Sowing the Seeds of Hunger. When Agriculture Fails to Deliver its Pro-Poor Promise, Paraguay 2001 - 2017

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Abstract:

Over the last decade the economic literature has produced a wealth of evidence that demonstrates that agricultural sectoral growth is not only good for poverty reduction, but in most contexts, it has a larger poverty reducing effect than growth in other sectors. This evidence comes from countries where agriculture represents a large share of GDP like Ethiopia, but also in high middle-income countries, like Chile, where agriculture contributes a minor share of national GDP. Agriculture expansion has a strong pro-poor impact, because it usually benefits the incomes of poor farmers, it generally reduces the price of food, and raises the salaries of unskilled labor, which can even benefit poor urban dwellers as well. However, when agricultural growth, like in the case of Paraguay is based in an extremely land and capital-intensive sector, like soy, a non-staple food commodity, with little downstream processing value-added, can agricultural growth still be pro-poor? In the following we show, that in Paraguay agricultural growth has had surprisingly a *positive* effect on poverty, and that this anti-poor effect of agricultural expansion is explained by the astounding expansion of the soy industry which has substituted other traditional crops. We also show that this surprising effect of increasing poverty is due to the effect of crowding-out employment that soy expansion has.

Keywords: Paraguay, poverty, agriculture, pro-poor growth.

JEL Codes: I32, Q10, J43

1. Introduction

Over the last couple of decades, the economic literature has produced a wealth of evidence that demonstrates that agricultural sectoral growth is not only good for poverty reduction, but in most contexts, it has a larger poverty reducing effect than growth in other sectors. This evidence comes from countries where agriculture represents a large share of GDP like Ethiopia, but also in high middle-income countries, like Chile, where agriculture contributes a minor share of national GDP. This evidence is recapped in the World Development Report of 2008 (Byerlee et al., 2008). Although, agriculture's contribution to growth declines with development as the sector relatively declines in terms of GDP, agriculture continues to have a strong poverty reducing effect. In agriculture-based (poorer) countries, agriculture contributes both to growth and poverty reduction directly given the relative size of the primary sector both in GDP and employment. In transforming countries, agriculture's contribution to GDP is lower, and in rural areas, the rural non-farm economy is increasingly important. Agriculture is still a key sector for poverty reduction in these countries because most poor are still in rural areas, and agriculture decrease poverty directly and by promoting the non-farm economy. Finally, in urbanized countries, even when agriculture is relatively smaller, and even when most poor are located in urban areas, agriculture still is a key sector for poverty reduction. In these countries, agriculture continues to play an outsized role in terms of national employment, and particularly in the employment of the unskilled, among whom poverty rates tend to be highest. Agricultural growth increases demand for unskilled labor that impacts the wages of the unskilled even in the urban areas of urbanized countries.

This is the shared understanding about the poverty potential of agriculture in developing countries at different stages of the agricultural transition. In this paper we test this argument in extreme conditions by examining if agricultural expansion has been pro-poor in Paraguay. This country has followed a particularly extreme version of agricultural growth during the 21st century. Agricultural growth in Paraguay has been driven by the expansion of modern soy farms, with technology and owners crossing the rivers from Brazil and Argentina. These soy farms are extremely capital intensive, compared to traditional Paraguayan farming, and this capital intensity has promoted farm consolidation, and more importantly, regarding their poverty impact, generated very little employment. If soy farms expanded into new agricultural land, they would still have a small but positive employment impact. But if soy farms expand by displacing other crops, there is little doubt that they are crowding-out employment and contributing to a negative impact on employment. On the other hand, soy and soy products have become one of the main exports of Paraguay, between 25-35% of value of exports during the last decade. The sector is so large that its good and bad year effects are felt in the capital Asunción through its macroeconomic impact. This large impact on national income must surely have a poverty reducing effect. Therefore, the question if Paraguay's notable expansion of the Brazilian and Argentinean soy farming model has had a negative or positive impact on poverty is ultimately an empirical question. An important question to better understand the effects of agriculture on poverty reduction, and a question we tackle in this paper.

The following section examines the evidence in the literature of the role of agricultural growth in poverty reduction. This is followed by a small section describing the recent developments in the Paraguayan agricultural sector to describe the context. Next, we show using national data that agriculture expansion has *increased* poverty in Paraguay, followed by a section that uses regional data to demonstrate, that is not agriculture per se, but the soy industry expansion that has been poverty increasing. Then we explore the hypothesis that the soy industry has been having a measurable negative impact on employment, followed by some concluding remarks.

2. The Evidence

By definition, as national income grows poverty will be reduced (barring some extremely perverse distributional effect). However, is it the same if income growth is derived from a particular industry? Does income growth promoted by agricultural productivity have the same impact on poverty reduction than income growth from expansion in manufactures? The answer to this question has occupied the development literature since the 1990's, and has promoted a renewed interest in the promotion of agriculture among development experts and policymakers.

There is strong international evidence that the composition of growth matters, that agriculture has a stronger effect than other sectors of the economy in alleviating poverty, and even in cases where it lags behind the services industry, it has a strong poverty alleviating effects that outweighs its relative size in the economy. López, (2002) provides a structured summary of the ways in which agricultural expansion promotes poverty reduction. Firstly, agricultural expansion increases incomes of farm households, many of which are poor in developing countries, and most importantly, countries at early stages of development have a large proportion of households that derive wellbeing from agriculture. Also, agriculture is usually one of the main employers of unskilled labor, among which poverty rates are higher. Therefore, agricultural expansion promotes an increase in the demand of unskilled labor that is accompanied with higher employment and wages for the unskilled, which has a strong poverty alleviating effect particularly in countries with developed and integrated labor markets. Finally, as was highlighted by early development economists (Lewis, 1954; Prebisch, 1949) agricultural expansion reduces food prices, which is particularly important to reduce urban poverty. Additionally, there is a macro feedback effect that contributes to poverty reduction. Given that agriculture is intertwined with the rest of the economy through forward and backward linkages, agriculture expansion promotes the growth of the non-agricultural economy, and thus further enhancing its poverty alleviating effect. Empirical studies show that this feedback effects are not symmetric, agricultural growth has a larger effect on non-agricultural growth than the opposite (see Bravo-Ortega and Lederman, 2005; Valdés and Foster, 2010), which further explains the higher poverty alleviating effect of agriculture vis-à-vis other sectors of the economy.

Studies that review the cross-country evidence have shown consistently that agricultural growth not only reduces poverty, but that it has a larger effect on poverty alleviation than the rests of the economy. Both (Christiaensen et al., 2011) and (Imai et al., 2017) examine the effect of agriculture income and income growth on poverty and poverty alleviation. Both studies conclude that the agricultural sector has a stronger effect than the non-agricultural sector in reducing poverty. (Loayza and Raddatz, 2010) arrives to a similar conclusion, but shows that the poverty alleviating effect from agriculture is mostly derived from its labor intensity, and that other sectors with high unskilled labor intensity like construction also have a strong poverty alleviating effect. Other authors have studied the effect of the composition of income growth on the per capita consumption of different quintiles. De Janvry and Sadoulet, (2009) show that on average agricultural growth has a large impact increasing the per capita consumption of the lower quintiles, while non-agricultural growth has an insignificant effect on the consumption of those same quintiles. These estimates where improved in (Ligon and Sadoulet, 2018) with the use of instrumental variables reenforcing previous conclusions, agricultural growth has an impact 4 times stronger (compared to non-agricultural growth) in increasing the consumption of the lower four deciles of the consumption distribution. Ivanic and Martin, (2018) provides further insight, as they do a cross-country study, but the impacts of sectoral growth are studied country by country. This analysis shows that although agricultural growth has a stronger effect on poverty alleviation than growth of the rest of the economy, the gap in these effects closes with the level of development of the country.

In the literature, country case studies that have studied the effect of agriculture in reducing poverty have analyzed the different effects identified by (López, 2002). For example, farm household income is crucial for the high effect of agricultural growth on poverty in Côte D'Ivoire, (Kakwani, 1993). The impact of food price in reducing poverty has been highlighted in Madagascar (Minten and Barrett, 2008) and in China (Fan et al., 2003). Also, the effect of agriculture on unskilled wages and employment as trigger of poverty reduction has been highlighted in India (Datt and Ravallion, 1998) and in Chile (Anríquez and López, 2007).

In contrast to the cross-country studies, where there is unanimity that agriculture has a stronger poverty reducing effect than the non-agricultural sector, the country case studies have found mixed results. Although agricultural growth is found to always have a significant poverty reducing effect, in some countries the services sector displays a stronger poverty reducing effect. Agriculture has been found to be the sector with the largest poverty alleviating effects in China (Montalvo and Ravallion, 2010; Ravallion and Chen, 2007), Indonesia (Suryahadi et al., 2009; Tambunan, 2009), and Congo (Yango and Mukoko, 2016). However, both in India (Ravallion and Datt, 1996) and in Brazil (Ferreira et al., 2010) studies have found that the services sector has a stronger poverty reducing effect than agriculture, the latter being still significant nonetheless. Also, (Dorosh and Thurlow, 2016) provide an analysis of sectoral growth on poverty in five African countries (Malawi, Mozambique, Tanzania, Uganda, and

Zambia). The authors find that in all countries, agriculture has a strong poverty alleviating effect, but in three of those countries, (Tanzania, Uganda, and Zambia) manufacturing and trade have equivalently large effects.

However, a few authors have come to question the poverty reducing impact of agriculture, particularly when they examine different types of agricultural growth. For example, (Pauw and Thurlow, 2011) examine the case of Tanzania, where growth had translated to negligible poverty reduction. The authors conclude that this was due to both, questionable accounting, and the source of agricultural growth, based in export crops instead of maize-staple growth which has a stronger poverty reducing effect. Similarly, (Santika et al., 2019) study the case of oil palm expansion in the Indonesian Borneo, and conclude that the expansion of the oil palm industry has had on average a neutral effect on wellbeing. However, oil palm growth benefited communities that were already linked to markets, while it decreased wellbeing of subsistence communities that originally had less access to markets. Our research contributes to this smaller strand of the literature that finds that not all types of agricultural expansion are poverty alleviating.

3. Agriculture in Paraguay

The first two decades of the 21st century have seen important social progress in Paraguay. The national economy started growing faster, 3.5% annual rate (average for 2000-19), compared to the 1990s (average 2.4% for 1990-2000), and this faster growth translated into a notable reduction of poverty. In fact, the national poverty rate was halved from 45% to 23% during these first two decades. As Figure 1 shows, during the period 2000-19, GDP roughly doubled, and this growth was driven in part by an even larger expansion of agriculture, as agricultural value-added was roughly tripled over the same period.

Paraguay's agriculture underwent a large transformation starting in the late 1990s. A model of extensive soy farming was imported from Brazil and Argentina into Paraguay. In the 1980s the main agricultural export was cotton, while soy products captured about 13 of exports. As the figure shows during the 21st century, area under soy as well as soy production grew faster than agricultural value added. Also, the figure shows that area under soy grew faster than agricultural land, which means there was conversion of agricultural land into soy production. The model of extensive soy farming is extremely capital intensive, with strong scale economies and with little labor requirements. This agricultural transformation had consequences. First, land concentration promoted an increase in farmland GINI, which were already high, into levels above 0.9, (World Bank, 2010). Furthermore, the expansion of a sector with little labor demand, translated into negligible growth of unskilled labor demand, so much so that the proportion of the unskilled in agriculture actually dropped in the period 2003-2013, (World Bank, 2014). Also, the expansion of soy farming has even caused the displacement of rural population, particularly in some oriental areas of the country, (Valdés et al., 2011).

Despite of the transformation of the productive backbone of Paraguayan agriculture, the sector still employs roughly 1/3 of the workers of the country, and accounts for about 60% of total exports of a small and landlocked country that is constrained for foreign exchange. Furthermore, having performed better than the national economy during the period, it is expected that it made an important contribution to the poverty alleviation observed during the first two decades of the century.

4. The contribution of agriculture to poverty reduction: The aggregate evidence

One way to assess the contribution of GDP growth to poverty reduction would be to run a regression of the log of Poverty against the log of GDP. However, if one would like to assess the hypothesis that sectoral composition of that GDP growth matters, one can estimate the following econometric specification using time series data:

$$\ln\left(P_t\right) = \alpha + \delta_{AG}\ln\left(Y_{AG,t}\right) + \delta_{IND}\ln\left(Y_{IND,t}\right) + \delta_{SS}\ln\left(Y_{SS,t}\right) + \gamma t + \varepsilon_t \qquad (1)$$

Here GDP is decomposed, following the literature, by sector as the sum of value added from the primary sector ($Y_{AG,t}$), secondary sector ($Y_{IND,t}$), and the tertiary sector ($Y_{SS,t}$), additionally, α is a constant, γ a parameter that measures the trend in poverty, and ε_t a mean zero *iid* error. If the hypothesis that the structure of GDP expansion matters for poverty alleviation, one would expect to find statistical differences in the δ_i's.

Although specification (1) can be estimated, the literature has followed the suggestion by (Ravallion and Datt, 1996). The authors note that the change in log of GDP, i.e. growth, can be approximated by:

$$\Delta \ln (Y_t) \approx \frac{\Delta(Y_t)}{Y_{t-1}} = \frac{Y_{AG,t-1}}{Y_{t-1}}\frac{\Delta Y_{AG,t}}{Y_{AG,t-1}} + \frac{Y_{IND,t-1}}{Y_{t-1}}\frac{\Delta Y_{IND,t}}{Y_{IND,t-1}} + \frac{Y_{SS,t-1}}{Y_{t-1}}\frac{\Delta Y_{SS,t}}{Y_{SS,t-1}}.$$

Thus, taking a first difference in (1), we can express the same relationship as:

$$\Delta \ln (P_t) = \gamma + \beta_{AG}\, s_{AG,t-1}\Delta \ln \left(Y_{AG,t}\right) + \beta_{IND} s_{IND,t-1}\Delta \ln \left(Y_{IND,t}\right) + \beta_{SS} s_{SS,t-1}\Delta \ln \left(Y_{SS,t}\right) + \epsilon_t \qquad (2)$$

In this specification, $s_{i,t-1} \equiv Y_{i,t-1}/Y_{t-1}$, for $i = AG, IND, SS$ is the share of GDP derived from each sector; due to the first difference, γ is now a constant, and $\epsilon_t = \varepsilon_t - \varepsilon_{t-1}$ is the new estimation error. Notice that in general $\delta_i \neq \beta_i$. However, if we make the simplifying assumption that aggregate GDP is the weighted geometric mean of sectoral output $Y_t \equiv [(Y_{AG})^{s_{AG}}(Y_{IND})^{s_{IND}}(Y_{SS})^{s_{SS}}]$, then it is easy to show that $\frac{\delta_i}{s_i} = \beta_i$. In principle, both specifications may be used, however the second formulation is preferred mainly for two advantages: specification (2) does not assume that the poverty to GDP elasticities are constant to changing composition of GDP (or in other words, does not assume that s_i's are constant), and taking differences avoids any problem associated to unit roots in the time series.

Table 1 shows the results of estimating specifications (1) and (2) for poverty headcount (FGT(0)) and the poverty gap (FGT(1)). First, we note that both specifications deliver very similar results, statistical tests for $\hat{\beta}_i = \frac{\hat{\delta}_i}{\bar{s}_i}$, and the trend in specification (1) being equal to the constant in specification (2) are all not significant, both individually and tested collectively as four restrictions. In fact, no Wald test for individual coefficients has a *t*-statistic higher than |0.7|. The magnitude of the coefficients in Table 1, however, delivers a remarkable result. Despite the imprecision imposed by the limited number of degrees of freedom, we observe that growth in agricultural output *increases* poverty, both the poverty headcount and the poverty gap. This is a surprising result, similar analysis in country case studies available in the literature have shown that sometimes agriculture does not have a significant poverty reducing impact (for example in Brazil, (Ferreira et al., 2010)), but the literature has not shown a significant poverty increasing effect. This unexpected result should raise suspicions, and the remainder of this paper will explore from different angles and methodologies its validity. With respect to industry and services sectors, the table shows that the expansion of the services industry has a stronger effect in reducing poverty (headcount), which is consistent with the employment analysis offered in (World Bank, 2017, 2010). The services sector is the sector with both the highest net employment growth, and labor productivity growth. In terms of the poverty gap (FGT(1)), the equation in differences (column (4)) does not identify a significant impact of services and industry in reducing poverty, a result likely driven by the lack of sample size, as coefficient *p*-values are at the outer border of standard significance levels. Taken at their face value, coefficients suggests that in terms of poverty gap the industry sector has a larger poverty reducing effect, suggesting better targeting of industry jobs among the poorer.

To better understand the positive coefficient of agricultural value added on poverty, we replicate specifications (1) and (2) using rural and urban poverty in Table 2. The table shows that agriculture does not have an impact reducing rural poverty, as the coefficients that accompany agricultural value added are insignificant both in terms of magnitude and statistical significance. However, agriculture does have a positive and significant effect on urban poverty. Therefore, the effect of the agricultural sector increasing national poverty is due to its impact in increasing urban and not rural poverty. This is a surprising result that we will further investigate but is consistent with the agricultural sector expansion displacing rural poor into urban areas. The table also shows that the industrial sector has an impact reducing rural poverty, while the services sector has a very strong impact in reducing urban poverty.

5. Understanding the anti-poor effect of the agricultural sector using regional variability

To further investigate this surprising result that the agricultural sector increases poverty, we will exploit regional variability (in the case of Paraguay departments) in addition to the time variation. We need to make a trade-off here, we are gaining an important amount of degrees of freedom by using departmental variation, however, Paraguay does not have regional-level national accounts. In the case of agriculture, reasonable agricultural output indices can be constructed with raw data from the Ministry of Agriculture, but in the case of non-agricultural output, in absence of a better regional output indicator we will use a proxy of non-agricultural output which is mean regional non-agricultural household income. This indicator is constructed using Paraguay's household survey (Encuesta Permanente de Hogares Continua), and includes all labor income from non-primary sectors and returns to assets, deflated to cancel inflation.

Without national accounts it is difficult to ascertain the true regional contribution of different sectors to department income ($s_{i,t}$ in specification (2)). Therefore, we continue our regional study of poverty and sectoral output using specification (1), but we will use different approaches that panel-data econometrics offers to deal with spatial (regional) and serial (temporal) correlation. A first approach is to estimate model (1) using the-fixed effects panel data model:

$$\ln\left(P_{i,t}\right) = \alpha_i + \delta_{AG} \ln\left(Y_{AG,i,t}\right) + \delta_{NAG} \ln\left(Y_{NAG,i,t}\right) + \gamma t + \varepsilon_{i,t} \, . \tag{3}$$

The index (i) indicates departments. Paraguay's administrative division consists of 18 departments, but given the representativity of the household survey used to measure poverty (and other indicators in this study) departments are grouped and reduced to 7 different departments (or agglomeration of smaller departments)[1]. In this model, α_i indicates the estimated department-level fixed-effect, and the error is assumed to be *iid* with $E\left[\varepsilon_{i,t}\right] = 0$, and with $E\left[{\varepsilon_{i,t}}^2\right] = \sigma_\varepsilon^2$. The standard fixed effects model assumes no serial correlation $E\left[\varepsilon_{i,t} \cdot \varepsilon_{i,t-s}\right] = 0 \; \forall \, s > 0$, and no groupwise (in this case regional) correlation $E\left[\varepsilon_{i,t} \cdot \varepsilon_{j,t}\right] = 0$ $\forall \, i \neq j$. However, we believe neither assumption holds in this model, because the use of yearly data most likely introduces serial autocorrelation, and given that these regional economies are intertwined, we do expect spatial correlation. To deal with both, we estimate the fixed-effects model using the covariance matrix proposed by (Driscoll and Kraay, 1998). This is a covariance matrix consistent with both serial and spatial correlation and can be understood as an extension to the Newey-West heteroskedasticity and serial autocorrelation consistent covariance matrix.

Another way to deal with possible serial autocorrelation, given that we do not have enough data over the time dimension to estimate complex ARMA error structures is to use the lag of the dependent variable as a control:

$$\ln\left(P_{i,t}\right) = \alpha_i + \theta \ln\left(P_{i,t-1}\right) + \delta_{AG} \ln\left(Y_{AG,i,t}\right) + \delta_{NAG} \ln\left(Y_{NAG,i,t}\right) + \gamma t + \varepsilon_{i,t}. \tag{4}$$

[1] Also, the large and sparsely populate Chaco department is not included in the household survey.

This model can not be estimated consistently by OLS, as the error will be correlated with the fixed effects. We estimate this model using the (Arellano and Bond, 1991) GMM estimator. Notice that θ, the coefficient of the lagged dependent variable, not only controls serial autocorrelation, but also would indicate the presence of a unit root if its value is close enough to the unit.

Finally, we can estimate the effect of structural composition of income on poverty using a restricted SUR model. Consider that we can estimate specification (1) as seven separate regressions $\{1,2, \dots ,7\}$, one for each department:

$$\begin{aligned} \ln\left(P_{1,t}\right) &= \alpha_1 + \delta_{AG,1} \ln\left(Y_{AG,1,t}\right) + \delta_{NAG,1} \ln\left(Y_{NAG,1,t}\right) + \gamma_1 t + \varepsilon_{1,t} \\ &\vdots \\ \ln\left(P_{7,t}\right) &= \alpha_N + \delta_{AG,N} \ln\left(Y_{AG,7,t}\right) + \delta_{NAG,N} \ln\left(Y_{NAG,7,t}\right) + \gamma_N t + \varepsilon_{N,t} \end{aligned} \quad . \qquad (5)$$

Here we make the SUR assumptions that although each equation error is *iid*, with $E\left[\varepsilon_{i,t}\right] = 0$, and $E\left[{\varepsilon_{i,t}}^2\right] = \sigma_i^2 \ \forall \ i$, there is additionally cross equation error correlation for contemporaneous disturbances, which means that $E\left[\varepsilon_{i,t} \cdot \varepsilon_{j,s}\right] = \sigma_{ij} \ \ \forall \ i \neq j \ \ \wedge \forall t = s$. Zellner's SUR model is a Generalized Least Squares estimator for this error structure that accounts for cross equation correlation for contemporaneous disturbances. Thus, the SUR model in our context allows for spatial correlation among departments. If we additionally impose the restriction that parameters δ and γ must be equal among departments, *i.e.,* $\delta_{AG,i} = \delta_{AG,j}$, $\delta_{NAG,i} = \delta_{NAG,j}, \gamma_i = \gamma_j \ \forall i, j$, we are then essentially estimating the fixed effects model, but where we allow and correct for spatial autocorrelation.

We begin in Table 3 by inspecting if the regional data models replicate the main results shown in Table 1. In the table models (3) – (5) are estimated for poverty headcount FGT(0) and the poverty gap FGT(1) using and regional agricultural output index, and mean regional non-agricultural index as a proxy for non-agricultural output. Our focus is on the poverty to agricultural output elasticity, while the non-agricultural proxy is expected to be a suitable control. The table shows that the coefficients on agriculture are remarkably close (and not statistically different) to their equivalent coefficients using aggregate national data (columns (1) and (3) in Table 1). The estimations using regional data confirm that agricultural expansion has a surprisingly positive effect on both poverty indicators. In the case of non-agricultural sector, coefficients are not directly comparable, but confirm the main result that the non-agricultural sector has contributed to decrease poverty in Paraguay.

Table 4 again shows the result of estimating models (3) – (5) for poverty headcount FGT(0) and the poverty gap FGT(1). However, to further inspect the surprising result that agricultural output has a positive effect on poverty, we have disaggregated agricultural output into two sectors: soy and non-soy output. Since soy is just one output, we just use the annual production in tons (Q_{AGS}), however in the case of the rest of agriculture, we create a Laspeyres index of output using the main crops produced in the country (I_{AGNS}). We also use the inverse hyperbolic sine transformation instead of logs to accommodate the capital Asunción in the model, as it has zeros for agricultural output. First, we confirm that the non-agricultural output proxy we are using performs as expected, having a negative and strongly significant effect on both poverty indicators. The surprises come with the agricultural indicators. Soy production has a positive and significant impact on poverty on all columns, except in the SUR estimation for the poverty gap (column (6)). On the other hand, non-soy agricultural output has a negative and significant effect on poverty on all estimations, except in the fixed effects model for poverty headcount, column (1). Also, the semi elasticities reported in the table are between 2-3 time higher for soy output than the absolute value of the semi-elasticities for non-soy agricultural output (except in column (6), the poverty gap estimated with the SUR model), which is consistent with the positive effect that agriculture overall has on national poverty and reported in Tables 1 - 3.

The table leaves an important lesson. It is not agriculture that has been anti poor in Paraguay, it has been the expansion of the extensive soy agricultural model. The modern, large scale, and highly mechanized soy production industry has created very little employment, and by replacing area which previously held traditional crops with higher labor requirements, it has in practice displaced employment and increased poverty. We will return to the employment question below.

In Table 5, we reassess the question of agriculture and labor intensity, and its impact on poverty. We again estimate the poverty equations described in (3) – (5) for poverty headcount and poverty gap, but now we further disaggregate non-soy agricultural output into mechanized crops (I_{AGM}) i.e., non-soy but still capital intensive, and more labor-intensive crops (I_{AGL}), the rest. Based on the Paraguayan context, and following the literature (Vega et al., 2006) we included rice, maize, sunflower, and wheat among the mechanized crops. Again, we note that as expected, and consistent with the national level evidence presented above, non-agricultural output has a strong poverty reducing effect in all estimations. On the other hand, we confirm what was found in the previous table, soy production has a positive and significant poverty increasing effect. The table also shows that mechanized agriculture has a very small and insignificant effect on poverty. Nonetheless, we do find a positive and significant effect of non-soy mechanized agriculture on the poverty gap in the SUR estimation, column (6). This latter result raises the questions regarding the true impact of non-soy mechanized agriculture on poverty, the insignificant effect may be due to little prevalence and variability of this type of agriculture. The effect of more labor intensive and traditional agriculture on poverty seems clearer, and consistent with what traditionally has been found in the literature. We find that the coefficient of labor-intensive agriculture on poverty is negative on all estimations, and significant in four of the six models. That fact that the coefficient is larger and significant in SUR estimations, and not in the fixed effects model suggest that accounting for spatial correlation is necessary to detect the effect of traditional agriculture on poverty.

Tables 4 and 5 tell a consistent story. Agriculture expansion is poverty increasing in Paraguay because it has been dominated by the soy industry which is a sector characterized by its notoriously low labor requirements. The rest of the agricultural sector is poverty decreasing as expected, particularly traditional and labor-intensive agriculture (non-mechanized). As the soy industry has expanded, particularly when it expands into areas previously covered by alternative crops, soy expansion has a negative labor effect as it crowds-out employment. This negative employment effect is probably behind the poverty increasing impact of soy expansion in Paraguay.

6. Is there an employment crowding-out effect of soy expansion?

As reported in (World Bank, 2017) Paraguay has been losing agricultural jobs over this century. This is not necessarily a sign of concern, because country growth promotes the agricultural transformation which is characterized by a growing agricultural sector that sheds labor as workers migrate to other industries. However, our hypothesis is that agricultural jobs are not being lost because of a technical change induced reduction of the labor requirements of Paraguayan agriculture, but because the expansion of the soy industry has crowded-out jobs by growing into areas where the growing of other crops offered more labor opportunities. This is consistent with the anecdotal evidence reported in (Valdés et al., 2011) that the soy industry expansion has displaced rural population into the cities.

We examine this empirical question with the available panel data in Paraguay. In Table 6 we estimate model (3) and (4), but using regional employment (number of employed in department (i) and time (t)) as the dependent variable. Also, we decompose agricultural output into soy and non-soy agriculture, as done in Table 4. We use as employment indicators, three different measures: the number of employed persons per department and year, the number of employed in rural areas, and the number of persons employed in agriculture. Although we show this latter indicator (columns (5) and (6)), we find the results unreliable, as we believe that insufficient agricultural employment is being identified by the survey. Due to shortcomings in the survey design, there is likely a severe under-identification of those self-employed in agriculture.

The table results must be interpreted with caution, because here we have an evident endogeneity problem with non-agricultural income, as more employment causes higher non-agricultural income, through wages. Thus, not much attention should be given to that coefficient, which here serves only as an essential control. We place our attention on the effect of agricultural expansion on regional employment (columns (1) and (2)). Note that both urban an rural employment within each region are included in this estimator. Although the non-soy sector has a positive coefficient, it is small and not significant, i.e., little employment is being created by the traditional sector. However, the soy expansion has been reducing employment at the regional level. This is evidence, that the jobs lost due to soy expansion are higher than jobs created elsewhere when the soy industry grows. In the case of rural employment, the elasticities with respect to agriculture are very similar. Non soy agriculture has a minor effect in employment creation, so low as to be statistically insignificant, while soy production expansion reduces rural employment, even though this elasticity is statistically significant only in one of the two specifications considered.

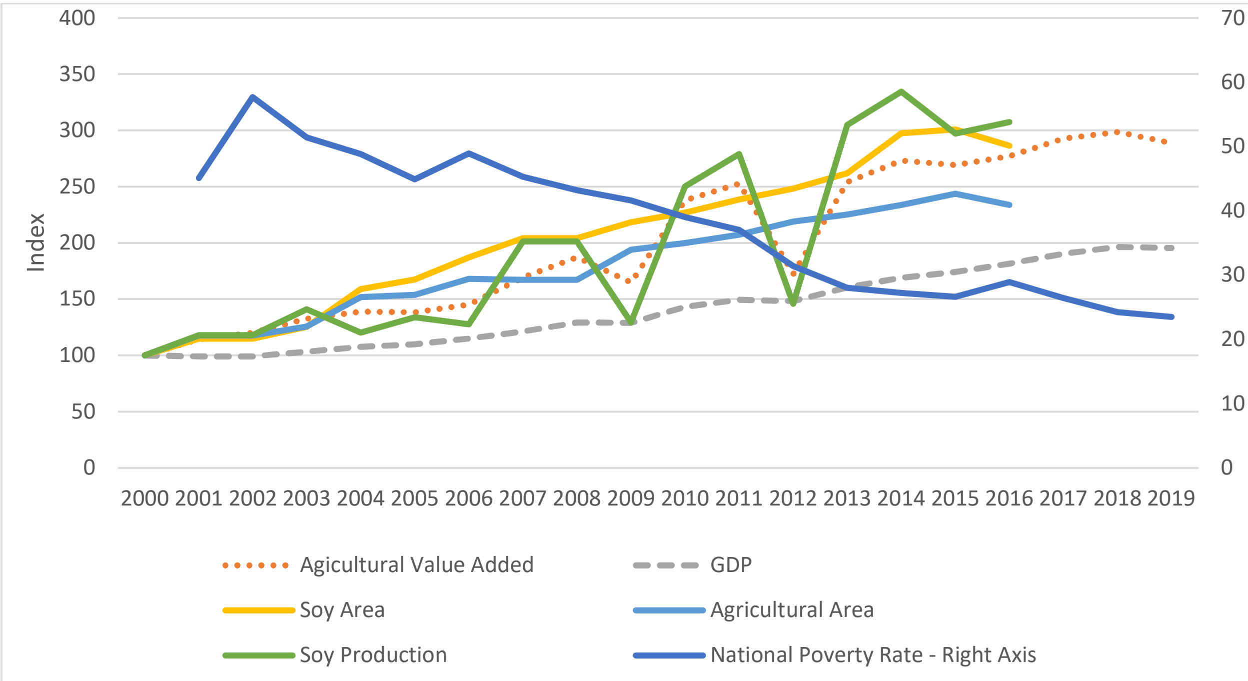
7. Conclusions

This paper presents a remarkable result that goes against the common understanding, and vast evidence in the literature that suggests that agriculture is a particularly pro poor sector, more so than other sectors in the economy. Here we show that agricultural expansion has, other things held constant, increased poverty in Paraguay. This surprising result can only be understood in the context of Paraguayan agricultural expansion during this century being of a particularly extreme nature, unlike others studied previously in the literature. Agricultural growth has been characterized by the expansion of a modern soy sector that is extremely capital intensive and generates very little employment. The land consolidation that this capital-intensive model has engendered also means that the rents of this agricultural expansion have been highly concentrated. Furthermore, the crop does not generate much processing or downstream activities in the rural non-farm sector, so any multiplier effect that this agricultural expansion can create is rather limited. Considering all these peculiarities of these agricultural growth, it should not be surprising to find this result that contradicts the literature.

The soy industry has not only had a poverty increasing effect in Paraguay. It has been shown (World Bank, 2014) that the Paraguayan economy has experienced increasing macroeconomic volatility. An important part of this growing macro volatility can be explained by the growing importance of the soy industry in GDP, and specially in exports. Also, the expansion of the soy industry may have other social costs in terms of rural displacement, but this hypothesis has yet to be demonstrated. Hence, the expansion of the soy industry has had significant negative externalities for Paraguay. The clear policy recommendation would be for Paraguay to tax (more than currently) soy production to garner the resources to fund social policies that benefit the most vulnerable in Paraguay, those that have been negatively affected by this agricultural success story.

Figures

Figure 1. Evolution of GDP, Poverty and Agricultural Indicators



Notes: All indicators, except for poverty, are indices year 2000 = 100. Initial levels are: Agicultural Value Added 1,628 MM US$ 2014, GDP 23,860 MM US$ 2014, Soy Area 1,176,460 thousand ha, Agricultural Area 2,436,604 thousand ha, and Soy Production 2,980,058 thousand tons.

Tables

Table 1. Poverty in Paraguay 2001 - 2018

	(1)	(2)	(3)	(4)
	FGT(0) / Poverty Headcount		FGT(1) / Poverty Gap	
	ln(P)	Δln(P)	ln(P)	Δln(P)
Year (t)	0.108*		0.111	
	(0.057)		(0.079)	
$\ln(VA_{AG})$	0.215*		0.288*	
	(0.115)		(0.157)	
$\ln(VA_{IND})$	-0.927***		-1.250***	
	(0.256)		(0.312)	
$\ln(VA_{SS})$	-3.228**		-3.594*	
	(1.304)		(1.873)	
$Share_{AG}(t-1)$ x		2.257**		3.390**
$\Delta\ln(VA_{AG})$		(0.808)		(1.149)
$Share_{IND}(t-1)$ x		-3.974		-7.054
$\Delta\ln(VA_{IND})$		(2.904)		(4.287)
$Share_{SS}(t-1)$ x		-4.823*		-6.239
$\Delta\ln(VA_{SS})$		(2.516)		(3.641)
Constant	-147.119	0.108	-141.459	0.141
	(89.108)	(0.075)	(123.768)	(0.106)
AR(1)	0.208	-0.372	0.150	-0.324
Obs.	18	17	18	17
R2	0.92	0.41	0.93	0.41

Notes: VA is value added by sector, AG = Agricultural and primary, IND = Industry, and SS = Services. Standard errors in parentheses. * Significant at 10%, ** at 5% and *** at 1%.

Table 2. Urban and Rural Poverty in Paraguay 2001 - 2018

	(1)	(2)	(3)	(4)
	Rural Poverty FGT(0)		Urban Poverty FGT(0)	
	ln(P)	Δln(P)	ln(P)	Δln(P)
Year (t)	-0.015		0.271***	
	(0.073)		(0.054)	
$\ln(VA_{AG})$	-0.123		0.679***	
	(0.146)		(0.113)	
$\ln(VA_{IND})$	-0.799**		-1.069***	
	(0.280)		(0.310)	
$\ln(VA_{SS})$	0.269		-7.697***	
	(1.737)		(1.149)	
$Share_{AG}(t-1)$ x		-0.348		5.846***
$\Delta\ln(VA_{AG})$		(1.116)		(0.790)
$Share_{IND}(t-1)$ x		-5.193		-2.047
$\Delta\ln(VA_{IND})$		(3.738)		(2.930)
$Share_{SS}(t-1)$ x		-0.436		-10.644***
$\Delta\ln(VA_{SS})$		(3.112)		(2.461)
Constant	40.961	0.012	-396.663***	0.239***
	(113.580)	(0.094)	(84.493)	(0.072)
AR(1)	0.185	-0.350	0.222	-0.297
Obs.	18	17	18	17
R2	0.83	0.17	0.94	0.70

Notes: VA is value added by sector, AG = Agricultural and primary, IND = Industry, and SS = Services. Standard errors in parentheses. * Significant at 10%, ** at 5% and *** at 1%.

Table 3. Regional Poverty in Paraguay

	(1)	(2)	(3)	(4)	(5)	(6)
	FGT(0) / Poverty Headcount			FGT(1) / Poverty Gap		
	Fixed Effects	A. Bond	SUR	Fixed Effects	A. Bond	SUR
Year (t)	-0.011	0.010	-009	-0.010	-0.005	0.042***
	(0.018)	(0.011)	(0.013)	(0.024)	(0.014)	(0.013)
FGT(0,1) Lag		0.517***			0.398***	
		(0.068)			(0.071)	
$\ln(IQ_{AG})$	0.239**	0.284***	0.210***	0.242*	0.348***	0.176***
	(0.089)	(0.0660)	(0.055)	(0.119)	(0.090)	(0.058)
$\ln(Y_{NAG})$	-0.346***	-0.421***	-0.434***	-0.521***	-0.557***	-0.811***
	(0.082)	(0.095)	(0.111)	(0.121)	(0.130)	(0.067)
Constant	35.63	-9.64	24.16*	35.99	4.03	-23.45
	(34.77)	(20.11)	(14.19)	(46.09)	(27.09)	(20.88)
Groups	7	7	7	7	7	7
Obs.	119	105	119	119	105	119
R2	0.605		0,700	0.660		0,796

Notes: IQ_{AG} is a Laspeyres quantity index of all crops. Y_{NAG} is mean non-agricultural income. Standard errors in parentheses. * Significant at 10%, ** at 5% and *** at 1%.

Table 4. Regional Poverty in Paraguay with Agricultural activity disaggregated into soy and non-soy output

	(1)	(2)	(3)	(4)	(5)	(6)
	FGT(0) / Poverty Headcount			FGT(1) / Poverty Gap		
	Fixed Effects	A. Bond	SUR	Fixed Effects	A. Bond	SUR
Year (t)	-0.010	0.007	-0.017**	-0.009	0.003	-0.273***
	(0.018)	(0.011)	(0.007)	(0.023)	(0.015)	(0.009)
FGT(0,1) Lag		0.509***			0.408***	
		(0.068)			(0.070)	
$IHS(Q_{AGS})$	0.174**	0.154***	0.127***	0.174**	0.197***	0.057
	(0.060)	(0.042)	(0.031)	(0.074)	(0.057)	(0.039)
$IHS(I_{AGNS})$	-0.042	-0.049**	-0.053***	-0.077**	-0.087***	-0.098***
	(0.028)	(0.024)	(0.016)	(0.033)	(0.033)	(0.025)
$\ln(Y_{NAG})$	-0.382***	-0.395***	-0.263***	-0.568***	-0.551***	-0.347***
	(0.119)	(0.092)	(0.052)	(0.149)	(0.126)	(0.066)
Constant	32.95	-4.12	43.24***	34.77	8.08	66.07**
	(34.91)	(20.99)	(14.62)	(44.06)	(28.14)	(18.30)
Groups	7	7	5	7	7	5
Obs.	119	105	17	119	105	17
R2	0.633		0.748	0.683		0.795

Notes: (Q_{AGS}) is the quantity of soybeans produced in tons. (I_{AGNS}) is a Laspeyres index of all crops, excluding soybeans. Standard errors in parentheses. * Significant at 10%, ** at 5% and *** at 1%.

Table 5. Regional Poverty in Paraguay with Agricultural Activity Disaggregated into Soy, Labor-Intensive and Mechanized Output

	(1)	(2)	(3)	(4)	(5)	(6)
	FGT(0) / Poverty Headcount			FGT(1) / Poverty Gap		
	Fixed Effects	A. Bond	SUR	Fixed Effects	A. Bond	SUR
Year (t)	-0.009	0.004	-0.008	-0.010	-0.0005	-0.023**
	(0.020)	(0.011)	(0.008)	(0.025)	(0.015)	(0.011)
FGT(0,1) Lag		0.511***			0.415***	
		(0.069)			(0.070)	
IHS(Q_{AGS})	0.179***	0.148***	0.058*	0.179**	0.181***	0.111**
	(0.058)	(0.043)	(0.033)	(0.073)	(0.058)	(0.050)
IHS(I_{AGL})	-0.025	-0.045*	-0.045**	-0.059	-0.084**	-0.070**
	(0.029)	(0.024)	(0.012)	(0.036)	(0.033)	(0.028)
IHS(I_{AGM})	-0.029	0.065	-0.115	0.011	0.114	0.080*
	(0.068)	(0.057)	(0.093)	(0.092)	(0.078)	(0.044)
ln(Y_{NAG})	-0.371***	-0.386***	-0.244***	-0.558**	-0.542***	-0.440***
	(0.124)	(0.092)	(0.052)	(0.156)	(0.126)	(0.079)
Constant	31.56	0.893	27.19*	36.22	15.12	59.72***
	(37.96)	(21.09)	(16.02)	(48.39)	(28.37)	(21.44)
Groups	7	7	7	7	7	7
Obs.	119	105	119	119	105	119
R2	0.630		0.713	0.679		0.790

Notes: (I_{AGL}) is a Laspeyres index of labor-intensive crops.(I_{AGM}) is a Laspeyres index of mechanized crops excluding soybeans. Standard errors in parentheses * Significant at 10%, ** at 5% and *** at 1%.

Table 6. The effect of output composition on Employment

	(1)	(2)	(3)	(4)	(5)	(6)
	Regional Employment		Rural Employment		Agricultural Employment	
	Fixed Effects	A. Bond	Fixed Effects	A. Bond	Fixed Effects	A. Bond
	ln(L)	ln(L)	ln(L)	ln(L)	ln(L)	ln(L)
Year (t)	-0.001	-0.001	-0.001	0.006	0.001	-0.006
	(0.004)	(0.004)	(0.005)	(0.007)	(0.004)	(0.013)
Lag ln(L)		0.404***		0.241***		0.168*
		(0.081)		(0.090)		(0.090)
IHS(Q_{AGS})	-0.087***	-0.060***	-0.034	-0.076**	-0.032	-0.030
	(0.025)	(0.019)	(0.038)	(0.034)	(0.060)	(0.057)
IHS(I_{AGNS})	0.031	0.033	0.027	0.036	0.059	0.050
	(0.034)	(0.028)	(0.061)	(0.049)	(0.098)	(0.094)
ln(Y_{NAG})	0.257***	0.131***	0.124**	0.043	-0.055	-0.044
	(0.044)	(0.036)	(0.047)	(0.066)	(0.062)	(0.119)
Constant	8.97	5.70	10.25	-4.84	9.20	23.62
	(7.73)	(7.03)	(9.40)	(13.79)	(8.59)	(25.13)
Groups	7	7	7	7	7	7
Obs.	119	105	119	105	119	105
R2	0.806		0.343		0.036	

Notes: (Q_{AGS}) is the quantity of soybeans produced in tons. (I_{AGNS}) is a Laspeyres index of all crops, excluding soybeans. Standard errors in parentheses. * Significant at 10%, ** at 5% and *** at 1%.

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