“The Size Distribution of Farms and International Productivity Differences” On-line Appendix†

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A Data Description

A.1 World Census of Agriculture

We use the 1990 Census. This year is chosen as the benchmark for our comparisons as this is the year for which we have the most extensive coverage of farm-size data. In addition, it it the year closest to the year for which we have data on agricultural productivity. The report is compiled by the FAO. The variables we use are: number and area of holdings classified by size (Table 4.1); average size of agricultural holding for total (Table 3.1), wheat (Table 3.7), rice (Table 3.8), maize (Table 3.9); livestock per farm for cattle (Table 3.10), chicken (Table 3.11), sheep (Table 3.12), pigs (Table 3.14).

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A.2 Penn World Table

We use PWTv6.2 and the variables: real GDP per capita ($RGDPCH$), real GDP per worker ($RGDPWOK$), and population (POP). PWTv5.6: We use 1990 values for capital stock per worker ($KAPW$) and real GDP per worker ($RGDPW$) to calculate the capital-output ratio. For Nepal we use the 1985 value.

A.3 Food and Agricultural Organization

From Rao (1993) we use the following variables: population (Table 5.8), economically active population engaged in agriculture (Table 5.9), total arable land (Table 5.10.1), agricultural final output (Table 5.4), share of non-agricultural intermediate inputs in final output (Appendix 3). The intermediate inputs share is available only for 1985.

A.4 U.S. Census of Agriculture

We use the 2007 Census. We calculate value added per acre and per worker for each size category as value added over land and farm workers. Value added in dollars is calculated as the difference between gross output (measured as sales) and intermediate inputs. Intermediate inputs include seed, feed, fertilizer and other chemicals, gasoline and other fuels, utilities, supplies, repairs and maintenance. Farm workers include operators and hired labor. Given that operators work on average more hours per year in every size category, we adjust hired workers by their relative average hour contribution. We calculate average annual hours for hired labor, by farm category, from the expenditures on hired labor in the U.S. Census and a 2007 wage rate per hour of \$10.23 (from the 2007 Farm Labor Survey of the USDA). We obtain average hours of work per farm operator by class size from Ahearn and Hamrick (2007), based on data from the 2006 Agricultural Resource Management Survey (ARMS) of the USDA. Capital is calculated as the market value of machinery and equipment (trucks, tractors, combines etc.).

A.5 Countries By Quintile

Quintile 1 (Q1): Ethiopia, Guinea Bissau, Malawi, Uganda, Burkina Faso, Dem. Rep. of Congo, Nepal, Zambia, Lesotho, Viet Nam, India, Pakistan. Quintile 2 (Q2): Guinea, Honduras, Samoa, Indonesia, Philippines, Egypt, Peru, Djibouti, Albania, Grenada, Iran, Namibia, Turkey. Quintile 3 (Q3): Thailand, Paraguay, Fiji, Colombia, St. Vincent, Panama, Dominica, Saint Lucia, Brazil, Argentina, St. Kitts & Nevis, Rep. of Korea, Greece. Quintile 4 (Q4): Ireland, Portugal, Barbados, Cyprus, Puerto Rico, Slovenia, Spain, Israel, Italy, United Kingdom, Finland, Australia, Bahamas. Quintile 5 (Q5): Belgium, Netherlands, Germany, France, Japan, Canada, Denmark, Austria, Norway, U.S.A, Switzerland, Luxembourg.

A.6 Data on Rich and Poor Countries

Table 1: Rich-Poor Disparities in the Data

	Rich (Q5)	Poor (Q1)
Real GDP Per Capita	1	1/21.1
Real GDP Per Worker	1	1/19.2
Capital-Output Ratio	1	1/2.9
Arable Land Per Capita	1	1/1.3
Non-Agricultural Real GDP Per Worker	1	1/6.8
Agricultural Real GDP Per Worker	1	1/46.7
Relative Productivity Agriculture/Non-Agriculture	1	1/6.9
Share of Employment in Agriculture (%)	3.9	65.3
Average Farm Size	1	1/34
Size Distribution (%):		
Farms $<$ 5 Ha	31.7	93.6
Farms $>$ 20 Ha	38.3	0.2
Share of Land (%)		
Farms $<$ 5 Ha	10.0	68.1
Farms $>$ 20 Ha	68.7	3.4

Note: Group averages for each variable are over countries with available observations.

A.7 Farm and Land Distributions across Countries

Table 2: Size Distribution of Farms across Countries

	< 1	1 to < 2	2 to < 5	5 to < 10	10 to < 20	20 to < 50	50 to < 100	100 to < 200	200 to < 500	500+
Q1	0.55	0.17	0.22	0.05	0.01	0.00	0.00	0.00	0.00	0.00
Q2	0.39	0.17	0.27	0.09	0.04	0.03	0.00	0.00	0.00	0.00
Q3	0.36	0.18	0.17	0.09	0.07	0.05	0.03	0.02	0.01	0.01
Q4	0.25	0.11	0.20	0.12	0.11	0.10	0.04	0.03	0.02	0.03
Q5	0.12	0.07	0.13	0.13	0.17	0.21	0.10	0.04	0.03	0.02

Source: Authors' Calculations. Data from the Report on the 1990 World Census of Agriculture. Reported values are means over countries in each income group.

Table 3: Land Distribution across Countries

	< 1	1 to < 2	2 to < 5	5 to < 10	10 to < 20	20 to < 50	50 to < 100	100 to < 200	200 to < 500	500+
Q1	0.23	0.19	0.26	0.15	0.13	0.02	0.02	0.00	0.00	0.00
Q2	0.10	0.12	0.25	0.14	0.09	0.18	0.09	0.01	0.01	0.00
Q3	0.08	0.07	0.12	0.09	0.07	0.10	0.07	0.08	0.11	0.22
Q4	0.02	0.03	0.08	0.09	0.18	0.11	0.15	0.16	0.11	0.07
Q5	0.03	0.03	0.05	0.06	0.14	0.28	0.22	0.08	0.02	0.08

Source: Authors' Calculations. Data from the Report on the 1990 World Census of Agriculture. Reported values are means over countries in each income group.

A.8 A Counterfactual Exercise

We examine the potential role of differences in the size distribution of farms for agricultural labor productivity across countries by asking: how much would agricultural labor productivity increase in the poorest group of countries (Q1) if they had the farm size distribution of the richest countries (Q5)? In this counterfactual, we assume that differences in labor productivity across farm sizes are the ones observed in the 2007 U.S. Census of Agriculture. We conduct the exercise as follows. Let

va_i and n_i denote value added and number of workers (operators and hours adjusted hired labor) in farm size class i. Our measure of labor productivity is value added per worker, va_i/n_i. Then average labor productivity in agriculture for an economy as a whole is,

$$\frac{va}{n} = \sum_i \frac{n_i}{n} \cdot \frac{va_i}{n_i}. \tag{1}$$

Given that the World Census of Agriculture does not contain labor input by farm size we proxy n_i/n by the reported fraction of farms for each class size. Further, from the US Census of Agriculture 2007 we can calculate differences in labor productivity across the different class sizes va_i/n_i. Given that the ranges in the U.S. Census and the World Census do not correspond one-to-one, we fit a curve to the observed productivities for the US farm sizes (average farm size within each range), and use the fitted equation to calculate productivity for the midpoints of the ranges in the World Census. In particular, we posit a power function of the following form,

$$productivity = c \cdot (size)^b,$$

where c and b are parameters to be estimated. We run the following regression for the US in log form,

$$ln(productivity) = c_0 + b \cdot ln(size),$$

where for *size* we use the average farm size in each range and for *productivity* we use the (weighted) average value added per worker in each range. Running a simple OLS regression for the US we get estimates for the parameters c_0 and b. We find that $b = 0.49$. We then use the estimated parameters to calculate "predicted" productivity for each of the midpoints of the ranges in the World Census. Then using these predicted productivities and the weights we observe from the World Census for each range, we calculate predicted aggregate productivity for poor (Q1) and rich (Q5) countries, as well as their ratio. We find that if poor countries had the size distribution of farms of the rich countries rather than their own, agricultural productivity would increase by a factor of 4.0.

A.9 Specific Policy Case Studies Data

Philippines Data sources: number of farms and total land in farms are from the World Census of Agriculture; real GDP per worker, real GDP per capita, and total population are from PWT6.3; the capital-output ratio for 1988 is from Easterly and Levine (2001), while the 2000 value is calculated using the perpetual inventory method and investment data from PWT6.3 with a depreciation rate of 6%; value added in agriculture in constant 1985 prices and persons employed in agriculture are from the Groningen Growth and Development Centre 10-sector database.

Pakistan Data sources: number of farms and total land in farms are from the World Census of Agriculture; real GDP per worker, real GDP per capita, and total population are from PWT6.3; the capital-output ratio is from Easterly and Levine (2001); the economically active population for agriculture and the total economy are from the International Labour Organization; value added in agriculture and GDP at constant factor cost are from the Handbook of Statistics on Pakistan Economy 2010 (State Bank of Pakistan).

B Characterization

B.1 Benchmark Model

The first order conditions from the maximization problem of the stand in firm in the non-agricultural sector are standard and imply that the non-agricultural firm hires capital and labor until their marginal products equal their market prices,

$$w = (1-\alpha)\, A \left(\frac{K_n}{N_n}\right)^{\alpha}, \tag{2}$$

$$r = \alpha A \left(\frac{K_n}{N_n}\right)^{\alpha-1}. \tag{3}$$

These conditions imply that the capital-labor ratio in non-agriculture depends on relative factor prices and relative factor intensities,

$$\frac{K_n}{N_n} = \frac{\alpha w}{(1-\alpha) r}.$$

From the maximization problem of a farmer of ability s, the first order conditions for land and capital are,

$$r = \frac{\theta \gamma p_a y_a}{\left[\theta \left(\frac{k}{\ell}\right)^{\rho} + (1-\theta) s^{\rho}\right] \ell^{\rho}} k^{\rho-1} \quad \text{and} \quad q = \frac{(1-\theta) \gamma p_a y_a}{\left[\theta \left(\frac{k}{\ell}\right)^{\rho} + (1-\theta) s^{\rho}\right] \ell^{\rho}} s^{\rho} \ell^{\rho-1}.$$

These conditions imply that the capital-land ratio chosen by a manager depends on the farmer ability and is given by,

$$\frac{k}{\ell} = \left[\frac{\theta}{1-\theta} \frac{q}{r}\right]^{\frac{1}{1-\rho}} s^{-\frac{\rho}{1-\rho}}.$$

Manipulation of the first order conditions implies that a farm operator with own productivity s, faced with sector-neutral and sectoral productivities (A, κ) and prices (q, r, p_a), chooses farm size (demand for land),

$$\ell(s) = \left[\gamma (1-\theta) A\kappa \frac{p_a}{q}\right]^{\frac{1}{1-\gamma}} \left[\theta \left(\frac{\theta}{1-\theta} \frac{q}{r}\right)^{\frac{\rho}{1-\rho}} + (1-\theta) s^{\frac{\rho}{1-\rho}}\right]^{\frac{\gamma-\rho}{\rho(1-\gamma)}} s^{\frac{\rho}{1-\rho}}, \tag{4}$$

and chooses demand for capital,

$$k(s) = \left[\frac{\theta}{1-\theta} \frac{q}{r}\right]^{\frac{1}{1-\rho}} \left[\gamma (1-\theta) A\kappa \frac{p_a}{q}\right]^{\frac{1}{1-\gamma}} \left[\theta \left(\frac{\theta}{1-\theta} \frac{q}{r}\right)^{\frac{\rho}{1-\rho}} + (1-\theta) s^{\frac{\rho}{1-\rho}}\right]^{\frac{\gamma-\rho}{\rho(1-\gamma)}}. \tag{5}$$

This operator's farm produces output,

$$y_a(s) = (A\kappa)^{\frac{1}{1-\gamma}} \left[\gamma (1-\theta) \frac{p_a}{q}\right]^{\frac{\gamma}{1-\gamma}} \left[\theta \left(\frac{\theta}{1-\theta} \frac{q}{r}\right)^{\frac{\rho}{1-\rho}} + (1-\theta) s^{\frac{\rho}{1-\rho}}\right]^{\frac{\gamma(1-\rho)}{\rho(1-\gamma)}},$$

and makes profits,

$$\pi(s) = (1-\gamma) p_a y_a(s).$$

The preference specification for agricultural and non-agricultural goods implies that the income elasticity with respect to food is less than one and thus, at low levels of income, a disproportionate amount of income is allocated to food consumption. The first order conditions to the household's problem with respect to consumption imply the following consumption allocations,

$$c_n = (1-\phi)\cdot(I-\bar{a}p_a) \quad \text{and} \quad c_a = \bar{a} + \frac{\phi}{p_a}\cdot(I-\bar{a}p_a),$$

where income I is defined in equation (4) in the paper. The allocation of labor across sectors is governed by equation (6) in the paper. Capital is allocated across sectors until the marginal return to capital is equated across sectors.

B.2 Land Reform

Let s_{max} be the cut-off level of farmer ability that satisfies the farmer first order condition with respect to ℓ when $\ell = \ell_{max}$,

$$\ell_{max} = \left[\frac{p_a\gamma(1-\theta)A\kappa}{q}\right]^{\frac{1}{1-\gamma}} \left[\theta\left(\frac{\theta}{1-\theta}\frac{q}{r}\right)^{\frac{\rho}{1-\rho}} + (1-\theta)\, s_{max}^{\frac{\rho}{1-\rho}}\right]^{\frac{\gamma-\rho}{\rho(1-\gamma)}} s_{max}^{\frac{\rho}{1-\rho}}.$$

Thus, farmers with $s < s_{max}$ choose $\{l(s), k(s)\}$, given by (4)-(5). Farmers with $s \geq s_{max}$ choose $l(s) = \ell_{max}$, with their optimal k given implicitly by, $r = \gamma\theta p_a A\kappa\left[\theta k^\rho + (1-\theta)(s\ell_{max})^\rho\right]^{\frac{\gamma-\rho}{\rho}} k^{\rho-1}$. The market clearing condition for land is,

$$L/N_a = \int_{\underline{s}}^{s_{max}} \ell(s)dF(s) + [1-F(s_{max})]\,\ell_{max}.$$

B.3 Progressive Land Tax

A farmer wanting to expand land input use beyond $\widehat{\ell}$ faces a cost $q(1+\tau_L)\widehat{\ell} + q(1+\tau_H)(\ell - \widehat{\ell})$.

Then the problem of a farmer in the agricultural sector is,

$$\max_{\ell,k} \left\{ p_a A\kappa \left[\theta k^\rho + (1-\theta)(s\ell)^\rho\right]^{\frac{\gamma}{\rho}} - rk - q(1+\tau_H)\ell + q(\tau_H - \tau_L)\widehat{\ell} \right\}.$$

Profit maximization implies that there are three types of farmers: low ability farmers that fall in the low tax bracket and choose $\ell(s;\tau_L,\tau_H,\widehat{\ell}) < \widehat{\ell}$, high ability farmers with $\ell(s;\tau_L,\tau_H,\widehat{\ell}) > \widehat{\ell}$ that face a higher marginal cost because they pay tax τ_H on the excess units of land, and the group for which $\ell(s;\tau_L,\tau_H,\widehat{\ell}) = \widehat{\ell}$. This implies that for a given $\widehat{\ell}$ there are two thresholds (s_L, s_H) that satisfy,

$$\widehat{\ell} = \left[\frac{p_a\gamma(1-\theta)A\kappa}{q(1+\tau_i)}\right]^{\frac{1}{1-\gamma}} \left[\theta\left(\frac{\theta}{1-\theta}\frac{q(1+\tau_i)}{r}\right)^{\frac{\rho}{1-\rho}} + (1-\theta)\, s_i^{\frac{\rho}{1-\rho}}\right]^{\frac{\gamma-\rho}{\rho(1-\gamma)}} s_i^{\frac{\rho}{1-\rho}}, \quad \forall i \in \{L, H\}.$$

Then the low ability farmers facing the low tax are those with $s \in [\underline{s}, s_L)$, the intermediate group includes those with $s \in [s_L, s_H]$, and the highest ability farmers facing the high cost of land those with $s \in (s_H, \overline{s}]$. Note that farmers in the $[s_L, s_H]$ choose $\ell = \widehat{\ell}$ and their optimal choice of k is given by, $r = \gamma\theta p_a A\kappa \left[\theta k^\rho + (1-\theta)(s\widehat{\ell})^\rho\right]^{\frac{\gamma-\rho}{\rho}} k^{\rho-1}$. The optimal choices of (ℓ, k) for the low and high ability farmer groups are given by equations (4) and (5) for $(\ell(s), k(s))$ with the rental prices of land $q(1+\tau_L)$ and $q(1+\tau_H)$.

C Additional Experiments

C.1 Land Quality

In Section 5.1 we briefly discuss land quality as another potentially important aggregate factor impacting agricultural productivity. Here we provide additional details on our cross-country experiment on land quality. Studying the importance of land quality quantitatively involves two issues: (a) to obtain good measures of land quality differences across rich and poor countries; (b) to map these differences into efficiency units of land that go into the production function of agriculture.

This is similar to the issue of mapping education (average years of schooling) into human capital in development accounting. We focus on exogenous measures of land quality and use estimates from the literature to back out the effect of land quality on productivity.

The FAO in collaboration with the International Institute for Applied Systems Analysis (IIASA) has developed a system, known as the Global Agro-ecological Zones (GAEZ - 2000), which classifies land in terms of its suitability potential for agricultural production. The classification is based on an intricate combination of information on soil (e.g., depth, fertility, drainage, texture, chemical composition), terrain (e.g., slope, elevation), and climate (e.g., moisture, temperature) characteristics. The classification of world land surface is established at a very fine grid-cell level, which allows aggregation at the country and regional level. We use country-level information which classifies a country's land according to the extent of soil, terrain, and climate constraints for rain-fed agricultural production. Constraints are classified according to none, moderate, severe for each characteristic. Using this information we calculate a country's endowment of suitable land per capita for various degrees of constraints, for each of the countries in our rich and poor sample. If we focus on the best quality land within each country (the land that has no soil, terrain, or climate constraints) then the ratio of the average rich to average poor is 1.1.

Another measure of land quality is constructed by Wiebe (2003). He constructs a land quality index which utilizes soil (e.g., slope, depth, salinity) and climate (e.g., temperature and percipitation data) properties to classify a country's cropland (a much more narrow concept of land, already used for agricultural production). The index ranges from 3 to 11, where a higher number reflects a higher land quality class. While this index varies across the countries in our sample, it does not vary systematically with income. The ratio between the averages for the poor and rich countries is 1.1. Wiebe, Soule, Narrod, and Brenman (2000), use the same underlying data to construct a complementary measure of land quality: the share of country's cropland that is not limited by major soil or climate constraints to agricultural production (cropland in the highest three land quality classes). This measure is a fraction and ranges from 0 to 1. They include this measure in a regression to study the effect of land quality on agricultural labor productivity. They find that good soils and climate are associated with a 13% increase in agricultural productivity relative to poor soil and climate.

A remaining question is: what is the quantitative impact of the observed differences in land quality across countries? We use the estimated effect of land quality on agricultural productivity in Wiebe, Soule, Narrod, and Brenman (2000), to feed in differences in land quality we report above. In the context of our model, we find that while aggregate factors without land quality generate a rich-poor disparity in agricultural productivity of 11.2, including land quality differences of 1.1, generate a disparity of 11.7. Considering the range of land quality differences from GAEZ, 0.5-1.6, yields a disparity in agricultural productivity of 9.9 to 12.5.

C.2 Elasticity of Substitution

We evaluate the robustness of our results in Section 5.2 to variations in the elasticity of substitution between capital and land ρ. Recall that when ρ approaches 0, capital and land enter the production function of agriculture as a Cobb-Douglas term. In this case, capital to land ratios are equalized across farms and this in turn implies that labor productivity across farms varies much more than in the data for the United States. Alternatively, when ρ approaches 1, capital and land are perfect substitutes in agricultural production and this implies that labor productivity is equalized across farms. Our calibration of ρ was disciplined by the ratio of capital to land between the smallest and largest farm size categories reported in the U.S. data and therefore implicitly restricts the pattern of labor productivity across farms sizes. To assess the importance of this elasticity for our results (and the importance of the empirical observations used to restrict it) we compute the experiment of generic farm-size distortions for alternative values of ρ. In each case we only recalibrate the value of the aggregate capital stock so that the capital to output ratio is as observed between rich and poor countries. Table 4 reports the results for the share of employment in agriculture, average farm size, and agricultural and labor productivity. The results show that less substitution between capital and land would actually amplify the results of the model. The evidence from direct estimates of production functions as well as the observed differences in labor productivity across farms in poor and rich countries suggest that extreme values for ρ are not supported but then the results are fairly robust to values of ρ in the range between 0.1 and 0.4.

Table 4: Robustness Results with Generic Farm-Size Distortions

	ρ				
	0.01	0.1	0.24	0.4	0.95
Employment in Agriculture N_a (%)	75.5	70.4	65.2	61.7	55.1
Average Farm Size (AFS)	39.3	36.3	34	32.1	28.7
Labor Prod. in Agriculture ($\frac{Y_a}{N_a}$)	53.9	50.2	46.9	43.9	39.2
Aggregate Labor Productivity ($\frac{Y}{N}$)	23.0	19.6	17.0	15.6	13.5

Note: Average farm size, labor productivity in agriculture and aggregate labor productivity are reported as the ratio between the benchmark economy and the poor economy. Farm-size distortions represent the model with aggregate factors and generic farm-size distortions. Results reported for each value of ρ in each case only adjusting the aggregate capital stock K to match the disparity in capital to output ratios in the experiments.

C.3 Progressive Land Tax in Pakistan

In Section 6 we report summary results on progressive land taxes in Pakistan, as an additional specific farm-size policy. Here we provide the details of that experiment. We use our model to assess the quantitative impact of progressive land taxation. We assume there is some threshold level of land $\widehat{\ell}$ such that farmers face a tax rate of τ_L for $\ell \leq \widehat{\ell}$ and a tax rate of τ_H for $\ell > \widehat{\ell}$. The characterization of the farmer problem is provided in Appendix B.

The 1976 amendment to the West Pakistan Land Revenue Act 1967, introduced steep progressivity in the land tax system. According to the 1976 Act all irrigated land holdings of up to 5 Ha were exempted from paying a land tax. Among the non-exempt farmers, those with holdings between 5-10 Ha paid the same rates as before, while farmers with holdings between 10-20 Ha were subject to a 50% rate increase, and farmers with over 20 Ha were subject to a 100% increase relative to the previous rates.[1] Neither the original 1967 Act nor its 1976 Amendment contain specific tax

[1]See Sections 4-5 of the 1976 Act (North-West Frontier Province Amendment), available at: http://www.khyberpakhtunkhwa.gov.pk/Gov/files/v8_0019.htm.

rates. However, according to the 1967 Act the land tax rate could not exceed 25% of "net assets" (calculated as the value of gross produce minus "ordinary" expenses of cultivation, which include mainly intermediate inputs).[2] In the Census (1971/73) prior to the 1976 progressive land tax policy, average farm size was 5.29 Ha. By the 1989 Census average farm size had dropped to 3.78 Ha, a reduction of -28.7%.

In our model, we consider an economy that resembles Pakistan at the time of the 1976 Amendment in terms of land taxes, aggregate factors, and sectoral structure. We assume a pre-reform average tax rate that is uniform across farms of all sizes. Given that no explicit tax rate is provided in the 1967 Act, we side with the conservative choice of choosing a tax rate in value added that is half of the maximum allowed in the 1967 Act. Hence, we select a land tax of 12.5% of value added in farming. We calculate aggregate factors and reproduce the agricultural employment share in 1976 Pakistan following the same approach as in the land reform application. The implied disparities in aggregate factors between the benchmark economy and 1976 Pakistan are: 1.6 in land per capita, 2.49 in capital-output ratio, and 9.5 in non-agricultural productivity. We choose $\kappa = 1/1.9$ to reproduce a pre-reform share of employment in agriculture of 53.9%. The data sources are provided in Appendix A. To implement the progressive land tax policy, we set the threshold $\widehat{\ell}$ at 5 Ha in line with the 1976 Amendment. Given that farms smaller than the threshold are exempt from the land tax after 1976 we set $\tau_L = 0$. For all farms above the threshold we assume an average land tax rate τ_H that is 50% higher than the pre-reform uniform tax rate (the average of the three tax rates in the more gradual progressivity of the 1976 Amendment).

We compare the results produced by the model after the policy reform to the actual changes in the key variables of interest over 1976-1985. The first column of Table 5 reports the results of implementing the progressive land tax policy. The model generates an increase in the share of employment in agriculture of less than 2 percentage points, a reduction in average farm size of 3.1%, a reduction in agricultural labor productivity of 3.2%, and a reduction in aggregate labor productivity of 3.3%.

[2] See Chapter 1 (4) of the 1967 Act at: http://www.khyberpakhtunkhwa.gov.pk/Gov/files/v6_0015.htm.

Table 5: Progressive Land Taxation in Pakistan (Changes 1976-1985)

	Progressive Tax	$+\Delta L$	$+\Delta(\frac{K}{Y}, A)$	Data
Employment in Agriculture N_a (%)	55.6	58.6	45.4	48.7
Average Farm Size (%Δ)	-3.1	-31.1	-11.0	-28.7
Labor Prod. in Agriculture $\frac{Y_a}{N_a}$ (%Δ)	-3.2	-8.2	19.3	11.8
Aggregate Labor Productivity $\frac{Y}{N}$ (%Δ)	-3.3	-8.9	40.1	36.3

We also incorporate changes in aggregate factors over 1976-1985: a reduction in land per capita of 29.9%, an increase in non-agricultural productivity of 23.2%, and a decrease in the capital-output ratio of 13.3%. Combining these changes with the policy reform in the model, the results capture the observed changes in the key variables of interest with the exception of the average farm size which ends up falling less than in the data. Because the increase in non-agricultural productivity was particularly stellar in Pakistan over 1976-1985, it dominates the opposing effects of the capital-output ratio, masking the negative productivity effects of the progressive land tax.

D Farm-Size Policies

In this section we document several farm-size policies in developing countries from Africa, Asia, and the Americas. We provide information on the type of policy, the title of the legislation, the year it was legislated, and a brief description of its provisions.

Country	Year	Policy	Title	Description
Africa				
Ethiopia	1975	land reform	Proclamation No.31 of 1975	Distribution of private land to the tiller; prohibition of any transfer of use rights by sale or exchange; prohibition of the use of hired labor on an individual's holdings; max size of holding permitted per family: 10 Ha.
Ethiopia	1967	progressive output taxes	Proclamation No.255 of 1967, Article 17B	Steep progressivity in agricultural income tax schedule, with rates ranging from an average of under 3% for income less than Eth. $1,000, to 20% for income over Eth. $27,000.
Kenya	2006-2010	input subsidies to smallholders	National Accelerated Agriculture Input Access Project	One time vouchers for fertilizer and seed, with subsequent access to credit for input purchase. Targeted to farmers with land size less than 1 Ha.
Malawi	1998-2000	input subsidies to smallholders	Starter Pack Programme	Small packages of fertilizer, maize seed, and legume seed sufficient for 0.1 ha were distributed for free to maize smallholders.
Malawi	2006-2009	input subsidies to smallholders	Agricultural Inputs Subsidy Programme	Coupons to farmers to purchase fertilizer for maize and tobacco production, and improved maize seed at considerably reduced prices. An upper limit on these coupons implied higher effective subsidy per Ha for smallholders.
Malawi	2004	land redistribution	Community - Based Rural Land Development Project	Pilot program in which the landless and land-poor are given grants to purchase land on willing seller-willing buyer basis.
Namibia	2005	progressive land taxes	Resolutions based on Commercial Land Agriculture Reform Act 1995	General rate at 0.75% of assessed value; a progressive rate of 0.25% for each additional property; and a rate of 1.75% for foreign absentee landlords.

Country	Year	Policy	Title	Description
Africa				
Tanzania	2008	input subsidies to smallholders	Input Voucher Program	Vouchers for fertilizer and seed (maize/rice), sufficient for 0.5 Ha, targeted to smallholders. Vouchers covered 50% of market price of input.
Zambia	2002-2010	input subsidy to smallholders	Fertilizer Support Program	Supplied standardized input packs for maize - containing fertilizer and seed, to plant 1 Ha of maize. Targeted to smallholders. Covered 50%-60% of input cost.
Zimbabwe	1988	progressive land taxes	Rural District Councils Act, No. 8 of 1988	0 - 20 Ha, 0.5 tax unit; 20-1619 Ha, 1 unit; next 809 Ha, 1.2 units; next 2024 Ha, 1.5 units; next 4047 Ha, 2.0 units; next 8094 Ha, 12 units; next 16188 Ha, 32 units; and beyond 40470 Ha, 1.0 unit for each 405 Ha. The value of the unit tax is decided upon by the rural district councils of each region.
Zimbabwe	2000	maximum land size constraints	Rural Land Regulations 2000, Subsection 4	Ceilings on farm sizes that differ according to Natural Region (NR): NR I 250 Ha, NR II 400 Ha, NR III 500 Ha, NR IV 1,500 Ha, or NR V 2,000 Ha.
Zimbabwe	1976 1996	subdivision regulations	Regional Town and Country Planning Regulations 1976 Regional Town and Country Planning Act 1996, Ch.29:12	Subdivision proposals are subjected to: (a) planning assessment (e.g. access to roads, water, electricity, and size of property relative to size of adjacent properties) (b) “agricultural viability” assessment (farm must provide net income equivalent to the salary of a middle manager in the financial and industrial sectors).

Country	Year	Policy	Title	Description
Asia				
Bangladesh	1984	land reform	Land Reform Ordinance	Imposed ceiling of 8 Ha. Prohibition of transfers to relatives to avoid the ceiling.
India	varies by province	land reforms	varies by province	Ceiling on land holdings and year of implementation varied by province: Assam (1956, amended 1976); Bihar (1961, 9.71-29.14 ha [1960-1972] and 6.07-18.21 ha [after 1972]); Gujarat (1960, 4.0553.14 ha [1960-1972] and 4.05-21.85 ha [after 1972]); Karnataka (1974, 4.05-21.85 ha); Kerala (1969, amended 1979, 6.07-15.18 ha [1960-1972] and 4.86-6.07 ha [after 1972]); Madhya Pradesh (1960, 10.12 ha [1960-1972] and 4.05-21.85 ha [after 1972]); Maharashtra (1961); Orissa (1960, amended 1973 and 1976, 8.09-32.37 ha [1960-1972] and 4.05-18.21 ha [after 1972]); Tamil Nadu (1961, 12.14-48.56 ha [1960-1972] and 4.86-24.28 ha [after 1972]); Uttar Pradesh (1960, 16.19-32.37 ha [1960-1972] and 7.30-18.25 ha [after 1972]); West Bengal (1953, 1981, 1986).
India	varies by province	tenancy reforms	varies by province	Include: tenancy security; preferential right of purchase; prohibition of subletting; restrictions on crop shares.
Indonesia	1960	lower/upper limits on size	Basic Agrarian Law	Minimum size: 2 Ha; maximum size: 20 Ha.
Japan	1952	land-tenancy reform	Agricultural Land Law (Nochi Ho)	landlords restricted to selling their leased out land to their tenants; ceiling on farmland holdings set at 3 Ha (12 Ha in Hokkaido); corporations prohibited from owning farmland; land rent ceilings; tenancy rights protection.

Country	Year	Policy	Title	Description
Asia				
Korea (South)	1950	land redistribution	Agricultural Land Reform Amendment Act	Imposed ceiling of 3 Ha on farm land holdings; mandatory sale to government of excess land; prohibition of tenancy arrangements and renting of farm land.
Pakistan	1959 1972 1977	land reforms	The Land Reforms Regulation, 1959, 1972. The Land Reforms Act, 1977 (FA No.II)	1959: ceiling at 202 Ha of irrigated land; 1972: ceiling at 61 Ha of irrigated land, with excess land expropriated without compensation and granted to tenants; 1977: ceiling at 40 Ha of irrigated land, with land in excess of ceiling expropriated with compensation and granted free of charge to tenants.
Pakistan	1976	progressive land taxes	1976 Amendment to the 1967 West Pakistan Land Revenue Act	Farmers with holdings less than 5 Ha were exempt; those with holdings 5-10 Ha paid the previous flat rate; those with holdings 10-20 Ha were subject to a 50% increase; those with 20+ Ha were subject to a 100% increase.
Philippines	1972 1988	land reforms	Presidential Decree 27. Comprehensive Agrarian Reform Program - Republic Act 6657	1972: covered rice and corn farms; land ownership ceiling of 7 Ha; confiscatory method of land acquisition. 1988: covered all agricultural lands; land ownership ceiling of 5 Ha; compulsory acquisition and voluntary offer to sell.
Philippines	1991	subsidized credit to smallholders	Republic Act 7606	Provides to smallholders: minimum collateral requirements; interest on loans capped at an interest rate 3/4 of the annual market rate.
Sri Lanka	1972	land reform	Land Reform Law, No.I	Imposed ceilings of 10 Ha for paddy land and 20 Ha for other categories of land.
Taiwan	1949-1954	land reform		Imposed ceilings: 1-3 ha for paddy land; 2-6 ha for dry land.

Country	Year	Policy	Title	Description
Americas				
Brazil	1964	progressive land taxes	Estatuto da Terra	Farms less than 2 modulos pay no land tax, while farms greater than 100 modulos pay 3.5% of the unimproved value of their land (terra nua). However the tax can be reduced depending on the intensity of land-use.
Chile	1967-1970	land reform	Agrarian Reform Law 16640	Imposed ceiling of 80 Ha of irrigated land.
Peru	1964-1979	land reform	Agrarian Reform Decree Law 17716 / 1969	Expropriation of excess areas of all land holdings larger than 150 Ha on the coast and larger than 15-55 Ha in the Sierra.
Puerto Rico	1941	land reform	Land Law	Limited landholding to 500 acres in estates; eliminated corporate ownership of large estates; expropriation (with compensation) of excess lands in large estates and redistribution to smallholders; individual farms restricted to be above 5 acres but less than 25 acres; stimulated development of small co-operatives of farmers (proportional profit farms).
Mexico	1940-1976	land reform		Imposed ceiling of 100-200 Ha.

Table 1: Sources: Bangladesh (CARE, 2003); Brazil (Binswanger, 1991); Chile (de Janvry, 1981); Ethiopia (Nega, Adenew and Sellasie, 2003; Schwab, 1972); India (Besley and Burgess, 2000); Indonesia (FFTC); Japan (Kawagoe, 1999); Kenya (World Bank, 2010); Korea (Jeon and Kim, 2000); Malawi (Levy, 2005; Dorward, Chirwa, and Jayne, 2010; Machira, 2009); Mexico (de Janvry, 1981); Namibia (Childress, Hilton, Solomon, and van den Brink, 2009); Pakistan (Database of Laws in Pakistan; Memon, 1993; Khan and Khan, 1998); Peru (Saulo-Adriano, 1991); Philippines (Saulo-Adriano, 1991; Department of Agriculture, Philippines); Puerto Rico (Santiago Caraballlo, 2009); Sri Lanka (Peiris, 1978); Taiwan (Saulo-Adriano, 1991); Tanzania (Pan and Christiansen, 2011); Zambia (World Bank, 2010); Zimbabwe (Roth and Bruce, 1994; Roth and Sukume, 2003).

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