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ABSTRACT

We analyze the effects of land market restrictions on the rural labor market outcomes for women. The existing literature emphasizes two mechanisms through which land restrictions can affect the economic outcomes: the collateral value of land, and (in)security of property rights. Our analysis focuses on an alternative mechanism where land restrictions increase costs of migration out of villages. The testable prediction of collateral effect is that both wage and labor force participation move in the same direction, and insecurity of property rights reduces labor force participation, and increases wage. In contrast, if land restrictions work primarily through higher migration costs, labor force participation increases, while wage declines. For identification, we exploit a natural experiment in Sri Lanka where historical malaria played a unique role in land policy. We provide robust evidence of a positive effect of land restrictions on women's labor force participation, but a negative effect on female wages. The empirical results thus contradict a collateral or insecure property rights effect, but supports migration costs as the primary mechanism.

Key Words: Land market restrictions, Collateral effect, Property rights insecurity, Migration costs, Labor market, Women's labor force participation, Wage, Sri Lanka, Historical malaria

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(1) Introduction

There is a growing literature in economics that analyzes the effects of restrictions on land market on household choices and outcomes. The literature has focused on the effects of restrictions on the alienability of land on credit access, labor supply, agricultural productivity, and savings (see, for example, Field (2007), Iyer at al. (2009)), and on the effects of uncertainty about property rights on incentives to invest (see, for example, Besley (1995), Jacoby et al. (2002), Goldstein and Udry (2008)). This paper deals with a set of issues that have largely been ignored in the economics literature: the effects of restrictions on sales and rental on the labor force participation of rural women and their wages.

The effects of insecure property rights to land on women's labor market are well-recognized in the literature; reforms that improve security of property rights can lead to higher labor supply by women, as they do not need guard labor (Field, 2007). Formalized alienable property rights in land can potentially create collateral value and better access to credit (de Soto, 1989). Policy restrictions on sales and rental may create insecurity, and destroy the collateral value of land, as the banks cannot claim the land in case of a default.

The literature has, however, so far largely neglected another important channel through which sales and rental restrictions may affect women's labor force participation and wages in a village: rural-urban migration.[2] As emphasized recently by Hayashi and Prescott (2008), land market restrictions increase costs of migration substantially as a household loses the income stream from the land when it decides to leave the village. We explore the implications of the migration channel, both theoretically and empirically, and contrast it with the predictions of the more widely-recognized collateral and property rights channels.

To understand the workings of the migration mechanism, we develop a model that focuses on women's traditional role in producing home goods for labor force participation decision, and the land market restrictions imply that a household loses the land in the event of out-migration from the village.[3] It is straightforward to see that higher migration costs are likely to reduce migration

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[2] We use "urban" as a short for any destination which includes international migration.

[3] The standard model of labor-leisure trade-off can be seen as a special case of our model where the home goods production function is CRTS: one unit of labor produces one unit of leisure. Note that in our model, home goods

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and lower the equilibrium wage rate in the local labor market. The effects of land restrictions on women's propensity of labor force participation are, however, not obvious; it depends on whether the women who stay back in the village at the margin are more or less likely to participate in the labor force compared to an average rural woman before land restrictions. Since a household is more likely to benefit from the higher wages in urban labor market when it uses only a small proportion of its labor endowment in home goods production, propensity to migrate is a negative function of productivity in home goods production. An important result from our analysis is that the set of women whose migration status is changed by land restrictions are the ones with highest productivity among the migrants in the initial equilibrium, but they have the lowest productivity compared to the women who chose not to migrate without the land restrictions. This also implies that these women are more likely to participate in the labor force compared to an average rural woman. Imposition of land restrictions thus increases women's propensity of labor force participation in a village.[4] The resulting higher labor supply to the market reduces the wage rate.

We thus have predictions from three different mechanisms that can mediate the effects of land market restrictions. Insecure rights imply higher wage and lower labor force participation, a collateral effect implies that wage and labor force participation move in the same direction, and a higher migration cost yields the prediction that wages go down, but participation goes up. These contrasting predictions allow us to discriminate among these three alternative mechanisms.

To identify and estimate the effects of land market restrictions on women's labor force participation and wage, we take advantage of a historical natural experiment in Sri Lanka where the cross-section variations in the incidence of land restrictions across different sub-districts (i.e., proportion of land under policy restrictions) were primarily determined by historical malaria prevalence (endemicity) through its effects on 'crown land'. Historical malaria caused an exodus of households from the affected areas during the 13-18th centuries, and the abandoned land was

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include many more things such as child bearing and rearing, home schooling, meal preparation, house care, and tending to kitchen garden.

[4]Interpreting the increased labor force participation in rural areas as a sign of women's economic mobility may, however, not be appropriate, as the increased labor force participation in rural areas comes at the expense of migration and better jobs in urban areas.

taken over by the government during the colonial period and designated as crown land (Peebles (2006), De Silva (1981)). The crown land was later distributed through settlements, and restrictions on sales, mortgage and rental were imposed. The historical malaria thus is significantly correlated with the extent of land restrictions in an area through the availability of crown land. We exploit this correlation between historical malaria and the incidence of land restrictions in a sub-district to identify the causal effects of land restrictions. To be more precise, we rely on the interaction of historical malaria and average rainfall across different sub-districts for identification in an empirical model with district fixed effects. This approach uses subdistrict level rainfall as weights to uncover variations in malaria across subdistricts from the district level average estimates available from Newman (1965) (see the discussion on empirical strategy in section 4 below). This strategy is motivated by two considerations. First, the variation in land restrictions in the data is at the subdistrict level and the interaction of district level malaria with the subdistrict level rainfall provides an instrument that varies across subdistricts. Second, a large literature shows that rainfall is one of the most important determinants of spatial variations in malaria in Sri Lanka; the malaria incidence is lower in a subdistrict within a district if it has higher rainfall ((Clemesha, 1934; Rustomjee, 1944; Briet et al, 2008). As we discuss in detail later, we control for rainfall in a subdistrict in the regressions to ensure that the exclusion restriction imposed is credible. In addition, the interpretation that the interaction of historical malaria with subdistrict rainfall provides an estimate of historical malaria variations across subdistricts implies testable sign restriction in the first stage regression, which is borne out by the empirical results reported later. The strength of our identification strategy derives from the following observations: (i) the timing of the malaria eradication program was determined by the technological breakthrough abroad for tackling malaria (DDT), and thus can plausibly be treated as exogenous,[5] (ii) a successful nationwide malaria eradication program was implemented in Sri Lanka in 1947; malaria endemicity (as measured by enlarged spleen rates) fell close to zero by 1950-51.[6] We thus rely

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[5]Although DDT was first synthesized in 1874, its insecticidal properties were discovered in 1939 by Swiss scientist Paul H Muller. It was widely used during second World War to control malaria and typhus, and after the war DDT was made available as an agricultural pesticide and for malaria eradication programs.

[6]Reported malaria cases in Sri Lanka were reduced from about 3 million per year during pre-eradication era to only 29 in 1964 (Harrison, 1978). The number of malaria death cases were 30 in 2002 among a population of 21

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on historical malaria more than half a century ago to identify the effects of land restrictions, and (iii) most of the current population in a subdistrict ravaged by high historical malaria were never exposed to historical malaria there, as they were resettled from other relatively malaria free areas. A number of possible objections to the identification scheme and evidence on their relevance are discussed in detail later in the paper (please see section 4.3 below).

The empirical results show that the incidence of land market restrictions has a numerically and statistically significant negative effect on the wages. More interestingly, the effects on women's labor force participation is positive: a one percentage point increase in the land under policy restrictions in a sub-district leads to about a 2.3 percent increase in the labor force participation of women (evaluated at the mean). The corresponding estimates for wages imply that a one percentage point increase in land under restrictions leads to a 1.7 percent decrease in female wage. The results on wages thus reject the hypothesis that land restrictions affect women's labor market because of insecurity of rights to land. The results on labor force participation on the other hand contradict the collateral channel. The evidence on both wages and labor force participation is consistent with the predictions from the model developed in this paper that focuses on higher migration costs.

The rest of the paper is organized as follows. Section 2 develops a simple model to understand the effects of land market restrictions on women in rural labor markets that focuses on migration costs and women's traditional role in home production. Section 3 discusses data and variables definitions. Section 4 lays out the identification approach we use. Section 5, arranged in a number of subsections, report the results of the empirical analysis. The paper ends with some concluding remarks.

2. Land Market Restrictions, Migration, and Women's Labor Market: Theory

We develop a simple model of wage determination that incorporates higher migration costs due to land restrictions. The labor force participation is determined by shadow value of labor in

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million. The reported malaria death were 4 in 2003, and 0 in 2005.

home production that includes, among other things, child bearing and rearing, home making, meal preparation, homework help for kids. As noted earlier, the home good can also be interpreted as leisure.

The Basic Set-up

Each household owns L amount of female labor, but they differ in terms of land endowment. Household i owns $H_i \geqq 0$ amount of land. There are two goods: a home good (denotes as d good), and an agricultural good (denoted as a good). We assume that the agricultural good is traded beyond the village and its price is normalized to 1, i.e., $P^a = 1$. The household can produce the agricultural good in its own land and can buy from the market if it earns wage income. The agricultural production function takes the Cobb-Douglas form with CRTS:

$$Q^a = F\left(H, L^a\right) = H^\gamma \left(L^a\right)^{1-\gamma}$$

The technology for home goods production is household specific which generates heterogeneity in labor force participation (i.e., labor supply to market activities, either own farming, or wage labor):[7]

$$Q_i^d = \left(L^d\right)^{\delta_i}$$

A household consumes two goods (home good and agricultural good) and the utility function is:

$$U_i = \alpha Ln\left(C_i^d\right) + \beta C_i^a$$

The utility function captures the idea that women perform some necessary home production

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[7]We thank an anonymous referee for noting the importance of heterogeneity in labor force participation in our analysis. Women's labor force participation may partly depend on other factors not captured in the simple model here. For example, educated women are, in general, more likely to participate in the labor force and labor market, because of skill premium earned in the labor market. We chose not to focus on the heterogeneity in human capital as a driving force in labor force participation for the sake of both realism and tractability. In a model with education and skill heterogeneity, education also will be relevant for migration decisions and labor market equilibrium will be characterized by a vector of wages reflecting skill premium for different levels of education. The model thus becomes substantially more complex without generating important new insights about the effects of land restrictions in our context.

before participating in the labor force, and households increase their consumption of market goods as income increases (a variant of Engel's Law). A quasilinear utility function also simplifies the algebra for the corner solution needed to derive non-participation in the labor force as an optimizing outcome for some women. Although we cast the household heterogeneity in terms of productivity differences, all the results below hold if instead the heterogeneity is in the preference for home good, i.e., if $\alpha_i \neq \alpha_j$ but $\delta_i = \delta \ \forall i$.

Household Optimization In the Absence of Land Restrictions

A household i maximizes the following utility function by allocating its fixed labor endowment across three alternatives: home goods production, own farming, and wage labor.

$$Max_{L_i^d, L_i^a} U_i = \alpha Ln \left(C_i^d \right) + \beta C_i^a$$

where

$$C_i^d = Q_i^d$$

$$C_i^a = Q_i^a + w_0 \left(L - L_i^d - L_i^a \right)$$

Solving the first order conditions we have the following labor allocation:

$$L_i^{a*} = \left[\frac{H_i^\gamma (1 - \gamma)}{w_0} \right]^{\frac{1}{\gamma}}$$

$$L_i^{d*} = \frac{\alpha \delta_i}{\beta w_0} \tag{1}$$

So woman from a household i will devote all her labor to home good production, and thus will not participate in the labor force, if the following holds:[8]

$$L_i^{d*} \geq L \Longrightarrow \delta_i \geq \frac{\beta}{\alpha} w_0 L \tag{2}$$

The condition for woman from a household to participate in the labor force, but not in the

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[8]Note that we do not impose concavity on the production function for home good, i.e., it is possible to have $\delta_i > 1$ in this model.

labor market is given by:

$$\delta_i \ni L_i^{d*} < L \text{ and } L_i^{d*} + L_i^{a*} \geq L \tag{3}$$

Denote the indirect utility function for household i residing in the rural area as $V^R(..)$, then we have:

$$V_i^R(H_i, L, \delta_i, w_0) = \alpha \delta_i Ln L_i^{d*} + \beta \left[Q_i^{a*} + w_0 \left(L - L_i^{d*} - L_i^{a*} \right) \right] \tag{4}$$

where L_i^{d*} and L_i^{a*} are given in equation (1) above as function of endowment, technology and prices.

Migration Decision without Land Restrictions

A woman from household i has the option to migrate to the urban area where the wage is higher $w_u > w_0$, but migration also entails some costs denoted as Φ which may include monetary and non-monetary costs. Without any restrictions in the land market, we assume that the household can be an absentee landlord, and can earn the profit generated by the land by renting out the land (say through a fixed rent contract). In general, the absentee landlord would bear costs of monitoring and enforcement, but we will mostly ignore such costs for the sake of simplicity and to focus on the costs that arise from sales and rental restrictions.

The optimization decision facing household i after it migrates to the urban area is as follows:

$$Max_{L_i^d, L_i^a} U_i = \alpha Ln C_i^d + \beta C_i^a$$

where

$$C_i^d = Q_i^d$$

$$C_i^a = w_u \left(L - L_i^d \right) + \Pi_i^a$$

where $\Pi_i^a(H_i, w_0) = Q_i^{a*}(H_i, w_0) - w_0 L_i^{a*}(H_i, w_0)$ is the profit from land H_i using only hired labor at wage rate w_0.

Denote the indirect utility for household i in the urban areas (without taking into account of migration costs) as $V_i^U(H_i, L, \delta_i, w_u)$. Then woman from household i will migrate to the urban

area only when the following holds:

$$V_i^U\left(H_i, L, \delta_i, w_u\right) - \Phi \geq V_i^R\left(H_i L, , \delta_i, w_0\right) \tag{5}$$

Two immediate results follow from the above migration condition: (i) migration decision depends on the productivity of home work, households with high enough value of δ_i will not find it optimal to migrate; and (ii) land ownership does not have any implications for the migration decision. To see the first result, consider the household k such that the following holds: $\delta_k \geq \frac{\beta}{\alpha} w_u L$. The productivity of home good is high enough for this household so that the woman does not participate in the labor market after migrating to the urban area, which also implies that she does not participate in the labor force while being a rural resident (because $w_0 < w_u$). For the household k, migration thus entails a net welfare loss of Φ; intuitively, a higher wage in urban area is not relevant for her because she does not sell any labor to the market when facing the higher wage in the urban area. The threshold productivity level above which a household does not find it desirable to migrate is denoted by $\hat{\delta}_0$, defined by the following:

$$w_u\left\{L - L_i^{d*}\left(\hat{\delta}_0, w_u\right)\right\} - w_0\left\{L - L_i^{d*}\left(\hat{\delta}_0, w_0\right)\right\} = \Phi \tag{6}$$

The left hand side in equation (6) shows the net gain in labor income arising from migration, and the threshold value equates the benefits with the costs of migration Φ. Note, however, that the second result about irrelevance of landownership for migration is driven by our assumption that there are no monitoring costs for an absentee landlord. As noted before, in general, an absentee landlord will incur monitoring costs that depend on the amount of labor hired. In that case, the costs of migration will be higher than Φ and would include the loss of profit due to monitoring costs leading to a lower threshold value of productivity above which a household find it undesirable to migrate.

Effects of Imposition of Land Restrictions

Restrictions on alienability and transferability of land, for example, ban on sales and rental of

land is expected to affect the migration decision because the household effectively loses the land and the associated income (profit), as emphasized by Hayashi and Prescott (2008), among others. The migration condition in this case becomes:

$$V_i^U\left(0, L, \delta_i, w_u\right) - \Phi \geq V_i^R\left(H_i, L, \delta_i, w_0\right) \tag{7}$$

where we set $H_i = 0$ in the urban (post migration) case implying that the household loses its rural land once it moves to the urban areas. Two important implications of the migration condition under land market restrictions deserve attention. First, given a positive land endowment, the threshold of productivity above which a household finds migration undesirable is lower than $\hat{\delta}_0$, because for $H_i > 0$, $V_i^U\left(0, L, \delta_i, w_u\right) < V_i^U\left(H_i, L, \delta_i, w_u\right)$. Second, land ownership now matters for migration decision; for a given productivity level δ, a household is less likely to migrate if it owns enough land so that the loss in profit outweighs the gain in wage income due to higher wages in urban areas. What is more important for our analysis is that land restrictions increase the probability that a randomly chosen woman in the village under land restrictions will participate in the labor force (in market activities, either own farming or wage labor). To see this, consider the households in an arbitrary land ownership category $\tilde{H}$, and denote the productivity threshold above which households do not migrate under land restrictions by $\hat{\delta}_1(\tilde{H})$, determined as follows:

$$V_i^U\left(\tilde{H}, L, \hat{\delta}_1, w_u\right) - \Phi = V_i^R\left(\tilde{H}, L, \hat{\delta}_1, w_0\right) \tag{8}$$

Since $\hat{\delta}_1(\tilde{H}) < \hat{\delta}_0$, the woman who are induced to stay back in the village after the imposition of land restrictions are the ones with $\delta_i \in \left(\hat{\delta}_1(\tilde{H}), \hat{\delta}_0\right)$, i.e., they have less productivity in home goods production than the households that chose not to migrate before the restrictions. If there is at least one woman j who participates in the labor force without land restrictions, $L - L_j^{d*}\left(\hat{\delta}_0, w_0\right) > 0$, then *all* of the women that stay back in the village because of land restrictions also participate in the labor force. The upshot of the above analysis is that the probability that a randomly drawn woman will participate in the labor force is higher in the villages under land restrictions.

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Land Market Restrictions and Village Wage Rate

The analysis so far ignores any effects of land restrictions on wage rate in the village. But when land restrictions affect many households in a village, we would expect it to alter the wage rate in the village labor market. To keep the exposition as simple as possible, we ignore the heterogeneity in land ownership and assume every household owns $\tilde{H} > 0$ amount of land. Denoting the CDF of productivity by $F(\delta)$, the labor market clearing condition without land restrictions can be written as:

$$L_S^T = \int_{\hat{\delta}_0}^{\bar{\delta}} \left[L - L_i^{d*}(\delta, w_0) \right] dF(\delta) = L_D^T \left(H^T, w_0 \right) \tag{9}$$

where $L_D^T \left(H^T, w_0 \right)$ is the total demand for labor in the village (own farming and market demand) at wage rate w_0.[9] The imposition of land restrictions reduces the productivity threshold and also the equilibrium wage rate so that the local labor market clearing and the migration equilibrium conditions are simultaneously satisfied. Denote the new productivity threshold as $\widetilde{\delta}_1$ and the corresponding equilibrium wage as $\widetilde{w_1}$, then we have the following:

$$L_S^T = \int_{\widetilde{\delta}_1}^{\bar{\delta}} \left[L - L_i^{d*}(\delta, \widetilde{w_1}) \right] dF(\delta) = L_D^T \left(H^T, \widetilde{w_1} \right) \tag{10}$$

$$V_i^U \left(\tilde{H}, \widetilde{\delta}_1, w_u^f \right) - \Phi = V_i^R \left(\tilde{H}, \widetilde{\delta}_1, \widetilde{w_1} \right) \tag{11}$$

A comparison of market clearing with and without land restrictions makes it clear that the equilibrium wage rate in the village labor market has to be lower after the imposition of restrictions, but the number of women who find it desirable to stay back because of land restrictions is smaller than the simple partial equilibrium case considered above with a fixed local wage w_0. In

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[9]We can treat the demand side as a single agent problem given that the technology is CRTS and there is no productivity heterogeneity in agriculture across households.

other words, we have the following relations:

$$\widetilde{w_1} < w_0; \widetilde{\hat{\delta}_1} > \hat{\delta}_1$$

A competitive land market equilibrium determines the rental rate once the labor endowment is pinned down by local labor market clearing and migration conditions in (10) nd (11) above. Given the CRTS technology in agriculture, the land rental rate (denoted as R) is given by the marginal productivity of land in the aggregate production function:

$$R^* = \frac{\partial Q^a \left(H^T, L_S^T \left(\widetilde{w_1} \right) \right)}{\partial H}$$

Proposition 1

Assume that (i) in the initial equilibrium without land restrictions, at least one woman participates in the labor force, and (ii) a household loses the land if it migrates after the land restrictions. The imposition of land restrictions in a village would lead to a decline in the village wage rate, but a higher probability of women's labor force participation.

In rest of the paper, we test the predictions from proposition 1 using data from and a policy experiment in Sri Lanka, and contrast them with the predictions from the collateral and insecure property rights mechanisms.

3. Data and Variables Definitions

The main data source for the estimation of the female labor force participation and wages is the Household Income and Expenditure Survey, 2002 (HIES, 2002) of Sir Lanka. We use the rural sub-sample of HIES 2002. The HIES 2002 collected information from a nationally representative sample of 16,924 households drawn from 1913 primary sampling units. The survey covered 17 of Sri Lanka's 25 districts, and 249 of its 322 Divisional Secretariat Divisions (DSDs).[10] From the 16,924 households in the survey, about 17140 females are in working age group (25 to 65

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[10]Data collection in the North and Eastern provinces was not possible due to on-going civil conflicts at the time of survey field work.

years). To define our sample, we used two criteria: (i) we excluded age groups which may have been exposed to historical malaria that afflicted Sri Lanka before 1950; (ii) we focused on the rural sample. Note that the rural sample does not include any household that has moved to urban areas with all the members, but the split households where some members stay behind in the village are part of the sample. The number of adult females who were born after 1950 and are currently residing in rural areas is 10,850. The sample for the wage regressions are, however, smaller. Among females in our main sample (10850), 42 percent are employed. About a third of those employed are self-employed. We have thus complete information on wages and other relevant variables for 2918 females who were born after 1950 and live in rural areas. The dependent variable in wage regression is deflated using region specific consumer price index.

A key piece of information for our analysis is the amount of land under LDO restrictions in a DSD. We draw this information from the Agricultural Census of 1998. We estimated percentage of agricultural land under LDO leases (including permits and grants). The DSD identifiers in the HIES (2002) and Agricultural Census allow us to merge individual level data from HIES 2002 with data on percentage of land under LDO leases from Agricultural census. The geographic information including travel time from surveyed DSDs to major urban centers with population of 100 thousand or more are drawn from the Geographical Information System (GIS) database. The travel time is estimated using the existing road network and allowing different travel speed on different types of roads.

A critical variable for our instrumental variables analysis is the historical district level malaria prevalence rate. The data on historical malaria prevalence are taken from Newman (1965). The measure for malaria prevalence used in this paper is called Gabaldon's endemicity index (see column 2 in Table 4, P.34, Newman, 1965). This index is based on the estimates of enlarged spleens in children due to malaria, and is a good indicator of the degree to which malaria is high and permanent in a district. However, we need a measure of malaria variations at the subdistrict level because the land restrictions vary at that level in the data. Also, we rely on district fixed effects in the IV regressions reported below in section 5 to control for unobserved land and labor productivity differences. Our approach to constructing an instrument that represents historical

sub-district level malaria incidence is to find exogenous sub-district characteristic(s) that can essentially be used as "weights to recover the variations in malaria prevalence across different sub-districts from the district average malaria data. A large literature on malaria in tropical countries identify a few ecological characteristics that can potentially be used to generate the sub-district level historical malaria estimates. Among the candidate ecological variables, rainfall is perhaps the most reliable predictor of spatial malaria variation in the specific context of Sri Lanka (Briet et al., 2003, 2008). We thus use rainfall in a sub-district as the relevant exogenous characteristic to uncover the incidence of historical malaria across sub-districts. The effects of rainfall on the incidence of malaria, however, can be different in different countries.[11] In Sri Lanka, the relationship between malaria and rainfall is negative across geographic space, as higher rainfall washes out the breeding grounds of *Anopheles Culicifacies*, and *Anopheles Subpictus*, the main malaria vectors in Sri Lanka (Clemesha, 1934; Rustomjee, 1944; Briet et al., 2008). An interaction of rainfall with historical malaria is used as an instrument in our empirical analysis. As we discuss in the empirical strategy below, all regressions control for rainfall directly to capture any productivity effect of rainfall.

The HIES 2002 also collected information on education, age, gender, ethnicity and religion. The individual and household level explanatory variables are defined from the HIES 2002. HIES 2002 however did not collect information on health status of the household members. We draw information on the chronic illness of household heads from HIES2006 data (Table A.20, p.99 in the final report on HIES 2006/7). The information on anemia prevalence rate among non-pregnant women is drawn from Demographic and Health Survey 2006/7 (Table 6, p.19, DHS report (2009)).[12] The area characteristics including rainfall, slope, area and land quality are drawn from various GIS data sources. Appendix Table A.1 provides summary statistics for all variable included in our analysis.

Among 10850 women in our main sample, 51 percent participated in the labor force, with

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[11]Many researchers in Asia found that rainfall reduces malaria incidence/prevalence by washing out the breeding grounds of Anopheles mosquito (Wijesundera, 1988.)

[12]Anemia status was determined by haemoglobin level in blood. Anyone with haemoglobin level below 7.0g/dl is classified as severely anemic, and with haemoglobin level between 7.0-10.p g/dl classified as having moderate to mild anemia.

42 percent employed and another 8.65 percent unemployed but seeking jobs. Though Sri Lanka has a higher per capita income compared with rest of the South Asian countries, labor force participation rate in Sri Lanka (51 percent) is somewhat larger than that in India (around 34 percent) but smaller than that in two poorest countries Bangladesh (57 percent) and Nepal (58 percent) (Chaudhuri, 2010). As opposed to other South Asian countries where work migration among women is very limited due to social and cultural norms, Sri Lankan women are quite mobile in search of jobs. For instance, about half of all emigrant workers in Sri Lanka are women (about 2.5 million women) and a large fraction of garment workers – the most important manufacturing – are also women who migrated from rural areas (Ukwatta, 2003). In the following section, we discuss our empirical strategy.

4. Empirical Strategy

The core identification challenge is that the different sub-districts may differ systematically in observed and unobserved dimensions, and when the unobserved characteristics are correlated with both the incidence of land restrictions and the outcome variables across different sub-districts, it may lead to omitted variables bias. The sources of omitted variables bias are likely to be unobserved labor and land productivity heterogeneity.

4.1 Possible Sources of Bias

It is common for governments to impose restrictions on sales of land in settlement areas, and settlement usually takes place in low quality marginal land. Also, historically private property rights emerge first in high productivity land. As a result, when we observe land under private property rights to coexist with land under government restrictions, the land under restrictions in general turns out to be of lower quality. A second important issue is the labor productivity heterogeneity. Since lands under policy restrictions in Sri Lanka are mainly settlement lands, one might worry that the people who were brought to these lands are of lower productivity due to adverse human capital characteristics. Evidence from Sri Lanka however shows that land and labor productivity is higher in areas under land policy restrictions.

Crop yield is a good summary statistic for land and labor productivity of an area. Crop

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yields are found to be higher in land under policy restrictions for a number of different crops including rice, the main crop in Sri Lanka (please see Table 1 for details). There is no evidence of adverse health conditions in areas under land restrictions. The correlations between two indicators of health status – incidence of chronic illness and disability, and percentage of non-pregnant women suffering from different degrees of anemia – with proportion of land under restrictions are statistically insignificant and mostly bear negative signs (please see Table 2). The higher land productivity in areas under land restrictions are outcomes of Sri Lanka government's heavy investment in irrigation development in resettled areas. Similarly investments in health, education and social services across the entire country successfully eliminated regional differences in the labor productivity outcomes as well (Sen, 1981).

Higher productivity in a subdistrict, however, does not have unambiguous effects on women's labor force participation and wage, because it can have conflicting effects on the demand and supply sides of the labor market. On the demand side, higher land/labor productivity increases marginal productivity of labor and thus raises demand for labor and equilibrium wages. However, higher land quality also implies higher income for the land owning households which can reduce labor force participation (and labor supply) by women when work outside the home is associated with social stigma (Goldin (1995)). The bias from unobserved land and labor quality thus depends on the net effect: if the labor demand shift due to higher productivity dominates, the OLS estimates will tend to overestimate the effects of land restrictions on women's labor force participation (because the causal effect is positive according to the theory), and underestimate their effects on wage (because the causal effect is negative according to the theory).

Another potentially important issue is measurement error in the land restrictions variable and the resulting 'attenuation bias'. Thus the OLS estimates of the effects on both labor force participation and equilibrium wages are likely to be biased toward zero.

4.2 Historical Malaria as a Natural Experiment

 To estimate the effects of land restrictions on women's labor force participation and wage, we need to find a source of exogenous variation in the incidence of land restrictions in different sub-districts. The unique role played by malaria infestation starting from 13th century till early

twentieth century in the history of land policy of Sri Lanka offers such an exogenous source of variations. The areas affected by historical malaria endemicity witnessed exodus of population and abandonment of land (De Silva (1981)). The abandoned land was taken over by the government and designated as 'crown land' during the colonial period. The crown land was later distributed after the independence in 1948 under Land Development Ordinance of 1935, and restrictions on sales, mortgage, and rental were imposed (henceforth called LDO restrictions). Since the amount of crown land available in a sub-district was historically determined by the intensity of malaria, the historical malaria incidence created exogenous variations in the incidence of land restrictions in a sub-district; the proportion of land under restrictions is higher in a sub-district, the higher was the intensity of historical malaria prevalence.[13]

An important part of our empirical strategy is to use district fixed effects to control for time-invariant land and labor productivity factors which are the main sources of omitted variables bias. This precludes the use of district level malaria variation for identification. *More important, we need an instrument that can provide variations at the subdistrict level to explain the incidence of land restrictions which varies across different subdistricts.* Also, the district average is likely to smooth out a large part of the identifying variation in historical malaria across different subdistricts, and thus may result in weak instrument problem. This is important because there were significant variation in the historical malaria endemicity across different sub-districts within the same district. For example, in Jaffna district, the Jaffna city was almost malaria free while the south Jaffna suffered from severe malaria in early 1930s (Newman (1965), p. 35). To uncover this variation across sub-districts in a district, we exploit the correlation between rainfall and malaria by using interaction of these two terms as instrument. As discussed in the data and variables section above (section 3), rainfall is one of the most important exogenous ecological determinant of malaria in Sri Lanka, and the higher the rainfall in a subdistrict (DSD) in a district, the lower is the malaria incidence compared to the other DSDs in the district, because rainfall washes away the

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[13]One potential worry is that the households facing historical malaria might have abandoned land selectively which can create a negative correlation between the extent of land restrictions in a sub-district and its land quality, because one would expect a household to abandon the low quality lands first. However, as discussed earlier, the lands under the restrictions are of higher quality, which implies that we do not need to worry about such selective land abandonment. We thank Michael Clemens for raising this point.

breeding grounds (standing waters in ponds, canals, marshes etc.) of the main malaria vectors (see, for example, the discussion on the effects of rainfall on historical malaria in (Clemesha, 1934; Rustomjee, 1944). Thus the interaction of district level malaria estimate with DSD level rainfall in the first stage regression of the incidence of land restrictions that includes district fixed effects will have a *negative* sign, if the interaction in fact represents variation in historical malaria across DSDs. This a priori sign restriction is useful for our identification strategy, because one might worry that the interaction represents primarily variation in productivity due to rainfall differences across DSDs, instead of variations in historical malaria across DSDs within a district. Note that we directly control for rainfall in the regressions, but if our instrument is still picking up productivity effects of rainfall, we would find a positive coefficient on the interaction of malaria and rainfall at the DSD level in the first stage regressions. This is because productivity is higher in high land restrictions areas, as discussed earlier, and higher rainfall increases crop yield. The sign of the instrument in the first stage thus provides us with a way to check whether the interaction based instrument captures the variations in historical malaria across DSDs.

4.3 Potential Objections to Identification Strategy

There are a number of possible objections to our identification scheme which we discuss below.

A legitimate concern is that the sub-district level historical malaria might proxy for the direct effect of rainfall on the labor market, especially in the agricultural sector. To make sure that our instrument (rainfall weighted historical malaria) does not capture the direct effect of rainfall on the labor market, we control for rainfall in a sub-district directly in all of the IV regressions.[14] In addition to rainfall, regressions control for slope (steeper slope means less standing water and less malaria), share of paddy land in total agricultural land and a dummy indicating whether the DSD is within 5 km of a river (land productivity). The district level fixed effects are also included to control for land and labor productivity heterogeneity. As discussed before, land productivity as measured by yield is not lower in high land restriction areas. Evidence in Table 1 also indicates

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[14]Since rainfall is conducive to rice cultivation, one might worry that they might affect the cropping mix in a subdistrict. We thank Andy Foster for raising this point. To the extent crops differ in terms of their labor intensity, it might affect demand for labor. The rainfall as control should pick up the resulting variation in labor demand across sub-districts. As an additional check, we later report IV results that control for share of paddy land.

that conditional on exogenous indicators of land productivity (rainfall, slope and nearness to river dummy and district fixed effects), our instrument is not correlated with crop yields. This is strong evidence in favor of the identification scheme.

Another important objection to the identification strategy comes from the recent literature on institutions and growth that shows that historical malaria can affect the quality of institutions through its influence on settler mortality (Acemoglu et al, 2001). However, it is important to appreciate that the long-term effects of malaria on the quality of institutions emphasized in the cross-country literature are not relevant for our identification scheme. Because identification in our case comes from *variations in historical malaria across sub-districts within a district,* as we use district fixed effects.[15] The relevant institutions such as legal system and enforcement of contracts and property rights, however, are determined at the national level. As an additional precaution, we also control for the proportion of Sinhalese population in a sub-district as a measure of ethno-linguistic fractionalization that can potentially affect public goods provision.[16] A further concern is that historical malaria may have affected human capital of current labor force adversely in our sample. There are good reasons to believe that this is not the case. First, and probably the most important, is the fact that the settlement schemes brought in people from relatively malaria free regions to the subdistricts which were abandoned because of historical malaria. As a result, vast majority of the current population were never exposed to historical malaria in the sub-district of their current residence (i.e, residence in 2002). Second, we exclude the cohorts that were potentially exposed (in utero or post-natal) to historical malaria in Sri Lanka.[17] Thus our sample is not contaminated by the possibility that someone might have been exposed to historical malaria before his/her mom resettled in a historical malaria ravaged sub-district.[18] The upshot of the above discussion is that historical malaria in a sub-district should not be correlated with

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[15]A district as an administrative unit is similar to a county in USA.

[16]We, however, do not find any evidence that ethnolinguistic fractionalization is correlated with the incidence of land restrictions across sub-districts in Sri Lanka. A regression of proportion of land under restrictions on a constant and share of Sinhalese population yields a coefficient close to zero (-0.002) with a very low t statistic (-0.33).

[17]Since malaria exposure in utero can have effects on adult health and education, we exclude cohorts born before 1950, even though nationwide malaria eradication was implemented in 1947.

[18]Note that the probability of such exposure is not high as malaria endemicity was much lower in the sub-districts from where the people were resettled.

the health outcomes of most of the current population. Indeed, evidence in Table 2 confirms that the interaction of historical malaria and rainfall is *not* correlated with the current health conditions (measured by anemia and chronic illness/disablity). To allay the concern that historical malaria might pick up the current malaria infections, we control for recent malaria incidence (both Plasmodium Vivax and Plasmodium Falciparum infection rates).

Note that historical malaria can potentially affect the attitude (for example, risk preference) of the exposed population, and it can have long-term effects on women's labor force participation if intergenerational transmission of changes in attitude is significant enough. But, in our sample, such effects are not possible because the parents and grandparents of the current generation under land restrictions were never exposed to the historical malaria in the current village of residence, as they were resettled from relatively malaria free parts of the country. This fact also implies that the migration network inherited by the current generation was not affected by historical malaria in their current residence. This is important because historical malaria can have direct effects on migration if parental generation was exposed.[19]

5. Empirical Results

(5.1) OLS Estimates

We start with the simple OLS results for alternative sets of controls and samples. Regressions include a set of individual and household level controls, area-specific controls, and a dummy for estate (tea plantation). The estate dummy captures variation in economic opportunities particularly for women as tea estates in Sri Lanka employ primarily women workers. The distance to the nearest city plays a double role; it represents the standard migration costs due to transport and search, but it may also capture differences in economic structure, as the composition of output and pattern of crop specialization in a village economy depend on the access to urban markets (Emran and Shilpi (2012)). The area-specific controls include share of Sinhalese (main ethnic group in the country), number of cases of Plasmodium Vivax and Plasmodium Falciparum infections in 2002. The set of individual and household level controls vary slightly depending on

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[19]We thank an anonymous referee for raising these points.

the dependent variable of regression. Most regressions also include land productivity controls such as average rainfall, average slope, a dummy indicating whether sub-district is within 5 kilometer of a river, and proportion of land devoted to paddy and district level fixed effects. In addition to capturing unobserved land and labor heterogeneity, the district fixed effects also control for any formal or informal institutional differences across areas which might be relevant for labor market. All standard errors reported in this paper are corrected for heteroskedasticity and clustered at DSD level.

The regressions for labor force participation are reported in columns 1 and 2, and for wage in columns 3 and 4 of Table 3 respectively. The wage regressions correct for selection into employment as labor force participation rate among women is about 51 percent. The estimates of Table 3 exploit heteroskedasticity for identification following a growing econometric literature that shows that identification can be obtained without any exclusion restrictions if there is heteroskedasticity in the participation equation (Schaffner (2002), Lewbel (2012), Klein and Vella (2009)). As shown by Schaffner (2002) and Klein and Vella (2009), heteroskedasticity effectively induces an exclusion restriction even if there is no external instrument available.[20] The second approach we take imposes explicit exclusion restriction following Mulligan and Rubinstein (2008) who use numbers of infants and toddlers as instruments for sample selection correction in female wage equation (the corresponding OLS results are omitted for the sake of brevity).[21]

The specifications in columns 1 and 3 of Table 3 include controls for individual and household characteristics, a dummy for estate (mainly tea) and distance to the nearest large city but do not include land productivity controls or district fixed effects. We include individual and household level characteristics that are expected to affect a women's reservation and actual wages; age (in log), marital status, education level (log) and indicators of differences in stigma effect of women's work (religion and ethnicity). The labor force participation regression includes a squared term for education as education is observed to have non-linear effect on participation decision. The simple

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[20] For recent applications of heteroskedasticity based identification, see, for example, Chowdhury et al. (2014), Emran and Hou (2013), Emran and Shilpi (2012), Emran et al. (2014), Mallick (2011).

[21] We, however, present the results that include number of infants and toddlers as an identifying instrument of the selection equation as part of the robustness checks of the main IV results.

OLS regressions indicate no significant correlations between land restrictions and women's labor force participation and wage. These regressions, however, do not control for any agro-climatic or other indicators of productivity such as rainfall. Thus potential negative effect of land restrictions may be offset by the omitted productivity effects.

The next specifications (columns 2 and 4) add geographic (slope, proximity to river), agro-climatic (rainfall), and land productivity (share of paddy land) variables to the specification in columns 1 and 3. They also include district level fixed effects. The estimated partial correlation between land restrictions and women's labor force participation is positive, large in magnitude (0.28) and statistically significant at the 1 percent significance level.[22] The estimated partial correlation (-1.42) in the case of wage is on the other hand negative and statistically significant at the 1 percent level. The estimates in column 2 and 4 thus provide some preliminary indication that the omitted land and labor productivity may bias the estimates of the impact of land restrictions on women's labor force participation and wage toward zero.

(5.2) Estimates from the Instrumental Variables Approach

The OLS regressions in Table 3 provide some interesting preliminary evidence on the effects of land restrictions on women's labor force participation and wages. However, the estimates are likely to be biased due to unobserved heterogeneity and measurement error. To correct for the possible bias in the estimates in Table 3, we use the instrumental variables approach developed in section (4) above. We use the most complete specifications in columns 2 and 4 of Table 3 for the instrumental variables estimation. Table 4 reports the main results from the instrumental variables approach. The first row shows the IV estimates of the effects of land restrictions on women's labor force participation and wages, and the following four rows report the first stage regressions and diagnostics for the relevance of the instrument.

The first stage results show that historical malaria incidence at the subdistrict level has excellent power in explaining the variation in the incidence of land restrictions (proportion of land under restrictions), even after district fixed effects are included. The lowest Kleibergen-Paap

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[22]The pattern of the estimates from the probit models for labor force participation are similar to the ones from OLS and are omitted for the sake of brevity.

F statistic for the exclusion of the instrument are 11.99 across the four IV regressions in Table 4, implying that all of the F statistics are larger than the Stock-Yogo critical value 9.08 for 10 percent maximal relative bias.[23] The sign of the instrument (interaction of district malaria with DSD rainfall) in the first stage regressions is *negative* across all four regressions. As discussed before, this can be interpreted as strong evidence that the interaction of rainfall with historical malaria in fact captures the variation in historical malaria across DSDs (after employing district fixed effects); if the interaction represents direct productivity effects of rainfall instead, we should have observed a positive coefficient on the instrument in the first stage regression. This provides additional evidence that conditional on district fixed effects, subdistrict rainfall, and a rich set of controls in the IV regressions, the exclusion restriction imposed on the rainfall weighted historical malaria is credible.

Columns (1) and (2) in the first row of Table 4 reports the estimated causal effects of land restrictions on women's labor force participation. The specification in column (2) adds number of infants and toddlers as additional regressors. The estimated effect of land restrictions on women's labor force participation is statistically significant at the 1 percent level, and the magnitudes (1.05 and 1.04) are significantly larger than the corresponding OLS estimates.

Columns (3) and (4) in row 1 of Table 4 present the 2SLS estimates of the effects of land restrictions on female wage. The wage regressions include a selection term to correct for self selection into the labor force. The specification in column 3 exploits heteroskedasticty in the participation equation following a growing econometric literature that shows that identification can be obtained without any external instruments when there is heteroskedasticity in the selection equation (Schaffner (2002), Lewbel (2012) and Klein and Vella (2009, 2010). Since the selection equation is a binary choice model, one can argue that it is identified from the nonlinearity of the normal CDF. However, it is well-appreciated in the literature that such identification is weak, as it relies on the data variation in the tails of the distribution (Altonji et al. (2005)). When there is heteroskedasticity, it allows us to exploit the observations from the middle part of the

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[23]We use the critical value for 3 instruments, as Stock-Yogo (2005) do not report the critical value for 2 instruments.

distribution which is approximately linear, and thus the resulting identification is no longer weak (for a discussion, see Klein and Vella (2009)). The specification in column 4 on the other hand utilizes the number of infants and toddler as identifying instrument in the selection equation following Mulligan and Rubinstein (2008).

The estimated effect of land restrictions on female wage as reported in column (3) is negative, numerically substantial (-1.54) and statistically significant at the 5 percent level (row 1). The estimate using the alternative selection correction scheme reported in column 4 also suggests statistically significant (at 1 percent level) and negative (-1.78) effect of land restrictions on female wage. The IV estimates of the effects of land restrictions on female wage are numerically (in absolute magnitude) larger than the OLS estimates reported in Table 3 (column 4). The IV estimates for both labor force participation and wage seem to justify the worry that the OLS estimates are significantly biased toward zero due to omitted variables and measurement error.

We also perform a variety of robustness checks for the IV results in Table 4, but we omit the results for the sake of brevity (available in an online appendix to this paper). The robustness exercises deal with the following issues: (i) potential correlation between unobserved land productivity and farm size,[24] (ii) possible effects of malaria eradication in 1947 on the population and hence density of economic activity, (iii) broader measure of relevant urban market for a subdistrict, and (iv) heterogeneity in non-farm opportunities, and investments in land improvements across subdistricts.

(5.3) Mechanisms: Collateral for Credit, Insecure Property Rights, or Migration Costs?

The results discussed so far provide strong evidence that the land market restrictions affect women's labor force participation and wages significantly. The evidence is consistent with the theoretical analysis in section (2) above that identifies rural-urban migration as the main channel through which the land market restrictions work.

The results reported so far are, however, not consistent with the predictions from the two

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[24]This point was raised by Andrew Foster.

other alternative mechanisms discussed in the introduction. First, consider the implications of an important credit and interest rate channel for the land market restrictions. A lower access to formal credit can have conflicting effects on the demand for labor. On the one hand, a higher interest rate faced in the informal sector would lead to capital-labor substitutions in favor of relatively cheaper labor, and thus increase the demand for labor in a sub-district with higher proportion of land under restrictions.[25] The equilibrium wage in this case will be higher along with higher level of labor force participation in the rural areas. The fact that we find very robust evidence of a negative effect of land restrictions on equilibrium wage casts strong doubts on the relevance of such interest rate channel in our case. However, at least in some cases, the capital and labor may be complementary. For example, if lower access to credit reduces the adoption of new seed technology in agriculture, this might reduce demand for labor.[26] More generally, a lack of credit and higher interest rate will affect investment adversely and also can lead to failure and exit of non-farm business in a village. Such negative effects at the extensive margin will reduce the demand for labor. In this case, we would observe a reduction in both wage and labor force participation by women. Our evidence that labor force participation in fact increases after land restrictions thus contradicts this particular credit mechanism.

If land market restrictions create uncertainty regarding property rights, then women would need to stay back home to guard and protect property rights as in Field (2007). In the context of our model, this can be interpreted as higher productivity in home work, which now also includes guard labor. More insecurity in property rights would reduce women's labor force participation and push up wages in the village labor market. Our evidence on both wages and participation contradict both of these predictions.

(5.4) Additional Evidence on Migration Mechanism

In this section, we provide additional evidence that the effects of land restrictions on women's labor force participation and wage are due to the increased costs of migration arising from re-

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[25]The farmers would not find it profitable to adopt labor saving technologies such as tractors and thrashing machines.

[26]Most of the existing evidence shows that the green revolution increases demand for labor.

strictions in the land market. We provide several pieces of evidence that relates to the effects of higher migration costs.[27] First, we find that propensity of outmigration is lower across districts (see Figure 1 based on population census 2012) and proportion of split households where some members are left behind to hold on to the land is higher (see Figure 2 based on HIES 2002) in subdistricts with land restrictions. The census did not provide the out-migration data by gender. To check if female migration is also less in the areas with higher land restrictions, we use census data on female share in total population. The census data show that share of female in total population is higher when land restrictions are higher (Figure 3). This is true if we focus only on adult women (graph omitted for brevity). Using population census data from 2002 and 2012, we compute the change in female share of population for the same age cohort (15-49 year old in 2002 and 25-59 year old in 2012). Figure 4 plots this variable against proportion of land under restrictions. The positive slope confirms that more female are staying back in areas with more land under restrictions. Third, female share in the labor force –defined from HIES 2002 data – is also positively correlated with the incidence of land restrictions (see Figure 5). Taken together, these can be interpreted as strong direct evidence in favor of the proposition that women stay back in the village in response to higher migration costs arising from land restrictions. Finally, using HIES 2002 data, we find that farm size is negatively correlated with land restrictions, as one would expect if more women (and possibly some men) stay back in the village facing higher migration costs (Figure 6).

We also find suggestive evidence that support the model where heterogeneity in labor force participation and the consequences of higher migration costs depend on productivity in home goods production. Due to cultural norms, women are responsible for providing home goods in Sri Lanka, and this gender role creates productivity differences between male and female in home goods production. It is also common that the older women bear most of the responsibility for home, and accumulate advantages due to learning effects and experience. If home production is important as postulated in our model, then increased migration costs due to land restrictions will

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[27]We are grateful to an anonymous referee for suggesting these additional test for the migration mechanism. As mentioned before that the migration mechanism has prediction for farm size was also noted by Andrew Foster.

affect the men much less than the women, and among women, the effect will be smaller on the younger women. In an online appendix (see Table A.3), we report evidence on differential effects of land market restrictions across gender and different age cohorts of women. The evidence is consistent with an important role of home production heterogeneity.

(5.5) Economic Significance

Are the estimated effects economically important enough to warrant attention? A 10 percent increase in the land under restrictions starting from a mean incidence level of restrictions increases women's labor force participation by about 2.3 percent according to the estimate in Table 4. The mean level of land restrictions in our data set is about 11 percent, thus a 10 percent increase in the land under restrictions is equivalent to an increase of about 1 percentage point for an average sub-district. A close to 2.3 percent increase in the labor force participation due to a 1 percentage point increase in the land restrictions is not a small effect given that the mean labor force participation rate for women in our sample is 51 percent. The estimates for female wage imply that a one percentage point increase in land under restrictions reduces wage by about 1.7 percent. The average annual real wage for women is Rs. 51133 in our sample. A 1 percentage point increase in land under restrictions decreases annual wage by Rs.866 (evaluated at the mean so that the area of land under restrictions goes up from 11 percent to 12 percent). The official poverty line annual expenditure for 2002 was Rs.17076, and food poverty line was Rs. 11676. The reduction of wage due to a percentage point increase in land under restrictions accounts for 5.1 percent of official poverty line expenditure and 7.4 percent of food poverty line expenditure. The results thus indicate that the effect of land market restrictions on female wage is substantial.

6. Conclusions

This paper examines the effects of land market restrictions on female labor force participation and wages in a rural labor market. The existing literature emphasizes two channels through which land restrictions affect economic outcomes of a household: the collateral value of land, and insecurity of property rights. Our theoretical analysis focuses on an alternative mechanism where land restrictions increase costs of migration. In a model where women differ in terms of

their productivity in home goods production, we show that land restrictions lower equilibrium wage, but increase labor force participation rate. This evidence contradicts both the collateral and insecure property rights mechanisms.

We use a historical quasi experiment in land policy in Sri Lanka to estimate the effects of land market restrictions on the local labor market. The IV estimates that exploit the historical natural experiment show that the effect of land restrictions on women's labor force participation is numerically substantial and statistically significant at the 1 percent level. According to the IV estimates, when the land restrictions increase by 1 percentage point (starting from a mean level of restrictions), it increases women's labor force participation by close to 2.3 percent. The corresponding estimate is 1.7 percent reduction in the wage for women. The results also suggest a greater burden of land market restriction on older women, and a much lower effect on men. To the best of our knowledge, the theoretical and empirical analysis presented in this paper is the first attempt in economics literature to understand the effects of land market restrictions on women's labor force participation and wage in rural areas of a developing country.

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Table 1: Relationship between historical malaria and current productivity (yield)

	Rice	Cassava	Banana	Ground Nut	Other Oilseeds
Proportion of Area Under LDO	1,589**	-1,513	-1,645	843.5***	-314.1
	(2.058)	(-0.736)	(-1.417)	(3.593)	(-0.275)
Malaria Incidence*rainfall	-0.386	-14.24	-2.003	-0.574	-1.77
	(-0.105)	(-1.541)	(-0.366)	(-0.400)	(-0.325)
Observations	118	90	98	57	101

Note: Regressions control for rainfall, average slope, proportion of irrigated land and dummy for within 5 km of a river.
Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 2: Land under Restrictions, Historical Malaria and Health Status

	Anemia among non-pregnant women			% suffering Chronic Illness/disability		
	Mild/Moderate	Severe	Any	Male	Female	All
Proportion of Area Under LDO	-27.82	1.859	-25.96	-4.912	-9.060	6.093
	(-1.017)	(1.139)	(-0.966)	(-0.576)	(-1.474)	(0.372)
Malaria Incidence*rainfall	-0.240	1.05e-02	-0.230	7.30e-03	-1.48e-02	3.79e-02
	(-1.626)	(1.117)	(-1.581)	(0.150)	(-0.397)	(0.409)

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3: Land market restrictions, Female Labor Force Participation and Wages
OLS Regression Results

	Labor Force Participation		Log(Real Annual wage)	
	1	2	3	4
Proportion of area under LDO	-0.0148	0.280***	-0.240	-1.424***
	(-0.150)	(2.752)	(-1.058)	(-6.931)
Travel Time to Large City	0.0187***	0.00944*	-0.0594***	-0.0512***
	(3.862)	(1.911)	(-5.235)	(-3.821)
Selection Term			1.032***	2.474***
			(4.804)	(9.722)
Observations	10,850	10,850	2,918	2,918
Individual/household characteristics	Yes	Yes	Yes	Yes
District Fixed Effect, Area Characteristics	No	Yes	No	Yes

All regressions include individual's age, education, marital status, and dummies for household's religion/ethnicity
Robust t statistics in parentheses. Standard errors corrected for clustering at the sub-district level (DSD)
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Land market restrictions, Female Labor force participation and Wages
IV Regression Results

	Labor Force Participation		Log(Real Annual wage)	
	1	2	3	4
Proportion of Area Under LDO	**1.046***	**1.032***	**-1.541****	**-1.778***
	(2.658)	**(2.657)**	**(-2.308)**	**(-2.672)**
First stage Regressions				
Malaria*Average Rainfall	**-0.0439***	**-0.0440***	**-0.0433***	**-0.0425***
	(-3.463)	**(-3.465)**	**(-3.656)**	**(-3.587)**
Relevance of Instruments				
Kleibergen-Paap/Angrist-Pischke F	11.99	12.01	13.37	12.87
Stock-Yogo 10% max. rel. IV bias	9.08	9.08	9.08	9.08
Controls				
Individual characteristics	Yes	Yes	Yes	Yes
Household Composition	No	Yes	No	Yes
Area characteristics, District FE	Yes	Yes	Yes	Yes

(1) All regressions include full set of regressors as in columns (2) and (4) of Table 3.

(2) Column 2 includes household composition (no. of infant and kids) as controls

(3) Selection term in column 3 is defined in terms of heterocedasticity in the participation equation

(4) Selection term in column 4 is defined using numbers of infants and kids as exogenous controls in participation regression.

(5) Robust t statistics in parentheses. Standard errors corrected for clustering at sub-district (DSD)

* significant at 10%; ** significant at 5%; *** significant at 1%

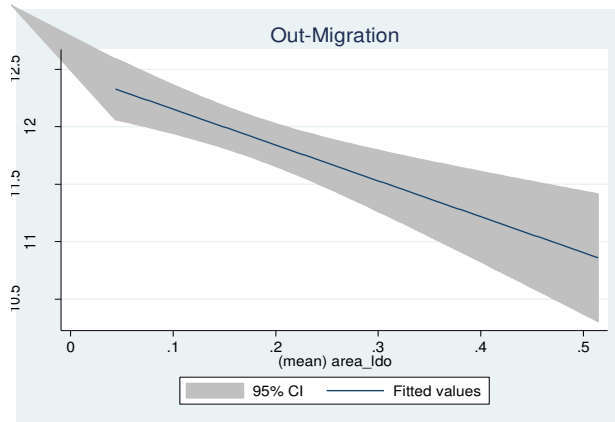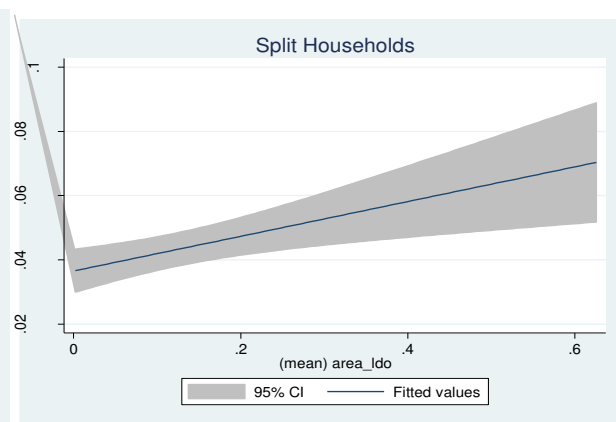| Figure 1: Proportion of Land under Restrictions and Out-Migration: Population Census 2012	Figure 2: Proportion of Land under Restrictions and split households, 2002 (HIES)

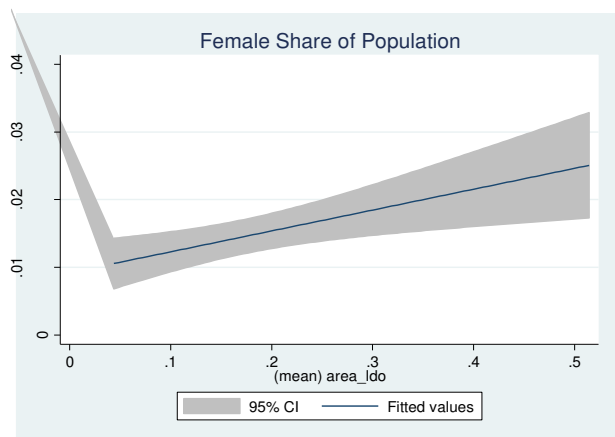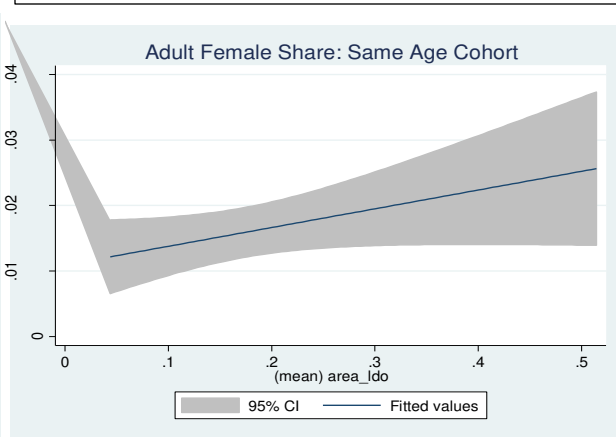| Figure 3: Proportion of Land under Restrictions and share of female in total population, 2012	Figure 4: Proportion of Land under Restrictions and change in female share in total population for same age cohort (15-49 in 2002), 2002-2012

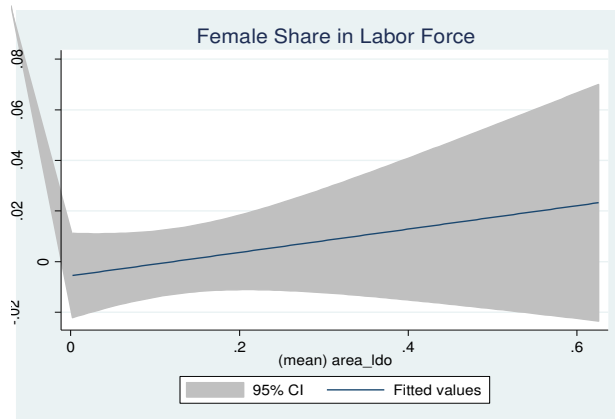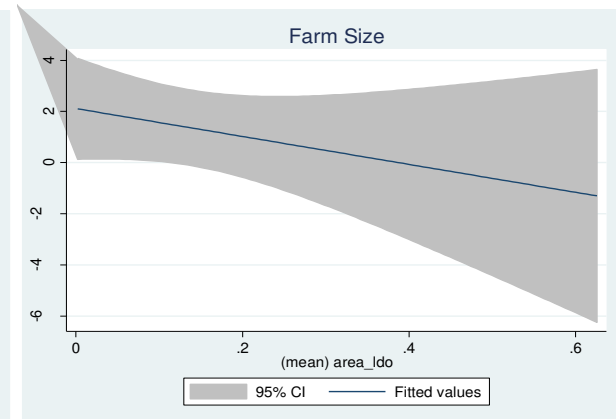| Figure 5: Proportion of Land under Restrictions and female share in labor force, 2002 (HIES)	Figure 6: Proportion of Land under Restrictions and Farm Size, 2002 (HIES)

Online Appendix: Not for Publication

IV Estimates: Robustness Checks

In this subsection we report a number of robustness checks for the IV estimates reported in Table 4. Table A.2 reports the results from the robustness checks. The upper panel reports the robustness checks for labor force participation and lower panel for wage regressions. All of the estimates for labor force participation in Tables 5 are based on the specification in column (1) of Table 4. For wages, the specification corresponds to column 3 of Table 4.

The first robustness check deals with the issue of potential correlation between farm size and unobserved land productivity in a sub-district.[1] If productivity varies systematically with farm size, then it can affect labor demand and hence labor force participation and wages directly. The IV regression in column (1) of Table A.2 controls directly for farm size and results indicate no significant change in the estimated effects of land restrictions on labor force participation and wages.

A related concern is that historical malaria and its eradication in 1947 may have affected the population of a sub-district through migration and re-settlement. Such population movements may have affected the density of economic activities and hence our dependent variables. Note that the regressions already control for travel time to the larger cities which is a reliable predictor of density of economic activities. In addition we include population density of a sub-district in an IV regression, and the results reported in column 2 of Table 5 indicate little change in parameter estimates.

In the IV regressions reported Table 4, travel time to the nearest large city (with population of 100 thousands or more) is used to control for the effects of remoteness from urban markets. One might argue that focusing on a single city (even if the largest) may not capture the extent of the market households in a village have access to. Column 3

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[1]Note that farm size may not be an appropriate control because it can be the outcome of land restrictions. As land restrictions affect land/labor ratio, it can affect the farm size in a subdistrict.

of Table A.2 reports the IV estimates from a specification that includes urban population within 5 hours of travel time as a measure of the relevant market. The estimated effects of land restrictions are again nearly unchanged for both labor force participation and wage regressions.

Column (4) of Table A.2 addresses the question whether the negative effect of land restrictions can partially reflect heterogeneity in the availability of non-farm opportunities. The estimate, after controlling for the share of non-farm employment in a village (PSU), is 1.15 (with a P-value of 0.00) for labor force participation and -1.35 (p-value=0.05) for wage. One should however interpret these estimates with caution, as non-farm activities are likely to respond to the incidence of land restrictions, and thus may be a 'bad control' a la Angrist and Pischke (2009), when the focus is on estimating the causal effects of land restrictions on equilibrium wages.

An additional concern is that eradication of historical malaria in 1947 may have induced private investment in land improvement affecting labor demand in post-eradication periods.[2] This, however, has not been the case in Sri Lanka. In the case of lands under restrictions which were distributed under the Land Development Ordinance Act, government invested massively in the development of large-scale irrigation systems as well as other land improvements prior to distributing these lands to private individuals. Treating all irrigation investment as private investment, we include proportion of agricultural land irrigated in a subdistrict as an additional control in the IV regression. The results in column 5 of Table A.2 again show some change in the estimates of the effect of land restrictions on female labor force participation and wages though in opposite direction. Even after inclusion of irrigation, the estimates suggest numerically and statistically significant impacts of land restrictions on female labor force participation and wages. As in the case of non-farm employment, irrigation qualifies as a 'bad' control since land restriction may affect private

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[2]It is important to appreciate that positive land or labor productivity improvements cannot explain our result that land restrictions have a negative effect on wages; such productivity increases would result in higher wages.

investment in irrigation directly.

Finally we check the sensitivity of the estimates with respect to the inclusion/exclusion of DSDs with very high incidence of land restrictions; are the estimates driven by a few outliers in the right tail? Column (6) of Table A.2 reports the estimates from a sample that excludes sub-districts with proportion of land under restrictions more than 30 percent. The restricted sample has 212 DSDs and thus loses 30 out of a 242 DSDs in the full sample. The estimated effects are significant at 5 percent or less and much larger in magnitudes (1.73 for labor force participation, and -2.01 for wage).

The results in Tables A.2 are very reassuring; although the precise numerical magnitudes of the estimated effects of land restrictions on women's labor force participation and wages vary somewhat across different specifications, the estimates for the full sample fall within reasonably tight bounds. The range of estimates are [0.85, 1.15] for women's labor force participation, [–1.39, -1.56] for female wage.

Suggestive Evidence on the Relevance of Home Goods Production

The variation in labor force participation in our model comes from the heterogeneity in productivity of home good production. While we do not have data to analyze this heterogeneity directly, we provide two pieces of supporting evidence. In a traditional South Asian society such as Sri Lanka, women bear a disproportionate share of home production with minimal participation from men. One can model this as a heterogeneity in productivity of home production with δ_i larger for women than men.[3] An implication of this heterogeneity is that men will be more likely to migrate than women after imposition of land restrictions, and as a consequence, impact of land restrictions should be smaller for men compared to women. The first column in Table A.3 reports the IV results for men's wage using a regression specification similar to column 3 of Table 4 in the main text.[4]

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[3]Although we cast the heterogeneity in the production technology, one could alternatively interpret the model as one involving preference heterogeneity where δ_i) is a preference parameter that varies across households and the production of home goods is done with the same technology.

[4]The selection term is not included in this regression as labor participation is nearly universal among adult male in Sri Lanka.

The estimated coefficient of proportion of land under restriction (-0.978) is much smaller in absolute magnitude compared with that for women (-1.54). This is consistent with a model where land restrictions impose less burden on men due to heterogeneity in home good production. Note that labor force participation by men is close to 100 percent, thus we do not report estimates for them.

To the extent older women are more responsible for home production – as is the custom in much of South Asia including Sri Lanka – one would expect productivity in home production to be different between older and younger women. Older women are likely to be more productivity in home production because of learning by doing and accumulated experience. Having an older woman in the household also means less burden of provision of home goods for younger women allowing them to participate and spend more time in outside work. This in turn implies that migration costs imposed by land restrictions will be lower for younger women compared with older ones. If this is so, then we expect land restrictions to have larger impact on labor force participation of older women. As to impact on wage, a change in labor supply by anyone regardless of age could have general equilibrium effect particularly if there is no segmentation in the labor market in terms of types of task performed by different age cohorts. If, on the other hand, older and younger women perform differentiated tasks in the labor market allowing some degree of labor market segmentation, then we expect larger impact of land restriction on wages of older women as well. To check these possibilities, we split the female sample into two age groups: older women [age $\geqslant$ 40 years] and younger women [25-40 years]. Columns 2 and 3 of Table A.3 report the IV results for labor force participation and columns 4 and 5 report that for wages. The results in columns 2 and 3 of Table A.4 are interesting: the estimated effect land restrictions on labor force participation becomes smaller for the younger women. The land restrictions have statistically significant and positive effects on the participation rates of both groups of women, but the magnitude of effect is larger for older women (1.33) compared with younger women (0.86). The pattern of the estimates between age groups is consistent with what one would expect when older women play a greater role in the provi-

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sion of home goods. For wages, the IV results suggest significant negative effects for both groups, and the absolute magnitude of the effect is slightly larger for the older women. The results for wages are consistent with the case where tasks done by older and younger women in the labor market are only mildly differentiated. The robustness checks (not reported here for brevity) shows that the patterns reported above hold for other age cohorts as well.

The labor force participation pattern reported in Table A.3 also provides convincing evidence that the estimates of effects of land restrictions are not picking up any omitted intergenerational health effect emanating from transmission of parental exposure to malaria. One would expect health of older age cohort to have been affected more adversely due to intergenerational transmission of historical malaria's effect on parental health. To the extent bad health affects female labor force participation adversely, one should expect to find a smaller effect of land restrictions on labor force participation for older age cohorts compared with that of younger age cohorts if our identification scheme is compromised by such intergenerational health effects. The results in Table A.3 are quite the opposite. This, however, may not be surprising to a keen observer of impressive achievements in health, nutrition and education across the board during the post eradication period, thus offsetting any lingering intergenerational effects (for a discussion, please see for example, Sen (1981)).

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Table A.1: Summary Statistics

Variable	Mean	Median	Std. Dev.
Labor force participation rate	0.51	1	0.50
Female Wage (annual in rupees)	51132.75	36962.05	44145.32
Proportion of Area Under LDO Leases	0.11	0.05	0.14
Travel Time to Large City (hour)	2.60	1.99	2.43
Share of Sinhalese in population	0.86	0.93	0.18
Malaria incidence (spleen rate)	22.77	12.20	20.71
P.Vivax (1000)	0.05	0.01	0.11
P.Fac. (1000)	0.01	0.00	0.03
Rainfall (000 metre)	2412.32	2268.71	800.49
Slope (%)	10.74	7.38	9.09
River within 5 km (yes=1)	0.35	0.00	0.48
Share of land allocated to paddy	0.36	0.29	0.29
Age (Year)	37.29	37	7.62
Education Level (year)	8.30	10	3.82
Married (yes=1)	0.83	1	0.38
Number of Infant/Toddlers (< 1 year)	0.38	0	0.61
Number of Infant/Toddlers (1-5year)	0.94	1	1.02
Christian (yes=1)	0.05	0	0.22
Muslim (yes=1)	0.05	0	0.21
Buddist (yes=1)	0.83	1	0.38
Moor (yes=1)	0.05	0	0.21
Tamil (yes=1)	0.08	0	0.28
Estate (yes=1)	0.08	0	0.28

Table A.2: Land Market Restrictions, Female Labor Force participation and Wages: Robustness Checks for IV Results: Estimates from 2SLS

	Labor Force Participation					
	Additional Controls					
	Farm Size	Populaion Density	Pop. in 5 hrs travel time	Non-farm Share	Irrigation	LDO less than 30%
	1	2	3	4	5	6
Area Under LDO	**1.042***	**0.971**	**1.061***	**1.149***	**0.847**	**1.732***
	(2.639)	**(2.433)**	**(2.743)**	**(2.802)**	**(2.236)**	**(3.245)**
Instrument Strength						
Angrist Pischke F	11.98	11.27	13.24	11.83	10.84	9.326
Stock-Yogo 10% bias	9.08	9.08	9.08	9.08	9.08	9.08
No. Of Observations	10850	10850	10850	10850	10850	9767
	Log(Real Wage)					
Area Under LDO	**-1.556**	**-1.481**	**-1.511**	**-1.351**	**-1.388***	**-2.014**
	(-2.339)	**(-2.192)**	**(-2.273)**	**(-1.960)**	**(-1.881)**	**(-2.343)**
Instrument Strength						
Angrist Pischke F	13.50	12.53	15.32	13.18	11.49	12.25
Stock-Yogo 10% bias	9.08	9.08	9.08	9.08	9.08	9.08
No. Of Observations	2,918	2,918	2,918	2,918	2,918	2,708

(1) All regressions include full set of regressors as in columns (2) and (4) of Table 3.
(2) Robust t statistics in parentheses. Standard errors corrected for clustering at sub-district (DSD)
* significant at 10%; ** significant at 5%; *** significant at 1%

Table A.3: Female Labor Force Participation and Male and Female Wages

	Male	**Female Labor Force Participation**		**Log(Real Wage)**	
		Older Women	Younger Women	Older Women	Younger Women
	Log(real Wage)	(age=>40yr)	(25-40yr)	(age=>40yr)	(25-40yr)
		2SLS	2SLS	2SLS	2SLS
	1	2	3	4	5
Proportion of Area Under LDO	**-0.978***	**1.327***	**0.855**	**-1.656**	**-1.344***
	(-1.942)	**(2.818)**	**(2.261)**	**(-2.109)**	**(-1.773)**
Instrument Strength					
Kleibergen-Paap/Angrist Pischke F	10.95	12.59	11.24	11.83	13.14
Stock-Yogo 10% max. rel. IV bias	9.08	9.08	9.08	9.08	9.08
No. of observation	6,492	4,352	7,017	1,205	1,867

(1) All regressions include full set of regressors as in column (3) of Table 4.
(2) Robust t statistics in parentheses. Standard errors corrected for clustering at sub-district (DSD)
* significant at 10%; ** significant at 5%; *** significant at 1%