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ABSTRACT

We analyze the effects of land market restrictions on the rural labor market outcomes for women. The land restrictions can have a gender and age bias because of an ex-post asymmetry in migration costs arising from older women's comparative advantage in home goods production. 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, and negative effects on female wages. The empirical results suggest that the burden of land market restrictions falls disproportionately on older women.

Key Words: Land Market Restrictions, Labor Market, Women's Labor Force Participation, 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 to land 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 land market restrictions on the labor force participation of rural women and their wages.[2]

Do the effects of land market restrictions found in many developing countries have a gender differentiated effect? We use a simple general equilibrium model to sort out the potential effects of land market restrictions on women.[3] Our analysis shows that the increased migration costs due to land market restrictions (especially sales restrictions) and women's comparative advantage in producing home goods together imply that the burden of the restrictions fall disproportionately on women. For maximization of the household income, it is optimal for men to migrate leaving women behind in the farm to hold on to the land. This gender non-neutrality in the effects of land restrictions holds even if there are no ex-ante gender differences in the costs of migration before the land restrictions, and the rural-urban wage differential does not vary across gender. This is so because land restrictions create ex-post differential migration costs; the women face much higher effective migration costs after the imposition of the restrictions. An important implication of this gender non-neutrality is that the land market restrictions are likely to increase labor force participation by women in rural areas compared to the counterfactual where there are no restrictions on the alienability or rental of land. This 'labor endowment effect' of land market restrictions decreases the equilibrium wage in the local labor market.

[2] In a companion paper, we analyze the effects of land market restrictions on the spatial pattern of adult male wages. Please see Emran and Shilpi (forthcoming).

[3] To the best of our knowledge, there is no theoretical analysis on possible gender bias in the effects of land market restrictions in the existing literature.

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. Land market restrictions result in a negative income effect compared to the counterfactual where the family could sell the land, and the woman could also migrate to the urban area. This negative income effect induces women to participate in the labor force.[4] To focus on the migration costs due to the land market restrictions, we abstract away from the standard labor-leisure choice in the conceptual framework below. However, the negative income effect will also influence the labor supply, conditional on participation. Thus the equilibrium wage observed in the data will be an outcome of responses at both the extensive (participation) and intensive (labor-leisure choice) margins.

To identify 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 variation 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 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 em-

[4] One might think that the remittances sent by the husband constitute a positive income shock. Note that it is a positive income shock for the counterfactual where the husband would not migrate in the equilibrium without the land restrictions, but migrates under the restriction. This scenario is not possible. Moreover, our focus is on the case where the women would migrate in the absence of land restrictions along with the men. This means that the household income is lower under land restrictions because women cannot get higher income in urban labor market.

pirical 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 5 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 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.

Possible objections to historical malaria prevalence as identifying instrument are: (i) historical malaria might have affected the quality of institutions (Acemoglu et al, 2001), (ii) it may

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

be correlated with adverse local conditions such as low productivity due to lack of irrigation. 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. Identification in our case comes from *variation across sub-districts within a district,* whereas the relevant institutions such as the legal system and the enforcement of contracts and property rights are determined at the national level.[7] To many readers, probably the most important identification challenge we face is that the high land restrictions areas may be areas with adverse economic characteristics and thus with low productivity, and the effects of low productivity can be wrongly attributed to land restrictions. We address this issue in a variety of ways. In addition to including a set of land productivity controls, we provide strong evidence that if anything land productivity is higher in areas with high incidence of land restrictions, and conditional on observed productivity controls such as rainfall, slope, proximity to river and large city, actual land productivity (measured by yield per acre for major crops) are not correlated with our identifying instrument, i.e., interaction of rainfall and historical malaria. Section 5 provides detailed evidence on the credibility of our identification strategy.

The empirical results show that the incidence of land market restrictions has a numerically and statistically significant effect on the labor force participation of women and their wages. The higher the proportion of land under restrictions in a sub-district, the higher is the women's labor force participation. Restrictions in the land market on the other hand reduce female wages. The empirical analysis also indicates that the land market restrictions affect women's labor force participation and wage primarily through the migration cost channel. 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

[7] A district as an administrative unit is similar to a county in USA. The subdistrict is a small administrative unit, the average land area of sub-districts in our sample is 160 square kilometers and the median is 110 square kilometers.

percent decrease in female wage. The empirical results suggest that the burden of land restrictions falls disproportionately on older women whose labor force participation increases much more (2.9 percent) than that of younger women (1.8 percent).

The rest of the paper is organized as follows. Section 2 discusses the related literature and places the contributions of the paper in perspective. The next section outlines a simple general equilibrium model to help understand the effects of land market restrictions on rural labor markets with a focus on the implications for migration costs and gender differences. Section 4 discusses data and variables definitions. Section 5 lays out the identification approach we use. Section 6, arranged in a number of subsections, report the results of the empirical analysis. The paper ends with some concluding remarks.

2. Related Literature

The theoretical and empirical literature on labor markets in developing countries is rich with many interesting and important insights (for theory see, for example, Mirrlees (1975), Stiglitz (1976), Eswaran and Kotwal (1985)); for empirical contributions see, for example, Bardhan (1979, 1983, 1984), Foster and Rosenzweig (1993, 1994), and Ardington et al. (2009)). The literature has focused primarily on unemployment (open or disguised), rural-urban and international migration, dualism or segmentation in the labor market, interlocking contracts across different markets, and returns to education in the labor market. Women's labor force participation and labor supply in developing countries has been analyzed in a number of empirical papers in the literature, see for example, Eswaran et al. (2009), Cameron et al. (2001), and Khandker (1987). The focus of the literature on labor force participation of women in developing countries has traditionally been on the role played by factors such as education, health, marriage, fertility, and social norm.

There is a small but growing literature that looks at the effects of out-migration by husband and adult children on economic decisions and welfare of left-behind woman (Amuedo-Dorantes and Pozo (2006), Lokshin and Glinskaya (2008), Mu and Van de Walle (2009)). But they do not explore the roles played by different factors that affect the costs of migration. Probably the closest precursor to our work is Mu and Van de Walle (2009) where they analyze the time allocation and labor force participation of women in migrant households who are left-behind in the farm in rural China. The costs of rural-urban migration in China is high primarily because of the household registration system known as Hukou.[8] But Hukou involves a lot more than the restrictions related to land. When someone decides to move out of his/her own Hukou, he/she loses a bundle of benefits in addition to the land including access to schooling, subsidized inputs, access to jobs in local government owned township and village enterprises.[9] As a result, it is impossible to isolate the role played by land market restrictions alone. We are thus not aware of any paper, theoretical or empirical, in economics literature that addresses the issues we focus on here.

3. Conceptual Framework

To understand the effects of the land market restrictions on the labor market equilibrium in a village, we consider a simple general equilibrium model of wage determination that incorporates higher migration costs due to land restrictions. The focus is on the effects of the land market restrictions on female labor force participation decision and wages. We provide the basic intuitions for the theoretical results here, and refer the reader to the online appendix for a more complete theoretical analysis.

Let $d_{ku} \geq 0$ be the distance of village k from the urban center U. The equilibrium wages in the urban center are given exogenously as w_u^m and w_u^f for male and female migrants respectively. A member i of household h in village k incurs a cost of migration as follows:

$$\varphi_{khi} = \varphi(\pi_{kh}, d_{ku}, M_{kh}, s_i) \quad (1)$$

where π_{kh} is a dummy that takes on the value of 1 when a household is under land restrictions and M_{kh} is a vector of household specific determinants of migration cost and s_i is a gender dummy

[8]Mu and Van de Walle (2009) do not attempt to estimate the effects of Hukou, as their interest lies on the effects of migration.

[9]An indication of wide reach of Hukou is that a person could get a marriage license only from his/her own Hukou.

that takes on the value of 1 when the migrant is a female. Following Hayashi and Prescott (2008), we assume that the inability to sell the land and the threat of losing the rights to future earning from it increases migration costs for the households. Thus the following holds:

$$\varphi^1_{kh} = \varphi(1, d_{ku}, M_{kh}, s_i) \geq \varphi^0_{kh} = \varphi(0, d_{ku}, M_{kh}, s_i) \qquad \forall h \tag{2}$$

The inequality above is strict at least for one household member. We assume that M_{kh} is increasing in h and $\varphi_{kh}(.)$ is increasing in d_{ku}, and M_{kh}. So a household with higher h value faces higher migration cost. A household is composed of two members: a male and a female. We assume that, to avoid the additional cost of migration arising from land restrictions, the household needs to leave at least one member back in the village. Thus the migration cost faced by the first member to migrate from a household under land restrictions is φ^0_{kh} rather than φ^1_{kh}.

The local labor market, for both men and women, satisfies two equilibrium conditions: the rural-urban arbitrage condition (migration equilibrium condition), and the market clearing at the local labor market. They jointly determine the equilibrium local wage and the threshold household that is indifferent between migrating and not migrating. In this set-up, we consider the effects of land restrictions on the local labor market equilibrium. Consider village k where θ_k proportion of households are under land restrictions. It is convenient to think about three different groups of households in the initial equilibrium to understand the effects of land market restrictions. They are: (i) both members are in the village, (ii) only one member is migrant, and (iii) both members are migrants in the initial equilibrium (i.e., without any land restrictions). [10]

Note that if we fix the wages at their initial equilibrium levels in the local labor market (w^{m0}_k,w^{f0}_k), the imposition of land restrictions has no effect on the first two groups, i.e., the households which have at least one non-migrant in location k. However, even with unchanged

[10]We can have households with only one migrant (usually male) in a household even if the migration costs are not gender specific (i.e., $\varphi_{kh}(.)$ function does not depend on s_i) , for example, when the rural-urban wage gap is higher for male compared to female, i.e., $\left(w^m_u - w^{m0}_k\right) - \left(w^f_u - w^{f0}_k\right) > 0$.

wages, land restrictions can affect the migration decision of the last group, i.e., where both members find it profitable to migrate in the initial equilibrium. Facing land restrictions and associated higher migration cost φ^1_{kh}, at least one of the family member might find it no longer profitable to migrate even if the equilibrium local wages remain the same.

A second, and more interesting point is that even when there are no differences in migration costs across male and female workers prior to the land restrictions, the effective migration costs vary across gender once the land restrictions are imposed. To see this, assume that the migration costs are not gender specific. Now consider a migrant household whose land is under land restrictions, and the female member is a participant in the labor force prior to the imposition of the restrictions. The imposition of the land restrictions implies that a household will face higher migration costs $\varphi^1_{kh}(.) + \varphi^0_{kh}$ if both the workers migrate at the same time. In the case where one of the workers migrates, the household incurs $\varphi^0_{kh}(.)$ as migration cost, as it can still retain its land. Denote the new local wages after the land restrictions as w^{m*} and w^{f*}. As the first migrant, the gain from migration for a male worker is $(w^m_u - w^{m*}) - \varphi^0_{kh}(.)$ compared with $(w^f_u - w^{f*})L_f - \varphi^0_{kh}(.)$ for a female worker, where $L_f < 1$ is the female labor supplied to the market after producing home goods. We assume that there are two goods: a home good and a market good, and they are complementary in the household utility function. Also, the home good is essential in the sense that utility is zero when home good consumption is zero. Only the female member produces the home good, a simple formulation that captures the idea of women's comparative advantage in producing the home good. The total labor endowment is normalized to 1.[11] Note that even if the rural urban wage gap is same for male and female migrants, the gain from male migration unambiguously exceeds that from female migration, because $L_f < 1$, but a male devotes the entire labor endowment to the market work. Thus, in general, the male member will migrate first from a household, and as a result the effective migration cost for the male will be φ^0_{kh} compared with φ^1_{kh} for the female member. This ex-post asymmetry in migration costs

[11]We assume that the male member of the household inelastically supplies the total labor endowment to the market. For tractability and to focus on the effects of migration, we abstract away from the labor-leisure decision.

drives the main theoretical results where imposition of land restrictions lead to increased labor force participation by women and lowers their equilibrium wage in the local labor market (see proposition (1) below) relative to male wage.

The theoretical model so far considered households consisting of two adult members: one male and one female. If we extend the model to include female of different ages, then the ex-post asymmetry in migration costs may arise among the female members as well. To the extent older women are primarily responsible for home production – as is the custom in much of South Asia including Sri Lanka – one would expect ex post migration costs to be different between older and younger women. Having an older woman in the household 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 the impact on wages, 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.

The analysis above leads to the following testable predictions summarized in the propositions below. For a more fully developed theoretical analysis, please see the online appendix to this paper.

Propositions

Assume that women are the sole producers of home goods, and home goods are essential and complementary to the market goods in the utility function.

(1) *Land restrictions raise female migration costs disproportionately compared with that of male members resulting in an increase in women's labor force participation in rural areas.*

(2) *Land restrictions raise migration costs of older women disproportionately compared with that of younger women resulting in a larger increase in older women's labor force participation in rural areas.*

(3) *Land restrictions reduce equilibrium wage for women in the local labor market.*

4. 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).[12] From the 16,924 households in the survey, about 17140 females are in working age group (25 to 65 years). To define our sample, we used three 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. 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

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

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 6 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.[13] 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

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

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 (Table6, p.19, DHS report (2009)).[14] 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 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.

[14] 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.

5. 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.

5.1 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 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 because 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.

5.2 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.[15]

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 4), rainfall is one of the most important exogeneous ecological determinant of malaria in Sri Lanka, and the higher the rainfall in a DSD in a district, the lower is the malaria incidence compared to the other DSDs in the district, because rainfall washes away the 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.

[15]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.

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.

5.3 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.[16] 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 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.

[16]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.

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.[17] 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.[18]

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.[19] 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.[20] The upshot of the above discussion is that historical malaria in a sub-district should not be correlated with the health outcomes of most of the current population. Indeed, evidence

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

[18]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).

[19]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.

[20]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.

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).

6. Empirical Results

(6.1) 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 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.[21] 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).[22]

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 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

[21]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).

[22]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.

(0.28) and statistically significant at the 1 percent significance level.[23] 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.

(6.2) 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 (5) 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 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.[24] 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

[23] 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.

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

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 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.

(6.3) IV Estimates: Robustness Checks

In this subsection we report a number of robustness checks for the IV estimates reported in Table 4. Table 5 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.[25] 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 5 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

[25]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.

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 of Table 5 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 5 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.[26] 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 5 again show some change in the estimates of the effect of land restrictions on female labor force participation and wages though

[26] 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.

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 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 5 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 5 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.

(6.4) Effect of Land Restrictions by Age Cohort

The conceptual framework highlighted how greater role of older women in the provision of home good can increase their migration costs disproportionately, which in turn implies a greater labor force participation for them compared with younger women in response to land restrictions. In this subsection, we check if there is indeed heterogeneity in the way land restrictions affect labor force participation and wage of women of different age cohorts. We split the sample into two age groups: older women [age $\geqslant$ 40 years] and younger women [25-40 years]. Columns 1 and 2 of Table 6 report the IV results for labor force participation and columns 3 and 4 report that for wages. The results in columns 1 and 2 of Table 6 are interesting: the estimated effect land restrictions on labor force participation becomes smaller as the age declines. 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 provision 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 6 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 6 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)).

(6.5) Understanding the Channel(s): Migration Costs vs. Credit Access

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 (3) above that identifies rural-urban migration as the main channel through which the land market restrictions work. But an alternative causal mechanism familiar from a substantial literature is that land restrictions, especially restrictions on alienability of land, affect demand for labor in the local labor market through a reduced access to formal credit at lower interest rate. It is thus natural for a reader to ask if we can exclude such credit channel as an explanation for the results.

The results reported so far are, however, not consistent with 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.[27] The equilibrium wage in this case will be higher along with higher level of employment 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.[28] Such reduction in demand for labor reduces the wage, but is also expected to reduce the employment and labor force participation by women which contradicts our findings.

(6.6) 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

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

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

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.

7. Conclusions

This paper examines the effects of land market restrictions on female labor force participation and wages in a rural labor market. Our theoretical analysis shows that the land restrictions can create differential migration costs for women particularly for older women even if there are no ex-ante differences in migration costs before the imposition of the restrictions. The land restrictions also result in a negative income shock compared to the counterfactual where the women could follow their men to the urban areas by selling the land. These two effects together imply that women's labor force participation increases with the incidence of land market restrictions in a sub-district. The analysis also yields interesting testable predictions regarding the effects of land restrictions on wages.

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. 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)
P. vivax (current malaria cases)		0.0696		-0.563*
		(0.521)		(-1.778)
P. Falciparum (current malaria cases)		0.151		0.417
		(0.362)		(0.478)
Share of Sinhalese in population		0.121*		-0.483***
		(1.899)		(-3.210)
Average Rainfall		-8.53e-06		7.08e-05
		(-0.390)		(1.415)
Average slope		0.00281		-0.0173***
		(1.248)		(-3.850)
River within 5 km (yes=1)		-0.00469		-0.000740
		(-0.251)		(-0.0149)
Share of land allocated to paddy		-0.0815**		0.0643
		(-2.123)		(0.808)
Estate (yes=1)	0.206***	0.214***	-0.142	-0.471***
	(6.179)	(5.661)	(-1.403)	(-5.246)
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	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	Yes	Yes	Yes	Yes
District Fixed Effects	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 hosuehold 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%

Table 5: 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 6: Female Labor Force Participation and Wages: By Age Cohorts

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

(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.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