a small sample bias toward OLS. Since in this case most OLS estimates are not significantly different from zero, a weak instrument problem would mean that the 2SLS estimates are too conservative.

A second concern is that the instruments may affect the outcome variable through other channels than through the adoption of a particular nomination procedure. This violation of the exclusion restriction may occur for example if a party's seat share (the measure of political competition) also affects the president's ability to influence policy. In that case, the estimates could not be interpreted as the effect of primary adoption on quality of government, but only as a simple correlation.

I explore this issue in two steps. First, I test the validity of the set of instruments using the Sargan-Hansen over-identification test. The null hypothesis of this test is that the instruments are uncorrelated with the error term and thus correctly excluded from the main regression. The results are displayed in Column (5) in Table 2.6. In all the cases, the null hypothesis is not rejected. These results support the case for a consistent estimation of γ_1.

As a second step, I explore the presence of omitted variables that may confound the effect of primary adoption. To do that, I estimate the baseline regression using two alternative explanatory variables: *primary any other* which indicates whether other party uses a primary in the same election, and *primary in previous election* which indicates whether the president's party used a primary before.

Finding a similar result on quality of government when other party, but the president's, use a primary would shed doubts on the results being driven by the nomination procedure of the president. Instead, it would suggest that there are broader omitted factors driving primary adoption in a country and also affecting quality of government. Similarly, if the results are driven by the party previous use of primary, it would suggest that what matters is not the selection of a given candidate but the party characteristics driving primary adoption.

Columns (1) to (4) in Table 2.8 show the results. In contrast to the regressions using the president's selection method, the LIML estimates are all insignificant. Together, this evidence reduces concerns that common factors affecting parties' institutional decisions -such as a more democratic political environment- are driving the main results.

Taken together, these additional tests provide some support to the validity of the identification strategy. There are, however, several remaining issues that limit the interpretation of the results.

First, the over-identification test rely on the assumption that *at least one* of the instruments is uncorrelated to the error term. If this is not the case, the test will not be informative about the validity of the set of instruments. There may be several reasons for all the instruments to be invalid. For example, the party size and the candidate characteristic may interact an affect the ability of a president to affect policy, other than by adopting a particular nomination procedure.

Second, in addition to common unobserved factors, there may be party-specific unobserved variables -like ideology or internal structure- that are omitted from the baseline specification and confound the estimates of the effect of primaries. In presence of these omitted variables, the falsification tests would also produce a similar result and hence would not be informative of the validity of the identification strategy.

In any of these cases, the results would need to be interpreted as evidence of a positive correlation between primaries and quality of government.

Table 2.8: Primaries and quality of government - falsification tests

Dependent variable	(1) OLS	(2) LIML	(1) OLS	(2) LIML
Government efficiency				
Corruption	0.446	2.497	-0.111	-4.688
	(0.261)*	(2.598)	(0.25)	(9.496)
Bureaucracy quality	0.129	1.916	0.617	-0.989
	(0.217)	(1.479)	(0.291)**	(4.862)
Size of public sector				
Government expense	0.577	4.221	0.5	-28.835
	(0.296)*	(3.048)	(0.467)	(429.161)
Government revenue	0.879	4.317	0.271	-11.13
	(0.275)***	(3.25)	(0.500)	(36.806)
Economic outcomes				
Ln(GDP per capita)	0.791	1.493	0.911	-1.052
	(0.296)***	(0.993)	(0.312)***	(7.629)
GDP growth	-0.055	0.383	-0.402	-0.877
	(0.339)	(1.195)	(0.376)	(1.466)
Explanatory variable	Primary any other		Primary in previous election	

Notes: Robust standard errors in parentheses. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. The estimates correspond to the parameter associated with the explanatory variable. All regressions include a post-1990 dummy and a year trend. LIML regressions use *political competition*, *founder*, and the interaction term as excluded instruments.

2.6.2 Electoral Performance

The model predicts that primary-nominated candidates will obtain higher vote shares because they have a quality or attribute that attracts voters. Moreover, the gains of vote share are smaller for already large parties, since primaries broaden the party appeal among non-partisan voters.

To test these hypotheses, I estimate the following regression:

$$\begin{aligned} vote\ share_{ij} = \beta_1 primary_{ij} + \beta_2 seat\ share_{ij} + \\ \beta_3 (primary_{ij} \times seat\ share_{ij}) + \beta_4 \mathbf{W}_{ij} + \eta_i + \varepsilon_{ij}, \end{aligned} \tag{2.8}$$

where *vote share*$_{ij}$ is the proportion of votes obtained by the candidate of party i in presidential elections j, *seat share*$_{ij}$ is the proportion of legislative seats obtained by the party in the contemporaneous or more recent legislative election and *primary*$_{ij}$ is the selection method. $\mathbf{W}_j$ is a vector of control variables and η_i is the party fixed effect.

This specification uses *seat share* as a measure of partisan support λ and it is derived from the vote share equation (2.2).[101] Similar to (2.6), this specification exploits within-party variation and controls for time-invariant party characteristics. The parameters of interest are β_1 and β_3, which capture the vote share premium for primary-nominated candidates and the heterogenous effect by size of partisan support, respectively. The model predicts that $\beta_1 > 0$ and $\beta_2 < 0$.

Table 2.9 shows the estimates of equation (2.8) using as additional control variables the log of the number of candidates in the electoral process and *primary any other*. I cluster the errors by political party to correct for any serial correlation in the presidential vote share. Column (1) estimates the baseline regression without the interaction term to obtain the average vote premium. The evidence suggests that primary-nominated candidates have a better electoral performance. In particular, the average candidate obtains a vote share six percentage points above her partisan support when she is primary-nominated. To put this number in context, note that the average vote share of non-primary nominated candidates is 33 percent. Columns (2) and (3) estimate the full specification using the entire sample and restricting it to parties older than 10 years, respectively. In both cases, I find that primary-nominated candidates obtain larger vote shares and that the vote premium decreases with partisan support.

These results are similar to the estimates of Carey and Polga-Hecimovich (2006). Using a larger data set and a different empirical specification, they find that primary-nominated presidential candidates in Latin America obtained between four percent and six percent of additional vote share. The main difference of this thesis with their work is the inclusion of party fixed effects and the use of *seat share* as a proxy for partisan support.

Table 2.10 shows the results of a falsification test. The specification is similar to the baseline regression (2.8) but uses *primary in the previous election* instead of *primary* as an explanatory variable. In both regressions, the estimates of β_1 and β_2 are not statistically significant. This evidence reduces concerns that primaries play a reputational role. If that was the case, the use of primaries would increase vote share, not only in the contemporaneous presidential election but also in future ones.

Taken together, these results provide supportive evidence of the electoral benefits of adopting primaries. The existence of these benefits is consistent with the electoral incentives to adopt primaries and the role of political competition. The benefit of adopting primaries increases with political competition, since attracting non-partisan

[101] See Appendix B.6 for a formal derivation.

voters becomes more important for the party's success.

These results also suggest that nomination procedures play a relevant role in political selection. In particular, the results show that primary-nominated candidates have attributes which broaden party appeal among non-partisan voters.

Table 2.9: Primaries and electoral performance

	(1) Vote share	(2) Vote share	(3) Vote share
Primary	0.057	0.204	0.213
	(0.031)*	(0.078)**	(0.079)***
Seat share	0.638	0.731	0.726
	(0.121)***	(0.082)***	(0.106)***
Primary ×		-0.398	-0.439
seat share		(0.164)**	(0.172)**
Sample	Full	Full	Age > 10 years
Observations	179	179	147
Number of parties	47	47	40
R-squared	0.45	0.49	0.46

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at party level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include party fixed effects and as control variables: *primary any other* and *Ln(number of candidates.* Column (3) uses a sub-sample of parties older than 10 years.

Table 2.10: Primaries and electoral performance - robustness checks

	(1) Vote share	(2) Vote share
Primary in previous	-0.033	0.097
election	(0.037)	(0.145)
Seat share	0.604	0.657
	(0.128)***	(0.093)***
Primary in previous		-0.319
election × seat share		(0.340)
Observations	174	174
Number of parties	47	47
R-squared	0.43	0.44

Notes: Robust standard errors in parentheses. Standard errors are adjusted for clustering at party level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include as control variables: *primary any other* and *Ln(number of candidates)*.

2.7 Conclusion

Motivated by a simple model, this paper has provided empirical evidence linking parties' nomination procedures to political selection. The evidence supports the argument that party institutions play an important role in political selection and can affect the electoral outcomes and ultimately the quality of government. Moreover, the results highlight another channel for inter-party political competition to improve political selection by creating incentives to adopt more democratic nomination procedures.

By explicitly modeling party decisions, the model provides additional testable insights regarding the interaction of party characteristics and political competition. In particular, the evidence suggests that the incentives of political competition can be attenuated by the incumbency advantage of a politician. This bias makes it more difficult to adopt institutions that may challenge the status quo.

This paper shows how treating parties as organizations can enrich our understanding of the political process and its relationship to economic outcomes. However, I focus only on the candidate nomination process, assuming an office seeking party. In reality, parties have richer institutional setups and also have other motivations beyond just holding office. These features may be also relevant for understanding political selection and how electoral incentives shape policy making.

B Appendix

B.1 Proof of Proposition 2

Under assumption 1, there is a positive probability that a challenger with sufficiently high quality will replace the leader as party candidate. To see this, recall that a party member votes for the challenger if:

$$v(q_c) > v(q_l) + \sigma_i + \widetilde{\delta}$$

where $\widetilde{\delta}$ is the realization of δ. Thus, the swing party member - indifferent between the party leader and challenger - is represented by:

$$\widetilde{\sigma} = v(q_c) - v(q_l) - \widetilde{\delta} \tag{2.9}$$

Using expression (2.2), we can rewrite (2.9) as $\widetilde{\sigma} = \rho(1-\lambda)(q_c - q_l) - \widetilde{\delta}$. Then, the proportion of party members voting for the challenger is $\psi\widetilde{\sigma}$ and the probability that the challenger is nominated can be written as:

$$\begin{aligned} \pi_c &= \Pr\left\{\psi\widetilde{\sigma} > \frac{1}{2}\right\} \\ &= \Pr\left\{q_c > q_l + \frac{1}{\rho(1-\lambda)}\left(\frac{1}{2\psi} + \widetilde{\delta}\right)\right\} \\ &= 1 - q_l - \frac{1}{\rho(1-\lambda)}\left(\frac{1}{2\psi} + \widetilde{\delta}\right) \end{aligned}$$

which is positive for any $\widetilde{\delta}$ under assumption 1.

Hence, we can write the expected quality gains before the primary election as:

$$\Delta q = \pi_c (q_c - q_l)$$

which is positive because the challenger is nominated only when $q_c > q_l$. In addition, note that for similar reasons, Δq is decreasing in q_l.

B.2 Proof of Proposition 3

Recall that $q_p = q_l$ if a party uses a caucus, and $Eq_p > q_l$ in the case of a primary. Using equation (2.2), we can write the difference in expected vote share between a primary- and a caucus-nominated candidate as:

$$v(Eq_p) - v(q_l) = \rho(1-\lambda)\Delta q$$

which is strictly positive, increasing in Δq and decreasing in λ since $\Delta q > 0$ and $\lambda \in (0,1)$.

B.3 Proof of Proposition 4

Recall from equation (2.5) that:

$$p = \phi \left[\rho (1 - \lambda) \Delta q - \frac{1}{2\psi} \right]$$

thus $\frac{\partial p}{\partial (1-\lambda)} = \phi \rho \Delta q$, which is positive by proposition 2. Similarly, $\frac{\partial^2 p}{\partial (1-\lambda) \partial \phi} = \rho \Delta q > 0$.

B.4 Variables and Data Sources

Primary 1 if presidential candidate was nominated by primary (open or closed), 0 otherwise. Source: Carey and Polga-Hecimovich (2006)

Primary in previous election 1 if party used primary to select presidential candidate in the previous election, 0 otherwise. Source: Carey and Polga-Hecimovich (2006)

Primary any other 1 if other party used primary in the same electoral process, 0 otherwise. Source: Carey and Polga-Hecimovich (2006)

Seat share Proportion of seats obtained by candidate's party in lower chamber in the legislative election held simultaneously or immediately before the presidential election. Source: Center on Democratic Performance and Political Database of the Americas

Vote share Proportion of votes obtained by a presidential candidate. Source: Carey and Polga-Hecimovich (2006)

Founder 1 if candidate was one of the party founders, 0 otherwise. Source: Parties' websites and Political Database of the Americas

Number of parties Number of presidential candidates in a given election. Source: Carey and Polga-Hecimovich (2006)

Corruption Assessment of corruption within the political systems including: patronage, nepotism, secret party funding and close ties between government and business. Score ranges from 0 to 6, with higher values indicating lower corruption. Source: International Country Risk Guide

Bureaucracy quality Assessment of the strength and quality of the bureaucracy. Score ranges from 0 to 4, with higher values indicting a more autonomous and expert bureaucracy. Source: International Country Risk Guide

Government expense Government expense as % of the GDP. Source: World Development Indicators

Government revenue Government revenue excluding grants as % of GDP. Source: World Development Indicators

GDP per capita Real income per capita using Laspeyres index. Source: Penn World Table 6.1

GDP growth Annual growth rate of real GDP per capita. Source: Penn World Table 6.1

B.5 Derivation of the Index of Political Competition

Consider n parties competing in a presidential election. All of them have a candidate of similar quality, and thus they rely on their partisan supporters to decide the election. Each party has a proportion of partisan supporters λ_i, such that $\sum_{i \in n} \lambda_i < 1$. λ_i is a random variable with a cumulative distribution function $F_i(\lambda_i)$. I assume that all F_i have an identical shape but different means.

Denote the realizations of λ_i as $\widehat{\lambda}_i$ and rank them by size such that $\widehat{\lambda}_1 \geq \widehat{\lambda}_2 \geq ... \geq \widehat{\lambda}_n$. Thus, we can write the ex ante probability that party i wins the election as $G_i\left(\widehat{\lambda}_2\right) \equiv 1 - F_i\left(\widehat{\lambda}_2\right)$. Since parties are competing for one position, they need to surpass the votes obtained by the second highest candidate to win the election. In that case, the party becomes the one with the largest partisan support.

$G_i\left(\widehat{\lambda}_2\right)$ measures the ability of the party to win the election based purely on its partisan support. This measure corresponds to the concept of political competition used in the analytical framework.

Taking a first order Taylor approximation of $G_i\left(\widehat{\lambda}_2\right)$ around $E(\lambda_i)$ and using $\widehat{\lambda}_i$ as the best estimator of $E(\lambda_i)$, we obtain:

$$G_i\left(\widehat{\lambda}_2\right) \approx c_0 + c_1\left(\widehat{\lambda}_2 - \widehat{\lambda}_i\right)$$

where $c_0 = G_i(E(\lambda_i))$ and $c_1 = G_i'(E(\lambda_i))$ are positive constants.

Note that because of the assumption that all λ_i have distribution functions with identical shapes, both c_0 and c_1 are identical for all parties. Thus, to construct an empirical counterpart of $G_i\left(\widehat{\lambda}_2\right)$, we can focus only on the component $\left(\widehat{\lambda}_2 - \widehat{\lambda}_i\right)$, since c_0, c_1 can be pinned down during the econometric estimation.

B.6 Empirical Specification of the Vote Share Regression

Recall from equation (2.2) that the expected vote share a party can obtain is:

$$v_i = \delta \left[q_p + (1 - q_p)\lambda\right] + (1 - \delta)\left(\frac{1+\lambda}{2}\right)$$

and that $q_p = \Delta q + q_l$ if the party uses a primary, and $q_{pi} = q_{li}$ otherwise.

Under the assumption that Δq are q_l are party-specific but time-invariant and using the definition of q_p, we can re-write the expected vote share of the candidate from party i in electoral process j as:

$$\begin{aligned} v_{ij} = \delta \Delta q_i primary_{ij} + \left(\frac{1+\delta}{2} - \delta q_{li}\right)\lambda_{ij} \\ -\delta \Delta q\left(\lambda_{ij} \times primary_{ij}\right) + \frac{1-\delta}{2} + \delta q_{li} \end{aligned} \tag{2.10}$$

Note that in expression (2.10), both the partisan support λ and the selection method can vary between elections.

Equation (2.10) resembles a random coefficient model. Assuming that $\Delta q_i = \overline{\Delta q} + \varpi_{1i}$ and $q_{li} = \overline{q_l} + \varpi_{2i}$ with ϖ_{1i}, ϖ_{2i} independent from *primary* and λ, expression (2.10) becomes:

$$v_{ij} = \beta_1 primary_{ij} + \beta_2 \lambda_{ij} + \beta_3(\lambda_{ij} * primary_{ij}) + \eta + \varepsilon_{ij} \tag{2.11}$$

where

$$\begin{aligned} \beta_1 &= -\beta_3 \equiv \delta\overline{\Delta q} \\ \beta_{2i} &= \frac{1+\delta}{2} - \delta\overline{q_l} \\ \eta &= \frac{1-\delta}{2} + \delta\overline{q_l} \\ \varepsilon_{ij} &= \varpi_{1i}\left[\delta primary_{ij}\left(1 - \lambda_{ij}\right)\right] + \varpi_{2i}\left[\delta\left(1 - \lambda_{ij}\right)\right] \end{aligned}$$

Expression (2.11) provides the motivation for the proposed empirical specification (2.8).

3 The Flypaper Effect and Costly Tax Collection

One of the most documented empirical regularities in the fiscal federalism literature is the so-called flypaper effect (Hines and Thaler, 1995; Gamkhar and Shah, 2007). This effect refers to the observed greater responsiveness of local government's spending to increases in grants than to increases in the local tax base. However, in the traditional grants-in-aid theoretical framework, these findings are puzzling (Oates, 1999). If money is fungible, a local government representing the interests of the citizens should have the same propensity to spend out of individual income or out of lump-sum grants (Bradford and Oates, 1971).[102]

Some explanations of this paradox focus on flaws in the empirical strategy such as functional mis-specification (Becker, 1996), omitted variables (Hamilton, 1983), reverse causality (Knight, 2002) or measurement error (Moffitt, 1984). Other explanations rely on some sort of political bias due imperfect information (Courant et al., 1979; Oates, 1979), uncertainty (Turnbull, 1998) or the action of agenda setting budget-maximizing bureaucrats (Filimon et al., 1982).[103]

An alternative explanation, first proposed by Hamilton (1986), suggests instead that the flypaper effect is partly due to costly taxation. In Hamilton's original model, the cost of taxation comes from deadweight losses of local taxes. This explanation, however, has been criticized since the magnitude of the distortionary costs of local taxes may be insufficient to account for the observed flypaper effect (Hines and Thaler, 1995, p. 221).

In this paper I evaluate empirically Hamilton's hypothesis. First I develop a model of local public spending with costly tax collection. Then, I test the model predictions using data from Peruvian local governments.

The model is based on Hamilton's contribution and emphasizes the same mechanism -costly taxation- to produce the flypaper effect. There are, however, two relevant differences that make it more suitable for empirical testing. First, the model motivates costly taxation by introducing tax collection costs, such as administrative or compliance costs, instead of deadweight losses. These costs are easier to observe empirically and may be more relevant in the case of local taxes (Slemrod, 1990). Second, it provides a simpler and quantifiable expression of the magnitude of the flypaper effect as a function of tax collection costs and the tax rate. To the best of my knowledge, this result has not been obtained before and it is important since the flypaper paradox is mainly an empirical issue.

[102] A similar argument of fungibility is found in the aid literature. See Van de Walle and Mu (2007) for a recent survey of the literature.

[103] For a detailed survey of the literature see Hines and Thaler (1995), Bailey and Connolly (1998) or Gamkhar and Shah (2007)

The model predicts that local spending will be more responsive to additional grants than to increase of the local tax base, a result contrary to the standard grants-in-aid approach and consistent with the observed flypaper effect. Moreover, there is a substitution effect: local governments will use the additional grants to reduce costly local taxation.

These effects vary with the tax collection costs and tax rate. In particular, the model predicts that the grant elasticity of spending will be smaller for local governments with lower tax collection costs and will decrease with the tax rate. Furthermore, the substitution effect of local revenue by grants will be greater for local governments with lower tax collection costs.

I test these predictions using data from Peruvian district municipalities. I exploit variation on the Foncomun, a large equalization grant allocated by formula and funded with a share of the national value added tax. I focus on a particular type of tax collection costs: administrative costs. As a proxy for these costs I use the tenure of administrative tools -such as automated tax systems or an updated cadaster.

I find evidence supporting the model predictions. The grant elasticity of spending for a high cost municipality is 0.756, while for a low cost it is 0.561, almost 25 percent smaller. In contrast, the estimated sensitivity of spending to the local tax base is 0.089. These results suggest that the differences in administrative tax collection costs account for almost one third of the difference on the elasticities of spending. I also find evidence of the substitution effect. Municipalities with lower tax collection costs reduce their local revenue, and taxes, when receiving additional grants. The results are robust to the inclusion of observable confounding factors driving both the tax collection costs and grant elasticity of spending.

The rest of the paper proceeds as follows. Section 3.1 develops the analytical framework. Section 3.2 discusses the institutional background of Peruvian district municipalities. Section 3.3 presents the empirical strategy while Section 3.4 presents the main results and robustness checks. Section 3.6 concludes.

3.1 A Model of Local Spending

In this section I develop a model of the spending decisions of a local government in the presence of costly taxation. The model provides testable predictions about the magnitude of the flypaper effect as a function of tax collection costs and the tax rate.[104]

The model emphasizes the role of costly taxation as a mechanism to explain the flypaper effect. This explanation is similar to the one proposed by Hamilton (1986).[105]

[104]The magnitude of the flypaper effect is the difference between the propensity to spend out of grants and the propensity to spend out of local income (Becker, 1996).

[105] In Hamilton's model, the local public good is financed by a combination of local income taxes and grants from the central government. Local taxation is distortionary and creates a deadweight loss that reduces citizens' net income. This feature makes the propensity of spend out of transfers greater than out of local income, because grants allow the local government to reduce distortionary

There are, however, two relevant differences. First, the model uses tax collection costs instead of deadweight losses to introduce costly taxation. Tax collection costs -which include compliance and administrative costs- are easier to observe than distortionary costs. This feature facilitates the empirical evaluation of the model. Second, it provides a simpler and quantifiable expression of the magnitude of the flypaper effect as a function of tax collection costs and tax rate. To the best of my knowledge, this result has not been obtained before and it is important since the flypaper paradox is mainly an empirical issue.

Consider a community populated by a continuum of citizens of mass one. Citizens have heterogenous income denoted by y_i. In order to abstract from the effect of income inequality, I restrict attention to symmetric distributions such that both the average and median income are equal.[106]

There a two tiers of government: central and local. Both provide public goods, collect taxes and have their representatives elected in general elections. In addition, the central government provides financial support as lump-sum grants to the local government. I focus on the policy decisions of the local government and take the central government's policies as given.[107]

Citizens derive utility from private consumption c_i and a homogenous public good g provided by the local government. Preferences are defined by a quasi-linear utility function:

$$U_i = c_i + H(g), \tag{3.1}$$

where the utility from the public good $H(g)$ is an increasing and concave function.

The local government funds the provision of the public good from two revenue sources: a local income tax and a grant from the central government. Tax policy is not targeted and hence the local tax rate $\tau \in (0,1)$ is the same for all citizens. The local government sets the tax rate and collects the tax revenue. In contrast, the decisions on grant's funding and allocation are made by the central government.

Raising local revenue is costly. In particular, the local government faces a administrative cost of operating the tax system equal to $\Gamma C(\tau)y$ where Γ is a cost shifter and $C(\cdot)$ is an increasing and convex function. $\Gamma C(\tau)$ adopts values strictly between 0 and τ to avoid a corner solution with zero taxation. The administrative cost covers, among others, the cost of processing tax returns, monitoring tax evasion and the required legal proceeds. An alternative way to motivate costly tax collection is to include compliance costs. In the rest of the model I will focus on administrative costs because they are more relevant for the empirical case I study; however, the results using compliance costs are similar (see Appendix C.2).

From (3.1) and the previous definitions, we can write the indirect utility of citizen

taxation and increase citizens' consumption.

[106]The results are similar with asymmetric income distributions (see Appendix C.1)

[107]This is a plausible assumption if local governments are unable to, individually, affect central government's policies.

i as

$$V_i = y_i\,[1-\tau] + H(g), \tag{3.2}$$

while the local government's budget constraint is

$$g = y\,[\tau - \Gamma C(\tau)] + a, \tag{3.3}$$

where y is the tax base (an also the average income) and a is the lump-sum grant per capita. Note that expression $R \equiv y\,[\tau - \Gamma C(\tau)]$ represents the net tax revenue.

Assumption 1 $C' < 1$

This assumption guarantees that the net tax revenue is an increasing and monotonic function of the tax rate.

The political process to define the local tax rate and public spending is one of Downsian electoral competition. There are two office-seeking politicians running for local office, electoral promises are enforceable and the winning candidate is defined by simple majority rule. Politicians are office seekers and choose policy to maximize their vote share. The timing of events is as follows. Firstly, candidates simultaneously announce their policies τ and g. Secondly, local elections are held. Finally, the appointed politician implements her announced policy platform.[108]

This setup is relatively standard in the political economy literature and has been widely used by Persson and Tabellini (2000) in their analysis of public spending and redistributive politics. The only differences are the introduction of grants as an additional source of revenue and costly tax collection.

Equilibrium policy Rearranging the budget constraint (3.3), we can express τ as a function of g:

$$F(\tau) \equiv \tau - \Gamma C(\tau) = \frac{g-a}{y}, \tag{3.4}$$

where $F' > 0$, $F'' < 0$ by assumption 1 and convexity of $C(\tau)$. Since F is a monotonic function, we can write the tax rate as

$$\tau = f\left(\frac{g-a}{y}\right), \tag{3.5}$$

where $f(\cdot) = F^{-1}(\cdot)$ and hence $f' > 0$, $f'' > 0$.

The citizen's indirect utility (3.2) satisfies single-crossing property and allow us to use the median voter theorem.[109] Thus, the politician's program is equivalent to choose a level of public spending to maximize the median voter's utility. In equilib-

[108] To make the model sensible in the case of unanticipated grants , we can assume one of the candidates is the incumbent mayor seeking reelection.

[109] To see this note that $\frac{\partial^2 V}{\partial g \partial y_i} = f'' \frac{g-a}{y^2} > 0$

rium, the local public spending satisfies:

$$g^* = \arg\max \; y\,[1-\tau] + H(g). \tag{3.6}$$

Using (3.5) and solving (3.6) we obtain the equilibrium policy:

$$g^* = h(f'\left(\frac{g-a}{y}\right)), \tag{3.7}$$

where $h(\cdot)$ is the inverse function of $H'(\cdot)$. Note that $h' < 0$ because H is concave.

3.1.1 Costless tax collection

Let us first study as a benchmark the case of costless tax collection. In this case, expression (3.7) simplifies to $g^* = h\,(1)$ and it is easy to see that the effect of lump-sum grants and local tax base on g^* are both identical and equal to zero.[110]

When tax collection is costless, the model predicts that grants from the central government do not affect spending but instead are fully translated to citizens as tax rebates. Moreover, the mechanism to transfer resources becomes irrelevant because both grants and local income are equivalent in terms of their effect on local government spending and taxation.

This result replicates the veil hypothesis which has provided the theoretical basis for the flypaper paradox (Oates, 1999, p. 1129). According to this hypothesis, when the local authority is representative of the citizens both lump-sum grants and local income have similar effect on local spending. Thus, the local government acts only as a *veil* and does not distort the final allocation of resources.

3.1.2 Costly tax collection

Let us now relax the assumption of costless taxation. Taking total derivatives from expression (3.7) we can calculate the marginal propensities to spend out of local income and grants:

$$\frac{dg^*}{dy} = -\frac{h'f''}{y-h'f''}\frac{g^*-a}{y} \tag{3.8}$$

$$\frac{dg^*}{da} = -\frac{h'f''}{y-h'f''}. \tag{3.9}$$

Since $h' < 0$, and $f'' > 0$, these propensities to spend are positive. Thus, in contrast to the benchmark case, the model predicts a local spending increases both with tax base and central government grants. The reason is that grants reduce the tax rate required to fund a given level of spending. In turn, this lowers tax collection costs, reduces the marginal cost of the public good and promotes additional spending.

[110] This result is extreme due to the quasi-linearity assumption which eliminates the income effect.

Expressions (3.8) and (3.9) provide a way to compare both marginal propensities to spend and evaluate the magnitude of the flypaper effect. Using both results and definition (3.4), we can obtain the following expression:

$$\frac{dg^*}{da} = \frac{dg^*}{dy}\frac{1}{\tau^* - \Gamma C(\tau^*)}, \tag{3.10}$$

where τ^* is the equilibrium tax rate and $\Gamma C(\tau^*)$ is the administrative cost as a proportion of the tax base.

Equation (3.10) provides two important observations. First, the ratio $\frac{1}{\tau^* - \Gamma C(\tau^*)}$ is a measure of the flypaper effect. In most cases, this ratio is quantifiable since both the tax rate and administrative costs are, potentially, observable. This insight suggests a simple way to calculate, ex ante, the propensity to spend out of grants and evaluate the stimulatory effects of intergovernmental transfers.

Second, since $\Gamma C(\tau^*) \in (0, \tau^*)$ and $\tau^* < 1$, the marginal propensity to spend out of grants is *greater* than the marginal propensity to spend out of income (the local tax base).[111] This prediction is consistent with the observed flypaper effect and, contrary to the veil hypothesis, suggests that local income and lump-sum grants are not equivalent.

A corollary of this non-equivalence result is that additional grants reduce local tax revenue ($\frac{dR^*}{da} < 0$). Thus, in the presence of costly taxation, there is a substitution effect of local taxes by grants. To see this note that:

$$\frac{dR^*}{da} = \frac{dg^*}{da} - 1 \tag{3.11}$$

Similar to Hamilton (1986), the non-equivalence result is driven by the differences on the cost of funds faced by the local government. In particular, a local government finds more costly to collect local taxes than to use central government's grants. In the model, this cost difference arises from the inability of the local government to internalize the cost of funding the intergovernmental transfers. This result points out a potential source of inefficiency: local governments may overspend if they do not take into account the tax collection costs incurred by the central government.[112]

Testable predictions In the empirical section, I use a double logarithmic specification which provides estimates of elasticities instead of propensities to spend.

In order to link the previous results to the empirical exercise, we can rewrite

[111] Moreover, finding similar marginal propensities would be rare since it requires very high tax rates and negligible collection costs.

[112] Alternatively, the difference in tax collection costs can be due to technological differences. In that case, there would be no inefficiency.

equations (3.10) and (3.11) as

$$\varepsilon_a = \varepsilon_y \frac{a}{y} \frac{1}{\tau^* - \Gamma C(\tau^*)} \tag{3.12}$$

$$\varepsilon_{R,a} = \varepsilon_a \frac{g}{R} - \frac{a}{R}, \tag{3.13}$$

where $\varepsilon_a \equiv \frac{dg}{da}\frac{a}{g}$ and $\varepsilon_y \equiv \frac{dg}{dy}\frac{y}{g}$ are the grant elasticity and the tax base elasticity of spending, respectively, and $\varepsilon_{R,a} \equiv \frac{dR}{da}\frac{a}{R}$ is the grant elasticity of local tax revenue.

In addition, using (3.3) we can rewrite (3.12) as:

$$\varepsilon_a = \varepsilon_y \frac{a}{g-a}, \tag{3.14}$$

where $\frac{a}{g-a}$ is the ratio of grant to non-grant revenue.

From equations (3.12), (3.13) and (3.14) it is straightforward to obtain testable predictions about the relation between the elasticities of spending and tax revenue, tax collection costs and actual tax rate. In particular, the model predicts that :

1. $\frac{d\varepsilon_a}{d\Gamma} > 0$: the grant elasticity of spending increases with tax collection costs;
2. $\frac{d\varepsilon_a}{d\tau} < 0$: the grant elasticity of spending decreases with the tax rate;
3. $\frac{d\varepsilon_{R,a}}{d\Gamma} > 0$: the grant elasticity of tax revenue increases with tax collection costs (smaller substitution effect).
4. $\frac{d\varepsilon_a}{d(a/(g-a))} = \varepsilon_y > 0$: the grant elasticity of spending increases with the ratio of grant to non-grant revenue. This derivative also provides an estimate of ε_y, the tax base elasticity of spending.

In Section 3.4, I test empirically these model predictions in the context of Peruvian district municipalities.

3.2 Institutional Background

District municipalities are the lowest tier of autonomous sub-national government in Peru. Their main responsibilities are the provision of local services -such as waste collection, local police and civil register- and development and maintenance of local infrastructure. They do not participate in the provision of education or health services and cannot redistribute cash directly to citizens.

Municipalities finance their budget mostly from two sources: local revenue (such as local taxes, fees, fines and contributions) and transfers from the central government (see Table 3.1). In the period 1998 to 2001, these two sources represented around 84 percent of the total budget. The remaining budget corresponds mostly to debt, sales of assets and the amount saved from previous years.[113]

[113] Any amount of local revenues or transfers not spent in a fiscal year is rolled forward to the next year.

Table 3.1: Aggregate municipal budget 1998-2001, in millions of Nuevos Soles

Source	Annual Budget	% total budget
A. Transfers	1032.5	43.9
Foncomun grant	691.2	29.4
Vaso de Leche	221.9	9.4
Other transfers	119.4	5.1
B. Local Revenue	932.4	39.7
Taxes	368.9	15.7
Service fees	493.5	21.0
Fines and contributions	70.0	3.0
C. Other Revenue	309.7	13.2
D. Previous year balance	76.2	3.2
Total revenue	2350.8	

Source: Municipalities' budget reports.
Note: Other transfers includes Canon, Renta de Aduanas and Vaso de Leche. Other Revenue includes credit and capital income.

Local taxes The most important local tax is the property tax (*impuesto predial*). The property tax is levied on the estimated value of the real estate property. In 2001, this tax amounted to 80 percent of total local tax revenue.

Local governments have no control over the property tax rate or tax base. The tax rate is defined by national law while the property value is calculated using criteria defined by a national surveyor agency such as property size, quality and economic use. The amount actually collected, however, depends on the municipality's monitoring and enforcement effort.

A common form of tax evasion consists on failing to report improvements to existing properties (which could increase the taxable base). To address this problem, local tax authorities usually maintain a register of properties or cadaster, with details about properties' location, size and ownership.[114] As I explain below, I use the tenure of an updated municipal cadaster as one of the proxies for having low tax collection costs.

Transfers District municipalities receive several transfers from the central government (see Table 3.1). The most important are the Foncomun, an equalization grant, followed by the *Vaso de Leche* (Glass of Milk), a conditional grant earmarked to pro-

[114] The importance of the cadaster as a tool to implement and operate property tax systems is highlighted in international guidelines of land management. See for example United Nations (2005) and International Federation of Surveyors (2005).

vide food support to children and elders.[115] Other transfers include sharing schemes of taxes managed by the central government such as corporate tax of extractive industries and custom duties. These tax sharing schemes are earmarked to capital expenditures. I focus on the Foncomun because it is the largest transfer and the only one that resembles an unconditional grant.

The Foncomun is funded with a fixed proportion of the national value added tax.[116] This tax is managed and collected by the central government without any intervention of local governments.

The Foncomun is allocated by a formula that considers: urban and rural population of a district and children mortality at provincial level.[117]. The allocation weights were calculated by the Ministry of Economics using values from the 1993 Population Census and remained fixed during the period of analysis.[118] There is also a lower bound on the amount of Foncomun a municipality receives. This lower bound is set annually and benefits municipalities with small populations.[119] The amount of Foncomun received in a year does not depend on the spending performance of previous years.

Municipalities cannot directly affect the allocation formula or weights. This rule out a possible bargaining mechanism that may difficult the identification of the propensity to spent out of grants, as suggested by Knight (2002).

During the period of analysis, the Foncomun was partially earmarked to capital expenditures. Municipalities should have spent at least 70 percent of the transfer on capital expenditures. In practice, however, compliance with this conditionality was very limited. In aggregate, the proportion of the Foncomun actually spent on capital expenditures decreased from 67 percent in 1998 to 54 percent in 2001. This evidence suggests that the Foncomun may have been treated in practice as an unconditional grant. In 2003, the spending conditionality was removed.

3.3 Empirical Strategy

3.3.1 Data

I use a dataset of around 1350 Peruvian district municipalities with information about annual budgets, administrative resources and socio-demographic characteristics.[120] The budgetary information covers four years (1998 to 2001) while the data on administrative resources and socio-demographics is a cross section with data observed in 1999 or 1993. Table 3.2 presents summary statistics of the main variables.

[115]Foncomun stands for *Fondo de Compensación Municipal* or Municipal Compensation Fund

[116]Over the period of analysis this proportion was 2/19.

[117]A province is the immediately superior geographical jurisdiction

[118]The allocation formula for municipalities in Lima -the country's capital and largest city- includes more variables but follows the same general criteria.

[119]The value of the lower bound is indexed to a reference value used by the central government agencies to calculate income tax personal allowances, tax brackets and fines.

[120]The sample size is smaller than the universe of 1650 municipalities due to lack of budgetary information for some small municipalities.

I use the value of expenditure and Foncomun per capita as measures of local spending (g) and grants (a) respectively. Then I use these variables to estimate the grant elasticity of spending. To evaluate the substitution effect of grants on local taxes, I use the value of local revenue per capita as a measure of local tax revenue (R). As previously mentioned, this revenue category includes local taxes, fees, fines and contributions. I also evaluate the results using only the value of local taxes per capita.

The budgetary information comes from annual reports prepared by the local governments. These reports have official status and are used for national accounting and auditing by different government agencies.[121] They include detailed information on municipalities revenues and expenditures as well as the amount received from different transfers.[122] I express the revenue and expenditure variables in per capita values using population estimates for the year 1999.

I also collect data on the administrative resources of a municipality such as having an updated cadaster -a register with details about properties' location, size and ownership- or automated administrative systems. The data comes from surveys conducted in 1999 by the National Statistics Institute to assess the resources and capabilities of district municipalities.[123] The results of the survey were not intended to affect the transfers' allocation or the implementation of other governmental programs. Participation in the survey was compulsory for all district municipalities and the questionnaire was completed by the local authority or a representative.

I complement the dataset with socio-demographic variables from several sources. I obtain measures of population density and percentage of urban population from the 1993 Population Census, as well as population estimates for 1999 from the National Statistics Office. Poverty head count and access to utilities are estimates for 1999 from Foncodes -a public body in charge of several antipoverty programs- and used for the prioritization of public works and development projects.

Measures of tax collection costs The literature of the efficiency costs of taxation distinguishes four main costs: the deadweight loss, administrative costs, compliance costs and the risk bearing costs of tax evasion (Slemrod and Yitzhaki, 2002, pp. 1447-1449). The first cost refers to the loss of efficiency associated to the change on behavior due to taxes and the subsequent change on relative prices. In contrast, administrative and compliance costs refer to the costs incurred to meet the requirements of the tax

[121]The budget reports I use correspond to the copy sent to the Ministry of Economy.

[122]I compared the amount of transfers registered in the budget reports with the records from the Ministry of Economy -the office in charge of distributing the transfers. The values are similar for both data sources.

[123]The survey is called *Registro Nacional de Municipalidades* or the National Municipality Register. It covers areas such as human resources, equipment, municipality services, local infrastructure and current investment projects.

system borne by the tax office and taxpayers, respectively.[124]

Administrative and compliance costs are not negligible and, in the context of local public finances, may be as relevant as the distortionary costs of taxation (Slemrod, 1990, p. 169). For example, estimates of the compliance and administrative costs of the U.S. federal and state income tax are between 5-10 percent of total tax revenue (Slemrod and Sorum, 1984; Blumenthal and Slemrod, 1992; Slemrod and Yitzhaki, 2002). In the case of local governments, Wicks and Killwort (1967) estimate collection costs for real property taxes of around 9.5 percent of the tax revenue.[125]

I focus on a particular type of tax collection cost: the administrative cost. As a measure of the differences on this cost I use the tenure of tax administration tools such as an automated tax system or an updated cadaster. In particular, I construct a dummy named *low cost* equal to one if a municipality has an automated tax system or an updated cadaster.[126] In terms of the model, *low cost* equal to one corresponds to having a lower Γ. In the sample, around 32 percent of municipalities are classified as low cost.

The rationale for using tenure of these administrative tools as indicators for lower tax collection costs is that they may facilitate gathering of information required to manage and monitor local taxes. The focus on the cadaster, in particular, is motivated by the importance of property tax in the Peruvian local finances. For example, a municipality without a cadaster -a register of properties- may find more difficult to assess the size of the tax base of the property tax and hence the magnitude of tax evasion. In turn, lack of information about where the evaders are may difficult monitoring and enforcement of tax collection.

A comparison of the finances of municipalities with and without tax administration tools provides evidence consistent with this assumption. In particular, municipalities with low cost have an average tax per capita almost 70 percent higher than high cost municipalities and also collect a larger local revenue (see Table 3.2).

The model also provides ancillary predictions about the differences on elasticity of spending by the level of the tax rate (τ) and the ratio of grant and non-grant revenue, $\frac{a}{g-a}$. As a proxy for the tax rate, I use the average tax per capita collected during the period 1998-2001, while as a proxy for $\frac{a}{g-a}$, I use the ratio of Foncomun to non-Foncomun revenue.

Table 3.2 presents summary statistics of the measures of administrative costs and the tax rate, and compares municipalities with low and high cost. There are significant differences in the finance and socio-demographics characteristics of low and high cost municipalities. Even though they spent a similar amount, low cost municipalities receive smaller amounts of Foncomun per capita. Moreover, they have larger popula-

[124]The risk bearing cost of tax evasion refers to the loss of utility associated to the increased exposure to risk undertook to avoid paying taxes.

[125]For an empirical survey of compliance and administrative costs see Sandford (1995).

[126]The results are similar when I use the components of the dummy (having an automated tax system or an updated cadaster) separately.

tions, are more urban, more dense, less poor and have better access to basic utilities. These systematic differences raise relevant identification concerns that I discuss in Section 3.5.

3.3.2 Econometric Specification

The purpose of the empirical exercise is to estimate the grant elasticity of spending (ε_a) and the grant elasticity of local tax revenue ($\varepsilon_{R,a}$), and evaluate how they vary by the level of administrative costs and tax rate.

The model predicts that ε_a would be smaller for municipalities with low administrative costs and decrease with the tax rate. These results imply a smaller flypaper effect for low cost municipalities. A corollary of the model is that the substitution of local taxes by grants will be larger for low cost municipalities.

To test these predictions, I estimate the following regression:

$$\ln y_{idt} = \beta_0 \ln a_{it} + \beta_1 (\ln a_{it} \times X_i) + \gamma \mathbf{S}_i + \eta_d + t_d + \epsilon_{it}, \tag{3.15}$$

where y_{it} is either the expenditure per capita or the local revenue per capita of municipality i, in department d in year t.[127] The variable a_{it} is the amount of Foncomun per capita and X_i is a measure of the administrative costs or the tax rate. $\mathbf{S}_i$ is a vector of municipality characteristics such as: population density, percentage of urban population, poverty head count and access to basic utilities. I also include a dummy that indicates whether the municipality receives the minimum amount of Foncomun.

All regressions include department fixed effects (η_d) and department-specific trends (t_d). I cluster the standard errors by municipality to account for possible serial autocorrelation Following Becker (1996) I use a double logarithmic specification. This functional form reduces concern of mis-specification and produces measure of elasticities instead of propensities to spend.

In specification (3.15), the estimate of the grant elasticity is $\widehat{\beta_0} + \widehat{\beta_1} \times X_i$. $\widehat{\beta_1}$ provides a way to evaluate how the grant elasticity changes with either administrative costs or the tax rate. In particular, the model predictions suggest that $\widehat{\beta_1} < 0$. When X_i is the ratio of grant to non-grant revenue, $\widehat{\beta_1}$ has a useful interpretation because it equals to the sensitivity of local spending to changes on the tax base (ε_y) and we could expect this estimate to take positive values.

The main identification assumption is that the changes of Foncomun grant are uncorrelated to other unobserved variables that drive municipal spending. The features of the setup -a grant allocated by formula and financed by a national tax- reduce concerns about reverse causality. There are, however, relevant concerns regarding omitted variables. These concerns are partially addressed by including the vector of control variables; but they may be insufficient. I discuss these concerns in more detail

[127] A department is the largest sub-national administrative unit. Many central government spending projects are targeted at this level.

Table 3.2: Summary statistics and mean comparison

Variable	Total	Low cost		Difference
		Yes	No	
A. Revenue and expenses				
Expenditure per capita	179.5	187.9	175.5	12.4
	(321)	(369.9)	(294.6)	(9.2)
Foncomun grant per capita	99.1	87.9	104.5	-16.6
	(95.6)	(84.6)	(100.1)	(2.7)**
% received min. Foncomun	58.7	51.9	61.9	-0.1
	(49.2)	(50.0)	(48.6)	(0.0)**
Vaso de Leche per capita	14.8	15.2	14.6	0.5
	(16.3)	(24.2)	(10.7)	0.5)
Local revenue per capita	28.7	37.8	24.3	13.5
	(217.6)	(106.4)	(254.2)	(6.3)*
Foncomun/Non Foncomun	2.161	1.766	2.347	-0.581
revenue $(a/(g-a))$	(1.954)	(1.671)	(2.048)	(0.052)**
B. Measures of collection cost and tax rate				
% has automated tax	32.0			
system or cadaster	(46.6)			
Average tax per capita	13.8	18.9	11.3	7.6
	(100.3)	(50.6)	(116.6)	(2.7)**
C. Socio-demographic characteristics				
Population	10978.5	20280.8	6593.5	13687.3
	(35790.5)	(58525.6)	(14514.8)	(937.6)**
Population density	347.8	910.5	79.4	10.9
	(2074)	(3505.5)	(520.9)	(0.8)**
% urban population	40.3	47.7	36.8	831.1
	(30.1)	(33.2)	(27.9)	(54.6)**
Poverty head count	46.8	42.4	48.8	-6.3
	(14.2)	(15.5)	(13.1)	(0.4)**
% access electricity	61.9	60.4	62.7	-2.3
	(33.1)	(32.3)	(33.5)	(0.9)**
% access water	26.0	31.2	23.5	7.6
	(31.1)	(33.1)	(29.8)	(0.8)**
% access sewage	38.3	45.6	34.8	10.7
	(34.8)	(35.3)	(34)	(0.9)**

Notes: Standard deviation in parentheses, * significant at 5%; ** significant at 1%. Low cost is a dummy equal to one if a municipality has either an automated tax system or updated cadaster.

in Section 3.5.

3.4 Main Results

Table 3.3 presents the main results. Columns (1) and (2) estimate the grant elasticity of spending (ε_a) for different levels of administrative costs and tax rate, respectively. Consistent with the model predictions, $\widehat{\beta_1}$ is negative, which implies that ε_a is significantly smaller for municipalities with low administrative costs and decreases with the tax rate. For example, the estimated ε_a for a high cost municipality is 0.756, while for a low cost it is 0.561, almost 25 percent smaller.

Column (3) uses the ratio of Foncomun to non-Foncomun revenue, a proxy for $a/(g-a)$, as the interaction term. Consistent with the previous results, the value of $\widehat{\beta_1}$ is positive. Furthermore, we can interpret this estimate as the sensitivity of spending to changes on the local tax base, $\widehat{\varepsilon_y}$.

The results support the existence of a flypaper effect in the Peruvian case. The estimate of ε_a ranges from 0.561 to 0.756 while the estimate of ε_y is around 0.089.[128] Moreover, we can do a back of the envelope calculation to evaluate how much of the flypaper effect is explained by administrative costs. Using the estimates of ε_a from column (1) and ε_y from column (3), I find that the difference on administrative costs accounts for almost one third of the difference on elasticities of spending.

Column (4) and (5) explore the model predictions about the role of administrative costs on the substitution of local taxes by grants. In column (4) I use the value of local revenue, which include taxes and other sources, while in column (5) I narrow down the definition to include only local taxes. In both columns, we observe that low cost municipalities exhibit a larger substitution effect ($\widehat{\beta_1} < 0$).[129] This result is consistent with the previous findings and the model predictions: municipalities with low tax collection costs use additional grants to cut taxes instead of increasing local spending.

Taken together, the results are consistent with the model predictions. Municipalities facing higher tax collection costs spend a larger proportion of grants and reduce local revenue less. I interpret these findings as evidence that costly tax collection shapes the reaction of local government to grants and partly explains the observed flypaper effect

3.5 Additional Checks

A main concern with the previous results is that municipalities with high and low administrative costs also differ on several dimensions. For example, municipalities with low administrative cost municipalities have larger populations, are more urban,

[128] More formally, I test of the null hypothesis $\beta_0 = \beta_1$ in column (3) Note that $\widehat{\beta_0}$ provide a lower bound for the value of $\widehat{\varepsilon_a}$. This test is easily rejected with a F-statistic of 100.

[129] The estimate in column (5) is significant only at 10 percent.

Table 3.3: Main results

	Ln (total expenditure)			Ln (total revenue)	Ln (tax revenue)
	(1)	(2)	(3)	(4)	(5)
Ln (Foncomun)	0.756	0.717	0.64	0.063	0.121
	(0.021)**	(0.021)**	(0.048)**	(0.077)	-0.091
Ln (Foncomun) $\times X_i$	-0.195	-0.001	0.089	-0.214	-0.217
	(0.056)**	(0.000)**	(0.009)**	(0.103)*	(0.122)
Variable X_i is:	Low cost	Average tax per capita	Average $\frac{a}{g-a}$	Low cost	Low cost
Observations	5422	5427	5429	5321	4666
R-squared	0.716	0.785	0.754	0.551	0.515

Notes: Robust errors in parentheses. Standard errors are clustered by municipality. * significant at 5%; ** significant at 1%. All regressions include a set of municipality socio-demographic characteristics, department fixed effects and department-specific trends. a/(g-a) is equal to the ratio of Foncomun and non-Foncomun revenue. Low cost is a dummy equal to one if a municipality has either an automated tax system or updated cadaster. The expenditure, total revenue, tax revenue and Foncomun are expressed as per capita values.

more dense, less poor and have better access to basic utilities. To the extent that these differences are observable and only affect the level of spending, their effect is controlled by the vector of control variables $\mathbf{S}_i$.[130]

These differences, however, may also affect the grant elasticity of spending. For example, poorer municipalities may have a greater propensity to spend (out of grants or local income) because they obtain a higher marginal benefit from public spending. Similarly, there may be unobserved characteristics that confound the results. For example, high cost municipalities may have larger bureaucracies and be more willing to spend a larger proportion of grants. In both cases, the results obtained in Table 3.3 could not be attributed to heterogeneity on grant elasticities due to tax collection costs, but to other sources of observed, and unobserved, heterogeneity between municipalities.

I address these concerns in two steps. First, I include the interaction between $\ln(Foncomun)$ and all the variables in vector $\mathbf{S}_i$. If the variable *low cost* is just picking up these municipality features, the estimates of β_1 should become insignificant. Second, I include flexible time trends interacted with *low cost.* If municipalities with different tax collection costs also follow different trends of revenue or spending, then the differences of the elasticity to spend associated to administrative costs should become smaller.[131]

Table 3.4 displays the results of these additional checks. In all cases, the results are similar to the baseline regressions: the grant elasticity of spending is smaller for low cost municipalities. The results in Column (2) also provide some insights about factors driving the spending of local governments. In particular, the grant elasticity of spending increases with the municipality's poverty head count and decreases with the population density. This finding is consistent with poorer and less densely populated localities obtaining a larger marginal benefit from public spending, and hence having a larger propensity to spend out of grants.

Taken together, these results reduce concerns that the differences on grant elasticities between low and high cost municipalities are driven by some observable characteristics. They, however, do not provide any information about other sources of unobserved heterogeneity correlated with the municipality's administrative costs.

I partially address this concern by running a falsification test. The test adds to the baseline regression another important transfer: the *Vaso de Leche*, and explores the differences on the elasticity of spending of this transfer between high and low cost municipalities. The *Vaso de Leche* is a conditional transfer, earmarked to provide food support to children and elders. Since this transfer cannot be used to fund other activities and cut taxes, we could expect tax collection costs to be less relevant to

[130]This vector includes socio-demographic variables and the components of the allocation formula of the Foncomun (namely percentage of urban population, a measure of poverty and whether it receives the minimum amount).

[131]Municipalities may follow different spending trends, for example, if the increase of other revenue sources is correlated to the administrative costs.

decide how to spend this revenue. Finding differences on the elasticity of spending of this conditional transfer would suggest that the measure of administrative costs is picking up other sources of heterogeneity on the propensities to spend.

Column (3) of Table 3.4 displays the results. Note that the grant elasticity of spending of the *Vaso de Leche* (around 0.137) is smaller than the elasticity of spending of the Foncomun grant.[132] More importantly, there is not a significant difference between high and low cost municipalities on the elasticity of spending of the *Vaso de Leche.*

3.6 Conclusion

This papers presents robust evidence consistent with costly tax collection being a determinant of the flypaper effect -the observed greater responsiveness of local government's spending to increases in grants than to increases in local income. In particular, the spending of municipalities with lower tax collection costs -proxied by the tenure of administrative tools- exhibits a smaller sensitivity to additional grants. I also find evidence of substitution of local revenue by grant, which is stronger among low cost municipalities.

The analytical framework simplifies previous models and provides a quantifiable expression of the magnitude of the flypaper effect as a function of tax collection costs and the tax rate. Moreover, it makes explicit the role of heterogenous funding costs as an explanation for the lack of fungibility. Grant recipients are more responsive to increases in transfers because they are marginally cheaper than other revenue sources. This phenomenon is not exclusive of local public finances but may also be relevant among aid agencies.

In the model, the cost difference between transfers and local taxes is driven by the local government's failure to internalize the cost of funding the transfer scheme. This result points out a potential source of inefficiency in fiscal decentralization processes with overspending at local level.

[132] This is consistent with the additional conditionality, and less fungibility, of the Vaso de Leche transfer.

Table 3.4: Additional checks

		Ln (total expenditure)		
	(1)	(2)	(3)	(4)
Ln (Foncomun)	0.758***	0.402***	0.739***	0.336***
	(0.021)	(0.120)	(0.018)	(0.105)
Ln (Foncomun) × low cost	-0.200***	-0.087**	-0.158***	-0.069**
	(0.058)	(0.036)	(0.041)	(0.031)
Ln (Vaso de Leche)			0.137***	0.180***
			(0.048)	(0.045)
Ln (Vaso de Leche) × low cost			-0.178	-0.080
			(0.115)	(0.085)
Ln (Foncomun) ×:				
Poverty head count		0.005**		0.006***
		(0.002)		(0.002)
Population density		-0.082***		-0.091***
		(0.021)		-0.022
Received min. Foncomun		0.072		0.075*
		(0.047)		(0.045)
% without water		0.000		0.000
		(0.000)		(0.000)
% without sewage		0.001*		0.001*
		(0.001)		(0.001)
% without electricity		0.000		0.000
		(0.000)		(0.000)
% urban population		-0.001		-0.000
		(0.001)		(0.001)
Flexible trend x low cost	yes	no	no	no
Observations	5422	5422	5419	5419
R-squared	0.716	0.753	0.724	0.764

Notes: Robust errors in parentheses. Standard errors are clustered by municipality. * significant at 5%; ** significant at 1%. All regressions include a set of municipality socio-demographic characteristics, department fixed effects and department-specific trends. Low cost is a dummy equal to one if a municipality has either an automated tax system or updated cadaster. The total expenditure, Foncomun and Vaso de Leche are expressed as per capita values.

C Appendix

C.1 Asymmetric income distribution

In the baseline model I assume a symmetric income distribution, such that the income of the average and median voter are the same. Let us relax this assumption and consider a more general case. Denote the median income as y_m and the average income as y, and define the ratio $k \equiv \frac{y_m}{y}$. I assume that k can be affected by changes on average income and that $0 < k < 1$. In this setup k captures the degree of income inequality between the average taxpayer and the median voter. The rest of the setup is the same.

With this modification, the government's budget constraint remains the same, $g = y\left[\tau - \Gamma C(\tau)\right] + a$, and the tax rate can still be written as $\tau = f(\frac{g-a}{y})$. However the equilibrium policy becomes

$$g^* = \arg\max\; y_m\left[1-\tau\right] + H(g)$$

because the politician maximizes the median voter's indirect utility.

Solving the maximization problem we can rewrite the equilibrium policy as:

$$g^* = h(kf'(\frac{g-a}{y})) \tag{3.16}$$

Recall that $h' < 0$ and thus the level of public spending decreases with income inequality k.

Taking total derivatives to (3.16) we obtain the propensities to spend out of local income and grants:

$$\begin{aligned}
\frac{dg^*}{dy} &= \frac{yk'h'f'}{y-kh'f''} - \frac{kh'f''}{y-kh'f''}\frac{g^*-a}{y} \\
\frac{dg^*}{da} &= -\frac{kh'f''}{y-kh'f''}
\end{aligned}$$

From these two expressions and definition (3.4) we can relate both propensities to spend to obtain the magnitude of the flypaper effect:

$$\frac{dg^*}{da} = \frac{dg^*}{dy}(-\frac{k'}{k}\frac{f'}{f''}y + \tau - \Gamma C(\tau))^{-1} \tag{3.17}$$

Note that, similar to the case of symmetric income distribution, the magnitude of the flypaper effect is increasing on the administrative costs shifter Γ. Moreover, in the particular case when the income distribution is unaffected by changes on average income, $k' = 0$, expression (3.17) becomes identical to (3.10).

C.2 Compliance and administrative costs

Consider a more general case with both compliance and administrative costs. In particular, for citizen i the compliance cost is $\Gamma_c C_c(\tau) y_i$ while for the tax authority the administrative cost represents a proportion $\Gamma_a C_a(\tau)$ of the tax base. Both $\Gamma_c C_c(\tau)$ and $\Gamma_a C_a(\tau)$ are increasing and convex functions and adopt values strictly between 0 and τ.

Given the previous assumptions, we can re-write equations (3.2) and (3.3) as

$$V_i = y_i[1 - \tau - \Gamma_c C_c(\tau)] + H(g)$$
$$g = y\left[\tau - \Gamma_a C_a(\tau)\right] + a$$

Rearranging the budget constraint, we can express τ as a function of g:

$$F(\tau) \equiv \tau - \Gamma_a C_a(\tau) = \frac{g-a}{y} \tag{3.18}$$

where $F' > 0$, $F'' < 0$ by assumption 1 and convexity of $C_a(\tau)$. Since F is a monotonic function, we can write the tax rate as

$$\tau = f\left(\frac{g-a}{y}\right)$$

where $f(\cdot) = F^{-1}(\cdot)$.

It follows that the median citizen's indirect utility can be written as

$$y\left[1 - f - \Gamma_c C_c(f)\right] + H(g) \tag{3.19}$$

The maximization of equation 3.19 with respect to g provides the level of public spending in equilibrium;

$$g^* = h((1 + \Gamma_c C_c')f') \tag{3.20}$$

where $h(\cdot)$ is the inverse function of $H'(\cdot)$.

Calculating comparative statics from (3.20), we obtain:

$$\frac{dg^*}{dy} = -\frac{h'A}{y - h'A}\frac{g^* - a}{y} \tag{3.21}$$
$$\frac{dg^*}{da} = -\frac{h'A}{y - h'A} \tag{3.22}$$

where $A = (1 + \Gamma_c C_c')f'' + f'f'\Gamma_c C_c''$

From visual inspection of (3.21) and (3.22), and using definition (3.18), we obtain the following relation between both propensities to spend:

$$\frac{dg^*}{da} = \frac{dg^*}{dy}\frac{1}{\tau - \Gamma_a C_a(\tau)} \tag{3.23}$$

Note that the magnitude of the flypaper effect is similar to the obtain in the case without compliance costs. However, the propensities to spend are different.

Note that in the special case of no administrative costs, $\Gamma_c = 0$, expression (3.23) becomes:

$$\frac{dg^*}{da} = \frac{dg^*}{dy}\frac{1}{\tau^*}$$

Similar to the model only with administrative costs, this extension predicts a propensity to spend out of grants larger than the propensity to spend out of local income.

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