INSTITUTIONS IN THE MALIAN COTTON SECTOR:

DETERMINANTS OF SUPPLY

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Abstract:

Cotton, the source of livelihood for millions of poor rural households and contributing significantly to export revenues, is a vital commodity for the economic and social development of Mali. Decline in international prices and weak institutional arrangements are two recent developments threatening the sustainability of the Malian cotton sector. This study quantitatively analyzes cotton growers’ supply responsiveness to both price and non-price variables using an augmented supply model. The relationship between farmers' supply responses and institutional factors is estimated using a balanced panel dataset for six cotton regions over the period 1998-2008. Results from the fixed effect estimator suggest that delays in payment to producers and bad credit recovery negatively impact acreage decisions and production levels. The farmer boycott movement also explains a large part of the decline in hectares of cotton and production during the crop year 2000/2001. Moreover, a decline in farm-gate cotton prices significantly reduces per acre production but not acreage of cotton planted.

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1. Introduction

Cotton is considered the most important cash crop commodity in Mali, significantly contributing to the national economy by providing income and employment to over three million smallholder farmers. Moreover, cotton has positive residual crop rotation effects on cereal production, gives rise to jobs in the manufacturing and transport industries, and is a major source of foreign exchange and revenue for the Malian government. Despite historic successes, the Malian cotton sector is now facing external (e.g., low international prices) and internal (e.g., high credit default rates) challenges that are threatening to offset or slow down the economic growth derived from cotton exports. The decline in world prices, combined with increases in input costs, mismanagement, and ill-performing credit schemes over the last several years have undermined profitability of the entire Malian cotton sector.

The resulting cotton crisis put sector reforms, proposed in the 1990s under structural adjustment programs, back on the national policy agenda, and accelerated pressure for their execution. The principal objective of these reforms, recommended by the World Bank and the International Monetary Fund, is to liberalize and privatize the cotton sector, under the assumption this will lead to greater market efficiency and competitiveness. While the reform process is still ongoing, Malian cotton production continues to face huge institutional challenges. At the start of the 2000/2001 growing season, farmers’ unions organized to protest against low farm-gate prices and the mismanagement of the parastatal ginning company, CMDT (Compagnie Malienne de Développement des Textiles). As a result of their call for a boycott on cotton during that campaign, production decreased by about 53% compared to the previous year, and resulted in a significant loss in potential revenue of about 20 billion CFA francs ($29 million) (Tefft, 2010; CMDT, 2009). From the crop years 1997/1998 to 2007/2008, production sharply
declined by more than 50%. This recent downward trend in production negatively affects the entire economy through the decrease in export revenue, and the worsening in producers’ and the ginning parastatal company’s debts.

This study aims to quantitatively assess cotton growers’ supply responses to institutional factors that have shaped the sector over the last decade. Specifically, the objective is to analyze the determinants of the recent drop in production in terms of both price and non-price variables. The latter include the date by which farmers receive payment for the cotton they have sold to the gin, the credit recovery rate for farmers’ loans, and extension services. This analysis uses a balanced aggregated dataset for the six Malian cotton regions over the period 1998-2008. A fixed effect estimator is used to determine the principal factors responsible for the changes in cotton supply as well as their relative importance. Results provide valuable insights for policymakers seeking ways to boost production and exports of cotton, and consequently reduce poverty.

Existing research on the effect of institutional arrangements on African cotton sectors has been primarily qualitative (e.g. Tefft, 2010 and Fok, 2007) and only a limited number of quantitative studies have been conducted in this area. These empirical studies either disregard the impact of internal institutional changes in their econometric analysis (e.g. Douya 2008; Bond 1983) or incorporate them by means of one dummy variable on the presence or not of marketing reforms (e.g. Brambilla and Porto, 2007; Dercon, 1993). The main contribution of this paper is to shed new light on the effects of institutional factors on cotton supply, by using several important measures of institutional effectiveness, such as farmers’ credit recovery rates, date of payment, and extension services, thanks to the dataset richness and unique nature. Therefore, this paper not only provides additional evidence about the effects of pricing policy on cotton supply, but also
presents information on the effect of disaggregated internal institutions on cotton supply responsiveness.

This paper is divided as follow. Section 2 provides an historical background. Section 3 discusses the main institutional factors shaping the Malian cotton sector over the last decade. Section 4 explains the theoretical supply model and Section 5 summarizes the data. Section 6 presents the empirical results. Section 7 concludes.

2. Overview of the Malian Cotton Sector

The first impetus for cotton sector reforms within the ongoing structural adjustment programs in Mali appeared during the late 1980s and early 1990s. As was the case in other West African countries, the Malian cotton sector was severely affected by a sharp decline in world cotton prices during this time. Poor management and lack of transparency, combined with operating cost inflation due to low international prices, led the CMDT into financial deficit in 1998. To cover these losses, financial resources from the Malian governmental budget were transferred to the CMDT. These transfers then threatened improvements in Mali’s fiscal and economic performance brought about by economic reforms of the 1990s (Aksoy and Beghin, 2001). In response to the CMDT financial crisis, the World Bank and the International Monetary Fund (IMF) made their loans conditional on liberalization and privatization in the Malian cotton sector. The proposed liberalization and privatization were intended to foster higher farm-gate cotton prices and rural household incomes through a more competitive market structure. A transfer of some CMDT activities to the private sector and to farmers’ organizations was also proposed to improve the management of CMDT and lighten its debt burden, thus reducing the need for fiscal outlays from the government.
The privatization of the CMDT was initially planned to occur in 2005. Following an unsuccessful public offer of sale, the government decided to split the CMDT into a main holding and four regional monopolistic firms, whose majority share (61%) was to be transferred to private operators. The completion date was postponed to 2006, then to 2008, and it is now expected to occur in 2011 (Sako, 2009). Indeed, the Malian government is now analyzing the purchasing offers made by one national and four international investors to ensure that their interests go along with the long-term success of the Malian cotton sector. Each monopoly ginning company will be in charge of providing essential inputs on credit, purchasing, and marketing cotton produced in their assigned geographical zone.

The recent downward trend in cotton supply has had negative repercussions on the economy by shrinking producers’ income, enlarging ginning company debts, deepening the country’s balance of payment deficits due to lower export revenues, and leading to a reduction in government expenditures on education and health care. As reported by Fok (2007), the crisis facing the cotton sector has considerably slowed down money flows, since villagers are spending less on cement, sheet metal for roofs, motorcycles, loincloths, and even on sugar, which is seen as a luxury good.

### 3. Institutional Effectiveness

This section presents the key variables used to proxy institutional effectiveness in the Malian cotton sector over the last decade and discusses their current and eventual impacts. Specifically, date of payment, the farmers’ loans credit recovery rate associated with the interlinked input-credit-cotton markets, and the provision of extension services are explained in detail. As mentioned by Dorward et al. (2009), effective institutions play three different roles.
First, they facilitate coordination of exchange. For instance, a high level of coordination is required to ensure that transactions are reliable, in terms of prices, quantities, and qualities of services and goods traded, and timing in payment. As it will be seen, timely payment is a key issue in the Malian cotton sector, with important consequence on cotton farmer production decisions. Second, effective institutions promote good resource management while encouraging trust. For instance, a good extension service system leads farmers to make better decisions that will enhance their long-run productivity. However, this can only work well if the relationship between producers and extension agents is based on trust. Third, effective institutions provide incentives for complying with given norms, and thus solve collective action problem. The discussion on the joint liability program prevailing in the cotton cooperatives will show how the inability to exclude non-performing farmers may discourage the most performing ones from growing cotton.

**Date of Payment** - Farmers typically complain about delays in receiving their payments from cotton sales and also about the fact that the length of the delay has increased over time (CTA, 2009). Although producers should technically be paid soon after the harvest, it is not uncommon for many of them to receive their payment after the next year’s planting season. The peak in cotton harvest occurs during the months of December and January. Planting season starts with the first rains, which occur in late May and early June. Some producers received their payment for the crop year 2007/2008 in November 2008, which almost coincides with on time payment for the next crop year (2008/2009). This situation is not unique to Mali. According to Dercon (1993), Tanzanian farmers have experienced delays in their payments, creating a disincentive to produce cotton. Delays in payment reduce farmers’ capability to access inputs necessary for the upcoming crop year and to repay their previous loans on time. They can be
regarded as a form of market failure, leading farmers to plant smaller acreage of cotton than the optimum and to divert cotton inputs to other crops (Serra, 2009).

Market Inter-Linkages - Provision of inputs, mainly seeds and fertilizers, is provided by the CMDT, which does not require any payment until the harvest. After the harvest, input costs are directly deducted from CMDT’s payments to farmers for their harvested cotton. The inter-linkage between the input, credit and cotton grain markets aims to ensure higher loan repayment rates. The next year’s provision of inputs is also conditional on previous payment. Nevertheless, some inputs are diverted by farmers to other crops or sold on the market for immediate liquidity. Inputs are generally sold on the market at a price below their purchase price on credit. Otherwise, it would be more profitable for buyers to acquire them on credit with the CMDT. For instance, households that struggle to be food self-sufficient at the beginning of the cotton season, which coincides with the end of the dry period, are more likely to purchase chemical products on credit and to sell them at lower prices on the market in order to access liquidity to buy food. With a sub-optimal use of fertilizers, insecticides and herbicides, cotton yields are low and thus, farmers often fail to fully repay their loans. This credit default reduces their ability to access inputs for the next crop year and so on.

Cotton growers from the same village can form cooperative societies, under which they collect, grade and weight unginned cotton as well as manage credit and cooperative revenues, and distribute equipment and inputs among themselves. A system of joint liability (also known in French as *caution solidaire*) prevails in the cotton producer cooperative societies (known as SCPCs). If one or more producers are unable to repay their input loans to the CMDT, all the other members have the obligation to step in. In the instance in which the cooperative revenues are not enough to cover the unpaid portion, a deduction from each producer’s CMDT cotton
payment will be made until everything is paid back. The most productive and financially sound cotton growers will be in the very uncomfortable position of repaying other farmers’ debts. Joint liability is causing several disagreements in mismanaged SCPCs where good producers face diminishing profit margins due to other members’ insolvency.

Although the exclusion of insolvent cotton growers from the cooperative seems a priori a solution, tightly networked social relations prevailing in villages prevent it from happening. Peer monitoring, to ensure that borrowers do not exceed their credit limit capability and use fertilizers as expected, is not a common practice inside cooperatives. Peer pressure, exclusionary pressure and forced acquisition of defaulters’ assets are not mechanisms reported as being used by cooperatives to sanction defaulting members. As Paxton et al. (2000) also found, harmony inside villages is often considered more important than high repayment rates.

**Extension Services** - The CMDT, through producer associations, have offered reading and writing lessons to the rural population. With the ongoing reforms, the CMDT has gradually withdrawn from rural and social development activities and consequently, literacy is not a priority anymore. As discussed by Rivoli (2006), literate producers have an advantage over illiterate farmers since they are able to read and understand dosage instruction for chemical products and to analyze the potential impact of new policies. Moreover, under the liberalization and privatization process, the CMDT has refocused its activities mainly toward transformation and marketing of cotton. As a result, the CMDT has provided fewer technical training sessions on soil erosion, organic manure and animal nutrition to farmers. This degradation in extension services might be costly in terms of production and export revenue. For example, the CMDT agents previously provided guidance to farmers on how to adequately feed their draft animals during the dry season, when grazing is scarce. With this training, farmers were able to use their
cattle to plough the land earlier in the season, without compromising their animals’ health. In the absence of this technical support, some farmers now wait for pastures to grow green with the rains before utilizing their cattle for ploughing. This however delays the sowing and compromise production.

4. Model Specification

The choice of explanatory variables to evaluate the impact of institutional factors on cotton production over the last decade is based on previous qualitative (Tefft, 2010; CMDT, 2009; Fok, 2007) and quantitative (Dercon, 1993; Askary and Cummings 1977) studies as well as on fieldwork conducted during the months of May and June 2009 in Mali. During this trip, structured interviews with different stakeholders (e.g., farmers, producers’ union leaders, as well as representatives of the CMDT, banks and NGOs) were conducted in order to get a better understanding of local realities and economic institutions governing the cotton industry. Information collected through interviews provided deep insights into which institutions have shaped the cotton industry and how they might have possibly affected production.

The estimation of price and non-price relevant variables on cotton sector responsiveness is built on a supply model (e.g., Elobeid and Beghin, 2006; Fadiga et al., 2005; Dercon, 1993). The traditional framework consists of modelling supply, in terms of production, yield or acreage, as a function of current/lagged output and input prices. Following Walsh (1944) and Askary and Cummings’ (1977) reasoning, acreage is chosen as the dependent variable since it is less susceptible to exogenous shocks, such as weather conditions, pests and diseases and cultural practices, than production and yield. A production function is also estimated using the same set
of explanatory variables and compared to the acreage regression as a robustness check. This model extends prior research by taking into account regional disparities and institutional factors.

Under this framework, harvested cotton acreage \(A_{r,t}\) and cotton production \(\text{Prod}_{r,t}\) are a function of farm-gate cotton prices \(P_t\), input costs per hectare (including fertilizer, insecticide, herbicide and seed) \(C_t\), and non-price variables that would capture the effect of institutional factors. Specifically, these include delays in farmers’ payment the previous year \(D_{t-1}\), loan repayment rates in the previous year \(\text{RR}_{r,t-1}\), number of agents trained to provide technical assistance and literacy lessons to farmers last year as a proxy for extension services \(ES_{r,t-1}\), a time dummy to capture the effect of the 2000/2001 boycott movement \(B_t\), and a time trend to account for any changes in supply over time. The variable \(\text{DEP}_{r,t}\) denotes the dependant variable, acreage \(A_{r,t}\) or production \(\text{Prod}_{r,t}\) and the subscripts \(r\) and \(t\) represent regions and crop years, respectively.

\[
\text{DEP}_{r,t} = f(P_t, C_t, D_{t-1}, \text{RR}_{r,t-1}, ES_{r,t-1}, B_t, T_{\text{rend}}) \tag{1}
\]

The Nerlovian model, which takes into account price expectation in the estimation of a supply response, is not suitable for this analysis (Nerlove, 1956). Unlike other agricultural markets, where price is determined by the supply and demand equations, farm-gate cotton price is set by the CMDT at the beginning of the planting season. Therefore, farmers make their decision allocation based on a set price and not on their expectation of the anticipated price. Unlike past empirical studies (Baffes, 2009; Baquedano and Sanders, 2008) that evaluated changes in cotton quantity with respect to lagged price, this regression uses the current panterritorial price announced by the CMDT early in the planting season as done by Vitale et al.
Given that the actual price is exogenously fixed by the CMDT, its inclusion in the right-hand-side of the supply equation does not lead to endogeneity.

The constant increase in petroleum price and its derivative products, such as fertilizers used to grow cotton, is considered as a main factor that has contributed to undermining the cotton sector through lower production and productivity (CMDT, 2009). Even though different exogenous factors could influence fertilizer costs and farm-gate cotton prices, they appear to be highly correlated with each other in the context of a small dataset (correlation=76%). As seen in Figure 1, farm-gate cotton prices and input costs per hectare, which are mainly composed of fertilizer costs, have followed a similar trajectory over the last decade.

This highlights the specificity of the institutional pricing arrangement in the Malian cotton sector until recently. Although the price mechanism and call to tender to purchase inputs are being reformed in order to better link the former to the international market and transfer the latter activity to a committee composed of representatives from the ginning companies and the farmers’ organizations, these functions have been traditionally under the parastatal control. Indeed, the CMDT has been prominent in buying and distributing inputs to farmers as well as setting the pan-territorial farm-gate cotton price each year.

The inclusion of both variables in the regression, as suggested by Askary and Cummings (1977), might lead to a collinearity problem. Although no irrefutable test exists to detect the presence of multicollinearity, some elements might serve as warnings. On one hand, the relatively high correlation between the pairs of estimated coefficients for farm-gate cotton prices
and input costs per hectare\(^2\) and the large condition number\(^3\) (K=52) suggest that multicollinearity should be a concern (Williams, 2010, Greene 2003). On the other hand, Cameron and Trivedi (2005) consider that multicollinearity becomes problematic only with a condition number exceeding 100. The point at which collinearity is considered a critical issue is not clear-cut but rather arbitrary.

In the presence of multicollinearity, the inclusion of both variables would generate higher standard errors and lower significance levels which might lead to finding one or more explanatory variable coefficients not statistically significant from zero. Dropping the input costs or farm-gate cotton prices from the regression would allow one to estimate the parameters of the model more precisely, but these parameters are more likely to be biased. Indeed, if the dropped variable truly belongs to the model, then a specification problem arises and all the other estimated coefficients would be biased. In this specific case, the trade-off of some bias for smaller variance is worthwhile since we are more interested in the significance of the estimated institutional parameters than their magnitude per se. Nevertheless, results from all regressions, obtained from including both farm-gate cotton prices and input costs and excluding one or the other, will be reported. Using a consumer price index, nominal farm-gate cotton prices and input costs have been converted into real values using the base year 2000 (IMF, 2007).

\(^2\) The correlations between pairs of estimated coefficients (farm-gate cotton prices and input costs per hectare) are -58% and -63% for the acreage and production regressions respectively.

\(^3\) If two variables are perfectly correlated, then the variance is infinite and the inverse matrix \((X'X)^{-1}\) cannot be computed. The full rank condition is needed to inverse a matrix. In case of high but not perfect correlation, the condition number of the matrix \((X'X)\), which is the square root of the ratio of the largest to smallest eigenvalue of \(X'X\) can be computed. If the matrix \((X'X)\) has a large condition number (value greater than 20), then it is difficult to invert it and thus, multicollinearity is considered problematic. (Greene, 2003)
Given that cotton growers complain about increasing delays in payment over the years, a duration variable has been constructed to capture this effect on cotton supply. Although Dercon (1993) noticed the importance of timely payment, he did not include this non-price variable in his regression, since he assumed that delays of payments to farmers were time-invariant. The number of days passed (D) since the beginning of the planting season, set to May 31, up until the date by which all producers have been paid, is calculated in order to create a numerical value that captures delays in payment. Since we are interested in analyzing how delays in cash receipts for cotton from the previous crop year affects producers’ motivation to grow cotton in the current year, a lagged variable is used.

The rates of past credit repayment (RR) by farmers’ cooperatives are likely to influence their production decisions in two ways. First, cooperatives that struggle to repay their last year loans would have more difficulty in obtaining new ones this year than those with good credit records. As a result, they might incur more difficulty in accessing the inputs necessary to grow cotton. Second, cooperatives with bad credit recovery are more likely to discourage performing farmers from planting since they would have to use their own profit to cover the losses of others because of joint liability. A lagged loan repayment rate variable has been created by taking the ratio of the total amount reimbursed over the total amount payable from the previous year in order to capture cotton growers’ responses to overindebtedness. A value closer to 100 means that credit has been repaid in a timely manner while a value near 0 represents incapacity to pay back loans. Given that the data on hand are disaggregated at the regional level, it is impossible to isolate the impact of credit recovery by cooperatives on their own cotton supply response. Nevertheless, this variable can provide insight about the effect of credit on cotton production and might clarify the effects of joint liability to some extent.
The number of agents trained by the CMDT to teach literacy in cotton producing regions has been added to the number of agents trained to provide technical assistance in order to create a proxy for extension services (ES). Following the CMDT withdrawal from financing and supervising literacy training sessions, the rates of literate people have considerably declined since neither the government nor the NGOs fully stepped up to take care of it. Our proxy variable for extension services is lagged by one period in order to take into account the lapse of time before return to extension services become tangible (Poulton and Tsahirley, 2009).

The dataset regroups information per region allowing for more control over geographical features. Unobservable factors that might vary per regions such as soil quality, topography, proximity to the capital, Bamako, would be controlled for by regional dummies. Given the importance of the farmer boycott, a time dummy variable for the crop year 2000/2001 is included in the regression in order to capture its effect on cotton supply. Even though this time dummy might capture other specificities to the 2000/01 crop year, no other major event was reported. Therefore, this time dummy variable is considered to mainly represent the farmer strike movement. A time trend is also included in all regressions.4

5. Data

Nearly all data related directly to the Malian cotton industry come from CMDT electronic and paper files. This is a rich and unique dataset that contains information on prices, non-price

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4 Acreage and production models using only time dummies were run and only the time dummy for the crop year 2000/01 showed up statistically significant. Then, a joint test was run to see if all the time dummies were all equal to zero. In both cases, the null hypothesis that all time dummy coefficients are jointly equal to zero was not rejected at the 10% level of significance. Therefore, no time fixed effect is needed. However, a time dummy variable to take into account the farmer boycott movement in 2000/01 and a time trend are included in both regressions. In comparison, the null hypothesis that region dummy coefficients were all equal to zero was strongly rejected at the 1% level of significance in both models. Therefore, region fixed effects are needed.
variables at the regional and national level for the period 1998-2008. Table 1 provides a statistic summary of the variables used in the analysis.

Data are disaggregated by the six cotton regions of Mali: Fana, Bougouni, Koutiala, Sikasso, San, and Kita. Cotton historically has been produced in the southern region near the Niger River, also known as the Old Cotton Basin. Each year, 50% to 70% of the nation’s cotton is still grown in the Old Cotton Basin, which includes the whole region of Koutiala, and the northern parts of Fana and Sikasso. Spreading out from the Old Cotton Basin are the regions of Bougouni and San as well as the southern parts of Fana and Sikasso. The region of Kita, on the west side of Mali, which started growing cotton in 1995, is considered to be the New Cotton Basin.

---------------------------------------------------Table 1-----------------------------------------------

6. Empirical Results

Using a balanced panel dataset, this paper estimates cotton grower supply responsiveness to prices and institutional arrangements. The advantage of panel data is that two different kinds of additional information are captured. First, cross-sectional information reflects differences across regions and second, time-series information reveals variations within regions over time. Even though past studies (Elobeid and Beghin, 2006; Dercon, 1993) used an ordinary least square estimator to evaluate their supply function, this regression technique might not be optimal while using panel data, since the estimated coefficient might be subjected to unobservable effects (Cameron and Trivedi, 2005). The fixed effect estimator, which exploits special features of the

5 We are very grateful to the CMDT for giving us the permission to access such a rich and unique dataset.
panel data, is therefore used to estimate the relative effects of price and non-price variables on cotton supply. The specific linear panel regressions for the model are written as,

\[
\text{DEP}_{r,t} = \alpha_r + P'\beta_0 + C'\beta_1 + D'\beta_2 + \text{RR'}_{r,t-1}\beta_3 + \text{ES'}_{r,t-1}\beta_4 + \text{B'}\beta_5 + \text{Trend}\beta_6 + \epsilon_{r,t}
\]

(2)

\( r = 1,...,6, \quad t = 1,...,11, \)

The subscript \( r \) indexes the six cotton regions, \( t \) indexes the crop years from 1998 to 2008 and \( \alpha_r \) represents the unobservable regional effects. Under the fixed effect (FE) estimator, the random variable \( (\alpha_r) \) is assumed to be correlated with the observable explanatory variables. Given that the dataset contains a short time-series (1998-2008), a linear functional form is more suitable in order to save degrees of freedom (Elobeid and Beghin, 2006). Both simple linear and double-log functional forms have been used in previous studies on supply responsiveness. In this paper, a simple linear specification is chosen since the results from the Box-Cox test show that it has a better goodness-of-fit than the double-log.\(^6\)

**Acreage Model** - Table 2 shows results for the FE one-way acreage model corrected for first-order autocorrelation.\(^7\) The first column reports the estimated coefficients from the equation including all explanatory variables, whereas columns 2 and 3 excludes input costs and farm-gate cotton prices, respectively, as a way to solve for potential multicollinearity. The estimated

\(^6\)To compare whether the double-log or linear functional form is the most appropriate, we cannot only compare the two R-squared results, since the total sum of squares (TSS) in a linear dependent variable is different from a logarithmic one. Therefore, the data has to be transformed in order to make the residual sum of squared (RSS) comparable. Then, both models can be compared using the BoxCox test \( \{ \text{BC}=n/2*\log(\text{RSS}_\text{largest}/\text{RSS}_\text{smallest}) \sim \chi^2_1 \} \). If the null hypothesis that both models are similar is rejected, then the model with the lowest RSS is considered to have the best goodness-of-fit. In this case, the linear model is statistically different from the double-log and has the smallest RSS.

\(^7\)The Wooldridge test for autocorrelation in panel data rejects the null hypothesis that there is no first-order autocorrelation at the 5% level of significance for all three specifications. The null hypothesis of homoskedasticity fails to be rejected at the 10% level of significance for all three specifications. Therefore, our FE estimates for the acreage equations have been corrected for first-order autocorrelation only.
parameters for input costs and farm-gate cotton prices are statistically insignificant across all specifications, whereas the magnitude and level of significance of the other parameters remain relatively similar.

------------------------------------Table 2------------------------------------

The estimated coefficient of farm-gate cotton prices is not statistically significant from zero. This insignificance might suggest that farm-gate cotton prices are not one of the main factors influencing farmers’ cotton acreage decisions. In addition to providing a guaranteed income, farmers might continue to devote land to cotton independently of small changes in farm-gate cotton prices in order to keep access to inputs on credit. As mentioned earlier, the input-credit-cotton markets are strongly inter-linked. On one hand, it is very difficult for non-cotton growers to access fertilizers. Given that cereal farmers cannot provide guarantees that they will pay back their loans, financial institutions are more reluctant to lend them money. On the other hand, extending loans to cotton producers is safer since the CMDT commits to buy the entire cotton production at a set price and the credit is directly deducted from the cotton payments made to farmers. Therefore, growing cotton can be seen as an incentive to gain access to inputs on credit. Even though our results suggest that farm-gate cotton prices do not significantly influence the number of hectares devoted to cotton, they do not indicate, at this stage, whether production is impacted by prices. Facing low farm-gate cotton prices, farmers might decide to use their fertilizers, obtained on credit through the CMDT, on their cereal crops. In this case, decline in cotton prices would lead to a reduction in cotton production but not necessarily to less acreage.
The imperfection in the input-credit markets is also more likely to explain the statistical insignificance of the input cost parameter. Indeed, this insignificance should not be directly interpreted as a total farmers’ unresponsiveness to costs but should be put in perspective with their local realities. The input cost per hectare variable can be decomposed into two elements: input costs, mainly fertilizers, and quantity of inputs.

As seen in Figure 2, while input costs have followed an upward trend due mainly to increases in fertilizer costs, the quantity of inputs has been declining. Given the incompleteness of input and credit markets and their links to cotton, farmers appear to be less responsive to changes in input costs than otherwise. However, there is no indication at this stage of whether inputs purchased on credit are truly applied to cotton fields or diverted to cereals. Regressions with production as the dependent variable instead of acreage will provide further insight on this.

The number of days, after the start of the new cropping season set up to May 31, that producers have to wait for being paid influences negatively the acreage of cotton, as expected. The estimated coefficient of delays of payment is statistically significant at the 1% level. One more day of delay reduces land devoted to cotton by about 300 hectares. Our results suggest that date of payment is time-variant and that failure to make timely payment is costly, since it discourages producers from growing cotton.

The estimated repayment rate parameter is positive and significant at the 1% level. Therefore, acreage declines with deterioration in the credit repayment rates of the previous year (worsening of credit record). Higher credit default rates make it harder for farmers to access inputs necessary to start the new cropping season. Moreover, overindebtedness is more likely to
create a disincentive for profitable farmers to keep producing cotton, since their profits would be used to cover other farmers’ losses. Those outcomes are consistent with Brambilla and Porto’s (2007) conclusions and strengthen the argument that input and credit institutions are important determinants of cotton supply.

The insignificance of the estimated parameter measuring technical assistance and literacy does not necessarily mean that extension services are irrelevant to explain cotton supply, but rather suggests that our proxy possibly suffers from a major lack of precision. The time dummy parameter capturing the effect of the farmers protest is statistically significant at the 1% level and is negative, as expected. From the crop year 1999/00 to 2000/01, acreage went down from 442,496 hectares to 211,724 hectares. From this important decline, over 32,000 hectares lost (14%) is assumed to be due to the cotton grower boycott movement.

Production Model - Results from equation (2) using production rather than acreage as the dependent variable are also reported in Table 28. The third column reports the estimated coefficients from the equations including both input costs and farm-gate cotton prices whereas they have been dropped from the fourth and fifth columns, respectively. Unlike the acreage regression, the estimated parameter for input costs is statistically significant with production as dependant variable whereas cotton prices remain insignificant, when both are included in the regression. This might be due to the relatively high correlation between input costs and farm-gate cotton prices. After dropping input costs, as a way to solve for the potential multicollinearity problem, cotton prices turn significant at the 5% level. The magnitude of the other estimated

8 The Wooldridge test for autocorrelation in panel data rejects the null hypothesis that there is no first-order autocorrelation at the 10% level of significance for all three specifications. The null hypothesis of homoskedasticity is rejected at the 10% level of significance for two of the specifications. Therefore, our FE estimates for the production equations have all been corrected for first-order autocorrelation. Specifications 4 and 6 have also been corrected for heterokedasticity.
parameters is very similar across both regressions but they differ in terms of significance level. For instance, both delays in payment and repayment rates have larger standard errors and therefore, they are now statistically significant at the 5% level.

One of the two main differences between the acreage and production regressions regards the farm-gate cotton prices estimate. Indeed, the estimated parameter for cotton prices is statistically significant at the 5% level under the production function after dropping input costs. As predicted by production theory, a reduction in farm-gate cotton prices leads to a drop in cotton supply. This finding also supports our assumption that farmers might not react as strongly to a decline in cotton prices, in terms of acreage, in order to keep access to inputs on credit. One has to keep in mind that access to credit is a major constraint in many developing countries such as Mali. Given that no efficient monitoring is done to ensure that inputs (such as fertilizers, insecticides and herbicides) bought on credit are only used on cotton and not on cereal crops, diversion is more likely to occur in years of low farm-gate cotton prices.

Secondly, the estimated parameter for input costs per hectare is statistically significant under all production regression specifications. However, the magnitude of the coefficient is attenuated and the p-value is larger when the explanatory variable, farm-gate cotton prices, is also included in the model. A priori, the positive sign of the input costs coefficient might seem counterintuitive. However, this positive relationship between input costs and production provides interesting insights on cotton farmers’ realities. Under imperfect markets, it is very difficult for farmers to access inputs on credit for their cereal crops. As a result, some of the inputs obtained through the cotton sector are diverted toward cereal fields. Given that all cotton production is guaranteed to be purchased at a set price after the harvest, cotton is seen as a safer income option than cereals. Indeed, for the quantity of cereals that is not used to ensure food security for the
household but can be sold, there are no guaranteed outlets and prices are highly volatile. One hypothesis is: As input costs go up, farmers might be more likely to divert less (apply more to their cotton fields) in order to strengthen their capability to repay their loans. In case of defaulting, future access to inputs on credit is more likely to be denied. With more inputs applied on cotton and less on cereals, cotton production increases. A future research objective will be to further investigate the decision process of diverting cotton inputs toward other crops, due to institutional constraints in the credit system, and to measure their effects on farmer cotton revenues and household livelihood.

Results for the institutional variables are very similar in terms of size of the estimated coefficients and significance level across all six specifications. Date of payment, credit default rates and boycott movement explain a large part of the variation in cotton acreage and production that occurred over the last decade.

7. Conclusions

This research contributes to the literature by providing new evidence that not only prices, but also institutions, impact farmers’ production decisions. Indeed, statistically significant relationships between key factors measuring institutional effectiveness and cotton farmers supply responses were established. Therefore, failure to take them into account would lead to misspecification of the supply regression, and more importantly to misguided policies.

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9 Models including rainfall and lagged cereal prices as explanatory variables were also run. Given the small dataset and that those variables were insignificant; they have been excluded from the final models in order to save some degrees of freedom. This does not mean that climatic conditions and alternative crop prices are irrelevant but rather the data used do poorly to capture their effects on cotton supply. However, our main findings do not change by including or excluding those variables.
Results suggest that date of payment is time-variant and that timely payment positively influences farmers’ decisions to grow cotton. Moreover, credit default rates significantly impact cotton supply. Good farmer repayment rates from the previous year lead to higher cotton acreage and production the following year. As expected, a large part of the decline in cotton acreage during the crop year 2000/01 is due to the farmers boycott movement, which led to a significant drop in output. Being an imprecise measure, the number of agents trained to teach literacy and to provide technical assistance to farmers, which represent a proxy for extension services, does not significantly impact acreage and production in the tested models.

Given the incompleteness of the inputs-credit markets and their close relationship with the cotton sector, input costs and farm-gate cotton prices do not appear to significantly impact farmers’ acreage decisions. However, cotton production is influenced by input costs and by farm-gate cotton prices. A rise in cotton prices would positively influence production. Results also suggest an increase in input costs would lead to an increase in cotton production. This might be explained by less inputs diversion (from cotton to cereals) occurring when inputs are more expensive in order to ensure better loan repayment and to preserve future access to inputs on credit.

In conclusion, cotton exhibits special characteristics that require a well-functioning institutional system to ensure that a high degree of coordination among the various stakeholders is achieved. Otherwise, cotton performance is severely affected. Effective coordination is required to ensure prompt payment to producers, good extension services, and high credit recovery rates, among others. To be successful, the new institutional arrangements would have to be gradually implemented and to take into account the local realities. Under appropriate
institutional changes, the Malian cotton sector would be able to resume its promise of contributing to poverty eradication in Mali’s rural sector.
References


### Figure 1. Relationships between Input Costs per Hectare, Fertilizer Costs, and Farm-Gate Cotton Prices, 1998/99-2008/09

<table>
<thead>
<tr>
<th>Year</th>
<th>Input Costs (CFA/ha)</th>
<th>Farm-Gate Cotton Prices (CFA/kg)</th>
<th>Fertilizer Costs (CFA/kg)</th>
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<tr>
<td>1998</td>
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Source: Authors, based on CMDT data
Table 1. Summary Statistics, N=66 (Six regions, eleven years of data per region)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Measurement</th>
<th>Units</th>
<th>Mean</th>
<th>Standard Deviation</th>
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Source: Authors, as adapted from CMDT datasets.
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The p-values are in brackets. *** significant at the 1% level, ** significant at the 5% level and * significant at the 10% level. All regressions have been corrected for first-order autocorrelation AR(1). Regressions (4) and (6) have also been corrected for heteroskedasticity.
Figure 2. Relationships between Input Costs per Hectare, Fertilizer Costs per kg, and Input Quantity, 1998/99-2008/09

<table>
<thead>
<tr>
<th>Input Costs (CFA/Ha)</th>
<th>Fertilizer costs, Input Quantity (CFA/kg), (Unit/Ha)</th>
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Source: Authors, based on CMDT data