Land Reform and Productivity: A Quantitative Analysis with Micro Data†

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Abstract

We assess the effects of a major land-policy change on farm size and agricultural productivity using a quantitative model and micro-level data. We study the 1988 land reform in the Philippines that imposed a ceiling on land holdings and severely restricted the transferability of the redistributed farm lands. We study this reform in the context of an industry model of agriculture with a non-degenerate distribution of farm sizes featuring an occupation decision and a technology choice of farm operators. In this model, a land reform reduces agricultural productivity not only by reallocating resources from large/high productivity farms to existing small/low productivity farms (misallocation effect), but also by distorting farmers' occupation and technology adoption decisions (selection effect). The model, calibrated to pre-reform farm-level data in the Philippines, implies that on impact the land reform reduces average farm size by 34% and agricultural productivity by 17%. The government assignment of land and the ban on its transfer are key for the magnitude of the results since a market allocation of the above-ceiling land produces only 1/3 of the size and productivity effects. These results emphasize the potential role of land market efficiency for misallocation and productivity in the agricultural sector.

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1 Introduction

A key challenge in the literature on misallocation and development is to measure quantitatively how specific institutions, frictions, and policies that generate establishment-level (idiosyncratic) distortions affect productivity at the industry level. For the very poor countries in particular understanding how farm-level distortions affect agricultural productivity is an especially pressing issue. This is because the poorest countries are: (a) particularly unproductive in agriculture and devote a lot of resources to it when compared to rich countries (e.g. Restuccia, Yang, and Zhu, 2008) and (b) on average undertake farming on a much smaller operational scale than rich countries, at least partly the result of farm-size distortions (Adamopoulos and Restuccia, forthcoming).

In this paper, we assess the effects of a major land policy change on farm size and agricultural productivity using a quantitative model and micro-level data. We study the 1988 land reform in the Philippines, known as the Comprehensive Agrarian Reform Program (CARP). CARP was an extensive land redistribution program that imposed a restrictive ceiling on existing land holdings, channeled a substantial portion of above-ceiling land to landless and smallholders, and severely restricted the transferability of the redistributed farm lands. The period after the reform shows substantial reallocation of farms and land to smaller farm sizes –reflected in a substantial reduction in average farm size of 30%– and a reduction of agricultural productivity of almost 12% between 1989 and 1993. We study this reform in the context of a quantitative model of farm-size in agriculture, featuring an occupation decision and a technology choice of farm operators. The model, calibrated to pre-reform farm data in the Philippines, implies that on impact the land reform reduces average farm size by 34% and agricultural productivity by 17%. The government ban on transfers and intervention in the redistribution of land is key for the magnitude of the results since a market allocation of the above-ceiling land produces only 1/3 of the size and productivity effects. This result emphasizes the potential role of land market efficiency for misallocation and productivity in the agricultural sector.

We combine two sources of micro data on the Philippines to study the size and productivity effects of the land reform: (a) Decennial Agricultural Census Data, which offer a complete enumeration of farms, land and labor inputs at the farm-level in two separate cross sections, before and after the reform; (b) Philippines Cash Cropping Project, a panel of household survey data, which tracks a much more limited number of rural households before and after the reform but offers a wealth of production information on all inputs and outputs at the parcel and farm level. The survey data allow us to construct precise measures of productivity at the farm level.[1] By focusing on farm operators that are present before and after the reform we construct a balanced panel, which allows us to look inside the farm and observe what has changed in the farm-level choices of operators (controlling for farmer ability and location). As a result, we study not only the more obvious misallocation effect of the land reform, whereby farming activity is shifted from large/productive to existing small/less-productive farms, but also the within-farm effect, whereby productivity changes at the farm level over time. Our analysis of the balanced panel indicates a major change in the crop mix between food and cash cropping.

To study the effects of the Philippine land reform, we develop a quantitative industry model of agriculture that builds on Lucas (1978) and Adamopoulos and Restuccia (forthcoming). Agricultural goods are produced by farmers who are heterogeneous with respect to their ability in managing a farm. In this model, farm-level productivity is drawn from a known distribution. We assume that the productivity of the farmer remains constant over time. As in Lucas (1978), an individual can become a worker (hired labor) or enter the agricultural sector as a farm operator. We extend this theory to allow for a technology adoption choice for the farmer. The farmer chooses between two technologies, a "cash crop" technology and a "food crop" technology, with the key difference being that cash crops are produced on a larger scale. The motivation for this broad technology-choice specification is dictated by our farm survey data. In this framework, in the absence of any dis-

[1] Given that we observe outputs and inputs as well as their prices separately at the parcel level, we do not have to rely on industry deflators to compute farm-level productivity.

tortions the farm size distribution and the sorting of farmers across occupations and technologies is optimal. We calibrate the model to the agricultural sector of the Philippine economy before the reform, matching in particular the farm, land, and productivity distributions from the survey data prior to the reform. We discipline the parameters of the technology choice on farm cropping patterns from the farm survey data.

We implement the land reform as a government-mandated land redistribution program, consistent with CARP in the Philippines. The key components of this redistribution program that we account for are: (1) a ceiling (the maximum land size that a farm can operate); (2) imperfect enforcement (a probability that the ceiling is not effectively enforced); (3) redistribution of the farmlands above the effective ceiling to the landless and smallholders; and (4) a government ban on all transfers of the redistributed lands, effectively shutting down the land market. We show that this characterization of the reform resembles not only the spirit of the legislation but also the distributions of farms, land, and labor productivity after the reform. On impact this government-mandated land redistribution reduces average farm size by 34%, agricultural productivity by 17%, and the share of landless individuals in the economy by 20%. Moreover, we find that accounting for the post-reform share of farms above the ceiling implies a fairly weak enforcement of the reform. If the reform was enforced fully, the productivity drop in agriculture would double to 34%. We demonstrate that the land reform reduces agricultural productivity through two channels: (1) by reallocating resources from large/high productivity farms to existing small/low productivity farms–the misallocation effect, and (2) by altering how farmers sort across occupations and across technologies–the selection effect.

The mode of redistribution is key for the magnitude of the overall size and productivity drops. We compare the results of the Philippine government-mandated land redistribution program to a market-based alternative redistribution, where the market optimally allocates land to clear the land market subject to the ceiling and enforcement constraints. If the above-ceiling farmlands were allocated via a rental market for land, the distribution of farmers and land would be much more compressed mitigating the productivity impact of the reform. In particular, average farm size and aggregate agricultural productivity would drop by 9% and 5% respectively, less than 1/3 of the effects under the government-mandated redistribution. We also examine how farm size and productivity are affected when we combine the land reform with other changes occurring alongside the reform over the same period, such as overall productivity growth in the economy and the adoption of high-yield seed varieties in agriculture. We find that taking these changes into account can mask the negative effects of the land reform. This is especially important in evaluating land reforms since a key property of these reforms is that full implementation takes time.

Our paper is closely related to Adamopoulos and Restuccia (forthcoming) in integrating the literature on misallocation and productivity (e.g. Restuccia and Rogerson, 2008, 2013; Guner, Ventura, and Xu, 2008; and Hsieh and Klenow, 2009) into the study of the agricultural productivity gap across countries (e.g. Gollin, Parente and Rogerson, 2004; Caselli, 2005; Restuccia, Yang and Zhu, 2008; Adamopoulos, 2011; Lagakos and Waugh, 2013; Herrendorf and Schoellman, 2013; Gollin, Lagakos, and Waugh, 2014a, among many others). We differ from Adamopoulos and Restuccia (forthcoming) in that we study a specific farm-size distortion (land reform), in a particular context (Philippines), using micro-productivity data. Importantly, in Adamopoulos and Restuccia (forthcoming) conditional on any type of farm-size distortion, the market efficiently allocates resources, while in this paper the allocation of land is government-mandated. We also differ from Adamopoulos and Restuccia (forthcoming) in studying the distortionary impact in occupation and technology choices. Our approach uncovers a substantial negative productivity impact of land redistribution on the selection of individuals across occupation and technology choices. In utilizing micro data to motivate model features, calibrate the model, and assess the model's predictions, we relate to a recent literature on macro development using micro data (e.g. Hsieh and Klenow, 2009; Udry, 2012; Gollin, Lagakos, and Waugh, 2014b; Buera, Kaboski, and Shin, 2014, among others).

Land reforms have been a traditional theme in the development economics literature and have been prevalent in developing countries in the second half of the 20th century (see for example, de Janvry, 1981; Binswanger-Mkhize et al., 2009). We study the most common type of land reform, a ceiling on land holdings, with redistribution of above-ceiling land. While the primary goal of land reforms is to improve the welfare of the rural poor (reduce poverty, promote equity, secure nutrition etc.) there has been a large literature in development economics arguing in favor of land reform programs also on efficiency grounds. This view is rooted in the ample empirical evidence documenting an inverse relationship between farm size and land productivity (see for example, Berry and Cline, 1979; Carter, 1984; Cornia, 1985; and Banerjee, 1999, for a review and good discussion of this literature).

Despite the vast literature on land reforms and their prevalence in developing countries, the empirical work studying the effects of land reforms on agricultural productivity or other key variables has been limited. One of the challenges in assessing the impact of land reforms is to disentangle the effect of the reform from other concurrent economic or policy changes. To identify the impact of land reforms the empirical literature has tried to find an exogenous source of variation in policy. For this reason much of the existing empirical work has focused on India, exploiting the cross-state variation in the amount and timing of land reform legislation (Besley and Burgess, 2000; Ghatak and Roy, 2007), the cross-district variation in implementation of land reform legislation within states (Banerjee, Gertler, and Ghatak, 2002), as well as farm-level data across villages (Bardhan and Mookherjee, 2007). Complementing this literature, our approach is to use a quantitative model and micro-level data to disentangle the effects of the land reform legislation per se, from: (a) the degree of implementation, (b) the functioning of the land market, and (c) other changes occurring in the economy in parallel to the implementation of the reform. Our approach also allows us to assess the different mechanisms through which reforms operate on key variables.

In terms of welfare, the empirical literature finds that land reforms reduce poverty (see Besley and Burgess, 2000, on India) and raise incomes of beneficiaries (see Mendola and Simtowe, 2012 on

Malawi). However, Lahiff and Guo (2012) find no evidence of improvement in incomes in the case of the South African land reform, where relatively little land had been redistributed. We show that while the welfare of smallholder recipients always increases following the reform, the welfare of the landless increases only if the awarded land per beneficiary is sufficiently high. In terms of agricultural productivity, the empirical literature finds mixed results, partly due to the differences in the types of reforms studied. Ghatak and Roy (2007) show that land ceilings had a significant negative effect on agricultural productivity in India. On the other hand, tenancy reforms had a positive effect on productivity in West Bengal where reforms were implemented more rigorously (Ghatak and Roy, 2007; Banerjee, Gertler, and Ghatak, 2002; Bardhan and Mookherjee, 2007). Mendola and Simtowe (2012) find that decentralized market-assisted land redistribution raised agricultural yields in Malawi, while Lahiff and Guo (2012) find no such evidence in South Africa. Consistent with Ghatak and Roy (2007), but using instead farm-level data and a quantitative model, we find that ceiling reforms have a negative effect on agricultural productivity. A key insight of our analysis is that the functioning of the land market is important for the magnitude of the effects of the ceiling on size and productivity. The idea that impediments to the functioning of land markets can raise the costs associated with implementing land reforms is echoed in Deininger and Feder (2001) and Lipton (2009).

We emphasize that we are interested in the productivity effects of land reforms, through the operational size distribution of farms, rather than the land ownership distribution per se. While government-led land redistribution constitutes an intervention in the distribution of land ownership, when accompanied by distortions in land markets, it is effectively an intervention in the operational size distribution. As a result our analysis is separate, but complementary to the literature that studies the effect of inequality in land ownership on long-run economic growth, through its effect on the institutions and policies adopted (Engerman and Sokoloff, 2000; Adamopoulos, 2008; Galor, Moav, and Vollrath, 2009).

The paper proceeds as follows. The next section documents some land reforms and describes the details of the Philippine land reform. In Section 3 we present a set of facts from the land reform in the Philippines both using aggregate Census and Industry data as well as micro panel data from a sample of farmers. Section 4 describes the model. In Section 5 we calibrate the model to the Philippines before the land reform and perform quantitative experiments of land reforms and other aggregate factors. We conclude in Section 6.

2 Land Reforms

In Table 1 we have compiled a set of land reforms capping farm size that have been implemented since the 1950s for countries for which we were able to obtain data. The middle column indicates the period of the land reform. The column to the right provides the explicit legislated ceiling imposed by the reform. This ceiling per se might not be a good description of how restrictive or binding the reform was, as these countries differ in their pre-reform average farm size. One way to measure the restrictiveness of the reform is to look at the ratio of the ceiling to the pre-reform average farm size. This restrictiveness ratio varies substantially across reforms: e.g. 1.75 in the Philippines, 9 in Bangladesh, 18 in Sri Lanka. It should be noted that these reforms can vary not only in the set of accompanying institutional changes (e.g., operation of factor markets), but also in the degree of enforcement. In the first column, we calculate the change in average farm size before and after the reform using census data from the World Census of Agriculture (and where such data are absent from the respective national agricultural censuses).[2] It is particularly striking that in all these cases average farm size dropped following the reform, since the tendency is for average farm size to increase over time as a country goes through the process of structural transformation and

[2] *World Census of Agriculture*, Food and Agricultural Organization (FAO) of the United Nations. The World Census of Agriculture collects data on the number of agricultural holdings and land area in holdings classified by size in hectares.

Table 1: Some Land Reforms

Country	Change in AFS (%)	Land Reform Period	Ceiling on Land Size (Ha)
Bangladesh	-49.1	1984	8
Ethiopia	-44.1	1975	10
India	-25.8	by early 1970s	by province: 4-53
Korea	-21.5	1950	3
Pakistan	-11.5	1972, 1977	61, 40
Sri Lanka	-26.2	1972	10-20
Philippines	-29.6	1988	5

individuals move out of agriculture.[3]

Philippine Land Reform

It is difficult to draw general conclusions about the productivity effects of land reforms from the information in Table 1 given that such reforms differ in a variety of dimensions. Instead of examining a number of land reforms, our approach in this paper is to quantitatively assess the effects of a particular land reform by focusing on the institutional detail of that reform and using detailed micro data. We study the 1988 land reform in the Philippines, known as the Comprehensive Agrarian Reform Program (CARP). Its enabling law was the Comprehensive Agrarian Reform Law (CARL) or Republic Act (RA) 6657. The objective of the law was to give land to the tiller and deliver a more equitable distribution of land (Department of Agrarian Reform, 2006). To achieve these objectives, the reform imposed a ceiling on all agricultural holdings and redistributed the land in excess of the ceiling. The retention limit was 5 hectares for any landowner with farm size above this limit. Landowners above the ceiling could award up to 3 hectares of land to a child as long as the child was at least 15 years of age at the time the law was enacted and was actually working the land. For a beneficiary of the land reform (recipient of land) the maximum permitted

[3] That average farm size increases over time is strongly supported by the data, for example by examining the trends in average farm size of today's developed economies: in the United States, average farm size increased almost 4-fold over 1880 - 1997 and in Canada more than 7-fold over 1871 - 2006.

size was 3 hectares (Saulo-Adriano, 1991). To qualify as a beneficiary a farmer had to be landless or a smallholder and be willing to cultivate the land.

In terms of its scope the reform was extensive and very comprehensive. It targeted all agricultural lands, private and public, covered all crops, and all tenurial arrangements. This target involved 80% of the country's total farm land. The reform was to be completed within 10 years. However, for a number of reasons this was not possible and CARP's time frame was extended, and in fact is still being implemented today. However, about 80% of the targeted land had been redistributed by the mid 2000s. Land acquisition took place on a compulsory (expropriation) and voluntary basis (sale of land in excess of the ceiling to government or beneficiary directly) at fair market value ("just" compensation). The government heavily subsidized the reform by covering land transfer fees and titling costs, and by providing a credit subsidy to beneficiaries. A characteristic of this reform was that it restricted the transferability of the redistributed lands. In particular, the law precluded the sale, transfer, lease or donation of the redistributed land except to an heir or the government for the first 10 years after the land had been awarded to a beneficiary (failing to do so would lead the government to reclaim the land and disqualify the beneficiary from the reform). After the 10 years, the land could be transferred provided it had been fully paid off and the transferee did not own more than 5 hectares of agricultural land. But even then, the law provided that preference be given to those cultivating the land or the government (Section 27, RA 6657).

It is natural to ask, did the land reform completely eliminate farms, as operational units, above 5 hectares? The answer is no, for two reasons. First, because operational unit and owned land were not perfectly correlated. For example, if a large landowner had two children above the age of 15 working the farm, under CARP the landowner would have been able to retain 5 hectares and award his children 3 hectares each of ownership. If these lands were pooled together into one farm under single management in the agricultural census it would appear as an 11 hectare farm. If in addition, the spouse separately owned land, another 5 hectares could be added to the farm bringing the operational farm unit to 16 hectares. Second, while the law was strict in terms of the retention limits and the restrictions on the transferability of the land, in practice, enforceability was not perfect. In some cases landowners refused to accept the land valuation determined by the government and challenged it in court, delaying the awarding of the lands to beneficiaries. There are also accounts of reform evasion, whereby landowners voluntarily "sold" land to relatives, or awarded land to their children that were either minors at the time of the reform or were not working the land (Borras, 2003). Further, the cost of CARP became so high that the government funds allocated to the reform run out a few times, which also delayed the full implementation of the reform.

There are a few reasons why we study the land reform in the Philippines. First, as mentioned above it was an extensive and comprehensive reform. Second, it was a "successful" reform, as the majority of the targeted lands had been redistributed in the first 15 years. Third, the reform was restrictive. From the countries that we were able to obtain data for in Table 1 it was the most restrictive, with a restrictiveness ratio of 1.75. Finally, it is a relatively recent reform, and as a result good data exists before and after the reform.

3 Data Analysis

To study the effects of the Philippine land reform on farm size and productivity we use aggregate and micro-level data. The aggregate sectoral data allow us to observe what has happened to farm size and agricultural productivity for Philippine agriculture as a whole. The micro-level data allow us to conduct a deeper investigation of the sources of the changes in farm size and productivity.

We use two sources of micro-level farm data for the Philippines: (a) the decennial agricultural censuses and (b) the Philippines Cash Cropping Project. The decennial agricultural censuses are undertaken by the National Statistics Office (NSO) of the Republic of the Philippines (we use the

1981 and 2002 Census of Agriculture) and provide a complete enumeration of farms covering the entire country. Even though the census data is comprehensive, it does not provide information on outputs or other inputs (besides land and hired labor) at the farm level. In order to calculate productivity with precision at the farm-level we use more detailed survey data. In particular, we use household survey data from the International Food Policy Research Institute (IFPRI), known as the Philippines Cash Cropping Project (PCCP) which was conducted in the Bukidnon province on the island of Mindanao.[4]

3.1 Agricultural Productivity in the Philippines

Since we are interested in studying the effect of the reform on productivity we first ask, how has overall agricultural labor productivity evolved in the Philippine agricultural sector in the periods before and after the reform? In Figure 1 we plot real agricultural labor productivity over 1985-2005. Agricultural labor productivity is calculated as gross value added in agriculture, fishery, forestry in 1985 constant prices (mil. pesos) over agricultural employment (persons).[5]

We also indicate with a vertical line the timing of the legislation of the land reform. In the period following the reform agricultural productivity dropped by as much as 11.6% (over 1989-1993). This drop should be put into perspective as there are other changes that are occurring in the economy besides the land reform. For example, there is general growth: labor productivity in the non-agricultural sector increased 9.3% over 1988-2004 (Groningen Growth and Development Centre, 10-sector database, Philippines). Over a longer horizon, agricultural productivity increases by 17.1% over 1989-2005 and 36.4% over 1985-2005. Thus aggregate data over a longer horizon, may

[4]Mindanao is the second largest island (after Luzon) in the Philippines, located in the south-east of the country. Bukidnon is the food basket of the island. Compared to Luzon, Mindanao has a more even distribution of rainfall throughout the year, is not on the path of typhoons, and has lower population density.

[5]Gross value added for the entire period, and employment in agriculture from 1990 on are from the Bureau of Agricultural Statistics, Philippines. For the period 1985-1989 employment data are linked using the trend from the ILO, Labor Force Survey, Table 2B.

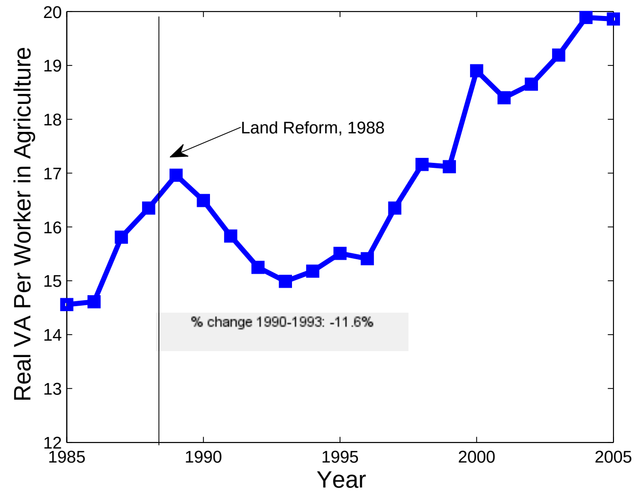


Figure 1: Agricultural Labor Productivity

confound the effects of the land reform. Our goal in this paper is to use a quantitative model to disentangle the effects of the reform from other changes that may be occurring alongside the reform in the Philippines over the same period.

3.2 Changes in Farm Size — Census Data

In the census data a farm is an operational unit regardless of ownership or legal status. A farm may consist of more than one parcels as long as all are under the same management and use the same means of production.

In the last decennial census before the reform (1981) average farm size was 2.85 hectares. By the 2002 census, average farm size had dropped to 2.01 hectares, a drop of 29.6%.[6] This drop in average scale of operation is also evident when examining the farm size distribution in Figure 2, which shows the share of farms within each size category for 1981 and 2002. There has been a noticeable shift in

[6]There is a decennial census in 1991 but given that the land reform had largely not been implemented by that time we look at the next census.

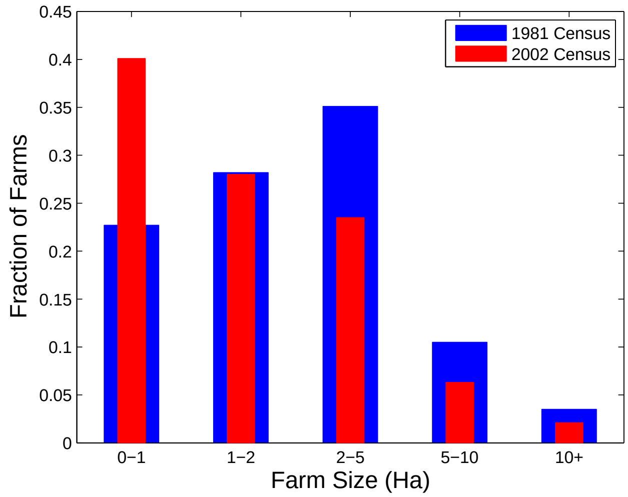


Figure 2: Changes in Farm Size Distribution - Census

the mass of farms from larger scale farms (2+ hectares) to smaller scale farms (less that 1 hectare) over 1981-2002. The share of farms under 2 hectares increases from 50.9% in 1981 to 68.1% in 2002. This is due to the fact that farms under 1 hectare almost double over the two censuses (from 22.7% to 40.1%).

In Figure 3 we plot the share of farm land operated by farms within each farm size category. While it is still the case that large farms account for a disproportionate share of land, the graph indicates a shift in land mass from larger farms (2+ hectares) to smaller farms (0-2 hectares). In 2002 25.5% of land is concentrated in farms under 2 hectares, whereas in 1981 this share was 16%.

3.3 Survey Micro Data

In the PCCP survey data 448 households were interviewed in four rounds over 1984-85 (just before the reform). Then the original households and their children were interviewed again in five rounds (seasons) over 2003-04.[7] Although the number of farms is much more limited than in the census, it

[7]Bouis and Haddad (1990) contains a detailed description of the project and an analysis of the 1984-85 data.

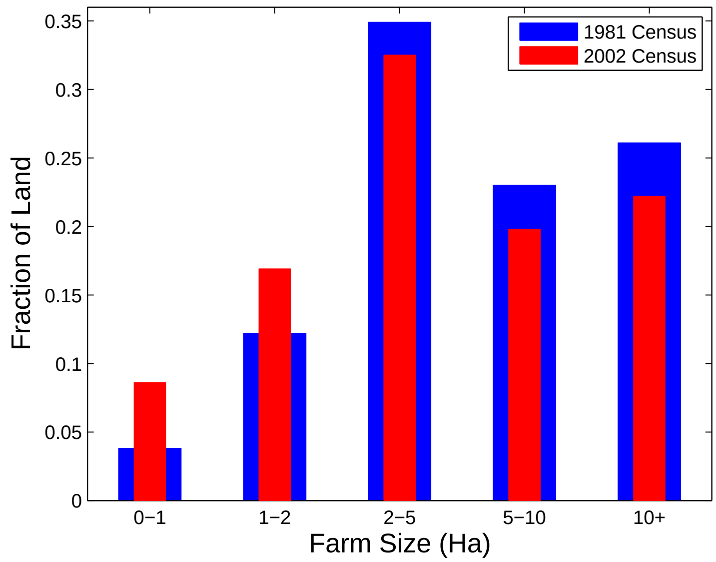


Figure 3: Changes in Land Share by Size - Census

tracks the same set of households before and after the reform. The survey offers a wealth of information, with precise and detailed measurement of inputs and outputs at the parcel and farm level.[8] There are two important benefits of using this data for production-unit productivity calculations. First, in contrast to many establishment-level studies that have access only to information on sales and input expenditures by establishment, we observe quantities and prices of outputs and inputs separately at the parcel-level. This allows us to obtain more precise measures of real productivity without having to resort to using industry-level deflators. Second, the unit of observation is at the parcel level with information on which parcels are operated by which households. As a result, we are able to accurately aggregate productivity up to the farm-level.

We use the PCCP survey data in order to understand how the land reform affects productivity at the farm level. In particular, how does the land reform alter the farmer's allocation of resources across activities within the farm? This within-farm effect, in combination with the more obvious

[8]This survey provides rich data not only on production, but also on consumption and nutrition patterns of households, as the primary purpose of the survey was to study the effect of agricultural commercialization on nutrition.

reallocation effect, allow us to get a better handle of the effects of the reform for agricultural productivity in the Philippines over time.

In 1984-85, when the first rounds of the survey were conducted, the study area was primarily engaged in corn, rice, and sugarcane production plus some other crops such as bananas, cacao, rubber, coffee, pineapples, coconut. We group these crops into two categories based on the purpose of production. The first category, food crops, include corn and rice, which are produced on a semi-subsistence basis by farmers for their own consumption and for sale to the market. The second category, cash crops, are crops for which production is undertaken on a commercial scale and its primary purpose is to sell to the market and/or export. Among cash crops, the pre-dominant one in the study area is sugarcane and to a lesser extent coffee, coconut, and rubber. The dominance of sugarcane production as a cash crop was facilitated by the establishment in 1977 of a sugar mill in the area named Bukidnon Sugar Company (BUSCO), which provided farmers with the opportunity to switch from corn and rice to sugarcane production. In our sample there are farms that produce exclusively food crops, those that produce exclusively cash crops, and those that mix production between the two types. We use our data to study the allocation of resources across cash and food crops at the farm level and how the land reform affects that allocation. This crop choice decision at the farm level constitutes the "within" farm mechanism we emphasize.

To compare farm-level productivity across farms and across time (from 1984-85 to 2003-04) we use as constant prices for all farms the average 2003-04 crop and intermediate input prices to calculate value added. By fixing prices to their averages across farms in 2003-04, we are effectively purging the effect of price changes from changes in value added. Thus our reported changes in value added reflect real changes. Productivity by farm in 1984-85 is calculated as the weighted average of productivities over the four rounds in that first wave of the survey. Similarly, productivity by farm in 2003-04 is calculated as the weighted average of productivities over the five seasons in this second wave of the survey.

Table 2: Percentage of Farms By Crop and Size

	1984-85	2003-04
All Crops	100	100
<5 Ha	77.8	84.4
5+ Ha	22.2	15.6
Cash Crops	61.7	73.7
<5 Ha	42.5	59.3
5+ Ha	19.2	14.4
Food Crops	38.3	26.3
<5 Ha	35.3	25.1
5+ Ha	3.0	0.2

In order to control for farmer ability and location we only focus on the farms that are present in both 1984-85 and 2003-04. This allows us to construct a two-year balanced panel, with observations for the same set of farms in each year. There are 167 farms with productivity data in both years. We group the cash crop farms and mixed crop farms together because they are similar in their characteristics. Thus it should be clear that the category "cash crop" farms includes both those that produce only cash crops and those that produce cash crops and some food crops. The category "food crops" includes those that produce only food crops. Another categorization that we emphasize is that between "small" - below 5 hectares, and "large" - above 5 hectares, where the cutoff of 5 hectares is chosen to match the ceiling in the 1988 land reform. Table 2 reports the shares of farms by crop and size in each of the two years of the panel.

There are two shifts that occurred over time that are apparent from Table 2. First, a shift from food-crop farms to cash-crop farms. Given that the set of farms is the same in each year, this indicates that some farmers switched from producing food crops to cash crops.[9] Second, there is a

[9] In 1984-85 the mixed crop farms are the biggest component of "cash crop" farms (97 out of 103). By 2003-04 mixed farms still remain the largest component of cash crop farms (76 of 123) but there is a major increase in the number of pure cash crop farms.

Table 3: Size and Productivity By Crop

	1984-85	2003-04	% change
All Farms			
Average Farm Size	3.7	3.1	-17.6
Value Added Per Work Day	257.5	372.7	44.7
Cash Crop Farms			
Average Farm Size	4.6	3.7	-19.8
Value Added Per Work Day	298.2	386.1	29.5
Food Crop Farms			
Average Farm Size	2.1	1.3	-39.0
Value Added Per Work Day	101.2	201.0	98.7

Note: Average farm size is calculated as the ratio of total land in farms within each crop category over the total number of farms in that category. Value added per work day is calculated as the total value added in constant 2003-04 input and output prices over total workdays.

shift from large scale farms to small scale farms. This is true for both types of crops. Interestingly, the number of farms over 5 ha is not eliminated. This is consistent with the census data reported above. In sum, the share of cash crop farms increased from 62% in 1984-85 to 74% by 2003-04, while the share of small farms increased from 78% to 84% over the same period.

Table 3 displays average farm size and real labor productivity by crop. Real labor productivity is measured as value added at constant 2003-04 prices over the number of work days. The number of work days is a more precise measure of labor input as it counts how many full days are worked. The total number of work days includes both family labor and hired labor. We note from Table 3 that for all farms, average farm size dropped by 18% while labor productivity increased by 45%. This is consistent with the aggregate data reported earlier. Why this happens is not obvious at first sight since the tendency is for average farm size to increase as productivity rises and labor moves out of agriculture (see for instance Adamopoulos and Restuccia, forthcoming). The other points to note from Table 3 is that in 1984-85 cash-crop farms are on average larger (more than double in average farm size) and more productive (almost 3 times more) than food crop farms. Also, average farm size falls for both types of crops while labor productivity increases for both (although these effects are more pronounced for food crop farms).

The balanced panel nature of our data allows us to observe which farms are the ones that changed their crop mix over the study period, what were their characteristics in terms of farm size and productivity, and how those characteristics evolved over time. To do this we first construct a mobility matrix in Table 4. An entry in the mobility matrix indicates, given the crop farms were producing in 1984-85, what are they producing in 2003-04? The matrix shows that 83% of those farms producing cash crops in 1984-85 are still producing cash crops in 2003-04. From those producing food crops in 1984-85, 58% switched to cash crops by 2003-04, while much less switching occurred the other way. So overall there was a shift of farmers towards cash cropping (as was seen with the summary statistics earlier).

Table 4: Crop Mobility Matrix

	2003-04	
1984-85	cash crops	food crops
cash crops	0.83	0.17
food crops	0.58	0.42

Note: Each row gives the fraction of farms producing that crop in 1984-85 that are producing each of the two crops in 2003-04. Calculations based on constructed panel from survey data.

In Tables 5 and 6 we examine for each of the four entries in the crop mobility matrix, the level and change in average farm size and productivity. Of particular interest are the characteristics of the

Table 5: Mobility Matrix – Size

AFS, 1984-85

	2003-04	
1984-85	cash cr.	food cr.
cash cr.	5.1	2.3
food cr.	2.5	1.6

AFS, % change

	2003-04	
1984-85	cash cr.	food cr.
cash cr.	-16.5	-68.3
food cr.	-5.6	1.3

Note: Calculations based on constructed panel from survey data.

Table 6: Mobility Matrix – Productivity

VA per person day, 1984-85

	2003-04	
1984-85	cash cr.	food cr.
cash cr.	317.2	95.6
food cr.	107.8	85.1

VA per person day, % change

	2003-04	
1984-85	cash cr.	food cr.
cash cr.	27.0	78.8
food cr.	162.2	150.5

Note: Calculations based on constructed panel from survey data.

farms that switched from food crops to cash crops. Tables 5 and 6 indicate that, from the food crop farms in 1984-85, it was the largest in size and the most productive among food crop farms that switched to cash cropping by 2003-04. Also these switching farms are the ones that exhibited the strongest productivity growth among all farms over the time period (largely the effect of catch-up within the cash crop).

The last observation we document from the micro data is that there do not appear to be strong selection effects on the farmers that remain in operation after the reform. So far we have focused on a balanced panel of farmers. Table 7 documents the average farm size and average labor productivity in 1984-85 for farms that exited compared to those farms that continue in the panel. Only for the top 1% of farms there are some important size effects but their productivity difference is small. This suggests that the drop in productivity after the land reform in the aggregate data is not coming from the exit of very large and productive farmers to other sectors of the economy (see the work of Bridgman, Maio, Schmitz, and Teixeira, 2012, for the case of Puerto Rico where exit from the industry was a key factor).

Table 7: Farm Size and Productivity of Exiting and Continuing Farms

	Exiting Farms	Continuing Farms
All		
Average Farm Size	2.3	3.5
Labor Productivity	242.3	254.3
Top 1%		
Average Farm Size	6.5	2.3
Labor Productivity	922.2	917.4
Top 10%		
Average Farm Size	5.2	6.7
Labor Productivity	529.5	556.7
Top 50%		
Average Farm Size	3.0	4.8
Labor Productivity	320.1	342.0

Note: Farms are sorted in descending order of productivity. "Top x%" refers to the x% most productive farms. Average labor productivity is measured as value added per work day.

4 Model

We consider an industry model of agriculture in the spirit of Lucas (1978) and Adamopoulos and Restuccia (forthcoming). A key extension of the theory is that we allow farm operators to choose a cropping technology: cash versus food crop. The motivation for this technology choice is dictated by our data discussed previously. We also extend the theory to allow for a land reform policy that closely mimics the land reform implemented in the Philippines. To make the analysis more transparent we abstract from the allocation of labor between agriculture and non-agriculture and from capital. These features are well understood in the literature and they are known to magnify the farm size and productivity impact of land reforms.[10] We instead focus on the distortionary impact of land reforms within the agricultural sector. In what follows we describe the economic environment in detail.

4.1 General Description

Technology The production unit in agriculture is a farm that requires as inputs the managerial skills of a farm operator, the land input (which defines farm size) and hired labor. There are two technologies to produce agricultural goods, which we denote as cash c and food f crops. The production of a farm unit with farmer productivity s, land input l, and hired labor n is described by a decreasing returns to scale technology:

$$y_i(s) = (A\kappa_i s)^{1-\gamma}(l^\alpha n^{1-\alpha})^\gamma, \qquad \gamma \in (0,1),$$

for each crop $i \in \{c, f\}$. The idiosyncratic productivity of farmers s is drawn from a discrete set S according to a known distribution with cdf $F(s)$ and pdf $f(s)$. We note that productivity s does not include only operator ability but also potentially other characteristics associated with the location of the farm operators such as land quality, climate etc. A is an economy-wide productivity parameter that captures aggregate factors affecting all production units. The span-of-control parameter $\gamma \in (0,1)$ and the land elasticity parameter $\alpha \in (0,1)$ are the same across the two crops. The two

[10]For a treatment of distortions to agriculture in a model with these features see Adamopoulos and Restuccia (forthcoming).

technologies differ in two dimensions: the crop-specific TFP parameter κ_i and the crop-specific fixed cost of operation C_i in units of output of the crop.

Market Structure and Occupational Choice Markets for hired labor and land are competitive. We denote the exogenous price of each crop by p_i. The rental prices of capital and hired labor are q and w. The profit of the farmer with productivity s in each crop is given by

$$\pi_i(s) = \max\{p_i y_i - wn - ql - p_i C_i\},$$

The first order conditions with respect to land and hired labor inputs imply that it is optimal for farmers in both types of crops to choose the same hired labor to land ratio regardless of size/productivity:

$$\frac{n}{l} = \frac{(1-\alpha)}{\alpha}\frac{q}{w}.$$

From the first order conditions of these problems, the input demand functions are the following:

$$l_i(s) = \left(\frac{\alpha}{q}\right)^{\frac{1-\gamma(1-\alpha)}{1-\gamma}} \left(\frac{1-\alpha}{w}\right)^{\frac{\gamma(1-\alpha)}{1-\gamma}} (\gamma p_i)^{\frac{1}{1-\gamma}} A\kappa_i s,$$

$$n_i(s) = \left(\frac{\alpha}{q}\right)^{\frac{\gamma\alpha}{1-\gamma}} \left(\frac{1-\alpha}{w}\right)^{\frac{1-\gamma\alpha}{1-\gamma}} (\gamma p_i)^{\frac{1}{1-\gamma}} A\kappa_i s.$$

Given these demands, output in each farm/crop $y_i(s)$ can be readily computed. Profits can be written as:

$$\pi_i(s) = (1-\gamma)p_i y_i(s) - p_i C_i.$$

Note that the input demand functions are linear in s and so is output. Profits are also an affine function of s. Thus, more able farmers operate larger farms, demand more labor, produce more output, and make more profits. Then, for a given distribution of managerial ability, the model implies a distribution of farm sizes.

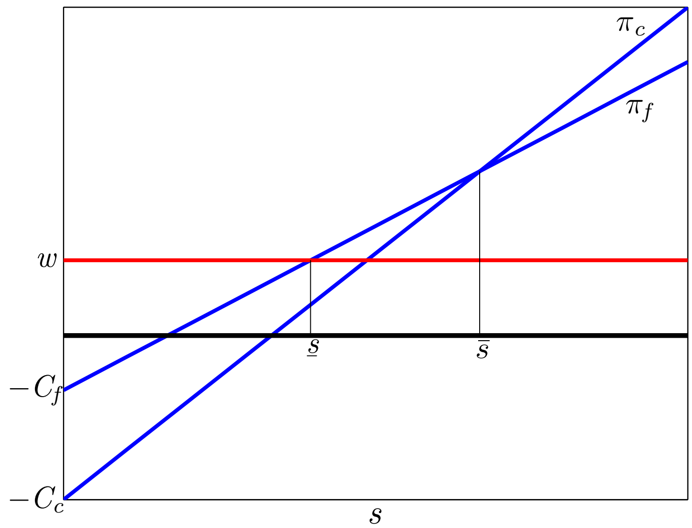


Figure 4: Occupational and Technology Choices

Given that $\pi_i(s)$ is affine in s, there are two thresholds that determine the fraction of workers, cash crop farmers, and food crop farmers. We denote the occupational choice by $o_i(s)$ with the convention that $o_i(s) = 1$ if $\pi_i \geq \max\{\pi_{-i}(s), w\}$ so that an individual with ability s chooses to operate a farm in crop i and 0 otherwise. For reasonable parameter values that are in line with the calibration ($\kappa_c > \kappa_f$ and $C_c > C_f$) the occupational choice and crop choice decisions of farmers are characterized by two thresholds $\underline{s}$ and $\overline{s}$, such that,

$$\pi_f(\underline{s}) = w,$$

$$\pi_f(\overline{s}) = \pi_c(\overline{s}).$$

In Figure 4 we show how farmers are sorted across occupations and crop technologies for this configuration of parameters and for a given wage rate. The profit function for cash crops has a lower intercept (higher fixed cost) and is steeper (higher TFP) than the corresponding food crop profit function. Then, farmers with ability below $\underline{s}$ become hired workers, farmers with ability between $\underline{s}$ and $\overline{s}$ become food farm operators, and farmers with ability above $\overline{s}$ become cash crop operators. In other words, $\underline{s}$ determines the split between workers and farmers (occupational choice decision) and $\overline{s}$ determines the split between cash and food farm operators (crop technology choice).

Definition of Equilibrium A *competitive equilibrium* is a set of prices (q, w), occupational decision rules $\{o_i(s)\}_{i \in \{c,f\}}$, and farmers decision functions $\{n_i(s), l_i(s), y_i(s), \pi_i(s)\}_{i \in \{c,f\}}$ such that: (i) Given prices, farmers optimize, (ii) given prices, o_i are optimal occupational choice decisions, and (iii) land and labor markets clear, i.e.,

$$\sum_i \int_s l_i(s) o_i(s) f(s) = L,$$

$$\sum_i \int_s n_i(s) o_i(s) f(s) = N_w,$$

where $N_w = \sum_i \int_s (1 - o_i(s)) f(s)$ is the fraction of workers in the economy.

4.2 Land Reform

We model the land reform to mimic the implementation of CARP in the Philippines as a government-mandated land redistribution program. In particular, we model the land reform to account for four key features of CARP: (1) a land ceiling; (2) imperfect enforcement (as there are farmers above the ceiling following the reform); (3) redistribution of land above the effective ceiling to both landless and smallholders; and, (4) prohibition of transfer of the redistributed lands. To account for the ban on transfers of awarded land, we make the land market inoperative. In other words, the land awarded to each farmer under the redistribution program is treated as an endowment, and farmers cannot adjust their farm size by renting in or renting out land.

We use the following parameters to model the government-mandated land redistribution program:

- Land ceiling l_{max}: the legislated maximum size of land holdings.
- Degree of enforcement $(1-\theta)$: where θ is the probability that farmers above the ceiling retain their previous farm size. This occurs mainly because there are informal arrangements among family members that permits ownership to abide by the reform while operation can remain above the threshold or simply because the implementation of the land redistribution takes time and is subject to enforcement problems.
- Landless beneficiaries ψ_0: the fraction of landless (hired workers) that receive land.
- Smallholder beneficiaries ψ_1: the fraction of smallholders that receive land.

These parameters fully determine the post-reform distribution of farms. In particular, each individual farmer of ability s is endowed with the awarded amount of land $\bar{l}$. The vector $(s, \bar{l})$ defines a farmer, who cannot adjust the amount of land used in production. The only choice variable for a farmer is the amount of hired labor n.

The production function is the same as before but now each individual is characterized by a vector $(s, \bar{l})$. The output and profit of a farmer with productivity s and land size $\bar{l}$, under crop $i \in \{c, f\}$, are given by,

$$y_i\left(s, \bar{l}\right) = (A\kappa_i s)^{1-\gamma}(\bar{l}^{\alpha} n^{1-\alpha})^{\gamma},$$

$$\pi_i\left(s, \bar{l}\right) = \max\{p_i y_i - wn - p_i C_i\}.$$

The optimal demand for hired labor by a farmer facing $\left(s, \bar{l}\right)$ is,

$$n_i\left(s, \bar{l}\right) = \left[(1-\alpha)\gamma \frac{p_i}{w}\left(A\kappa_i s\right)^{1-\gamma} \bar{l}^{\alpha\gamma}\right]^{\frac{1}{1-\gamma(1-\alpha)}}.$$

Given this labor input choice, output $y_i\left(s, \bar{l}\right)$ can be readily computed, and profits can be written as,

$$\pi_i\left(s, \bar{l}\right) = \left[1 - \gamma(1-\alpha)\right] p_i y_i\left(s, \bar{l}\right) - p_i C_i.$$

To implement the land reform and determine the land (farm size) endowment $\bar{l}$ associated with farmer idiosyncratic productivity s we proceed as follows. First, we find the set of farmers that prior to the reform had a farm size in excess of the ceiling l_{max}. We define an indicator variable z, which takes the value of 1 if $l > l_{max}$, and 0 otherwise. For potentially constrained farmers (those with $z = 1$), with probability θ they get to keep their pre-reform land holdings l, and with probability $(1-\theta)$ they can only keep farm size equal to the land ceiling l_{max}. Then, effective land holdings for any farmer that operated a farm before the reform are,

$$\bar{l}(s) = (1-z)l(s) + z\left[\theta l(s) + (1-\theta)l_{max}\right].$$

If $\mathcal{C}$ is the set of constrained farmers, then the excess land to be redistributed is,

$$\Delta\frac{L}{N} = \frac{L}{N} - \int_{s\in\mathcal{C}} \bar{l}(s) f(s) ds.$$

This extra land can be given to landless individuals (hired workers) and/or smallholders. As noted above we denote by ψ_0 the fraction of landless (those under $\underline{s}$ before the reform) that receive reformed land. We assume that when land is distributed to the landless it is given to a fraction ψ_0 of all ability types among this group (i.e., for each $s < \underline{s}$). Given that we do not target landless beneficiaries on the basis of ability, this approach is more neutral. Further, it is consistent with the actual reform, as the government had no way of assessing the farming ability of potential landless beneficiaries.[11] We assume that the fraction ψ_1 of smallholders that receive land, are the ones with the smallest farms before the reform. For simplicity we assume that every recipient of redistributed

[11] Nevertheless, we have also experimented with giving the land to the lowest ability landless, as well as the highest ability landless, and find quantitative results that are in the same ballpark.

land (landless or smallholder) receives the same amount l^*. We define a reform beneficiary indicator function $b(s)$ that takes the value of ψ_0 if $s < \underline{s}$, the value of 1 if $\underline{s} \leq s < s_1^*$, and 0 otherwise. s_1^* is determined by the parameter ψ_1 as follows,

$$F(s_1^*) - F(\underline{s}) = (\text{share of hired workers}) \cdot (1 + \psi_1).$$

Then it must be that the redistributed land exhausts the above-ceiling land of the large landholders,

$$\int_{s_{min}}^{\underline{s}} l^* b(s) f(s) ds + \int_{\underline{s}}^{s_1^*} l^* b(s) f(s) ds = \Delta \frac{L}{N}.$$

The implied land amount given to each farmer is,

$$l^* = \frac{L/N}{\int_{s_{min}}^{\underline{s}} b(s) f(s) ds + \int_{\underline{s}}^{s_1^*} b(s) f(s) ds} = \frac{L/N}{F(s_1^*) - (1 - \psi_0) F(\underline{s})}.$$

The equilibrium of this version of the model is determined by a system of two equations in two unknowns, the technology choice cutoff $\overline{s}$, and the wage rate w. The first equation is the no-arbitrage condition between operating a cash crop farm vs. a food crop farm. The marginal farmer of ability $\overline{s}$ must be indifferent between the two options,

$$\pi_f\left(\overline{s}, \overline{l}\right) = \pi_c\left(\overline{s}, \overline{l}\right).$$

The second equation is the labor market clearing condition,

$$N_w = \int_{s_{min}}^{\underline{s}} n_f(s, \overline{l}) \psi_0 dF(s) + \int_{\underline{s}}^{\overline{s}} n_f(s, \overline{l}) dF(s) + \int_{\overline{s}}^{s_{max}} n_c(s, \overline{l}) dF(s).$$

4.2.1 Government-Mandated vs. Market-Based Land Redistribution

A key feature of CARP was the ban on all transfers (rent or sale) of the redistributed lands. Our modeling of the land reform explicitly accounted for this aspect of the program. In this program, redistribution of the land above the effective ceiling took place through a government mandate, whereby the government identified and assigned the lands to be reformed, as well as facilitated the land exchanges between large landowners and recipients. To emphasize the importance of this mode of redistribution, we also implement a market-based land redistribution whereby the land in excess of the ceiling is redistributed via a rental market for land where the price of land adjusts to clear the land market. While this market assignment of land does not reflect how CARP was implemented in the Philippines, it serves to illustrate the quantitative importance of the mode of redistribution for the aggregate impacts of the reform. It also allows to ask the counter-factual question: what would have been the effect of the land ceiling alone had the land market been permitted to function following the reform?

We model the market-based land redistribution as a constraint on farm size, given by the ceiling l_{max}. Similar to the previous case farm operation cannot exceed this level although in practice there are a few farms that do. We model this aspect of the land reform as a probability θ that the operation can remain at the optimal level (dictated by the productivity of the farmer) while with probability $(1 - \theta)$ operation is at the constrained level.

We define the indicator function $c_i(s)$ to take the value 1 if the optimal demand of the farmer is potentially constrained by the ceiling limit, i.e., $c_i(s) = 1$ if $l_i(s) \geq l_{max}$ and 0 otherwise. When a farmer is constrained, land size is l_{max} and hired labor is $n_{i,max}$ given implicitly by the first order condition for hired labor with $l_i = l_{max}$. We can write land and hired labor demand functions as,

$$\hat{l}_i(s) = (1 - c_i(s))l_i(s) + c_i(s)[\theta l_i(s) + (1 - \theta)l_{max}],$$

$$\hat{n}_i(s) = (1 - c_i(s))n_i(s) + c_i(s)[\theta n_i(s) + (1-\theta)n_{i,max}],$$

and profits as,

$$\hat{\pi}_i(s) = (1 - c_i(s))\pi_i(s) + c_i(s)[\theta \pi_i(s) + (1-\theta)\pi_i^{l_{max}}(s)],$$

where $\pi_i^{l_{max}}(s)$ is the profit associated with the constraint $l = l_{max}$. Then the occupational choice decisions are $\hat{o}_i(s) = 1$ if $\hat{\pi}_i(s) \geq \max\{\hat{\pi}_{-i}(s), w\}$ and 0 otherwise.

The market clearing conditions in this case are,

$$\sum_i \int_s \hat{l}_i(s)\hat{o}_i(s)f(s) = L,$$

$$\sum_i \int_s \hat{n}_i(s)\hat{o}_i(s)f(s) = N_w.$$

where N_w is the share of hired labor in the economy, i.e., $N_w = \sum_i \int_s (1 - \hat{o}_i(s))f(s)$. Hence, the market-based land reform affects not only land demand directly, but indirectly also affects hired labor, and occupational choice decisions of all farmers through general equilibrium effects.

5 Quantitative Analysis

5.1 Calibration

We calibrate a benchmark economy without any restriction on farm size to pre-reform Philippines, using the 1984-85 survey data from the balanced panel. The parameters to be calibrated are: technological parameters $\{A, \kappa_c, \kappa_f, C_f, C_c, \alpha, \gamma, \{s\}\}$, parameters of ability distribution, and the land endowment L. Some parameter values are chosen based on a priori information, while others are solved for as part of the solution to the model's equilibrium in order to match targets in the data. The model parameters along with their targets and calibrated values are provided in Table 8.

Table 8: Parameterization

Parameter	Value	Target
Technological Parameters		
A	1	Normalization
κ_f	1	Normalization
p_c/p_f	1	Normalization
γ	0.7	span-of-control
α	0.3	land income share
κ_c	1.21	Ratio of average crop productivities
C_f	-0.56751	Share of hired labor in total farm labor
C_c	-0.51119	Share of cash crop operators in total operators
Parameters of Ability Distribution		
μ	-0.85714	Size distribution
σ	1.25	Size distribution
Land Endowment		
L	1.4393	Average farm size

We choose the distribution of farmer ability to match the distribution of farm sizes in the 1984-85 survey data.[12] The distribution of farmer ability is approximated by a log-normal distribution with mean μ and variance σ^2. We approximate the set of farmer abilities with a linearly spaced grid of 6000 points in $[s_{min}, s_{max}]$, with s_{min} close to 0 and s_{max} equal to 15 which ensures a maximum sized farm of 23 hectares, the largest farm in our panel in 1984-85. Our calibration involves a loop for the parameters of the productivity distribution: given values for (μ, σ), we construct a discrete approximation to a log-normal distribution of ability and solve the model matching the rest of the targets. The model then implies a distribution of farm sizes. We choose (μ, σ) to minimize the distance between the size distribution of farms in the model relative to the data.

[12]Since the ability of farmers is important for the quantitative effect of redistribution in this economy, there could be a potential bias in our results arising from calibrating an economy with no distortions to data of the Philippines prior to the land reform. We note, however, that if this bias is present, it is likely to underestimate the negative productivity impact of the reform. This is because, as emphasized in Adamopoulos and Restuccia (forthcoming), distortions affecting farm size tend to compress the size distribution of farms which result in a flatter relationship between labor productivity and farm size.

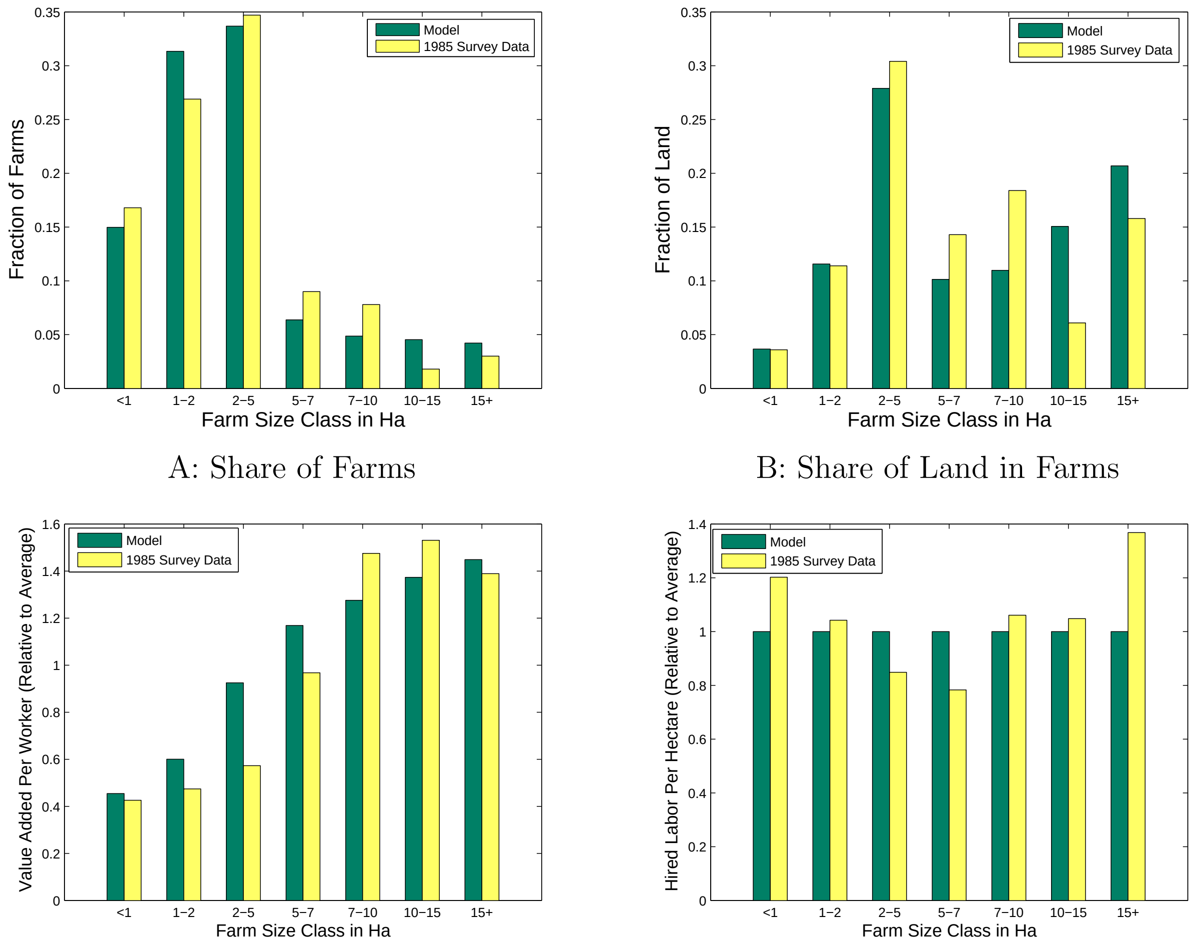
We normalize economy-wide productivity A and the food crop-specific productivity κ_f to 1 for the benchmark economy. Given that the two crop prices are exogenous in our formulation we normalize their prices to unity. We set the span-of-control parameter to 0.7 and then choose α to match a land income share of 20%. The aggregate land endowment is chosen to match a pre-reform average farm size of 3.7 hectares from the panel data for 1984-85. We then choose the remaining parameters, the two fixed operating costs (C_f, C_c) and the cash crop TFP κ_c, to match three targets in the pre-reform round of the survey: (1) a share of hired labor in total farm labor of 61.1%; (2) a share of cash crop operators in total operators of 61.7%; and (3) a ratio of average output per worker between cash crops and food crops of 2.95.

The calibrated model does well in matching the pre-reform farm-size distribution from the survey data, by choice of the parameters of the ability distribution (see Figure 5, Panel A). The model matches well other aspects of the data that were not targeted in the calibration. In particular, the model accounts well for the distribution of land, e.g. it reproduces the observation that about 45% of the land is in farms of less than 5 hectares (see Figure 5, Panel B). The model is also consistent with the positive relationship between labor productivity and farm size observed in the survey data (see Figure 5, Panel C). Finally, the model is consistent with the absence of a systematic relationship between the hired labor to land ratio and farm size (see Figure 5, Panel D). In the model this occurs because every farmer chooses the same hired labor to land ratio due to the Cobb-Douglas nature of the production technology.

5.2 Quantitative Results

The main quantitative experiment we conduct is the following. From the benchmark economy calibrated to pre-reform Philippines, we implement a land reform following CARP as the government-mandated land redistribution program described in Section 4.2. We first study the size and pro-

Figure 5: Calibrated Model versus Data by Size



A: Share of Farms

B: Share of Land in Farms

C: Value Added Per Worker

D: Hired Labor per Hectare

ductivity effects of CARP on impact as if this is the only change occurring in the economy. We also vary the enforcement parameter θ to gauge its quantitative importance on the magnitude of the size and productivity effects. We then analyze the importance of the mode of redistribution, by comparing the results from CARP to an alternative market-based land redistribution. Here, we also study the mechanisms through which the two reforms impact size and productivity. Finally, we consider the effects of CARP together with other aggregate changes occurring at the same time. This is important to consider, as the implementation of land reforms takes time, and as a result often the pre- and post-reform analysis includes a period of ten years or more.

5.2.1 Aggregate Effects of Land Reform

The implementation of CARP as a government-mandated land redistribution program requires the determination of four parameters: the ceiling l_{max}, the degree of enforcement $(1-\theta)$, and the fractions of the landless ψ_0 and smallholders ψ_1 that are recipients of land. We set the ceiling equal to the legislated level of 5 hectares. We choose θ to match the farm-size distribution above 5 hectares after the implementation of the reform. This target implies $\theta = 0.8$. Note, that this value of θ implies a fairly lax enforcement of the reform which as discussed earlier includes not only effective enforcement but also any other formal or informal arrangement allowing the farm scale operation to remain above the established ceiling. We choose ψ_0 and ψ_1 to closely match the share of farms under 1 hectare and the share of farms in the $1-2$ hectares bin after the reform. Note, that we do not allow farmers with farm size above 3 hectares to receive land, as 3 hectares was the legal ceiling for recipients of redistributed land as explained above. We find that $\psi_0 = 0.33$ and $\psi_1 = 0.08$ most closely match those bins in the post-reform farm-size distribution. The implied amount of land given to each beneficiary is $l^* = 0.34$ hectares.

In the first column of Table 9 we report the aggregate effects that result from the government-mandated land redistribution program calibrated to CARP, in terms of changes in average farm size, agricultural productivity, and the share of landless in the economy. In the model the share of landless is equivalent to the share of hired workers. In the second column we report the aggregate changes for the Philippine economy before and after the reform. The percentage change in average farm size results from comparing this statistic in the 1981 Census to the 2002 Census. The change in agricultural productivity is over 1989-1993 based on aggregate data from the Bureau of Agricultural Statistics in the Philippines (reported in Section 3.1). The change in the share of landless in the economy is calculated as the total certificates of land ownership awarded under CARP by 2007 (World Bank, 2009), as a share of total agricultural employment in 1991 (1991 Census of Agriculture).

Table 9: Aggregate Changes of Land Reform

	Government-mandated Land Redistribution	Data
Average Farm Size	-34.2	-29.6
Agricultural Labor Productivity	-17.0	-11.6
Share of Landless	-20.0	-19.0

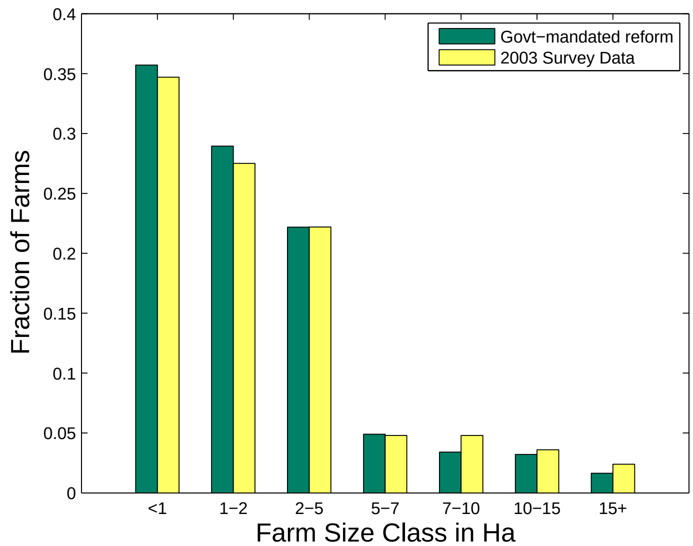
Note: Average farm size and labor productivity in agriculture are reported as percentage (%) changes relative to their pre-reform values (in the benchmark economy). The share of landless is reported as the absolute change relative to its benchmark value. Data: change in average farm size from Census of Agriculture (1981, 2002); change in agricultural productivity 1989-93 from Bureau of Agricultural Statistics, Philippines; change in share of landless calculated as share of certificates of land ownership awarded in total agricultural employment in 1991.

From Table 9 we observe that after imposing the land reform, average farm size, agricultural productivity, and the share of landless in the economy all drop. Further, these changes are close to the changes observed in the data for the Philippines in the period after the reform. In the model, farm size and productivity fall because of: (a) the government reassignment of land from large-productive operators to small-less productive smallholders and landless, and (b) the induced selection effects. The large drop in the share of landless is due to the fact that they are largely the beneficiaries of the reassigned land. While not reported in the table, we also note that the model has implications for the ex-post welfare of the beneficiaries of the reform. In particular, we find that the average income of smallholder beneficiaries increases by 13.3% following the reform, while that of the landless drops by 9.4%. The reason that the landless are worse off is that each landless receives a small amount of land in the reform, and as a result each would have been better off as a hired worker.

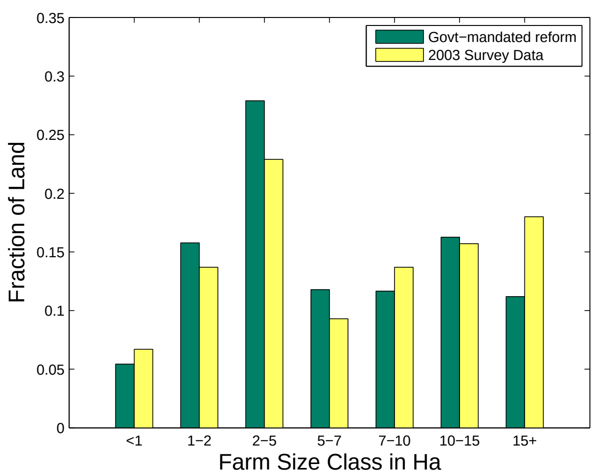
5.2.2 Distributional Implications of Land Reform

Our quantitative model allows us to examine the micro-level implications of the theory against the corresponding statistics in the data. In Table 9 we do not report the changes in these variables in the survey panel data. The reason is that we only observe the post-reform values in 2003-04. Over the period 1984-2003 there are several other changes that have occurred besides the reform (as we discuss below) which could mask the effects of the reform. In fact, we know from Section 3 that average productivity increased over 1984-2003. We can however examine the distributional implications of the reform for the number of farms, the amount of land, and value added per worker by farm size category. Farms and land are expressed as shares, and value added per worker is calculated relative to the average. This allows us to make comparisons between the model and the data, in spite of the aggregate changes. We report the distributional properties of the government-mandated land redistribution in Figure 6, along with the corresponding distributions from the 2003-04 round of the survey panel. Given the parameterization of the reform the model accounts well for the farm-size distribution in the post-reform period (Figure 6, Panel A). However, the model also does well in accounting for the 2003-04 distributions of land shares and relative labor productivity by farm-size (Figure 6, Panels B and C) in the survey data.

Panel A: Farm-Size Distribution



Panel B: Land Share by Farm Size



Panel C: Value Added per Worker

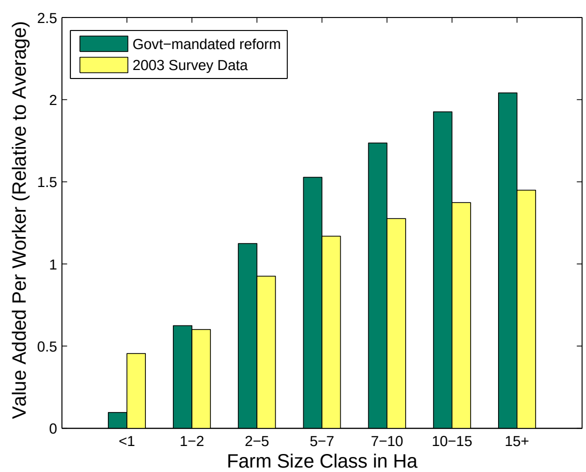


Figure 6: Distributional Properties of Government-Mandated Land Redistribution

5.2.3 Importance of Enforcement of Reform

In the baseline experiment the value of θ required to account for the farm-size distribution above the legislated 5 hectare ceiling, implied a fairly lax enforcement of the reform. What would the size and productivity effects of CARP be if the reform was enforced more strictly? In Table 10 we show the effects of the government-mandated land redistribution program in our model for varying levels of θ. The first column provides the results of the baseline experiment. A lower θ implies stricter enforcement, with $\theta = 0$ being the case of perfect enforcement. The results indicate that the magnitude of the drops in productivity and average farm size are larger the greater the degree of enforcement. A stricter enforcement of the reform could have lead to considerably greater losses in size and productivity, as high as 47% in farm size and 34% in productivity. These are substantial impacts for any single policy to generate.

Table 10: Impact of Enforcement

	Enforcement			
	$\theta = 0.8$	$\theta = 0.4$	$\theta = 0.1$	$\theta = 0$
Average Farm Size	-34.2	-39.2	-42.5	-46.5
Ag. Labor Productivity	-17.0	-22.6	-27.5	-34.2

Note: Average farm size and labor productivity in agriculture are reported as percentage (%) changes relative to their pre-reform values (in the benchmark economy).

We note that in terms of welfare, both the landless and the smallholders are better off in the case of full enforcement. After the reform the average income of smallholders increases by 38.1%, while that of the landless by 7.4%. The reason the landless are better off here is that full enforcement of the ceiling results in much more above-ceiling land for redistribution, increasing the amount of land awarded per beneficiary. However, we note that this is precisely the case in which productivity drops the most.

5.2.4 Importance of Mode of Redistribution

In the baseline experiment the land market is inoperative as per the provisions of CARP. Here we contrast the aggregate changes induced by the baseline government-based redistribution to those induced by a market-based redistribution program, that imposes the same ceiling but in which the land market is operative. In the market-based redistribution the land in excess of the ceiling is redistributed through the market, whereby the rental price of land adjusts to clear the land rental market. While average farm size and aggregate labor productivity fall under the market-based reform, these drops are considerably less pronounced than those induced by the baseline government-mandated redistribution (less than 1/3). It is not surprising that under the market mode the effects are smaller since conditional on the ceiling the market efficiently allocates land for those under the ceiling and this allocation is regulated through adjustments in the rental price of land. In particular, the excess land above the ceiling leads to a drop in the rental price of land which would induce those previously under the ceiling to increase their farm size. Even though the market-based redistribution is less obtrusive than the government assigned mode, the ceiling is still distortionary as it restricts farm growth for the more talented farmers, and "artificially" props-up less productive farms.

Table 11: Impact of Redistribution Mode

	Government-mandated Land Redistribution	Market-based Land Redistribution
Average Farm Size	-34.2	-9.3
Agricultural Labor Productivity	-17.0	-5.0
Share of Landless	-20.0	-4.0

Note: Average farm size and labor productivity in agriculture are reported as percentage (%) changes relative to their pre-reform values (in the benchmark economy). The share of landless is reported as the absolute change relative to its benchmark value.

The fact that the market-based redistribution cannot account for the reality of the CARP in the

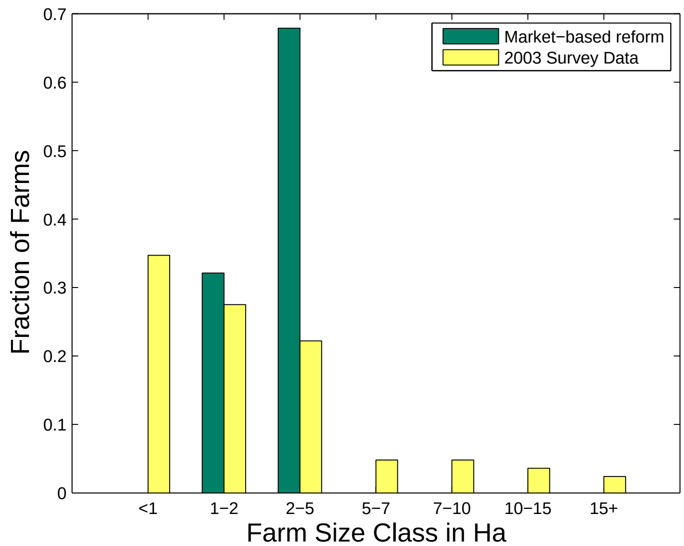
Philippines is further confirmed by the distributional implications of this mode of redistribution. In Figure 7 we show the distributional properties of the reform for the number of farms (Panel A), the amount of land (Panel B), and value added per worker (relative to average) (Panel C) by farm size category, against the corresponding distributions in the 2003-04 survey data. This figure is the counterpart to Figure 6 in the baseline government-mandated redistribution mode. In contrast to the Philippine government-mandated reform, the market-based one cannot account for the post-reform distributions. The reason is that the ceiling on farm size in combination with the adjustment in rental price of land induces a concentration of farms in the 1-2 and particularly 2-5 hectare bins under the ceiling.

5.2.5 Mechanism and Decomposition

Our model allows us to dig deeper into the channels through which productivity and farm size change with the land reform. We describe the mechanism and provide intuition for the sources of the drop in agricultural productivity in the baseline government-mandated land redistribution. We focus on average productivity by crop (food vs. cash) and the allocation of labor across crops and occupations (operator vs. hired worker). We present the results of this breakdown in the first column of Table 12. To show how the mechanism of the government-based redistribution works differently from the market-based redistribution, in the second column we provide the same statistics for the market-based mode.

In the government-mandated land redistribution, farm size is not a choice variable for any farmer. The government reassigns the land of large landowners (those above the effective ceiling), to some of the landless (fraction ψ_0) and some of the smallholders (fraction ψ_1). While the total amount of land expropriated balances with the total amount of land redistributed there is no rental price of land to regulate the allocation of the resource. This land reassignment from large-productive units to small-less productive ones reduces aggregate farm size and productivity. The fraction of landless

Panel A: Farm-Size Distribution



Panel B: Land Share by Farm Size

Panel C: Value Added per Worker

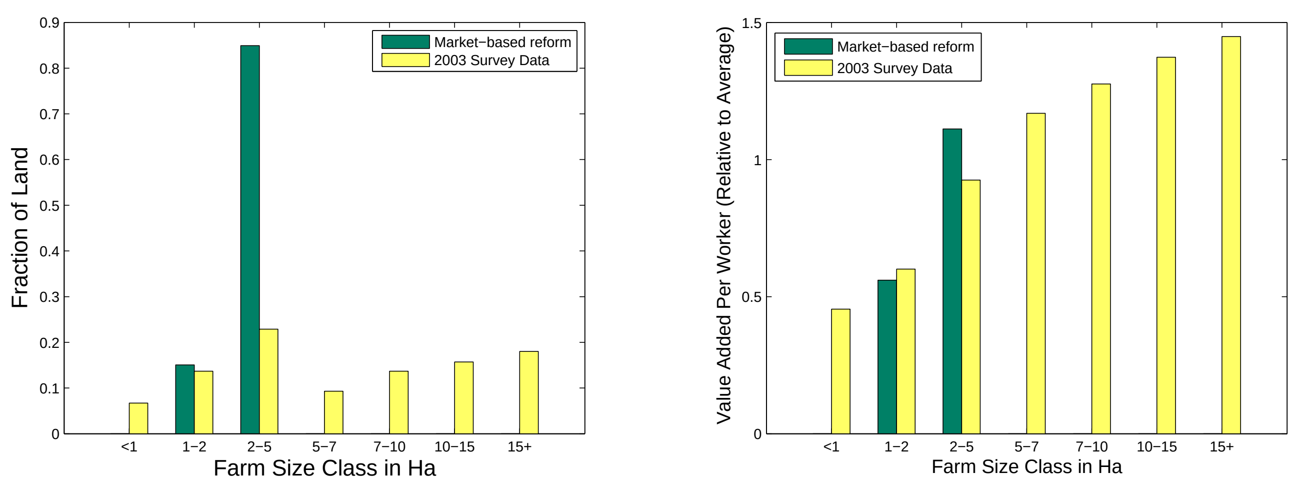


Figure 7: Distributional Properties of Market-based Land Redistribution

Table 12: Accounting for Productivity

	Government-mandated Land Redistribution	Market-based Land Redistribution
Agricultural Labor Productivity	-17.0	-5.0
Output per Worker - Cash Crops	10.1	-6.9
Output per Worker - Food Crops	-31.0	3.3
Share of Hired Workers	-20.0	- 4.0
Share of Cash Crop Operators	-3.6	5.0
Share of Food Crop Operators	24.0	-1.0

Note: Labor productivity in agriculture, food crops, and cash crops is reported as a percentage (%) change relative to the corresponding pre-reform value. The shares of hired workers, food crop operators and cash crop operators are reported as absolute changes relative to the benchmark values.

that are beneficiaries of the reform operate food crop farms. This selection into food crops leads to a big drop in average labor productivity in food crops because of the influx of many low ability farmers. At the same time, the reduced supply of hired labor leads to an increase in the real wage rate, reducing profits of any farmer $(s, \bar{l})$, under both technologies. However, for a given $(s, \bar{l})$ the increase in w reduces the profits of the cash crop technology more than the food crop technology (since $\kappa_c > \kappa_f$). This increases the upper cutoff $\overline{s}$ implying a switch in technology from cash to food crop. However, this effect is fairly small and as result has no large impact on average productivity in food crops. The switch of low ability cash croppers to food crops raises average productivity in cash crops, as the lower ability food croppers "exit."

The intuition for the market-based reform works quite differently since conditional on the ceiling all the effects operate through markets. The ceiling reduces farm size for all constrained farmers, i.e. those with a farm operation previously above the ceiling (direct effect). Constrained farmers also reduce their demand for hired labor. The oversupply of land and labor in the land and labor markets respectively tend to reduce both the rental price of land and the wage rate. As factor inputs are now cheaper, unconstrained farmers increase their demand for hired labor and land (general equilibrium effect). For a given allocation of hired workers-operators (i.e., given $\underline{s}$) the decrease in factor prices raises the profits for all food crop farmers while reducing the return to being a hired worker. This implies an increase in the number of operators and a decrease in the number of hired workers. For a given allocation of food crop operators - cash crop operators (i.e. for a given $\overline{s}$) and for given decreases in factor prices, profits increase for both food crop farmers and cash crop farmers but increases more so for cash crop farmers (because $\kappa_c > \kappa_f$). That is, some food crop operators switch to cash crops. The influx of low ability operators (previously landless) in food crops, and the "exit" of the more able food crop farmers to cash crops, tend to dampen productivity in food crops. But these food crop farmers are the ones that are less likely to be constrained. Due to the general equilibrium effect of the decrease in w and q they hire more and produce more. Here this positive productivity effect dominates the effect of selection and food crop farming productivity increases in equilibrium. The flow of low ability operators in cash cropping and the constraint on size dampen average productivity in cash crops.

We summarize these impacts on aggregate productivity into two effects. First, the misallocation effect, which involves the reallocation of farming activity from large-productive farmers to pre-existing smaller-less productive farmers. Second, the selection effect, which involves the changes in the cut-off levels of productivity that determine the splits between operators vs. hired workers and between cash crop vs. food-crop operators. The misallocation effect captures the distortion in the allocation of aggregate resources across a given set of operating production units. The selection effect captures the distortions in the entry and technology choice decisions of farmers. These effects combined summarize the aggregate impact of reallocation on agricultural productivity due to the land reform. To decompose the overall effect on productivity into the misallocation and selection effects, we run the following counterfactual experiment: what would the effect be on productivity if we precluded the occupational and crop allocations to change, that is, if reallocation across pre-existing operators was the only channel through which productivity was changing. The results of this experiment are reported in Table 13 for the Philippine government-mandated redistribution, as well as the market-based one. We find that under the baseline government-mandated redistribution the bulk of the effects is coming through selection and, in particular, the entry of a large mass of previously landless unproductive farmers. In other words, most effects are coming through a distortion of the entry decisions. Misallocation of resources across production units accounts for only 6.5% of the overall productivity drop. In contrast, under the market-based redistribution we find that the misallocation channel accounts for 60% of the overall productivity drop. The reason for this difference is that under the market-based mode the change in the rental price of land induces adjustments in farm size for all farmers with those above the ceiling downwards and those below upwards. Under the Philippine government-mandated reform farmers below the ceiling, for the large part, are allowed to keep their previous farm size (with the exception of the very small-holders who receive some additional land as part of the reform), and the reformed land is largely reassigned to the previously landless.

Table 13: Agricultural Productivity Decomposition

	Government-mandated Land Redistribution	Market-based Land Redistribution
Total Effect	-17.0	-5.0
Misallocation Effect	-1.1	-3.0
Selection Effect	-15.9	-2.0

Note: Effects on agricultural labor productivity are reported as percentage (%) changes relative to their pre-reform values (in the benchmark economy).

5.2.6 Other Factors

A key feature of land reforms is that they take time to implement. The land reform experiments show that aggregate agricultural productivity falls following the reform. In fact, in the aggregate data in the period right after the reform productivity does fall. However, over a longer horizon productivity increases. For example, in the aggregate data agricultural labor productivity increases a total of 17.3% over 1989-2004. Our micro data indicate that for the set of farms in our panel average productivity increased 44.7% over 1984-2003. How do these results square with the fall in agricultural productivity we find? We argue that in the time series data, whether aggregate or micro, there are other changes that have occurred besides the land reform, which are also impacting agricultural productivity and, as a result, can confound the negative productivity effects of the reform. For example, there is general growth in the economy and there are growth-enhancing changes that are specific to agriculture. The key is to measure these factors in the data and capture them in the model to assess their quantitative effects alongside the reform.

We examine two sets of factors. First, non-agricultural productivity increased over the period 1988-2004 by almost 10% (Groningen Growth and Development Centre, 10-Sector Database, Philippines). In the model, we capture this growth in the rest of the economy through an increase in economy-wide TFP A, which affects all production units operating any technology. Second, a major trend within Philippine agriculture in general, and in our survey data in particular, is the adoption of high-yield-variety seed for rice, corn, and sugarcane. The high-yield-variety seed has large productivity gains for farmers relative to conventional seed. The FAO reports gains in terms of average yield for rice, between high-yield and conventional varieties as high as 65% for the Philippines in the 1990s (FAO, 2000). In the model, we capture the adoption of high-yielding varieties of seeds for all crops as increases in the technology-specific productivity parameters for each crop κ_f, and κ_c. We first feed in a 10% increase in economy-wide TFP A in addition to the land reform and examine the size and productivity effects. These results are reported in the second column of Table 14. The first column contains the effects of the land reform alone. We then increase κ_f and κ_c by 65%, in addition to the increase in A, and the land reform. These results appear in the third column of Table 14. We also report the size and productivity effects that would result from the market-based redistribution along with these other changes. The comparison serves to illustrate the importance of the government-mandated nature of the reform in generating the overall changes in size and productivity observed over time.

The results show that the increase in A, and κ_f, κ_c, along side the reform leads to a reversal of the negative productivity effects imparted by the reform alone. While this is true under both the government-assignment mode and the market mode, under the market mode the overall effect ends up being strongly positive (as it starts from a much smaller negative reform impact). What is important to note however, is that under the market-based redistribution the effect on farm size is also reversed as it moves in the same direction as productivity. In the government-mandated reform the negative effect of the reform on size remains intact. The baseline government-mandated reform can therefore reconcile a positive trend in productivity over a longer horizon with a negative effect on farm size. The standard model with complete markets cannot account for a drop in farm size with a substantial rise in productivity. We conclude from these experiments that other changes occurring in the economy and/or the agricultural sector can mask the negative effect of the reform on productivity, and that the government-assignment of lands is key for breaking the positive relationship between farm size and productivity.

Table 14: Effect of Land Reform and Additional Factors

	Land Reform	$+\uparrow A$	$+\uparrow \kappa_f, \kappa_c$
Government Redistribution			
Average Farm Size	-34.2	-34.2	-34.2
Agricultural Productivity	-17.0	-14.5	-0.5
Market Redistribution			
Average Farm Size	-9.3	-7.1	4.7
Agricultural Productivity	-5.0	- 1.5	18.0

Note: Labor productivity in agriculture is reported as a percentage (%) change relative to the corresponding pre-reform value. Average farm size is reported as a percentage (%) change relative to the corresponding pre-reform value.

We also want to examine not only the overall change in productivity but also the time path after the reform. Note that our model is static (no dynamic decision made by farmers). In order to

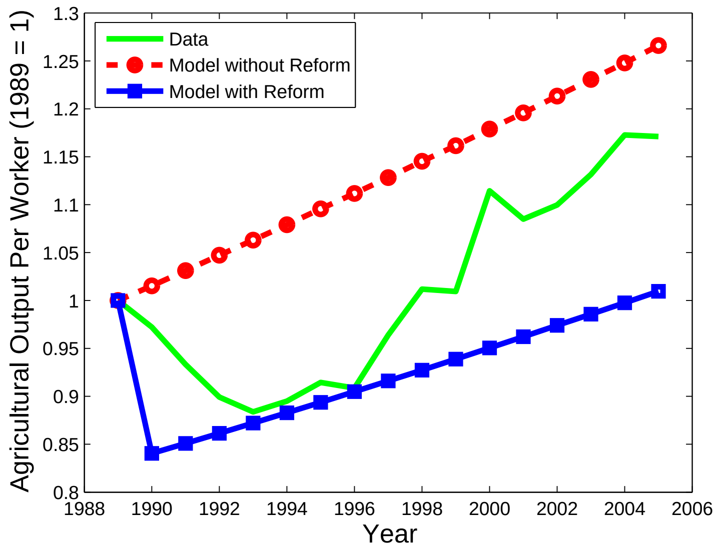


Figure 8: Land Reform and Other Factors

study the time series we run the model as a sequence of static problems, where in each period the only parameters that we vary are (A, κ_f, κ_c). We construct the time path of each parameter over 1989-2005, using their initial values in the calibration, and augmenting them each period by the average annualized growth rate implied for a total growth in A of 10%, and total growth in (κ_f, κ_c) of 65% over the entire period. In Figure 8 we show the results for aggregate labor productivity, under the baseline government-mandated land redistribution along with the actual data. We also repeat the experiment with our benchmark model without reform, but with the same time paths for (A, κ_f, κ_c). The results are stark: in the absence of the reform, productivity would have increased much more than it actually did. Furthermore, ignoring the reform could not account for the strong drop in agricultural productivity over the period 1989-1993. Note that the reform has not only a level effect but also a growth effect: the productivity path in the absence of the land reform is steeper than with the reform (the annual growth rate with the reform is 1.2% vs. 1.5% without the reform). Given that land reforms take time to be implemented and time series data can confound a number of different factors besides actual policy changes, it is crucial to be able to isolate other factors from the reform in order to properly assess the size and productivity effects of land reforms.

6 Conclusions

We studied the effects on farm size and agricultural productivity of the 1988 government-mandated land reform in the Philippines using a quantitative model and micro-level data. In our quantitative theory the land reform depresses agricultural productivity by reallocating land from large to existing small farms (misallocation effect) and by distorting the occupational choice and technology choice decisions of farmers (selection effect). Our model and micro data have allowed us to quantitatively evaluate: (a) the overall impact of the reform alone; (b) the channels through which the reform impacts productivity (across-farm vs. within-farm changes); (c) the importance of each of the components of the reform (ceiling, enforcement, government-assignment of land and ban on land transfers); (d) the importance of other changes occurring in the economy in parallel to the reform.

We showed that in our model overall the land reform reduced average farm size by 34% and agricultural productivity by 17%. These effects were primarily due to the distortions in the decisions of farmers across occupations and technologies, in particular the large reassignment of land to previously landless farmers. A stricter enforcement of this reform could have generated considerably larger drops, as high as 47% in size and 34% in productivity. If redistribution had occurred through the market the effects on size and productivity would have been considerably smaller, less than 1/3 of those generated under the government-assignment of land and the ban on land transfers. We also find that, given that reforms take time to implement, other changes occurring in the economy over time, such as general growth and the adoption of high-yield varieties in agriculture, would tend to mask the effects of the reform in time series data. Measuring and assessing quantitatively the contribution of other factors on productivity growth such as the reduction in protectionism, the improvement in transportation infrastructure, or the more intensive use of intermediate inputs would be interesting.

While our analysis has focused on the institutional detail of the Philippine land reform in order to exploit the micro-level data, we think our conclusions have implications for other countries as well, as many of the features of the Philippine land reform are shared by many reforms in the developing world. Importantly, our analysis sheds light on the components of the reform that are more costly in terms of productivity, which could provide guidance for policymakers. Specifically, we conclude that policies and institutions that impede the operation of the land market could prove particularly detrimental when accompanying land reforms. A well functioning rental market for land can mitigate the productivity effects of imposing a ceiling on farm size. In terms of welfare, we find that while smallholder beneficiaries of the reform are always better off, the landless beneficiaries are better off only when the land awarded per beneficiary is sufficiently large (over 1.5 hectares).

We caution that our analysis has focused on the pure productivity effects of land reforms. However, land reforms are often justified on grounds other than productivity: promote equity, reduce poverty, secure nutrition of land-poor, correct social injustices, avert social unrest, all features from which we abstract in our analysis. Assessing the different economic and political costs and benefits and weighing their importance against the potential productivity losses is an area in which more work is needed in the future. Also, studying the impact of other agricultural reforms such as tenancy reforms or changes in land administration would be fruitful.

Our work demonstrates that land reforms in the presence of inefficient land markets can be an important source of misallocation and productivity losses in agriculture in developing countries. We see benefits to be reaped by studying in more contexts establishment-level policies coupled with factor market frictions both in agriculture as well as other sectors of the economy, for both developed and developing countries.

References

Adamopoulos, T. (2008), "Land Inequality and the Transition to Modern Growth." *Review of Economic Dynamics* 11(2), 257-282.

Adamopoulos, T. (2011), "Transportation Costs, Agricultural Productivity, and Cross-Country Income Differences," *International Economic Review* 52(2), 489-521.

Adamopoulos, T., and D. Restuccia (forthcoming), "The Size Distribution of Farms and International Productivity Differences," *American Economic Review*.

Banerjee, A. V. (1999), "Prospects and Strategies for Land Reforms," in B. Pleskovic and J. Stiglitz (eds), *Annual World Bank Conference on Development Economics 1999*, Washington, DC, World Bank, 253-84.

Banerjee A., P. Gertler, and M. Ghatak (2002), "Empowerment and Efficiency: Tenancy Reform in West Bengal," *Journal of Political Economy* 110(2), 239-280.

Berry, R.A. and W.R. Cline (1979), *Agrarian Structure and Productivity in Developing Countries*, Baltimore: Johns Hopkins University Press.

Besley, T., and R. Burgess (2000),"Land Reform, Poverty Reduction, and Growth: Evidence from India," *Quarterly Journal of Economics*, 389-430.

Binswanger-Mkhize, H.P., C. Bourguignon, and R. van den Brink (2009), "Agricultural Land Redistribution: Toward Greater Consensus," World Bank, Washington D.C.

Borras, S.M. (2003), "Inclusion-Exclusion in Public Policies and Policy Analyses: The Case of Philippine Land Reform, 1972-2002," *Journal of International Development* 15, 1049-1065.

Bouis, H.E., and L.J. Haddad (1990), *Agricultural Commercialization, Nutrition, and the Rural Poor: A Study of Philippine Farm Households,* Boulder, Colorado, U.S.A: Lynne Rienner.

Bardhan, P., and D. Mookherjee (2007), "Land Reform and Farm Productivity in West Bengal," Mimeo, University of Boston.

Bridgman, B., M. Maio, J. Schmitz, and A. Teixeira (2012), "Why Has Puerto Rico Performed So Poorly? Lessons from Its Sugar Manufacturing Industry," Staff Report 477, Federal Reserve Bank of Minneapolis.

Buera, F., J. Kaboski, and Y. Shin (2014), "Macro-Perspectives on Asset Grants Programs: Occupational and Wealth Mobility," *American Economic Review: Papers and Proceedings*, forthcoming.

Carter, M.R. (1984), "Identification of the Inverse Relationship Between Farm Size and Productivity: An Empirical Analysis of Peasant Agricultural Production," *Oxford Economic Papers* 36, 131-145.

Caselli, F. (2005), "Accounting for Cross-Country Income Differences", *Handbook of Economic Growth, Volume 1*, P. Aghion and S. Durlauf (eds.), Elsevier, Ch. 9, 679-741.

Cornia, G.A. (1985), "Farm Size, Land Yields and the Agricultural Production Function: An Analysis for Fifteen Developing Countries," *World Development* 13(4), 513-534.

FAO (2000), "Yield Gap and Productivity Decline in Rice Production," Food and Agricultural Organization, United Nations. See Chapter "High-yielding technologies for increasing rice production in the Philippines," S.R. Obien, E.D. Redona, S.R. Francisco, P.Alviola IV, and L.S.Sebastian.

de Janvry, A. (1981), "The Role of Land Reform in Economic Development: Policies and Politics," *American Journal of Agricultural Economics* 63(2), 384-392.

Deininger, K., and G. Feder (2001), "Land institutions and land markets," in: B.L. Gardner and G.C. Rausser (ed.), *Handbook of Agricultural Economics*, edition 1, volume 1, chapter 6, 288-331, Elsevier.

Department of Agrarian Reform (2006), "Primer on CARP Extension," Philippines.

Engerman, S. L. and Sokoloff, K. L. (2000), "History Lessons: Institutions, Factors Endowments, and Paths of Development in the New World," *The Journal of Economic Perspectives*, 217-232.

Galor, O., Moav, O., and Vollrath, D. (2009), "Inequality in Landownership, the Emergence of Human-Capital Promoting Institutions, and the Great Divergence." *The Review of Economic Studies* 76(1), 143-179.

Ghatak, M., and S. Roy (2007), "Land Reform and Agricultural Productivity in India: A Review of the Evidence," *Oxford Review of Economic Policy* 23(2), 251269.

Gollin, D., S.L. Parente, and R. Rogerson (2004), "Farm Work, Home Work, and International Productivity Differences," *Review of Economic Dynamics* 7(4), 827-850.

Gollin, D., D. Lagakos, and M. Waugh (2014a), "The Agricultural Productivity Gap, *Quarterly Journal of Economics*, 129(2).

Gollin, D., D. Lagakos, and M. Waugh (2014b), "Agricultural Productivity Differences Across Countries," *American Economic Review: Papers and Proceedings*, forthcoming.

Guner, N., G. Ventura, and Y. Xu (2008), "Macroeconomic Implications of Size-Dependent Policies," *Review of Economic Dynamics* 11(4), 721-44.

Herrendorf, B., and T. Schoellman (2013), "Why is Labor Productivity so Low in Agriculture?" Mimeo, Arizona State University.

Hsieh, C.T., and P. Klenow (2009), "Misallocation and Manufacturing TFP in China and India," *Quarterly Journal of Economics* 124, 1403-1448.

Lagakos, D., and M. Waugh (2013), "Selection, Agriculture, and Cross-Country Productivity Differences," *American Economic Review* 103(2), 948-980.

Lahiff, E., and Guo Li (2012), "Land Redistribution in South Africa - A Critical Review," WP 80874, World Bank, Washington D.C.

Lipton, M. (2009), *Land Reform in Developing Countries: Property Rights and Property Wrongs*, Routledge.

Lucas, R. (1978), "On the Size Distribution of Business Firms," *Bell Journal of Economics*, 9(2), 508-23.

Mendola, M., and F. Simtowe (2013), "The Welfare Impact of Land Redistribution: Evidence from a Quasi-Experimental Initiative in Malawi," Working Paper No.227, University of Milan, BICOCCA.

Restuccia, D., D.T. Yang, and X. Zhu (2008), "Agriculture and Aggregate Productivity: A Quantitative Cross-Country Analysis", *Journal of Monetary Economics* 55(2), 234-250.

Restuccia, D. and R. Rogerson (2008), "Policy Distortions and Aggregate Productivity with Heterogeneous Establishments," *Review of Economic Dynamics* 11(4), 707-720.

Restuccia, D. and R. Rogerson (2013), "Misallocation and Productivity," *Review of Economic Dynamics* 16(1), 1-10.

Saulo-Adriano, L. (1991), "A General Assessment of the Comprehensive Agrarian Reform Program," Working Paper Series No.91-13, Philippine Institute for Development Studies.

Udry, C. (2012), "Misallocation, Growth and Financial Market Imperfections," SED Plenary Talk, Cyprus.