Forest Management and Economic Rents:
Evidence from the Charcoal Trade in Madagascar

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Abstract

Licensing the exploitation of forest resources is often used as a preferred policy to regulate natural resource management in developing countries. While the stated intent is to control extraction of wood beyond regeneration limits, regulation can often serve those with access to rents and exclude rural communities. Based on primary data, this paper compares the regulated charcoal trade with the unregulated food trade sector in Madagascar. The two major findings are that a) marketing margins in the regulated charcoal sector significantly exceed those observed for similar transactions in the unregulated food sector indicating the existence of rents in the former; and b) margins are greater for charcoal traders with more rent-specific social capital, indicating that those in the charcoal sector with better connections to government officials have greater access to rents.

1. Introduction

Licensing the exploitation and trade of forest resources is often a preferred policy for regulating natural resource management in developing countries. While the common reasoning for maintaining such regulatory systems is that it prevents continued deforestation and forest degradation, and that it supports the collection of revenues to finance public service delivery, regulation can often serve those with access to rents and exclude rural communities from the benefits of resource commercialization (Ribot, 2009; Ribot et al., 2006; Post and Snel, 2003; Foley et al., 2002; Hofstad, 1997; Ribot, 1995, 1993). Although it is nearly impossible to establish the true motivation of the designers of regulatory policies given the obvious difficulty of collecting reliable data,[1] determining the effects of these policies and who gains from them is not. Indeed, empirically assessing what actually happens on the ground can help enhance the design of more appropriate policies for forest management. That is the purpose of this paper.

Using primary data collected on traders in the charcoal and agricultural sectors, we study the impact of regulatory forest management policies in Madagascar, where the preservation of forests is of large importance given the country's unique biodiversity.[2] In particular, we assess the impact of these policies on charcoal trade by comparing outcomes for traders in the regulated charcoal sector with those in the unregulated agricultural sector. The contribution of the paper to the literature is threefold. First, we analyze charcoal trade in Madagascar, a sector which has received surprisingly little attention despite its importance for a country where most people depend on wood products as their primary energy source. Second, we contrast the results of performance of traders in this sector with those with operating in an unregulated framework (i.e. agricultural trade) based on similar data collected for both types of traders.

[1] Illegal trade is important for the livelihood of a significant number of people. This trade includes at the global scale most importantly drugs, precious stones, endangered species, and wood products. For obvious reasons, little is known quantitatively on illegal trade and only a few recent exceptions exist. The most famous is the study on drug-selling gang's finances by Levitt and Venkatesh (2000). Svensson (2003) studies bribes in a cross-section of firms in Uganda. However, most of the studies on this theme analyzed illegal trade at the macro-level and numbers represent rather broad estimates (see Bevan et al. 1989, World Bank 2003b). None of these analyses looks at the trading sector itself and — most of the analysis is rarely based on micro-economic data.

[2] Madagascar has been recognized as one of the twelve megadiversity countries (McNeely et al., 1990). Madagascar's unique biodiversity stems from the fact that few plants and animals were present as the island split from Africa in the Gondwana supercontinent splitup. Over 80% of its plants, 95% of its reptiles, 99% of its amphibians, and close to 100% of its primates are found nowhere else in the world (White, 1983). In recent years, Madagascar has become internationally known for its rich and unique biodiversity that is threatened by rapid degradation. Since the mid 1980s, Madagascar has been the focus of international conservation efforts with international development organizations providing loan and assistance programs explicitly aimed at environmental objectives and forest preservation. This has made any wood exploitation being perceived as illegal or semi-illegal.

Third, we use recent advances in the methodologies on the analysis of the impact of social capital on economic performance (Fafchamps and Minten, 2001a, 2001b, 2002; Narayan and Pritchett, 1999; Barr, 2000) and extend it to our issue.

The econometric analysis confirms that regulatory control through a licensing systems leads to rents in charcoal trade. Margins for similar transactions are significantly higher for traders in the regulated charcoal industry compared to traders in the unregulated agricultural sector despite similar transaction costs. This indicates that at least a part of the rents created by regulation of the charcoal sector is captured by such intermediaries as traders. We find further that in the charcoal sector, where it is estimated that an important part of trade circumvents regulation, traders' margins are increasing in rent-specific social capital (i.e. number of government officials known). This is in stark contrast to the agricultural sector where no such effect is found.

The structure of the paper is as follows. Section 2 gives background information on the socio-environmental context of the charcoal trade in Madagascar. The data are described in Section 3, while the conceptual framework and testing strategy are outlined in Section 4. Descriptive statistics and analysis of trader margins appear in Section 5. The results of econometric models of margins to test the importance of rent-specific margins are presented in Section 6. Finally, concluding remarks appear in Section 7.

2. Charcoal production and trade

2.1. Background

Faced with severe poverty and the lack of other viable energy supply options, nearly 90% of Madagascar's population relies on biomass for their daily energy needs. An estimated 18 million cubic meters of wood is annually exploited for wood fuel, of which about half is converted to charcoal for urban use (Meyers et al., 2006). On average, a Malagasy family uses around 500 kg of charcoal per year (Meyers et al., 2006). Increased population growth, accelerated urbanization, and rising prices for alternative fuels all contribute to what is expected to be a rise in demand for woodfuels over the next several decades[3,4]. While firewood

[3] The International Energy Agency predicts that by 2030, biomass energy in Africa will account for an estimated three quarters of total residential energy (International Energy Agency 2006).

use rarely poses a threat to sustainable forest management, the implications of charcoal use are quite different because inefficiencies in the production process result in charcoal consumers using far more wood than consumers of firewood (Brouwer and Falcão, 2004; Hosier et al., 1993; van der Plas, 1995).

The current high levels of demand for charcoal are one of the main factors leading to the destruction of forests, particularly those on the periphery of sprawling urban centers[5]. The associated economic cost of environmental degradation has been estimated to be between 5% and 15% of GDP (World Bank, 2003). In response to these concerns, Madagascar recently began exploring the possibility of participating in a global carbon trading mechanism related to Reduced Emissions from Deforestation and Forest Degradation (REDD). Aside from the environmental issues, the charcoal sector is a source of income generation for tens of thousands of people, especially among the poor[6]. The most common way the rural poor benefit from the charcoal value chain is in their roles as either charcoal producers, small transporters, wholesalers, or as contracted laborers involved in loading, repairing, or driving trucks. In urban areas, the poor often work as transporters, retailers, and producers/retailers of stoves (GTZ, 2007; Sepp, 2008; van Beukering et al., 2007; Hosier and Milukas, 1993; Hosier and Kipondya, 1993).

According to the existing law in Madagascar, all natural forest is property of the state whether the land is owned by the state or not (World Bank, 2003a). Further, charcoal production and trade are regulated through a licensing system. This requires that permits be obtained for extraction of products from private property, even when it is for subsistence purposes. In addition to an exploitation permit, permits are required to transport charcoal (*laissez-passer*). The transport permit requires a large amount of information including a record of the type of wood, the number and volume of sacks of charcoal, the names of the transporter and producer, the destination, and the date of transport. Any trade or transport of charcoal without this permit is forbidden. The official objectives of this charcoal licensing system are twofold. First, with conservation of biodiversity as the guiding principle (World Bank, 2004), the regulatory system is intended to control forest resource exploitation within the limits of natural regeneration, and hence avoiding further deforestation and forest degradation. Second,

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[4] This does not only apply to Madagascar. For example, in their case study for Tanzania, Hosier et al. (1993) estimate that a 1% increase in urbanization leads to a 14% increase in charcoal consumption.
[5] This is also the case in Tanzania (Mwampamba, 2007; Luoga et al., 2000).
[6] Again, this is similar to other Sub-Saharan African countries such as Mozambique, Malawi, Tanzania, Rwanda, and Senegal (Brouwer and Magane, 1999; Kambewa et al., 2007; Ribot, 1998; World Bank, 2009).

the permit system is an important source of revenue generation, especially for local- and district-level governments.

In practice, however, few producers appear to obtain exploitation permits. There are several reasons for this. For example, traveling to the nearest forest service representative and waiting for the permit to be issued increases the costs of permits beyond the statutory fees. Further, resource- and liquidity-constrained households may find it difficult to pay the licensing fees as well as the potential bribes to the license issuing public service representative[7]. There is anecdotal evidence that few traders obtain the required paperwork for similar reasons and that bribes are offered whenever controls are executed (PPIM 1999). As a consequence of the difficulties of obtaining permits and of the high demand for charcoal in urban areas, illicit production and marketing of charcoal appear to be common (PPIM 1999). Although they are fraught with measurement problems, survey estimates of the magnitude of the clandestine trade are quite telling. For example, Brodbeck (1999) and PPIM (1999) find that between 80% and 95% of the volume of charcoal is marketed without the required permits. The cost to the state can be quite large, as sometimes only 3% of potential taxes are raised (Montange 2007; Richards et al., 2003). At the national level, foregone tax revenues due to uncontrolled forest exploitation are estimated to be roughly US$ 140 million (Meyers et al., 2006).[8]

Finally, it is worth noting that the conservation objectives of the licensing system are relevant throughout Madagascar. Charcoal is produced from a variety of ecosystems such as planted forests of eucalyptus and pines species in the central highlands, and natural forests in the lowlands (Meyers et al., 2006). Due to the significant variation in ecosystems, these natural forests range from dense, moist tropical forests in the East of the country to dry and spiny forests in the West and South-West (USAID, 2005). In the study area, the traditional ecosystem for charcoal procurement is dry natural forests. Continued degradation of resources and land-use changes in favor of agriculture and pasture in these areas have not only pushed production further into the hinterland, but have also resulted in a range of ecosystems being used for charcoal production, with mangroves being the most prominent among them.

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[7] Kambewa et al. (2007) estimate that such bribes can amount to 15-20% of the final charcoal price in Malawi.

[8] Similar observations have been made in other Sub-Saharan African countries (CHAPOSA, 2002; Kambewa et al., 2007; Malimbwi et al., 2007; Ribot, 1998; World Bank, 2009). In Tanzania, Kenya, and Malawi forgone tax revenues from clandestine charcoal production and trade are estimated to be about US$ 100 million, US$ 65 million, and about US$ 7 million, respectively (Malimbwi et al., 2007; Kambewa et al., 2007; World Bank, 2009).

2.2. The charcoal supply chain

We now turn to a description of the charcoal supply chain to provide more context for the research design and interpretation of the results. The simplified structural relationships of the charcoal supply chain between rural producers and urban consumers in the areas studied in Madagascar are depicted in Figure 1. Based on detailed interviews of key informants, we identify six types of charcoal traders: (1) rural collectors, (2) rural itinerant traders, (3) wholesalers, (4) urban semi-wholesalers, (5) urban retailers, and (6) government officials. As indicated at the bottom of Figure 1, the structure of the value chain differs according to the distance between the rural producer and the urban consumer.

When the distance between producers and consumers is short (i.e. less than 50 km), producers tend to take their own charcoal to the cities to sell. Transportation is either provided by their own zebu-carts or by hiring transporters with zebu-carts ('charettier') who are paid by the sack. Once in the cities, producers sell to urban retailers or deliver their charcoal directly to consumers.

For medium distances between producer and consumers (i.e. between 50 and 100 km), rural producers tend not to transport charcoal themselves to the city. Two channels exist. First, urban consumers who happen to be travelling through rural areas (on their way between cities or after visits to rural areas) sometimes buy sacks of charcoal and transport them to the city. To facilitate this, rural producers often cluster around rural transport depots or bus stops to sell their charcoal. Second, rural iterant traders buy charcoal from small producers and transport the charcoal by renting space on a truck or bus. The quantities bought and transported are small and the itinerant traders sell directly to urban retailers in the cities.

When distances between producers and consumers are long (over 100 km), wholesaler who own or rent trucks will travel to production areas to procure charcoal. They buy directly from producers who are often organized in associations, as well as from rural collectors who own storage spaces along the road. Rural collectors often possess permits for exploitation of forested areas and use laborers for the production of charcoal. Laborers are typically paid in sharecropping arrangements where the collector commonly receives a third of the charcoal. Those wholesalers who have exploitation permits also integrate rural collection in their activities and organize their own laborers. They also buy directly from rural producers on occasion. Wholesalers buy and transport large quantities and sell to urban semi-wholesalers or retailers in the cities.

Lastly, government officials might also take possession of charcoal when no permits exist. They typically organize their own transportation to the cities and sell directly to urban retailers or semi-wholesalers.

There are four different pathways related to the government licensing system through which trade takes place: a) all required permits for exploitation and transport are obtained, which sometimes requires payments of bribes; b) permits are not obtained, but bribes are paid along the marketing chain in order to pass checkpoints and controls; c) permits are not obtained and charcoal is confiscated by law enforcement authorities who themselves market the charcoal either on their own behalf or on behalf of the government; d) permits are not obtained and producers and traders avoid paying bribes altogether.

3. Data

Two primary data sources are used in this analysis. The first is a survey of charcoal traders that was conducted in August 2001 in the northwestern area of Madagascar. This was a collaborative effort between the Centre National de la Recherché Appliquée au Développement Rural à Madagascar (FOFIFA) and the *Ilo* program of Cornell University. The sample was stratified into three areas: the urban center of Mahajanga, the secondary urban center of Marovoay, and the rural area along the RN4 highway leading from Mahajanga to Ambondromamy. Every type of trader appearing in Figure 1 was interviewed. In rural areas, all of the traders who could be found on the days of the survey were interviewed. In the urban centers, districts ("quartiers") were randomly selected. In each of these districts, a fixed number of traders was randomly selected for interview from a census of charcoal traders drawn up in the district on that particular day. In total, 172 charcoal traders were interviewed.

Extreme care was taken during fielding of the survey to gain the confidence of the respondents given the understood importance of illegality in the charcoal sector. The survey benefited from the fortunate collaborating with a local project that had been working in the region for a long time and that had gained the trust of the local population. Through this link, the enumerators were able to dissociate themselves from local or regional authorities and were therefore able to obtain more truthful answers. At the end of every interview day, questionnaires were thoroughly verified in the field. In cases were answers were inconsistent, follow-up interviews were conducted the next day.

The second data source comes from a survey of agricultural traders conducted in March 2001. This project was a collaborative effort between Cornell University, Oxford University, and FOFIFA.[9] Three main agricultural regions in Madagascar were selected (Fianarantsoa, Mahajanga, and Antananarivo).[10] The sampling frame within these regions was set up as follows.[11] A total of 892 traders were surveyed in three different types of location: big and small markets in the main town of every province (faritany) and district (fivondronana); urban areas outside urban markets; and rural markets at the level of the rural county (firaisana). Rural counties were selected through stratified sampling based on agro-ecological characteristics so as to be representative of the various kinds of marketed products and seasons.

The structure of the questionnaire was similar for both surveys. It covered the following main areas: (a) characteristics of the trader and trading enterprise; (b) factors of production and operating costs; (c) trading activities and marketing costs; and (d) relationships and coordination costs. Data were also collected on search behaviors and costs, quality inspection, contract enforcement and dispute settlement, information gathering, and property rights enforcement.

4. Conceptual framework

The premise of this analysis is that if the benefits from regulations on the production of charcoal (i.e. the quota system at the production level) accrue only to the state or to charcoal producers, no significant effects should be noticed in the charcoal trade sector. In the absence of rents associated with regulation that are captured by traders, margins in charcoal trade should only reflect regular marketing costs such as those associated with transportation and distribution. Indeed, if this were the case, there should be no significant difference in margins for regulated charcoal traders compared to the unregulated agricultural traders. To formally

[9] Funding for the survey work was provided by USAID and the Pew project.
[10] As such, there is geographical overlap with the charcoal trader survey.
[11] The survey focuses on agricultural traders as both the wholesale and the retail level. 30 sites were selected in total. Due to the absence of reliable census information on the population of traders, a census of traders was conducted in each selected market prior to the sampling.

test this notion, we consider the following testable hypothesis, the rejection of which confirms the existence of rents from regulation:

> *H1: Margins for similar transactions in the agricultural and charcoal trading sectors are equal.*

This hypothesis is tested by comparing annual margins for charcoal and agricultural traders, as well as by estimating simple OLS models in which gross margins from the last transaction by traders are regressed on the characteristics of those particular trades. A simple t-test of the difference in the intercepts for the models estimated separately on the samples of charcoal and agricultural traders is equivalent to testing *H1*. By controlling for characteristics of the transactions, the unexplained differences in the margins can be attributed to rents from regulation.

Although we know that an important share of transactions is illicit, we cannot determine which transactions or what percentages of transactions for individual traders in the sample circumvented the regulations. As such, we are limited in the statements that we can make about the nature of the observed rents. Nonetheless, we can tease out information about the source of these rents by considering the impact of rent-specific social capital. [12] To formalize this, we consider a second testable hypothesis:

> *H2: The effects of rent-specific social capital on margins in the agricultural and charcoal trading sector are equal.*

The rent-specific social capital considered here is the number of government officials known. A rejection of *H2* therefore indicates that traders in the charcoal sector with more government connections have more access to the rents that stem from regulation in that sector.

To test *H2*, we follow the framework developed by Fafchamps and Minten (2002). Traders can generate value added or output (Q) by returns to physical or working capital (K), human capital (H), labor (L), or social capital (S):

$$Q = \mathrm{f}(L, K, H, S)$$

[12] The definition of social capital in different economic and social studies has not been uniform (Grootaert and Van Bastelaer, 2002). It has been defined in terms of trust and civic cooperation (Knack and Keefer, 1997), of cultural values such as degrees of compassion, altruism, and tolerance (Fukuyama, 1995; Greif, 1993, 1994), or of institutions and the quality or quantity of associational life (Putnam et al., 1993; Narayan and Pritchett, 1999). We will use it in this analysis as benefits that accrue directly to an individual or a firm as a result of knowing people with whom it forms networks of interconnected agents.

We allow social capital to enter into the production process in different specifications discussed below as either an input or as a productivity shifter. An important assumption associated with the latter is that social capital is Hicks neutral. In other words, firms with more social capital have significantly higher collective returns from their labor, physical and human capital.

Several potential identification problems may bias the regression results. First, the dependent variable and the independent variables may be simultaneously determined. For example, traders may respond to good market opportunities by raising more working capital and hiring more workers. Further, the independent variables may be correlated with the error term due to the omission of important unobservable variables. For example, if traders who are more sociable are also more efficient,[13] then the estimated coefficient for social capital will include the effects of both the unobserved entrepreneurial quality of the trader and the effect of the observed social capital on output. The estimated coefficient will thus be a biased estimate of the effect of social capital on output.

We employ instrumental variables (IV) methods to address this endogeneity problem. The instruments that we use include traders' initial start-up conditions[14] and their personal backgrounds, family sizes and family backgrounds. Since these are all historical variables, they are arguably not determined by the potentially endogenous variables – working capital, labor and social capital – nor do they determine current output. Further, as illustrated in Appendix Table 1, the instruments are correlated with the working capital, labor and social capital. As such, we are confident that these are valid instruments.

Second, it can be argued that social capital is partly a byproduct of economic success. If this were the case, an over-accumulation of social capital would bias the estimated coefficients for social capital toward zero. Thus a positive effect of social capital is likely to be an underestimate. Finally, firms might also accumulate financial and real assets that are not required for current production. As such, these assets should be omitted from production function analysis. In practice, however, it is not always possible to disentangle nonessential

[13] In a similar vein, the unobserved characteristics of the type trader who willingly self-selects into illicit trade in charcoal may also affect both productivity and accumulation of social capital. Unfortunately, this is difficult to address because we cannot model the selection process with the data at hand.
[14] These include working capital, labor, and social capital variables.

from essential factors of production in a firm's accounts. Therefore we proceed with caution by including all factors of production in the analysis, but recognize the potential effect this may have on our model estimates.

We estimate the production function using two functional forms. The first is a Cobb-Douglas production function that is estimated in log form:

$$\ln(Q) = \alpha + \sum_{i=1}^{n} \beta_i \ln(x_i) + \sum_{k=1}^{m} \delta_k z_k + \xi$$

where x is the vector of variable factor inputs (e.g. working capital measured in local currency, K, and labor measured in person-months, L), z is a vector of productivity shifters (including social capital, S, and human capital, H), and ξ is an error term distributed with zero mean and unknown variance.

The second functional form is that of a translog production function. This flexible functional form can be described as:

$$\ln(Q) = \alpha + \sum_{i=1}^{n} \beta_i \ln(x_i) + \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \beta_{ij} \ln(x_i) \ln(x_j) + \sum_{i=1}^{n} \beta_{ii} \left(\ln(x_i)\right)^2 + \sum_{k=1}^{m} \delta_k z_k + \mu$$

where μ is an error term distributed with zero mean and unknown variance, and x and z are defined analogously to those above. The exception here is that we allow rent-specific social capital to enter into specification either as a productivity shifter (z), or as an input (x).

Once the model is estimated, the elasticities of the different factor inputs for each trader can be computed as

$$\varepsilon_{Q,x_i} = \alpha_i + \sum_{j<i}^{i-1} \beta_{ji} \ln(x_j) + \sum_{j>i}^{n} \beta_{ij} \ln(x_j) + 2\beta_{ii} \ln(x_i) .$$

The elasticities reported in the tables are averages of the trader specific elasticities for each factor. Note that given that the elasticities are non-linear functions of the inputs, the average of the trader elasticities for a particular factor is not equal to the elasticity evaluated at the means of the inputs. Because we estimate the model with IV methods, and then evaluate the elasticities as averages within the samples of interest, we cannot determine the standard errors for the elasticities analytically. As such, the model and the elasticity estimates are bootstrapped (Brownstone and Valletta, 2001). Means of the bootstrapped average elasticities from 1,000 replications along with their t-statistics are reported in the tables.

We therefore estimate three models: (1) Cobb-Douglas with rent-specific social capital as a Hicks neutral productivity shifter, (2) translog with rent-specific social capital as a Hicks neutral productivity shifter (denoted translog 1), and (3) translog with rent-specific social capital as an input (denoted translog 2). Given that the Cobb-Douglas production function is a special case of the translog production function, we test whether the former appropriately describes the data generating process (i.e. $\beta_{ij} = 0$ for all i and j). We also test Hicks neutrality in the translog specification.

Output for traders is measured as the total value added (or gross margin) during the 12 months prior to the survey – August 2000 through July 2001 for charcoal traders, and March 2000 through February 2001 for agricultural traders. Value added is computed by subtracting purchases from sales.[15] Physical capital is expressed in terms of the value of business equipment. Most continuous variables are entered in log form to account for the possibility that marginal returns (esp. to social capital) are increasing. To avoid losing observations due to nonessential variables with zero values, a value of one is added to each of these variables prior to taking logs.

The social capital variable of interest is the "number of government officials known by the trader who might be helpful for his/her business" as this captures a type of network that benefits traders through their access to rents. Two other social capital variables are included (the number of fixed suppliers and the number of fixed clients), but these are expected to increase margins through the trader's performance (Fafchamps and Minten, 2002; Barr, 2000), not through rents. Further, access to fixed suppliers and clients may also serve as a proxy for lower search costs. As such, it is difficult to interpret the estimated effects of these latter two variables. We do not attempt to disentangle these effects since the variable of interest in these models is rent-specific social capital (number of government officials known).

The trader's human capital is measured by years of schooling, years of experience in trade, and the ability to speak different languages.[16] In line with the human capital literature (Newman and Gertler, 1994; and Joliffe, 1996), these three variables are expected to increase efficiency in a Hicks neutral manner. Gender is included to control for differences in access to

[15] Measurement error is compounded by computing value added from two variables that are measured with error. However, direct questions related to value added were not available in the questionnaire.
[16] Malagasy is the common language in Madagascar, though French is used in administration.

resources. Age is included in a quadratic form to capture life cycle phenomena. Finally, location dummies are included to control for geographical differences in the trade environment.

5. Descriptive Statistics and Differences in Marketing Margins

Although average annual sales for charcoal traders are nearly 20 times smaller than for agricultural traders, the average annual gross margin[17] is over twice as large (Table 1). This also holds for the last completed transaction reported by the traders, and is consistent with a rejection of *H1*. In other words, these higher charcoal marketing margins support the notion that rents are generated in this regulated sector. The mostly clandestine nature of the charcoal trade is also consistent with these large margins, though the direction of causality cannot be determined. For example, while the high returns may be necessary to offset the higher risk associated with illicit trade, they may also induce traders to circumvent the regulations in the first place.

In order to more appropriately test the differences in margins across these two sectors (i.e. to test *H1*), however, we need to control for the characteristics of the transactions. We do this by using the information that survey respondents provided about their most recent transaction.[18] As illustrated in Table 1, there is little evidence of a difference in marketing costs between the charcoal and agricultural trade. This is not surprising given there is little difference in the weight of the product involved in the transaction.[19] However, there are differences in the taxes and fees incurred (higher), the size of the transaction (lower), the distance between the purchase and sales markets (lower), and the number of days between the purchase and the sale (higher) for charcoal traders relative to agricultural traders.

To see if these characteristics of the transaction account for differences in the observed marketing margins, we run a simple regression with the gross margin as the dependent variable and the transaction characteristics as the independent variable. The object of interest

[17] The gross margin is the difference between the value of sales to the value of purchases and is expressed as percentage.
[18] For a discussion on the impact of returns to scale in trade using a similar approach, see Fafchamps et al. (2006).
[19] Models of the determinants of these marketing costs resulted in no substantial differences across the agricultural and charcoal sectors.

in the results that appear in Table 2 is the intercept.[20] Controlling for differences in transaction characteristics and for region dummies, we find a strongly significant difference in the constant that can be interpreted as gross margins for similar transactions being 200 percent larger in the charcoal trade than in the trade of agricultural products.[21] This is a firm rejection of *H1,* that margins for similar transactions in the two sectors should not be different, and therefore provides evidence of rents that accrue to the regulated charcoal trade, but not to the unregulated agricultural trade.

Before turning to sources of the regulation-induced rents, we briefly comment on characteristics of the traders and their enterprises (Table 1). Traders in the agricultural trade are generally better educated (8 years) than in the charcoal trade (6 years). Further, the former are more likely to know more than one language than the latter. Agricultural traders also tend to employ more workers and have more working capital. This may be due to the evidence that they are more established in that they have been in business for a longer period of time and have a higher number of fixed suppliers and clients.

6. Rent-Specific Social Capital and Marketing Margins

We now turn to the results of the Cobb-Douglas and translog production function estimates that are used to test the effects of rent-specific social capital on gross margins (i.e. test of *H2*). We begin with the OLS estimates, and follow this up with the IV estimates and extensions based on these preferred estimates.

6.1. OLS Models

The OLS models fit the data well (R^2 range from 0.31 to 0.78) and largely conform to expectations. Working capital and labor are highly significant in all three specifications for both charcoal trade and agricultural trade. Further, returns to working capital are larger than for labor. Schooling has a positive effect on productivity in the charcoal sector, but is only significant in the translog 2 model. At first glance, it is surprising that schooling has a

[20] We also estimated this model on the pooled sample of charcoal and agricultural traders and included a dummy variable for charcoal. In this model, the estimated coefficient for the charcoal sector dummy variable was positive and significant, giving similar results to the models presented in Table 2. While we do not report the results of this model because it forces all of the other coefficients to be equal for agricultural and charcoal traders, the coefficient estimates are available upon request from the authors.

[21] Similar results were found for models in which taxes and value of purchase were included as explanatory variables. While these estimates are not presented here, they are available from the authors upon request.

negative and significant effect in the agricultural trader model. However, once we account for the collinearity between educational attainment and the ability to speak multiple languages by dropping the latter (which has a large positive effect) the education variable becomes insignificant. The coefficients on age and gender are not significant in both sets of regressions.

The variable of interest in these models is rent-specific social capital as measured by the number of government officials known by the trader who might help his/her business. This variable is positive and significant in the charcoal Cobb-Douglas regression. Although, the coefficient is not significant in the charcoal translog models, we cannot reject the hypothesis that the Cobb-Douglas and translog functional forms are similar. We thus proceed by cautiously interpreting the results from the Cobb-Douglas model. The large estimated effect (knowing twice as many government officials increases gross marketing margins by 24% in the charcoal sector) is not surprising given the multiple governance issues that plague the sector (World Bank 2003a). This result is consistent with traders working with the government officials whom they know to assure that they receive the necessary protection from the state to be able to go about their clandestine activities. Similar results of the involvement of government officials in illicit activities have been documented in the trade of stolen cattle in Madagascar (Rasamoelina, 2000; Razafitsiamidy, 1997; Fafchamps and Minten, 2006; Fafchamps and Moser, 2003).

This result, however, is not a sufficient test of *H2* since the hypothesis does not relate to just the positive effect of rent-specific social capital on margins in charcoal. Rather, the question is how it differs from the effect in the agricultural sector. The results here depend on the model that is estimated. The coefficient on the number of government agents known is negative in all three specifications[22], but is only significant in the translog 1 model. Given that we cannot reject Hicks neutrality in the translog 2 model, and given that we do reject the Cobb-Douglas model, the translog 1 model is the preferred model among this set of estimates for agricultural trade. The 0.41 difference between the rent-specific social capital estimates in the Cobb-Douglas charcoal model (0.24) and in the translog 1 agricultural model (-0.17) is statistically significant ($t = 2.9$), and thus indicates a rejection of *H2*. In other words, these models provide evidence that traders in the charcoal sector with more government

[22] This negative effect might be an indication of traders with strong roots in the administration who are remnants of the parastatal period, and who have not adjusted well to the dynamic emerging private-run agricultural trading system.

connections have greater access to the rents that stem from regulation in that sector than those with fewer connections. We caution, however, that these results are based on the OLS model estimates and return to this point below in the discussion of the preferred IV models.

Before turning to the robustness tests and the IV models, it is worth commenting on the estimated effects of the non-rent-specific social capital variables – number of fixed suppliers and number of fixed clients. These variables are positive and individually and jointly significant at the 10% level in the Cobb-Douglas charcoal trade model. They are not significant at all in the translog 1 agricultural trade model, however. The importance of these forms of social capital in the charcoal trade might be partly explained by the lack of legal and law enforcement institutions that enforce contracts and protect transactions in charcoal trade. Trust between supplier and the trader becomes then an important determinant to success and traders rely on relational contracting (McMillan and Woodruff, 1999; Fafchamps, 2004; and Rodrik, 2008). Traders who are unable to develop these types of relationships might be more vulnerable as they are more exposed multiple and uncertain clients/suppliers. They may also be unable to secure enough supply to be successful given the licensing system in place. Such relationships appear to be important and more difficult to establish in illicit trade as shown by the substantially smaller number of fixed clients and suppliers in charcoal trade compared to food trade (Table 1).

As noted previously, however, the fixed number of suppliers and clients may also be a proxy for trade efficiency. This follows from such implicit or explicit contracts serving to reduce transaction costs such as search costs. In developed and emerging economies for example, we increasingly see concentration and vertical integration with a small number of firms buying and selling agricultural produce (Reardon et al., 2003; Johnson, McMillan and Woodruff, 2002; McMillan and Woodruff, 1999; Fafchamps and Minten, 2002). Given that these supplier and client coefficients are not statistically significant in the food trade regressions, indicates that the former explanation (relational contracting) might carry more weight in the case of food trade in Madagascar.

6.2. IV Models

As discussed in Section 5, the estimates of the variables of interest in the OLS models (e.g. social capital) are likely biased due to these variables being correlated with the error term.[23] To test the robustness of the previous results and to address the endogeneity concerns, we estimate IV models allowing for working capital, labor and social capital to be endogenous. F-tests from the first-stage models indicate that the instruments[24] are valid predictors of each endogenous variable (Appendix Table 1).

The results of the IV model estimates appear in Table 4 and provide further evidence of the importance of rent-specific social capital to traders of charcoal trade, but not to traders of agricultural products. The number of government agents known has a positive and significant effect in each of the charcoal trade models, but is insignificant in each of the agricultural trade models. Tests of equality of these coefficients between the charcoal and agricultural models are rejected for each possible specification combination.[25] In other words, these models provide a robust rejection of the *H2* hypothesis. This is further supporting evidence that a source of the observed rents in the low-value regulated charcoal trade comes from access to government officials because similar returns to rent-specific social capital are not observed in the unregulated agricultural trade sector.

The results for the other social capital variables are similar to the OLS models, except that the effects are found to be consistently large and statistically significant across all three model specifications for charcoal. They are not significant for the agricultural trade Cobb-Douglas regression, though the number of fixed suppliers is positive and significant in each of the translog models regressions.

Finally, an interesting result of the IV models is that the number of years of experience in charcoal trade has a high pay-off for those traders who are willing and able to stay in the business. This effect is noticeably larger than that found in agricultural trade, where the effect is not statistically different from zero. Indeed, the doubling of years of experience in the charcoal trade from, the sample average of 1.2 to 2.4 years, translates into more than double

[23] Although Hausman and Davidson-MacKinnon tests (Davidson and McKinnon, 1993) do not reject the null hypothesis that the working capital, labor and social capital variables are exogenous (Appendix Table 1), our preferred estimates are those from the IV models due to concerns about unknown small-sample properties and low power of these tests (Kennedy, 1998).
[24] The instruments are traders' initial start-up conditions and their personal backgrounds, family sizes and family backgrounds.
[25] The t-statistics range from 1.77 for the charcoal translog 2 – agriculture Cobb-Douglas difference, to 2.17 for the charcoal translog 1 – agriculture translog 2 difference. The full set of test statistics is available from the authors upon request.

the gross margin. This rapid growth in margins might be typical for clandestine activities in regulated sectors where exit rates are likely higher than in unregulated sectors. Given that the survey is conducted among current traders, not those who have exited, we are unable to test this. Nonetheless, we can ask about the relationship between years of experience and rent-specific capital by examining the estimated coefficients for experience in the first-stage model. It is interesting to note that the experience has a positive and significant effect on all of the first-stage endogenous variables (Table 5)[26] except on the number of government officials known where it is insignificant. It appears that these relationships may have been previously established and could have induced entry into the profession. Whether the unobserved characteristics associated with development of contacts with government officials are also associated with efficiency of the trader in his/her profession is not clear since these characteristics could be related to entrepreneurial ability or to established family connections or both. [27]

7. Conclusions

This analysis uses primary data collected on traders in the charcoal and agricultural sectors to study the impact of regulatory forest management policies in Madagascar where the preservation of forests is of large importance given the country's unique biodiversity. In particular, we assess the impact of these policies on charcoal trade by comparing outcomes for traders in the regulated charcoal sector with those in the unregulated agricultural sector.

The econometric analysis confirms that regulatory control through a licensing systems leads to rents in charcoal trade. First, we find that not only are annual gross margins significantly higher for traders in the regulated low-value charcoal industry compared to traders in the unregulated high-value agricultural sector, but that differences in transaction characteristics cannot explain these differences in margins. Although this analysis is limited to the trading sector, and as such we do not have a complete picture of the total rents created by regulation in the charcoal sector and how these rents are distributed, this evidence does suggest that at

[26] In a three-country comparison, Fafchamps and Minten (2001b) show that yearly growth in social capital (defined as 'the number of traders known') is around 0.7% and this compared to working capital which grows at 3 to 4% a year. The results in this paper are of similar magnitude.

[27] This highlights the issue of self-selection discussed in footnote 13 that people may select into this specific activity based on their characteristics and connections. It also suggests a topic for future research to test whether those with political connections are more likely than those without such connections to be drawn into a profession by the prospect of capturing rents in a regulated sector. Unfortunately this type of analysis cannot be done with data on only current traders.

least a part of the rents are captured by such intermediaries as traders, and that these rents are not trivial (gross margins in charcoal trade are more than twice as large as in agricultural trade).

Second, the evidence indicates that traders in the charcoal sector with more government connections have greater access to the rents that stem from regulation in that sector. In this sector where a significant portion of trade circumvents regulation, traders' margins are increasing in rent-specific social capital (i.e. number of government officials known). This is in stark contrast to the agricultural sector where no such effect is found. Further, we find no evidence that this type of social capital can be accumulated over time through trade in the charcoal sector. It is more likely that these relationships were established prior to entry into the profession.

This research is not a comprehensive evaluation of the current licensing system towards forest management in Madagascar. As such, we have little to say about a comprehensive reform of the system. Nonetheless, we do provide evidence of an important weakness in the current system. Not only are nontrivial rents created by the current regulation, and not only are more of these rents captured by those with more rent-specific social capital, but these rents also appear to have a regressive nature to them. Since the higher margins observed in the charcoal trade cannot be explained by characteristics of the transactions, they must then be placing either excessive downward pressures on producer prices or excessive upward pressures on consumer prices. A consequence of this, for example, is that given the low price elasticity of demand for charcoal[28], higher consumer prices may make a difficult situation even worse for poor households as they must forgo other goods and service while charcoal takes up a larger share of their already limited budgets. Efforts to design or reform policies intended to prevent deforestation and forest degradation, must clearly take this into account.

[28] It has been show in other countries that due to price increases, bulk buying of woodfuel is often beyond the reach of most households leading to smaller portions of woodfuel bought at a time. However, total quantities consumed remain almost unchanged (Manvell and Shepherd, 2001; Woodwell, 2002). This is also observed in Madagascar. The consumption of charcoal for Madagascar as a whole has increased almost five-fold between 1980 and 1996 (FAO, undated) and an annual increase of about 8% of charcoal consumption is projected for the research area (PPIM, 1999).

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Figure 1: Rural-urban charcoal supply chain

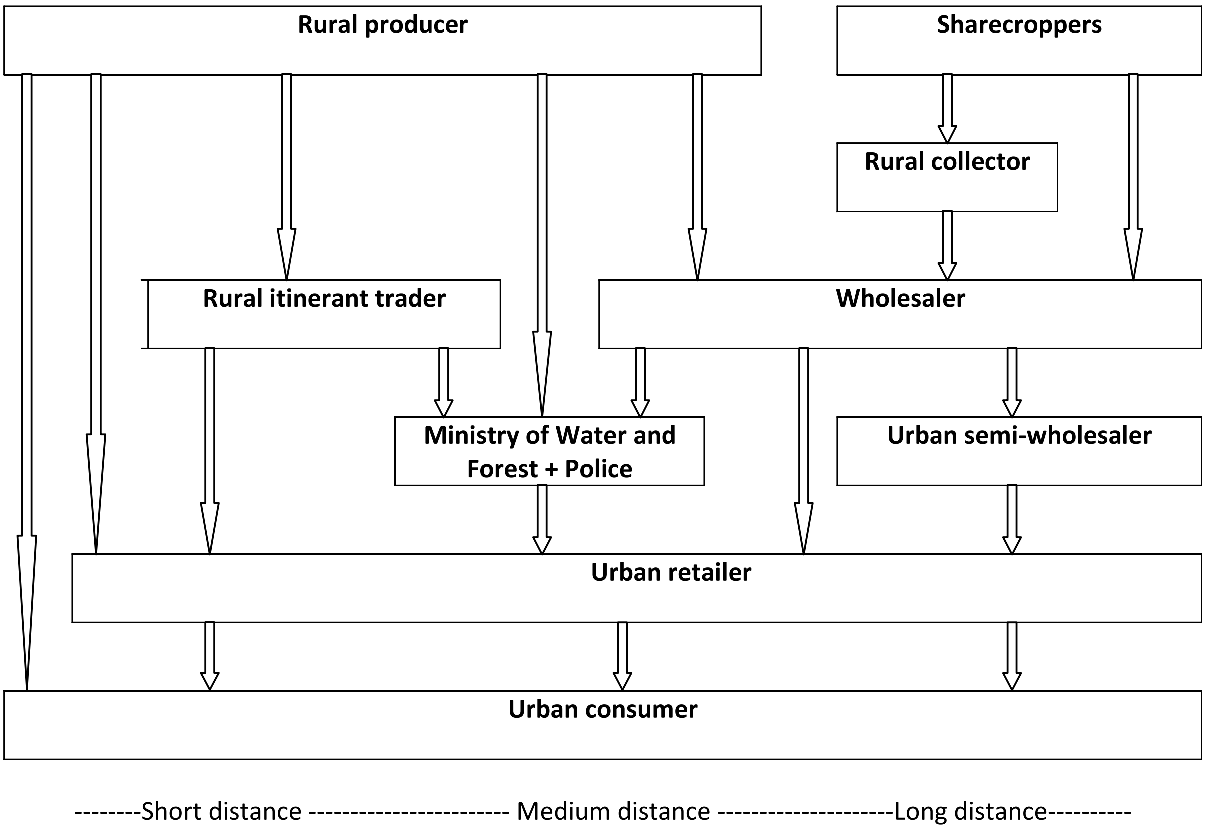

Table 1: Main Characteristics Agricultural and Charcoal Trade

	Unit	Agricultural Trade		Charcoal Trade		T-test: Diff=0	
		Mean	Median	Mean	Median	t	P > |t|
Characteristics of trader & enterprise							
Working capital	US$	4,477.4	192.31	84.60	41.53	-0.95	0.339
Manpower	# of people	4.25	1.72	1.33	0.91	-2.72	0.007
Fixed suppliers	# of people	3.81	2.00	1.99	1.00	-3.85	0.000
Fixed clients	# of people	8.54	6.00	2.09	0.00	-8.85	0.000
Government officials known that could help in business	# of people	1.87	1.00	1.11	1.00	-2.85	0.004
Female	Percent	61.21		59.88			
Years of schooling	# of years	8.43	9.00	5.93	6.00	-7.66	0.000
Experience in the sector	# of years	3.29	2.00	1.19	0.00	-5.71	0.000
Speak multiple languages	Percent	27.52		18.02			
Age	# of years	36.18	35.00	36.36	35.50	0.19	0.844
Last Transaction							
Quantity purchased	Kg	1,583.9	240.0	1,527.5	400.0	-0.09	0.927
Value of the purchase	US$	329.27	61.54	59.01	21.54	-2.53	0.011
Distance from purchase to sales market	Km	38.90	0.50	25.63	0.30	-1.87	0.061
Time between purchase and sale	Days	11.01	7.00	17.44	15.00	3.02	0.003
Gross Margin	Percent	32.06	13.64	44.04	33.33	1.69	0.092
Marketing costs (of which)	US$/ton	11.43	2.05	6.18	3.84	-1.04	0.300
transport costs	US$/ton	4.82	0.15	3.66	1.92	-0.68	0.494
handling costs	US$/ton	0.55	0.00	0.47	0.00	-0.68	0.494
taxes and fees	US$/ton	0.92	0.00	2.05	0.00	2.44	0.015
Annual sales							
Value of annual purchases	US$/year	20,518	7,514	688	294	-6.65	0.000
Value of annual sales	US$/year	24,552	8,617	1,276	408	-6.03	0.000
Ann. sales – ann. purchases	US$/year	4,422	792	588	118	-2.98	0.003
Gross Margin	Percent	25.9	16.5	58.5	33.3	6.72	0.000
Number of observations[1]		894		172			

[1] may vary across variables

Table 2: OLS models of gross margins for last transaction

Dependent variable is log of gross margin from last transaction

	Charcoal			**Agriculture**			**Difference**		
	Coeff.	t-stat		Coeff.	t-stat		Coeff.	t-stat	
Transaction Characteristics									
Quantity (log(kg))	-0.120	-2.13	**	-0.052	-1.92	*	-0.069	-1.11	
Distance between purchase & sale (log(km+1))	0.342	9.21	***	0.199	9.76	***	0.142	3.39	***
Time between purchase & sale (log(days+1))	0.125	1.48		0.192	3.96	***	-0.068	-0.70	
Region dummies (left out = Central)									
South	-0.604	-3.52	***	0.141	1.57		-0.745	-3.89	***
North	-0.846	-6.96	***	0.716	7.87	***	-1.562	-10.36	***
Intercept	4.18	10.47	***	2.12	12.85	***	2.06	4.83	***
Number of observations	155			855					
R-squared	0.56			0.26					

Note: *, **, *** indicate significance at the 90%, 95% and 99% level of confidence.

[a] Percent change

Table 3: Determinants of gross margins in charcoal and agricultural trade – OLS

	Charcoal Trade									Agricultural Trade								
	Cobb-Douglas			Translog 1			Translog 2			Cobb-Douglas			Translog 1			Translog 2		
	Elast.	t-stat		Elast.	t-stat		Elast.	t-stat		Elast.	t-stat		Elast.	t-stat		Elast.	t-stat	
Working capital	0.690	8.00	***	0.674	7.41	***	0.694	4.89	***	0.628	11.82	***	0.605	11.13	***	0.570	8.44	***
Labor	0.404	3.79	***	0.397	3.60	***	0.513	2.67	***	0.378	3.74	***	0.512	4.58	***	0.505	3.62	***
Number of government agents known																		
As an input							0.113	0.28								-0.101	-0.46	
As a productivity shifter (Hick Neutral)	0.244	2.27	**	0.196	1.49					0.135	1.36		-0.167	-1.78	*			
Number of fixed suppliers	0.204	1.96	**	0.214	2.02	**	0.049	0.29		0.015	0.18		0.130	1.35		0.208	1.76	*
Number of fixed clients	0.216	1.72	*	0.171	1.54		0.025	0.13		-0.171	-1.82	*	0.020	0.24		-0.018	-0.18	
Gender of trader	-0.165	-1.13		-0.177	-1.20		-0.075	-0.33		0.169	1.43		0.184	1.55		0.220	1.50	
Years of schooling of trader	0.025	1.19		0.021	0.97		0.092	2.96	***	-0.035	-2.09	**	-0.036	-2.25	**	-0.035	-1.86	*
Years of experience in trade	0.309	4.10	***	0.314	4.25	***	0.265	2.37	**	0.128	2.01	**	0.135	2.16	**	0.126	1.54	
Trader speaks another languages	-0.172	-0.92		-0.190	-1.03		-0.435	-2.00	**	0.514	3.40	***	0.500	3.38	***	0.600	3.26	***
Age[a]	-0.002	-0.08		-0.004	-0.14		-0.030	-0.63		0.038	1.20		0.033	1.04		0.053	1.44	
Age-squared	0.000	0.44		0.000	0.40		0.001	0.94		-0.001	-1.53		-0.001	-1.34		-0.001	-1.72	*
North	0.194	1.04		0.119	0.62		0.303	1.28		0.862	4.77	***	0.873	4.79	***	0.524	2.07	**
South	-0.067	-0.23		-0.186	-0.61		0.264	0.61		0.363	2.17	**	0.367	2.24	**	-0.045	-0.20	
Intercept	3.433	3.17	***	18.289	2.66	***	9.747	1.30		5.422	5.87	***	4.289	1.13		5.841	1.58	
Number of observations	171			171			171			719			719			719		
R-squared	0.79			0.80			0.87			0.47			0.47			0.52		
Tests	F test	p-val		F test	p-val		F test	p-val		F test	p-val		F test	p-val		F test	p-val	
Constant returns to scale (labor & capital)	0.57	0.45		0.98	0.32		0.06	0.81		0.00	0.95		11.93	0.00		3.24	0.07	
Translog equivalent to Cobb-Douglas				1.82	0.15		1.30	0.28					2.61	0.05		1.44	0.23	
Hicks neutrality							4.75	0.01								2.19	0.11	

Note: *, **, *** indicate significance at the 90%, 95% and 99% level of confidence.

[a] Coefficients are shown

Table 4: Determinants of gross margins in charcoal and agricultural trade – IV Models

	Charcoal Trade									Agricultural Trade								
	Cobb-Douglas			Translog 1			Translog 2			Cobb-Douglas			Translog 1			Translog 2		
	Elast.	t-stat		Elast.	t-stat		Elast.	t-stat		Elast.	t-stat		Elast.	t-stat		Elast.	t-stat	
Working capital	0.607	5.26	***	0.584	3.76	***	0.588	3.55	***	0.452	3.96	***	0.518	3.79	***	0.500	3.61	***
Labor	0.172	0.97		0.202	1.00		0.274	1.31		0.842	2.03	**	0.656	1.34		0.502	1.00	
Number of government agents known																		
As an input							0.202	1.88	*							-0.170	-0.94	
As a productivity shifter (Hick Neutral)	0.339	1.97	**	0.364	2.18	**				-0.008	-0.05		-0.140	-1.27				
Number of fixed suppliers	0.291	2.55	**	0.397	2.94	***	0.407	2.86	***	0.149	1.46		0.199	1.79	*	0.200	1.79	*
Number of fixed clients	0.267	2.59	***	0.446	3.22	***	0.505	3.58	***	0.074	0.80		0.094	1.07		0.079	0.90	
Gender of trader	-0.187	-1.29		-0.267	-1.33		-0.340	-1.73	*	0.141	1.11		0.167	1.17		0.243	1.66	*
Years of schooling of trader	0.027	1.26		0.018	0.60		0.012	0.41		-0.034	-1.94	*	-0.032	-1.64		-0.037	-1.86	*
Years of experience in trade	0.434	4.34	***	0.465	3.50	***	0.368	2.62	***	0.075	0.83		0.069	0.73		0.119	1.25	
Trader speaks another languages	-0.139	-0.74		-0.180	-0.72		-0.170	-0.65		0.575	3.51	***	0.477	2.83	***	0.541	3.08	***
Age[a]	0.007	0.26		0.001	0.02		-0.010	-0.27		0.040	1.20		0.037	0.97		0.038	0.99	
Age-squared	0.000	0.14		0.000	0.25		0.000	0.48		-0.001	-1.50		-0.001	-1.28		-0.001	-1.36	
North	0.211	1.09		0.184	0.69		0.208	0.72		0.658	3.02	***	0.605	2.71	***	0.212	0.83	
South	-0.400	-1.23		-0.908	-2.11	**	-0.609	-1.48		0.152	0.84		0.178	0.90		-0.047	-0.23	
Intercept	4.738	3.35	***	19.176	1.51		13.289	1.24		7.208	5.13	***	35.832	2.87	***	41.025	3.32	***
Number of observations	171			171			171			719			719			719		
R-squared	0.78			0.68			0.69			0.43			0.31			0.31		
Tests	F test	p-val		F test	p-val		F test	p-val		F test	p-val		F test	p-val		F test	p-val	
Constant returns to scale (labor & capital)	1.31	0.25		0.00	0.96		0.06	0.81		0.82	0.36		3.33	0.07		4.99	0.05	
Translog equivalent to Cobb-Douglas				0.90	0.44		0.89	0.45					1.82	0.15		2.15	0.09	
Hicks neutrality							4.09	0.20								3.18	0.04	

Note: *, **, *** indicate significance at the 90%, 95% and 99% level of confidence.

[a] Coefficients are shown

Table 5: Effects of "*experience in trade*" on endogenous variables in the first-stage IV equations.

		Charcoal Trade		Agricultural Trade	
Dependent Variables		**Coef.**	**t-stat**	**Coef.**	**t-stat**
Working Capital	log	0.221	3.94***	0.363	6.81***
Labor	log	0.460	10.19***	0.168	5.49***
Number of fixed suppliers	log	0.065	1.35	0.068	2.34**
Number of fixed clients	log	0.070	1.68*	0.107	2.98***
Number of government agents known	log	0.004	0.15	0.004	0.20

Appendix Table 1: Endogeneity and exogeneity tests

		Charcoal Trade		Agricultural Trade	
A. Trade regressions		**Test stat.**	**p-value**	**Test stat.**	**p-value**
a. Endogeneity tests (5 variables)					
1. Hausman tests	$\chi^2(13)$	10.76	0.631	3.14	0.994
2. Davidson MacKinnon test					
Working capital	t-value	0.146	0.357	0.140	0.325
Labor	t-value	0.278	0.180	-0.360	0.413
Number of fixed suppliers	t-value	-0.202	0.519	0.131	0.689
Number of fixed clients	t-value	0.021	0.941	0.212	0.546
Number of government agents known	t-value	-0.206	0.388	-0.268	0.120
b. Overidentification tests					
Wald test that instruments are exogenous	χ^2 (16)	15.498	0.488	11.221	0.796
B. Instrumenting regressions		**Test stat**	**p-value**	**Test stat**	**p-value**
a. Working capital					
F-test that instruments are jointly significant	F(21, N)	5.31	0.000	15.67	0.000
R-square		0.716		0.611	
b. Labor					
F-test that instruments are jointly significant	F(21, N)	1.76	0.029	7.80	0.000
R-square		0.721		0.428	
c. Number of fixed suppliers					
F-test that instruments are jointly significant	F(21, N)	2.23	0.003	7.14	0.000
R-square		0.709		0.241	
d. Number of fixed clients					
F-test that instruments are jointly significant	F(21, N)	2.49	0.001	4.79	0.000
R-square		0.622		0.324	
e. Number of government agents known					
F-test that instruments are jointly significant	F(21, N)	12.80	0.000	36.50	0.000
R-square		0.657		0.564	