Export Preferences and Rural incomes in Mozambique

by

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Export Preferences and Rural incomes in Mozambique

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Abstract

This paper has attempted to analyze empirically how changes in export prices impact rural incomes for the case of cotton and tobacco in Mozambique. The nature of agriculture in Mozambique, largely subsistence farming, implies the need for considering incomplete labor markets and non-separability between production and consumption. Therefore, after estimating a multi-output production function, we retrieved shadow wages, and estimated the price elasticity of shadow wages to changes in cotton and tobacco prices. We then simulate the impact of improving farmers share on export unit values. In the case of tobacco, we simulate the impact of increasing this share to 15%, equivalent to an increase in farm prices of 35%. In the case of cotton, we simulate an improvement in the quality of cotton translated into a reduction in the ratio of seed to fiber from 3 to 2.5. The results suggest a clear positive impact. Concretely, farm profits increase 10% as percentage of total revenue in the case of cotton and 15% in the case of tobacco.

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1. Introduction

Unilateral export preferences are very often presented by policy makers as an important tool for fostering developing countries' exports and development. This, in turn, is expected to help reduce poverty. The link to poverty reduction is thought to be particularly strong in the case of unilateral preferences granted to agricultural products and labor intense manufactures. For this reason, the issue of preference erosion, due to multilateral liberalization in preference granting countries, has become one of the main topics of discussion in international trade negotiations.

Despite the importance of the debate, to our knowledge, there has been a gap in the literature analyzing the impact of unilateral preferences on poverty. Do unilateral export preferences in OECD markets foster developing countries' exports? Do exports linked to these preferences have a positive impact on reducing poverty? The purpose of this paper is to contribute to the existing debate by analyzing empirically the impact of unilateral trade preferences via export prices on rural incomes in the context of Mozambique. In order to do so, we choose the two main agricultural exports to preferential markets, cotton and tobacco.

The methodology used here focuses on the price link between unilateral export preferences, export prices and rural incomes. We use the results from Alfieri and Cirera (2007) regarding the transmission of price margins from unilateral preferences for tobacco in order to generate a scenario of farm price change. For the case of cotton, which is currently liberalized in the EU market, and does not enjoy a preference margin, we built a scenarios based on changing the formula used for calculating minimum farm prices in Mozambique. These farm price change scenarios are then used to simulate the impact on rural incomes. The fact that cotton and tobacco are cash crops implies that price changes do not affect consumption directly, through changes in the consumption bundle. For this reason, we focus on the impact on income, defined by farm profits.

An important issue arises when working with rural incomes in Mozambique. Due to high transaction costs and market imperfections, households may not participate in labor markets and wages are not directly observed. This implies that we cannot directly observe the value of labor in production. In order to overcome this problem, we employ a multiple stage methodology that implies the calculation of the shadow wage as the implicit value of family labor. First, we compute a stochastic production function for agricultural output at the household level. This allows us to calculate the shadow wage for each household according to the marginal value product of labor, and the related shadow profits. Then we estimate the export crop price elasticity of shadow wages. This allows us to simulate the impact of different price changes to farm on shadow wages and profits.

The paper is organized as follows. The following section analyzes the link between export preferences, export prices and poverty. Section 3 explains the methodology used. Section 4 describes the data employed in the estimations. Section 5 describes the main results. The last section concludes.

2. The Micro Impact of Export Preferences: Potential Links

Unilateral export preferences imply a tariff differential advantage for benefiting countries. If large enough, the export preference will generate exports from preference receiving countries and divert trade from more efficient sources. At the same time, exports, in the absence of subsidies or distorted prices, should allow domestic producers to sell their production on foreign markets at a higher price than otherwise would have prevailed internally. In the case of unilateral export preferences, this export price should be higher than the international price, since non-preference receiving countries may pay a tariff. Therefore, we may expect that when export activities are concentrated in non-food products, so there is no increase in the domestic price of consumer goods, exports have a positive impact on households.

This positive impact, however, clearly relies on several assumptions. First, it assumes that there is a higher price obtained in the international market and that this is transmitted to the farmer. It is possible; however, that importers or domestic processors have some monopsonistic power that reduces the transmission of the international price to domestic farm prices. Second, it also assumes, that markets work efficiently and factors of production are mobile. It is well-known that some markets in developing countries do not function efficiently. High transport costs can prevent farmers from having access to domestic and international markets. Lack of storage facilities or information asymmetries also impede participation in certain crops. Therefore, it is not clear whether a significant amount of farmers may be able to benefit from export preferences.

From the analysis above, we can establish two potential links between exports and rural incomes. The first link, *export effect*, is whether the availability and size of the tariff preference allows the preference receiving country to export, and generate employment and income in agricultural activities. The question here is whether certain crops or products would have not been exported in the absence of the preference. The mechanism in this case would be that the price wedge introduced to the international tariff by imposing a tariff to third countries is used to cover inefficiencies or higher export costs by the preference beneficiary.

The second link is directly related to the price obtained by the farmer as a result of exporting, the *price effect*. This *price effect* has two main components in the case of unilateral preferences. The first component is related to the fact of having access to the international export price. As suggested above, in the absence of monopsonies along the chain and strong market imperfections, we expect the export unit value to be higher than the world price. The second component is related to the size of the export unit value. In the case of unilateral export preferences, for products where a price margin created by the preference is appropriated by the farmer, there is a direct transfer of income from the granting country to the recipient exporter.

The first link is difficult to analyze empirically, since it requires a large amount of information about the cost structure of firms exporting under MFN treatment and under preferential schemes. Alfieri and Cirera (2007) find that from the 54 main Mozambican exports to the EU, 20 have entered the EU market in some month during the period 2000-2005 paying an MFN rate higher than zero. This may show evidence that Mozambique could export these products without enjoying the preference. Several reasons, such as lack of time for obtaining the relevant certificate of origin, may explain non-used preferences. However, it is difficult to establish whether these exports would be competitive without the preference or whether importers focus on preferential suppliers in order to obtain part of the preference rent. Again, this would require some international cost comparison or competitiveness index. For this reason, we focus on the second link, the price link.

Alfieri and Cirera (2007) carry out a detailed analysis of export prices for Mozambican exports in the EU. They find that exporting through preferential scheme does not necessarily imply a higher price than exporting under MFN. First, this may be related to the market structure between exporters and importers, where some importers are able to exert monopsonistic power and capture a larger proportion of the tariff rent. This may be explained by the fact that price contracts between exporters and importers may be rigid and based on an imperfect competition setting, and therefore insensitive to preference margins. Furthermore, for those products where a price margin is identified, some authors find that a large share of the rent is captured by importers. Olarreaga and Ozden (2005) in the case of AGOA, and Ozden and Sharma (2004) find that importers capture a significant share of the rents created by preferential access.

Alfieri and Cirera (2007) also analyze the degree of price transmission of export unit values to farm prices for the case of tobacco; since cotton has no preference margin. They find a very high transmission of the preference to price margin; a one percent increase in the tariff differential increases the price margin between 3% and 4%. However, the specification shows a very low R^2, and the wrong sign for the market power variable, indicating that preference margins explain very little price margin variation. Thus, the transmission coefficient may not be very robust.

The purpose of this paper is to focus on the *price effect* described above. We concretely ask the question about what would be the impact on rural incomes from changing farm prices. For the case of cotton, we ask the question of what would the impact of increasing quality translated on improving the minimum price established by the government. For the case of tobacco, we simulate a higher share of farmers on export unit values. These scenarios are described in Section 5.5.

The following section describes the methodology employed for the simulations.

3. Methodology

The literature on the impact of trade policy on poverty/income distribution is relatively recent. The links between trade and poverty/income distribution are complex (see McCulloch, Winters and Cirera, 2001). However, in recent years a substantial amount of work has tried to analyze empirically the impact of different trade reform scenarios on poverty (see for example the JEL surveys by McCulloch, McKay and Winters, 2004), and more recently, on the impact on income distribution (Goldberg and Pavnick, 2007). For example, Porto (2006) establishes a methodology using household survey data that allows estimating income and consumption elasticity parameters that can then be used to simulate changes in prices related to trade reform in Argentina. Nicita (2004) uses a similar methodology to analyze the impact of trade reform in Mexico, where the degree of pass-through from border prices to different areas of the country is considered. Krivonos and Olarreaga (2006) use a similar methodology for analyzing the impact of world sugar liberalization on Brazilian sugar farmers.

One important element that needs to be considered when working in the context of Mozambique, is the fact that agriculture is largely based on a large number of small-scale producers. Thus, rural households mainly focus on subsistence production based on manual cultivation, with hardly any use of purchased inputs. In this context, it is difficult to assume, as it is done in most empirical work, the existence of complete labor markets and separability between household supply and demand decisions. De Janvry, Fafchamps and Sadoulet (1991) show the importance of considering shadow prices and wages when dealing with incomplete or missing markets in agriculture. The relevant price in cases where markets are absent or households do not participate is the marginal revenue value, which should equal the shadow price. Some early applications that compute shadow wages when labor markets are incomplete can be found in Jacoby (1993) or Skoufias (1994). To our knowledge, Seshan (2005), who calculates the impact of liberalization of rice in Vietnam on urban and rural households, is the only application that analyzes the impact of trade reform using the shadow wage approach.

We follow Seshan (2005) and assume that labor markets in Mozambique are incomplete. In order to calculate shadow wages, we need to calculate the marginal value product of labor. The marginal product of labor can be derived through a dual approach using a profit or a cost function. However, the dual approach requires information on prices of inputs and output. This information is difficult to find when agriculture production is mainly for subsistence and only a very small fraction of input and output is traded.[2] Prices are not necessarily observed and the use of unit values or district prices may imply large errors due to high price variation. For these reasons, a primal approach is preferred. This implies the calculation of a production function at the household level in order to retrieve the marginal productivity of labor for each household.

The following issues need to be considered when estimating production functions.

Specification

[2] In addition, for the cases of cotton and tobacco, inputs are provided to farmers by concession companies and then deducted from the final price that they receive. Therefore, there is no clear market or prices for agricultural inputs.

Agricultural households tend to produce more than one crop on the same plot, so called inter-cropping. This implies the need to estimate a multi-output production function. Several modeling alternatives are possible when dealing with multi-output functions (see Alvarez and Orea (2004) for an overview of different methodologies applied to fisheries).

First, multiple output functions for each crop could be estimated. However, this implies assuming non-jointness in production, where the marginal cost of producing one product is independent of the production of the other products. In other words, there are no complementarities in production, such as economies of scale. Moreover, estimating separated production functions implies having available information on the use of each input by product.

A second approach is to estimate separate production functions as a system of equations, where every specific output depends on the production of other outputs and inputs are aggregated. In this case, there is no need to assume non-jointness. However, it is assumed independent technologies across outputs.

A more feasible approach is to estimate a multi-output production function. This implies aggregating the output index and inputs use, and estimate the function as a single production function Mundlak (1963).

Aggregation

The estimation of multi-ouput production/frontier functions requires aggregating outputs and inputs in single indexes. Several aggregators and methodologies are possible. Total revenue can be used; however, this is problematic when prices of the same product are different across households. A second possible set of aggregators are multilateral superlative indexes, which are compatible with revenue maximizing behavior (Caves, Christensen and Diewert, 1982). This methodology, for both aggregations assumes separability in inputs and outputs; one can use the input normally used for a specific output in order to increase the production of another output

More recently, two new stochastic approaches have been developed in order to overcome the assumption of separability.[3] The first approach, the distance function approach (Shepard, 1970) is based on the representation of the output level through radial distances. It represents the output possible combinations, given a set of inputs, using a radial measure. It allows the estimation without assuming separability or non-jointness, and it does not require price information for the aggregation. Since the dependent variable, the distance function, is not observable, in order to be estimated it requires normalizing the functional form using a reference product and homogeneity assumptions (Lowell et al., 1994). This approach, however, may lead to the problem of endogeneity of the regressors.

An alternative stochastic approach that avoids the problems suggested above is the stochastic ray production function approach (Lothgren, 1997). This approach implies aggregating output using the Euclidean distance as a measure of output and regressing on a functional form and the *p-1* polar coordinates of each output. This approach does not require assuming separability and non-jointness, as in the distance function approach, and also avoids the potential endogeneity problems of the distance approach.

Functional Form

There is no clear methodology for choosing the functional form of the transforming technology. A translog functional form, when there are enough degrees of freedom for performing the estimation, should be preferred since it is a more flexible form.

[3] We omit non-parametric methods to estimate production frontiers due to the fact, that these methods retrieve ill-behaved slopes, and our objective is marginal product of labor estimates for each household.

Allocative Inefficiency

Barret, Sherlund and Adesina (2005) argue that observed wages for those households that participate in the labor market tend to be different from the marginal value product of labor, due to so-called allocative inefficiency. Households may not allocate labor efficiently due to asymmetric information, management capacity or transaction costs. Therefore, the authors argue that in order to obtain a more realistic price of labor, shadow wages need to be corrected from the estimated degree of allocative inefficiency.

Once the production function is estimated and the shadow wage retrieved, we can compute the likely impact of change in cotton and tobacco prices on farm profits. First, we estimate a reduced for equation for both, shadow wages and agricultural wages, to measure how the prices of family and hired labor changes when cotton and tobacco change. Assuming, that in the short-run pesticide and fertilizer prices are unaffected by changes on crop prices, we then can compute the impact on shadow farm profits. The change in cotton and tobacco prices affect farm profits via the change in revenue, the change in shadow wages and the change in hired labor wages (See section 5 for the detailed analysis).

4. Data

We use the *Trabalho de Inquéritos Agrícolas* (TIA) dataset from the Ministry of Agriculture that surveys small and medium farms. TIA has been conducted in 1996, 2002 and 2005. In the last survey in 2005, around 4,000 households surveyed in 2002 where surveyed again. In total we have 10,781 observations, 3,966 households surveyed in both years, 807 uniquely in 2002, and 1,945 uniquely in 2005.

Agriculture in Mozambique is largely based on subsistence farming. Most of the households produce only food crops, 4,445, and only 1,655 households produce cash crops. Intercropping is the main production process, due to the fact that some inputs are jointly applied. Therefore the relevant estimation procedure should be the estimation of a multi-output production function, instead of separate crop specific production function. In addition, the survey does not provide information on how labor is allocated across products.

Since our main crops of interest are tobacco and cotton, and the production of these crops is very concentrated geographically due to the system of geographical concessions, we estimate separate multi-output production functions for households producing each of these crops. We assume that the production technology for households in these areas is likely to be different to the one used by most households producing only food crops.

We start estimating a production function for an index of agricultural output *Q* for each household *i* in year *t*. The production function depends on a fixed input, land *T*, and a set of variable inputs *V*; formed by family labor (*l*), hired labor (*h*), pesticides *(p)* and fertilizers *(f).*[4]

$$Q_{it} = f(T, V) \qquad (1)$$

The first step in order to estimate the production function is to determine the functional form. We start by estimating a flexible translog production function, however, due to lack of explanatory power of the added interactive terms we reduce the functional form to a simple Cobb-Douglas function.[5] Concretely, we estimate the following function:

$$Q_{it} = T_{it}^{\alpha_k} \prod_{k=1}^{k} V_{it}^{\alpha_k} = T_{it}^{\alpha_k} l_{it}^{\alpha_k} h_{it}^{\alpha_k} p_{it}^{\alpha_k} f_{it}^{\alpha_k} \qquad (2)$$

Taking logarithms and adding an error term for the stochastic estimation, we estimate the following reduce form production function:

[4] Agriculture in Mozambique is mainly performed manually, without the use of tractors or animal traction. Therefore we do not use any proxy of capital factor in the estimation of the production function.
[5] We tried to estimate the production functions adding square and interactive terms. However, when estimating this translog specification, the R^2 would drop or increase marginally, supporting the choice of a more parsimonious functional form.

$$\ln Q_{it} = \alpha_0 + \alpha_1 \ln T_{it}^{k} + \alpha_2 \ln l_{it} + \alpha_3 \ln h_{it} + \alpha_4 \ln p_{it} + \alpha_5 \ln f_{it} + \varepsilon_{it} \qquad (3)$$

The second step in order to estimate the production function is to choose the relevant aggregator for the output index. We first group output production into five main groups of products: food crops, cotton, tobacco, other cash crops and cashew.[6] We then use three different output aggregators in order to compare the results. The main reason to use some sensitivity analysis in the choice of aggregator is the fact that we need a good estimate of the marginal value product of labor in order to determine the shadow wage. Thus, comparing the results from different aggregators will enhance the robustness of the analysis.

The first output index is based on the ray production function approach by Löthgren (1997), briefly described in the previous section (output_ray). As suggested above, this methodology employs an aggregator based on the Euclidian norm of the output vector. Concretely, we represent the aggregate output index as:

$$Q_{it} = \|Q_{it}\| n(\theta) \qquad (4)$$

where $n_j(\theta)$ is a vector of polar coordinates, and

$$\|Q_{it}\| = \sqrt{\sum_{j=1}^{j} q_{ij}^{2}} \qquad (5)$$

$$n_j(\theta) = \cos\theta_j \prod_{j=1}^{j-1} \sin\theta_j \qquad (6)$$

We then can retrieve the polar coordinate angles using (4) and the inverse of (6)

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[6] Food crops include: maize, rice, sorghum, millet, groundnuts, different types of beans, cassava, sweet potato and yam. Other cash crops include: twine, sunflower, sesame, soya, paprika and ginger.

$$\theta_j(Q) = \cos^{-1}\left(\frac{q_{itj}}{\|Q_{it}\|\prod_{j=0}^{j-1}\sin\theta_j}\right) \qquad (7)$$

For the first polar coordinate angle we use *(8)*, and then this allows us to retrieve the other angles recursively using *(7)*. The k-1 polar coordinates are then used as regressors in the production function.

$$\theta_1(Q) = \cos^{-1}\left(\frac{q_{itj}}{\|Q_{it}\|}\right) \qquad (8)$$

For the second output index we use a *standard divisia* index based on using the quantities of each category weighted according to the provincial price indexes in each category (output1). Then, the aggregate price index is constructed weighting provincial prices according to the share of each category in provincial production.

Finally, for the third aggregator we follow Seshan (2005) and use an aggregator based on a constant elasticity of transformation (CET) (Powell and Gruen, 1968) between outputs *σ/(σ-1)* (output_cet). The aggregator is defined by:

$$Q_{ii} = \left(\sum_{j=1}^{j}\delta_{ijt} q_{ijt}^{\sigma}\right)^{1/\sigma} \qquad (9)$$

where $\delta_j = \frac{(p_k q_k)^{1-\sigma} p_k^{\sigma}}{\sum_j (p_j q_j)^{1-\sigma} p_j^{\sigma}}$ and the price index is $P = \left(\sum \delta_j^{-1/(\sigma-1)} P_j^{\sigma/(\sigma-1}\right)^{(\sigma-1)/\sigma}$ (10)

We use a value of *σ* larger than one, to ensure convexity. Concretely we use a value for *σ* of 1.1.

An important element that arises when estimating primary production functions is the issue of endogeneity between variable inputs and the level of output. Households may vary input use according to climate or households shocks. Thus, the level of output may influence the level of these variable inputs. In order to overcome this problem we need to instrument some of the variable inputs.

In the cases of fertilizers and pesticides, we assume that the use of both inputs do not suffer from endogeneity bias.[7] These inputs are normally distributed at the beginning of the season by concessionary companies to farmers, and there is little flexibility, in order to change their use along harvesting.

In the case of labor, both hired and family labor, we try to instrument both variables. As instruments for family labor we use the number of child, male and female adults in the household; total farm size, number of plots, a dummy for whether other type of work in household - self-employment or other –; the value of animals, household head schooling; a dummy for the use of irrigation, a dummy for association membership and a dummy for whether household own a bike. Since the objective is to have a good prediction of family labor, we focus on the part of variance explained rather than the significance of the variables. The instrumental regression has an R^2 around 0.93, which implies a very good quality instrument. On the other hand the different specifications for hired labor show a very low R^2 and therefore very poor quality instruments. For this reason, we prefer not to instrument this variable. Despite risk of simultaneity bias, this seems a better choice than the loss of efficiency arising from using a weak instrument.

As the proxy for land, we use the total area cultivated, and the value of purchased fertilizers and pesticides for the other two variable inputs. The unit of measurement for family labor is person per year; and child and female labor are standardized to an equivalent adult work.

[7] Fertilizer is only used in 4% observations of our cotton sample and 42% of the cotton sample, while pesticides are used in 46% of the cotton sample and 79% of the tobacco sample.

In the case of hired labor, the survey only reports the number of days where workers were used for each task (i.e. seeding, harvesting,..) but we do not know whether the amount of days is equivalent to completing the task, and what percentage of the whole production process is completed. We assume, therefore, that each hired unit completes each task, and that each of the four main tasks has equal weight in the production process. Therefore, the number of hired labor units is divided by four in order to standardize labor for the whole production process. We should expect, however, that due to errors of measurement during this approximation, the units of family and hired labor may be different.

The fact that we estimate the production function in logarithms implies that observations with zero values for hired labor, pesticides or fertilizers would disappear from our sample. In order to avoid this problem, we replace all the zeroes by the minimum observed value for each variable and divide it by 10. This allows us to use all the observations available.

The following section reports the main results of the estimations.

5. Results

5.1 Production function

Table 2 and Table 3 show the results from estimating a production function for cotton and tobacco. We perform two types of estimations. First, we pool all the observations and estimate the three specifications, according to the three output indexes, using a year dummy. We also add to the regression the educational level of the household head in order to capture for managerial and technical ability. Second, we estimate a fixed effects panel using district fixed effects.

For the case of the cotton sample, we observe that all the variables have the expected sign, in both OLS and panel estimation. In the fixed effects panel specifications most of the variables of interest are statistically significant. Only family labor appears to be significant in the case of the output index *output1*, despite the fact that the coefficients estimated appear to be relatively similar across. This is a problem since we want to accurately estimate the marginal productivity of labor. For this reason, in the next section, we prioritize the shadow wage specifications based on statistically significant family labor coefficients; these correspond to the third index *output_cet* for the OLS specification and *output1* for the panel specification.

On the other hand, the coefficient on fertilizer in the cotton specification is marginally significant, indicating very low impact since fertilizer is hardly used in the production of cotton. The positive coefficient in the year dummy in the OLS specifications implies that production in 2005 increased with respect to 2002, indicating some likely efficiency improvements and, especially, better weather conditions. The coefficient on the education variable is also positive and statistically significant, indicating a positive impact of managerial capabilities on production.

Regarding the estimations for tobacco, in Table 3, the results are very similar than for the case of cotton. In this case, however, the coefficient on pesticide is not statistically significant. In addition, our main coefficient of interest, family labor is only statistically significant using the *output ray* aggregator.

5.2 Shadow wages

As suggested above, agriculture in Mozambique is largely based on subsistence production. Incomplete markets, especially labor markets, make it difficult to assume separability between production and consumption. On the contrary, we should expect that household members face difficulties in finding off-farm work and, therefore, focus labor decisions on family production. The fact that most of the members of the households are involved in production and do not participate in the labor market implies that we can not observe wages. Thus, we need to account for the implicit value of family labor, the shadow wage.

The shadow wage is the marginal value product of family labor. In order to calculate it, we need to first look at what share of the total value of output produced in the farm corresponds to family labor; this is the marginal product of labor estimated in the production function. We therefore, multiply the coefficient associated to family labor by the value of production for each household to retrieve shadow wages. Then, we divide total shadow wages by the amount of family labor used in order to calculate the equivalent shadow wage per person per year.

$$w_{it}^{*} = \frac{\alpha_2 P_{it} Q_{it}}{l_{it}} \qquad (11)$$

Table 4 shows descriptive statistics for the shadow wage specifications, based on the previous production function specifications where the family labor coefficient was statistically significant, and using the price and quantity indexes under each methodology. The calculations show very different level of shadow wages according to the different specifications. The preferred specifications show an average wage per person between 146 MT to 345 Mt for cotton, and much higher for tobacco, between 3,783 Mt and 4,150 Mt for tobacco. Since the results are dramatically different according to the specifications used, we recalculate shadow wages using as value of production the total value calculated by multiplying quantities by provincial prices; instead of using price indexes. The results are shown in Table 5. The fact that we use the same total value implies less variance, shadow wages for cotton oscillate between 137 Mt and 148 Mt, and for tobacco from 941 Mt and 1,033 Mt.

We should observe households not participating in the labor market when shadow wages are above observed wages in agriculture. On the other hand, when households participate in the labor market, we should expect shadow and observed wages being very similar. Barrett, Sherlund and Adesina (2006), test for the equality between shadow and observed wages in Cote d'Ivoire. They find systematic differences between both wages, which they label as allocative inefficiency, and conclude that shadow wages should be adjusted for existing allocative inefficiency in order to reflect the true value of family labor.

Ideally we would like to compare the estimated shadow wages with the observed wages for those households that do participate in the labor market. Unfortunately, the TIA survey reports total salaries per household, but does not indicate how many people were involved and for how long. In addition, salaries from hired labor are reported per month and can not be compared to salary per person per year. For this reason, we are forced to use our estimated shadow wage unadjusted for allocative inefficiency as the proxy for the value of family labor.

The next step is to estimate a shadow wage equation that depends on several household characteristics and the prices of the different production groups. We estimate equation *(12)*, where P_{jt} is a vector of prices of cotton (tobacco), food crops and other cash crops; and H_{kit} is a set of household characteristics that may influence wages, such as size, area cultivated, education of household head, use of irrigation, belonging to an agricultural association, animal assets and possession of a radio. We use the price of cotton for the cotton production function and not tobacco prices, and vice-versa, due to the fact that there is no inter-cropping with these two crops. In addition, we estimate two specifications, one using province prices for cotton (tobacco), and another using district prices.

$$w_{it}^{*} = \alpha_0 + \sum_{j=0}^{j} \beta_j P_{jt} + \sum_{k=0}^{k} \gamma_k H_{kit} + u_{it} \qquad (12)$$

The results are summarized in Table 6 and Table 7. We report the estimations for those shadow wages constructed using and statistically significant marginal productivity of labor in the previous section. In addition, we also report two different measures of aggregate value of output. Fist, we estimate the value of output using the price and quantity index that corresponds to the methodology used for calculating the aggregate output index measure (i.e. for the output_cet index, we use equation *(9)* times the price index in *(10)*). The second value measure is calculated by multiplying the quantities produced by each household times the province price. Thus, this second value measure is unique for each household.

In the case of cotton producers, the coefficients vary considerably according to each specification. Using provincial prices, the coefficients associated to cotton prices vary between 0.26 and 1.13; while using district cotton prices, we obtain a positive coefficient between 0.31 and 0.87. This implies that an increase in the price of cotton is translated into higher value of family labor and higher allocation of family labor in own production. We also find positive coefficients associated to food crops prices, while the coefficient associated to other cash crops prices is not statistically significant for most of the specifications. Household size is negatively related to wages, while, the size of the farm, having a radio, membership to an agricultural association and the level of education of the household head are positively related with the shadow wage level.

Regarding shadow wage determinants for tobacco producers, the results are very similar to the ones for cotton. The main coefficient of interest, the shadow wage elasticity to tobacco prices, varies considerably across specifications. The coefficient on provincial tobacco prices is not statistically significant. On the other hand, when using district tobacco prices the coefficients are positive and statistically significant for most specifications, varying between 0.28 and 0.66.

5.3 Hired Wages

We should expect that wages of hired labor may be also affected by any changes in the prices of cotton and tobacco. An increase in the price of the main cash crop should act as an incentive to increase production and the demand for hired labor, with the resultant pressure on agricultural wages.

We apply the same approach used for shadow wages, and estimate a wage equation based on product prices and household characteristics. Table 8 shows the results for both cotton and tobacco producers. Unfortunately, the number of observations does not allow drawing any significant results. We have only 111 households with observed agricultural wages for cotton producers, and 30 for tobacco. The coefficients on cotton and tobacco prices are negative and not statistically significant.[8] For this reason we choose to omit the potential impact of price changes on hired labor wages. Despite this omission, we believe that the impact should be smaller than on family labor, since most households are only employed in family labor and there is very low share of hired labor on production.

5.4 Shadow Profits

Once the impact of price changes on wages is estimated, we need to compute the impact on farm profitability; this is the impact on shadow profits for each household. We can define profits for each household, equation *(13)*, as the difference between the revenue raised from the production of the different products q_i, minus the cost of factors of production, factor prices times fixed and variable factors use.

$$\pi_i(p_i, q_i, T_{ki}, V_{ji}, \delta_{ki}, \gamma_{ji}) = \sum_{i=1}^{i=5} p_i q_i - \sum \delta_{ki} T - \sum \gamma_{ji} V_{ji} \qquad (13)$$

A first approximation to analyze the impact of changes in prices on household profits is by first differencing shadow profits on the price of cotton (tobacco). In the short run, assuming some rigidity in the use of factors of production, we may expect that changes in the price of cotton (tobacco) may impact shadow profits positively via an increase in revenue, at the same time than increasing the costs of family and hired labor (Equation *(14)*). We assume that the cost of pesticides and fertilizers is independent of the price of crops. Thus, as equation *(14)* shows, the impact of an increase in the price of cotton (tobacco), depends on the quantity of cotton (tobacco) produced and the price elasticity of shadow and hired wages.

[8] We try to estimate an agriculture age per capita regression in order to be able to predict agriculture wages for those households without observed wages. The results, however, show a very low R^2 and very low quality of the predictions.

$$\frac{\partial \pi_i}{\partial p_c} dp_c = \left(q_{ic} - \frac{\partial w^s}{\partial p_c} l_i - \frac{\partial w^l}{\partial p_c} h_i \right) dp_c \qquad (14)$$

5.5 Farm prices and export prices

Cotton and Tobacco are exported in Mozambique through concessions companies that perform the collection of the unprocessed crops from farms. These concessions are structured according to geographic locations, and perform very simple processing in the case of cotton, ginning. However, price setting for farmers are done in different ways.

Cotton

In the case of cotton, minimum prices are established by the Institute of Cotton (IAM) according to a formula that splits the international price between farmers and ginning companies (45% for farmers and 55% for ginning companies). Concretely, the international price is adjusted to transport costs, quality differences, inputs supplied to the farmers and a fixed established transformation rate from cotton seed to fiber (1 to 3). Then, the resultant value is split between farmer and ginning company. On exchange for the geographical monopolistic rights, ginning companies are supposed to provide inputs to farmers. Thus, for cotton the differences between export unit values and cotton prices are the result of two processes. First, export unit values depend on the relationship between ginning companies and importers, which sometimes are related companies. Then, the price that cotton farmers receive depends on the formula described above. Any changes in export unit values not reflected in the international price will not be passed on to farmers, and the only way how cotton farmers may increase the price they receive is by increasing the share on the formula or by an increase in the international reference price.

Table 9 and Figure 1 show the evolution of the price of cotton during the period 2000-2005 at the initial steps of the value chain: international price, *cif* export unit value, *fob* export unit value, and farmer prices. Clearly, the variables are highly correlated, and the main difference is the level between farm prices and export unit values. Export unit values and international prices are very similar, especially considering that cotton is subject to an export tax of 2.5%. The difference between unit values and farm prices has been reduced during the period, but still remain substantial. Concretely, the fob export unit value registered by customs in Mozambique is 4.5 times higher than the farm price for fist class and 6.4 for second class. Furthermore, the graph indicates that exporters, more or less, obtain the international price.

In the case of cotton, there are no MFN tariffs in the EU market, and therefore no extra price margins to capture. [9] Thus, for cotton farmers the relevant price change scenario is related to changes in the minimum price formula. Concretely, we define a scenario that implies an improvement in the quality of cotton translated in an increase the transformation rate from 33% to 40%. This rate is based on transformation rates currently being achieved in West Africa. We use the *fob* export unit value and we apply to the 45% share a change of the transformation ratio from a factor of 3 to 2.5. The result is an increase in the minimum price in 2005 from 4,219 to 5,109, an increase of 21%. Despite minimum prices are only indicative of the floor price and many districts have prices above the minimum price, we apply the 21% increase to all cotton prices for the simulation exercise.

Tobacco

In the case of tobacco, prices are set by concession companies and are not subject to government intervention. Table 10 and Figure 2 show the evolution of prices for tobacco. Although unit values and farm prices move together with the international price, it is striking the difference between *fob* and *cif* export unit values, 3.5 times on average for the period 2000-2005. This may be related to errors in customs recording or may indicate some under-invoicing, since transport costs can not be that high. As suggested above, transmission of preference margins seems to be relatively high, especially for tobacco refuse (Alfieri and Cirera, 2007). Thus, this may indicate that concession companies may

[9] Alfieri and Cirera (2007) do not find evidence that preference margins are necessarily translated to price margins.

be capturing a significant part of the price. We, therefore, use as our modeling scenario an increase in the share of tobacco farmers on the *cif* export unit value. Concretely, in 2005, farm prices were on average 10.8% of the *cif* export unit value. We assume an increase of farm prices of 35%, which implies an increase in the *cif* export unit value share to 14.6%.

Results

The results of the simulation suggest, as expected, a significant increase in the level of profits at the farm level. We use 2005 as the base year, and simulate the impact on farm profits for each household using *(14).*

For the case of tobacco, we find that an improvement in the quality of cotton translated into a change in the transformation rate between seed and fiber, improves farm profits substantially. Table 11 shows the average change in profits and average change in profits as percentage of revenue using both, district and province prices. The increase in improved quality is translated into an increase in farm profits around 700 Mt. This is equivalent to an increase in profits as percentage of revenue of between 9.5% and 9.9%.

In the case of tobacco, the simulations also indicate an increase in profits accruing from a better share of farmers in the export price. Concretely, we find that an increase in the share of 14.6% is translated in an increase in benefits of around 4,900 Mt. This is equivalent to around 16% of revenue.

6. Conclusions

This paper has attempted to analyze empirically how changes in export prices impact rural incomes for the case of cotton and tobacco in Mozambique. In a previous paper, Alfieri and Cirera (2007) find that tariff preferences are not necessarily translated in a significant price margin with respect to non-preferential exporters, and other factors may explain price margins. Without the existence of this margin, exporters face the international price, once controlled for quality differentials. For this reason, in this paper we have simulated the impact of improving farmers share on the export unit value. In the case of tobacco, we found large differences between farm prices and export unit values, and as a result we simulated the impact of increasing this share to 15%, equivalent to an increase in farm prices of 35%. In the case of cotton, where minimum prices are set by the IAM, we have simulated an improvement in the quality of cotton translated into a reduction in the ratio of seed to fiber from 3 to 2.5. This is a similar ratio than many other West African countries currently have.

The nature of agriculture in Mozambique, largely subsistence farming, implies the need for considering incomplete labor markets and non-separability between production and consumption. This implies the need for estimating a multi-output production function and the resultant shadow wages as the measure of family labor. After estimating the production function, we retrieved shadow wages, and estimated the price elasticity of shadow wages to changes in cotton (tobacco) prices. This has allowed us to compute the impact of changes in farm prices on farm profits through the impact on revenue and shadow wages.

The results suggest a clear positive impact on farmers, as we should expect. Concretely, farm profits increase 10% as percentage of total revenue in the case of cotton and 15% in the case of tobacco.

These results have clear policy implications. For the case of tobacco, it is important to analyze the reason of such a low share of farmers on export unit values. Whether is due to high transport costs from production to export, or due to the monopsonistic power given by the concession system, policies should be oriented towards increasing farmers share in export unit values. For the case of cotton, we show how an increase in the quality of cotton reaching the current levels in West African countries, would be translated in higher farm income. This implies the need for policies that achieve higher quality in the sector, such as better extension services or the introduction of higher quality varieties.

REFERENCES

Álvarez, A. and L. Orea (2001) “Different Methods of Modeling Multi-Species Fisheries Using a Primal Approach” *Efficiency Series Paper* 4/2001. Permanent Seminar on Efficiency and Productivity. University of Oviedo.

Barrett, Christopher B., Sherlund, Shane M. and Adesina, Akinwumi A., (2006) "Shadow Wages, Allocative Inefficiency, and Labor Supply in Smallholder Agriculture" *Cornell University Applied Economics Working Paper*

Bias, C. and C. Donovan (2003), *Gaps and Opportunities for Agricultural Sector Development in Mozambique,* MINAG Research Report No.54E, Mozambique, April.

Caves, D. W., L. R. Christensen and W. E. Diewert (1982) “Multilateral Comparisons of Output, Input, and Productivity Using Superlative Index Numbers” *The Economic Journal*, Vol. 92, No. 365, pp. 73-86

de Janvry, Alain, Marcel Fafchamps, and Elisabeth Sadoulet. 1991. "Peasant Household Behavior with Missing Markets: Some Paradoxes Explained." *Economic Journal*, 101(409): 1400-17.

Goldberg, P.K. and N. Pavnick (2007) “Distributional Effects of Globalization in Developing Countries” *The Journal of Economic Literature* Vol. 45, No. 1

Jacoby, Hanan G. (1993) “Shadow Wages and Peasant Family Labor Supply: An Econometric Application to the Peruvian Sierra” *The Review of Economic Studies*, Vol. 60, No. 4 (Oct., 1993), pp. 903-921

Krivonos, E. and Olarreaga, M. (2006) "Sugar Prices, Labour Income and Poverty in Brazil" (April 2006). *World Bank Policy Research Working Paper* No. 3874

Lambert, Sylvie, and Thierry Magnac. 1994. "Measurement of Implicit Prices of Family Labour in Agriculture: An Application to Côte d'Ivoire." In Caillavet, Gyomard, and Lifran (eds.) *Agricultural Household Modelling and Family Economics*, Amsterdam: Elsevier.

Lothgren M. (1997) “Generalized stochastic frontier production models” *Economic Letters* Volume 57, Number 3, 19 pp. 255-259(5)

Lovell, C. A. K., S. Richardson, P. Travers and L. Wood (1994). 'Resources and Functionings: A New View of Inequality in Australia', in W. Eichhorn, ed., Models and Measurement of Welfare and Inequality (Springer-Verlag).

McCulloch, Neil, McKay, Andrew, and L. Alan Winters, "Trade Liberalization and Poverty: The Evidence so Far." *Journal of Economic Literature*. 42.1 (March 2004): 72-115.

Mundlak, Y. (1963) "Specification and Estimation of Multiproduct Production Functions" *Journal of Farm Economics*, Vol. 45, No. 2, pp. 433-443

Nicita, A. (2004) "Who Benefited from Trade Liberalization in Mexico? Measuring the Effects on Household Welfare" *World Bank Policy Research Working Paper* No. 3265.

Nicita, A. (2006) "Export Led Growth, Pro-Poor Or Not? Evidence from Madagascar's Textile and Apparel Industry" *World Bank Policy Research Working Paper* No. 3841

Olarreaga, M. and C. Özden. 2005, "AGOA and Apparel: Who Captures the Tariff Rent in the Presence of Preferential Market Access?" *World Economy* 28(1), 63-77.

Özden, C. and Gunjan Sharma. 2004. "Price Effects of Preferential Market Access: the Caribbean Basin initiative and the apparel sector," *World Bank Policy Research Working Paper* 3244.

Porto, G. (2006) "Using Survey Data to Assess the Distributional Effects of Trade Policy", *Journal of International Economics*, 70

Powell, Alan A. and F. H. G. Gruen (1968) "The Constant Elasticity of Transformation Production Frontier and Linear Supply System" *International Economic Review*, Vol. 9, No. 3 (Oct., 1968), pp. 315-328

Seshan, G. (2005) "The Impact of Trade Liberalization on Household Welfare in Vietnam" (March 2005). *World Bank Policy Research Working Paper* No. 3541

Shepard, R. W. (1970) Theory of Cost and Production Functions. Princeton, N.J.: Princeton University. Press

Skoufias, E. (1994) Using shadow wages to estimate labor supply of agricultural households. *American. Journal of Agricultural Econo*mics, 76, 215-227

TABLES AND FIGURES

TABLES

Table 1 Variables Definition

Variable	Definition
Output_ray	An aggregator based on the Euclidian norm of the output vector (Löthgren, 1997)
Outputind1	Standard divisia index based on using the quantities of each category weighted according to the provincial price indexes in each category
CET	Aggregator based on a constant elasticity of transformation (CET) (Powell and Gruen, 1968)
Area	Total area cultivated, and the value of purchased fertilizers and pesticides for the other two variable inputs. The unit of measurement for family labor is person per year; and child and female labor are standardized to an equivalent adult work.
Labor	Family labor unit instrumented. Units are person per year; and child and female labor are standardized to an equivalent adult work.
Hired Labor	Hired labor units
Fertil	Value of purchased fertilizers
Pest	Value of purchased pesticides
hheduc	Level of household education

Table 2 Production function estimates – Cotton

	OLS			Panel – Fixed Effects		
	Output_ray	**Output1**	**Output_cet**	**Output_ray**	**Output1**	**Output_cet**
Area	0.6954***	0.4317***	0.4813***	0.7328***	0.4902***	0.4484***
	[0.0596]	[0.0353]	[0.0386]	[0.0671]	[0.0388]	[0.0425]
Labor	0.1109	0.0397	0.0947*	0.1028	0.0851*	0.0742
	[0.0733]	[0.0446]	[0.0487]	[0.0795]	[0.0469]	[0.0513]
Hired Labor	0.3183***	0.1932***	0.1526***	0.2386***	0.1274***	0.1413***
	[0.0380]	[0.0231]	[0.0253]	[0.0388]	[0.0229]	[0.0250]
Fertil	0.0462*	0.0541***	0.0064	0.0249	0.0221	0.0068
	[0.0256]	[0.0147]	[0.0160]	[0.0266]	[0.0149]	[0.0163]
Pest	0.0084	0.0089	0.0107*	0.0280***	0.0181***	0.0122*
	[0.0094]	[0.0057]	[0.0062]	[0.0105]	[0.0061]	[0.0067]
theta2b	416.0496***			409.0511***		
	[30.5253]			[30.5653]		
theta3b	349.5002			766.5712		
	[1,327.7837]			[1,366.4988]		
theta4b	-163.4876			-602.4458**		
	[227.5602]			[233.7378]		
theta5b	404.6056*			540.3666**		
	[216.1561]			[237.1803]		
hheduc	0.0644***	0.0475***	0.0354***	0.0598***	0.0346***	0.0349***
	[0.0167]	[0.0101]	[0.0110]	[0.0175]	[0.0103]	[0.0113]
year	0.5295***	0.3344***	0.0149			
	[0.0806]	[0.0466]	[0.0509]			
Constant	-1,569.07	7.2733***	5.5536***	-1,736.18	7.6908***	5.6369***
	[2,122.8640]	[0.0950]	[0.1039]	[2,193.5065]	[0.0706]	[0.0772]
Observations	712	712	712	712	712	712
Number Groups				42	42	42
R-squared	0.58	0.44	0.36	0.5	0.37	0.31

Standard errors in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3 Production function estimates – Tobacco

	OLS - Pooled			Panel – Fixed Effects		
	Output_ray	**Output1**	**Output_cet**	**Output_ray**	**Output1**	**Output_cet**
Area	0.5564***	0.3326***	0.3220***	0.6354***	0.3745***	0.3511***
	[0.0848]	[0.0570]	[0.0588]	[0.0944]	[0.0616]	[0.0626]
Labor	0.2196*	0.0502	-0.0004	0.2409*	0.0678	0.014
	[0.1239]	[0.0833]	[0.0860]	[0.1458]	[0.0946]	[0.0962]
Hired Labor	0.5264***	0.3307***	0.2923***	0.4664***	0.2729***	0.2886***
	[0.0595]	[0.0393]	[0.0406]	[0.0634]	[0.0410]	[0.0417]
Fertil	0.0297*	0.0569***	0.0826***	0.0567***	0.0416***	0.0438***
	[0.0155]	[0.0102]	[0.0105]	[0.0215]	[0.0139]	[0.0142]
Pest	0.0112	0.0013	0.0012	0.0079	0.0092	0.0081
	[0.0216]	[0.0143]	[0.0148]	[0.0221]	[0.0144]	[0.0146]
theta2b	849.1343*			947.0800*		
	[453.4002]			[548.8958]		
theta3b	1,058.3877***			1,087.0615***		
	[102.0888]			[123.3179]		
theta4b	664.6547			383.4946		
	[457.7912]			[533.9018]		
theta5b	1,890.1886***			2,976.3068**		
	[664.8275]			[1,386.1280]		
hheduc	0.0511**	0.0224	0.0349**	0.0450*	0.027	0.0340**
	[0.0232]	[0.0155]	[0.0160]	[0.0254]	[0.0166]	[0.0168]
year	0.6804***	0.3039***	0.1173			
	[0.1340]	[0.0878]	[0.0906]			
Constant	-6,997.0530***	7.7596***	5.3389***	-8,459.4511***	8.2522***	5.6372***
	[1,280.6536]	[0.1702]	[0.1757]	[2,329.2693]	[0.1475]	[0.1500]
Observations	396	396	396	396	396	396
Number Groups				60	60	60
R-squared	0.62	0.51	0.51	0.51	0.35	0.34

Standard errors in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4 Summary statistics for shadow wages (price indexes)

Cotton	**Obs**	**Average**	**Std. Dev.**	**Min**	**Max**
Pooled					
shadow (output_ray)	712	437.11	621.26	17.87	6097.92
shadow (outputind1)	712	156.37	222.26	6.39	2181.52
shadow (CET)	712	146.42	168.67	12.20	2589.46
Panel					
shadow (output_ray)	712	405.08	575.74	16.56	5651.08
shadow (outputind1)	712	335.26	476.51	13.71	4677.10
shadow (CET)	712	114.77	132.20	9.56	2029.68

Tobacco	**Obs**	**Average**	**Std. Dev.**	**Min**	**Max**
Pooled					
shadow (output_ray)	396	3783.50	8771.63	18.73	115606.60
shadow (outputind1)	396	865.12	2005.69	4.28	26434.18
Panel					
shadow (output_ray)	396	4150.18	9621.75	20.55	126810.80
shadow (outputind1)	396	1168.52	2709.08	5.79	35704.54
shadow (CET)	396	57.69	107.17	0.94	1338.68

Table 5 Summary statistics for shadow wages (provincial prices)

Cotton	Obs	Average	Std. Dev.	Min	Max
Pooled					
shadow (output_ray)	710	175.6216	245.7639	4.2789	3705.8690
shadow (outputind1)	710	61.4492	85.9917	1.4972	1296.6670
shadow (CET)	710	148.5395	207.8654	3.6191	3134.3980
Panel					
shadow (output_ray)	710	167.8835	234.9353	4.0904	3542.5850
shadow (outputind1)	710	137.4051	192.2840	3.3478	2899.4460
shadow (CET)	710	120.5788	168.7374	2.9378	2544.3880

Tobacco	Obs	Average	Std. Dev.	Min	Max
Pooled					
shadow (output_ray)	396	941.7894	1676.8470	27.1022	18886.9100
shadow (outputind1)	396	215.3461	383.4217	6.1971	4318.6110
Panel					
shadow (output_ray)	396	1033.064	1839.361	29.72878	20717.36
shadow (outputind1)	396	290.8671	517.8861	8.370366	5833.132
shadow (CET)	396	59.99747	106.8249	1.726564	1203.206

Table 6 Shadow wages equations - Cotton

	OLS Output_cet	OLS Output_cet	OLS value	OLS value	Panel Output1	Panel Output1	Panel value	Panel value
ln(pre_prov_cotton)	**0.6689*** **		0.2672**		1.1358***		0.1719	
	[0.0810]		[0.1139]		[0.1323]		[0.1890]	
ln(pre_dist_cotton)		0.3073***		0.4166***		**0.8729*** **		0.6751***
		[0.0597]		[0.0897]		**[0.1652]**		[0.1794]
ln(pre_prov_food crops)	0.5145***	0.4407***	0.4396***	0.0588***	0.3837***	0.4038***	0.5953***	0.0202
	[0.0636]	[0.0641]	[0.0893]	[0.0214]	[0.1234]	[0.1250]	[0.1757]	[0.0878]
ln(pre_prov_cash crops)	0.013	0.0294	0.0566***	-0.7908***	0.0223	-0.0066	0.1756**	-0.6372***
	[0.0141]	[0.0153]	[0.0199]	[0.0693]	[0.0487]	[0.0611]	[0.0695]	[0.0707]
lhhsize	-0.8221***	-0.8143***	-0.7985***	0.5793***	-0.7440***	-0.7334***	-0.6595***	0.5501***
	[0.0467]	[0.0495]	[0.0658]	[0.0547]	[0.0472]	[0.0492]	[0.0673]	[0.0598]
larea	0.4834***	0.5312***	0.5443***	0.1441***	0.4518***	0.4577***	0.5470***	0.1584***
	[0.0363]	[0.0391]	[0.0511]	[0.0449]	[0.0398]	[0.0417]	[0.0566]	[0.0459]
lhheduc	0.1030***	0.0529	0.1456***	-0.001	0.1169***	0.1160***	0.1529***	-0.1546
	[0.0301]	[0.0321]	[0.0423]	[0.1510]	[0.0305]	[0.0319]	[0.0435]	[0.1507]
irrigation	0.0063	-0.0008	0.0376	0.1229	-0.0726	-0.0753	-0.0858	0.1217
	[0.0985]	[0.1065]	[0.1402]	[0.1149]	[0.0979]	[0.1037]	[0.1408]	[0.1120]
hhgender	0.1728**	0.1526	0.1737	0	0.1457*	0.0998	0.1469	0
	[0.0785]	[0.0821]	[0.1103]	[0.0000]	[0.0760]	[0.0780]	[0.1083]	[0.0000]
Animal assets	0	0	0	0.1631**	0.0000**	0	0	0.1254*
	[0.0000]	[0.0000]	[0.0000]	[0.0732]	[0.0000]	[0.0000]	[0.0000]	[0.0722]
radio	0.1637***	0.1774***	0.1559**	0.3198***	0.1314***	0.1389***	0.1281*	0.1288
	[0.0489]	[0.0523]	[0.0688]	[0.1215]	[0.0478]	[0.0503]	[0.0681]	[0.1194]
association	0.2801***	0.3125***	0.3026**	0.1299	0.1639**	0.1756**	0.1108	0.6499***
	[0.0851]	[0.0868]	[0.1197]	[0.0835]	[0.0829]	[0.0831]	[0.1180]	[0.2372]
Constant	3.9151***	4.4779***	4.4265***	4.6378***	3.9849***	4.5329***	4.4406***	3.3023***
	[0.1630]	[0.1386]	[0.2291]	[0.1941]	[0.3230]	[0.4278]	[0.4614]	[0.6144]
Observations	673	621	671	620	673	621	671	620
Districts					36	35	36	35
R-squared	0.48	0.45	0.31	0.3	0.43	0.42	0.23	0.23

Standard errors in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7 Shadow wages equations - Tobacco

	OLS Output_ray	OLS Output_ray	OLS value	OLS value	Panel Output_ray	Panel Output_ray	Panel value	Panel value
ln(pre_prov_cotton)	**0.4194*** **		0.1853		-0.0788		-0.448	
	[0.1260]		[0.1160]		[0.2778]		[0.3239]	
ln(pre_dist_cotton)		**0.2845*** **		0.6607***		0.5226**		-0.7965
		[0.0734]		[0.2201]		[0.2442]		[0.6794]
ln(pre_prov_food crops)	1.4016***	1.6642***	0.5135**	-0.0164	-0.8312	-1.3582**	-0.7303	-0.0123
	[0.2171]	[0.2340]	[0.1998]	[0.0390]	[0.5752]	[0.5770]	[0.6708]	[0.0882]
ln(pre_prov_cash crops)	0.028	0.0625	-0.0323	-0.9453***	0.1103	0.1072	-0.0304	-0.9409***
	[0.0391]	[0.0414]	[0.0360]	[0.1088]	[0.0742]	[0.0749]	[0.0865]	[0.1130]
lhhsize	-0.8757***	-1.0076***	-0.9083***	0.6731***	-0.9066***	-0.9255***	-0.9241***	0.5699***
	[0.1108]	[0.1156]	[0.1019]	[0.0689]	[0.0945]	[0.0960]	[0.1102]	[0.0760]
larea	0.8677***	0.8092***	0.7242***	0.1713***	0.5945***	0.5593***	0.6094***	0.1659***
	[0.0709]	[0.0732]	[0.0652]	[0.0597]	[0.0641]	[0.0646]	[0.0747]	[0.0623]
lhheduc	0.1624**	0.1671***	0.1661***	0.1812	0.1571***	0.1658***	0.1631***	0.185
	[0.0628]	[0.0634]	[0.0578]	[0.1236]	[0.0524]	[0.0529]	[0.0612]	[0.1371]
irrigation	0.137	0.0691	0.2002*	0.4432***	0.1517	0.1568	0.1715	0.4282***
	[0.1311]	[0.1314]	[0.1207]	[0.1530]	[0.1138]	[0.1164]	[0.1327]	[0.1636]
hhgender	0.2495	0.3022*	0.4222***	0	0.2983**	0.3213**	0.4062**	0
	[0.1625]	[0.1626]	[0.1496]	[0.0000]	[0.1374]	[0.1389]	[0.1602]	[0.0000]
Animal assets	0	0	0	0.4370***	0	0	0	0.4027***
	[0.0000]	[0.0000]	[0.0000]	[0.1190]	[0.0000]	[0.0000]	[0.0000]	[0.1301]
radio	0.3678***	0.3753***	0.3806***	0.1437	0.2927***	0.2812**	0.4248***	0.0938
	[0.1208]	[0.1265]	[0.1112]	[0.1290]	[0.1081]	[0.1105]	[0.1260]	[0.1327]
association	0.3835***	0.3064**	0.2023	0.1685**	0.2264**	0.2096*	0.1187	0.2413
	[0.1369]	[0.1371]	[0.1260]	[0.0691]	[0.1120]	[0.1127]	[0.1306]	[0.2875]
Constant	4.8867***	5.3774***		3.5551***	9.1505***	8.6039***	5.1220***	3.8722***
	[0.4342]	[0.4025]	[0.3996]	[0.3787]	[0.9584]	[0.6602]	[1.1176]	[0.7773]
Observations	348	321	348	321	348	321	348	321
Districts					44	30	44	30
R-squared	0.54	0.55	0.45	0.46	0.42	0.42	0.35	0.35

Standard errors in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 8 Agriculture wage equations

	Cotton				Tobacco	
	OLS		Panel - FE		OLS	OLS
ln(pre_prov_cotton)	0.0601		-1.2453		-2.5326	
	[0.9864]		[2.2396]		[2.6399]	
ln(pre_dist_cotton)		-0.1109		-0.6082		-0.5071
		[0.4601]		[2.1943]		[0.3491]
ln(pre_prov_food crops)	0.3065	0.258	1.5186	1.7322	0.7478	-1.0101
	[0.2746]	[0.2768]	[1.2464]	[1.4294]	[1.6850]	[0.9158]
ln(pre_prov_cash crops)	0.0997	0.0768	0.8906*	0.6878	0.0184	-0.2037
	[0.0725]	[0.0759]	[0.5225]	[0.6282]	[0.3267]	[0.1640]
lhhsize	-0.0565	-0.1049	-0.2594	-0.2559	-0.4813	0.4766
	[0.3076]	[0.3101]	[0.3270]	[0.3385]	[1.0496]	[0.6296]
larea	0.2892	0.2594	0.0071	0.0225	0.9021	0.7397*
	[0.2532]	[0.2379]	[0.3089]	[0.3188]	[0.7527]	[0.3870]
lhheduc	0.2023	0.1625	0.1116	0.108	-0.3849	0.2381
	[0.1751]	[0.1769]	[0.1885]	[0.1953]	[0.5754]	[0.3419]
irrigation	0.2353	0.2027	0.6387	0.622	-1.7034	-0.5682
	[0.5498]	[0.5399]	[0.5918]	[0.6077]	[1.1751]	[0.6228]
hhgender	-0.5689	-0.5469	-0.2458	-0.2511	-0.3272	-1.0479
	[0.4109]	[0.4058]	[0.4238]	[0.4311]	[1.1443]	[0.8454]
Animal assets	0.0005	0.0009	0.0004	-0.0003	0	0.0009
	[0.0005]	[0.0006]	[0.0006]	[0.0011]	[0.0012]	[0.0006]
radio	0.3963	0.3948	0.2781	0.2864	-0.1368	-0.0357
	[0.2721]	[0.2698]	[0.2819]	[0.2893]	[1.2551]	[0.6472]
association	0.1057	0.0987	0.0336	0.0261	1.2788	-0.2745
	[0.5369]	[0.5318]	[0.5262]	[0.5373]	[1.3088]	[0.7338]
Constant	4.6662***	5.0400***	8.8111*	7.1646	9.5922*	5.2682***
	[1.6441]	[0.9146]	[4.8025]	[5.3539]	[4.8995]	[1.3021]
Observations	114	111	114	111	30	19
Districts			24	24		
R-squared	0.11	0.1	0.12	0.09	0.21	0.69

Standard errors in brackets.* significant at 10%; ** significant at 5%; *** significant at 1%

Table 9 Cotton prices (USD/kg)

year	Unit value EUROSTAT cif[a]	Unit value Customs fob[b]	INDEX "A" US$/kg[c]	TIA[d]	IAM (First)[e]	IAM (second)[f]
2,000	1.1747	0.9245	1.3032		0.1472	0.1236
2,001	1.1885	0.8402	1.0573		0.1166	0.0907
2,002	0.9204	0.6354	1.0173	0.1206	0.1259	0.0923
2,003	1.1878	0.8728	1.3956	0.1408	0.1594	0.1259
2,004	1.3954	1.1199	1.3634		0.2520	0.1764
2,005	1.1051	0.8807	1.2143	0.1966	0.1966	0.1376

[a] cif export unit value in the EU, [b] fob export unit value registered in customs in Mozambique, [c] international reference price for cotton price formula, [d] TIA national average, [e] IAM established minimum farmer price first class cotton and [f] IAM established minimum farmer price second class cotton

Table 10 Tobacco prices (USD/kg)

	uv EUROSTAT cif	US IMP uv	UV1 Customs fob	TIA
2000	2.9316	2.9762	0.6333	
2001	2.9437	3.0037	0.8233	
2002	3.1452	2.7445	0.9243	0.3137
2003	3.4537	2.6461	0.8474	
2004	3.1619	2.7409	1.1525	
2005	3.4863	2.7808	1.1361	0.3768

Table 11 Simulation results - Cotton

	Obs	**Mean**	**Std. Dev.**	**Min**	**Max**
Profit change (province prices)	406	680.62	1435.07	0	15577.46
Profit change (district prices)	403	713.33	1656.96	8.30	20239.85
Profit change as % of revenue (province prices)	406	0.095	0.06	0	0.21
Profit change as % of revenue (district prices)	403	0.099	0.06	0.005	0.32

Table 12 Simulation results - Tobacco

	Obs	Mean	Std. Dev.	Min	Max
Profit change (province prices)	219	4820.10	15963.64	0	154738.70
Profit change (district prices)	207	4935.73	17232.41	0.10	157722.20
Profit change as % of revenue (province prices)	219	0.159	0.10	0	0.35
Profit change as % of revenue (district prices)	207	0.158	0.11	0	0.61

FIGURES

Figure 1 Cotton prices (USD/kg)

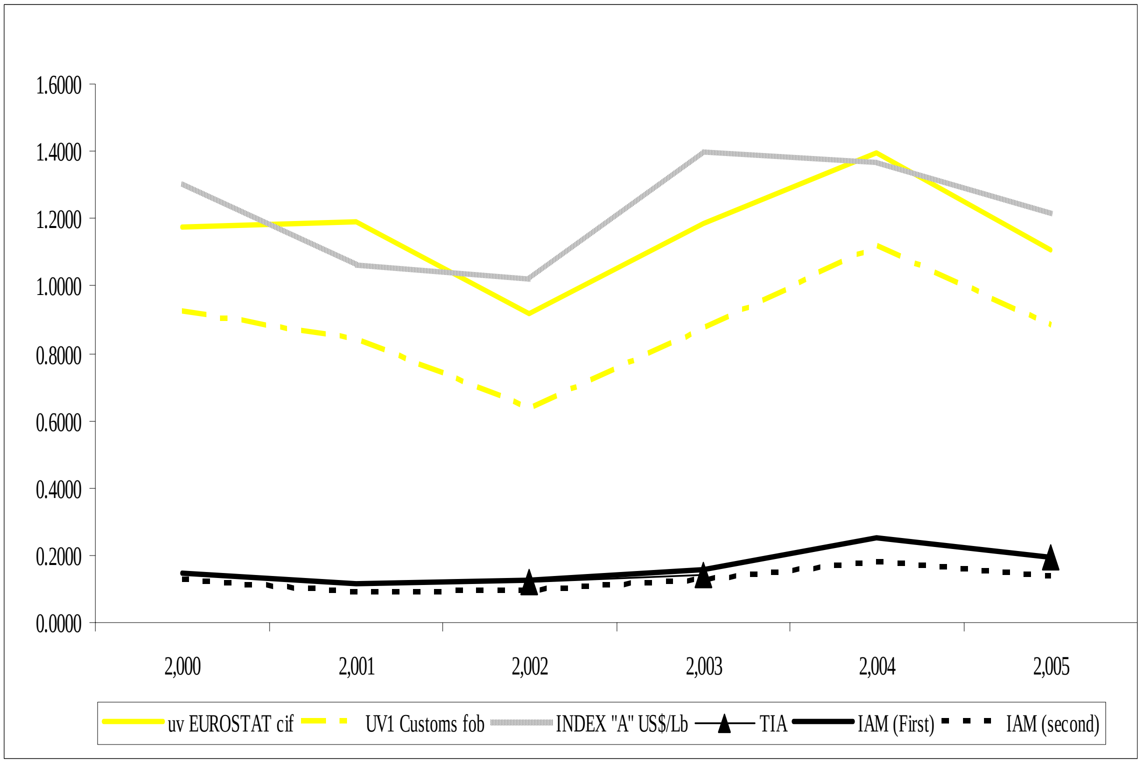

Figure 2 Tobacco prices (USD/kg)