General Equilibrium Effects of Land Market Restrictions on Labor Market: Evidence from Wages in Sri Lanka

M. Shahe Emran[1]
George Washington University
and IPD, Columbia University

Forhad Shilpi
World Bank

July 2010

ABSTRACT

Taking advantage of a historical quasi-experiment in Sri Lanka, this paper provides evidence on the effects of land market restrictions on wages and its spatial pattern. For identification, we exploit the effects of historical malaria prevalence on the incidence of land restrictions through its effects on the availability of 'crown land'. The results show that land restrictions can reduce wages substantially, and this effect is smaller in remote locations. A one percent increase in land restrictions reduces wages by 6.6 percent at median travel time from urban center, and the effect becomes effectively zero after 6 hours of travel time.

JEL Codes: O10, J31, J61

Key Words: Policy Restrictions in land Market, Sales Restriction, Rental Restriction, Labor Market, Wages, General Equilibrium Effect, Interaction Effect, Travel Time, Malaria, Sri Lanka

[1]Corresponding author: M. Shahe Emran (email: shahe.emran@gmail.com). We would like to thank Joseph Stiglitz, Stephen Smith, Atonu Rabbani and Kazi Iqbal for helpful discussions and/or comments on earlier drafts. We are grateful to Dr. Galappathy and Chaitri Hapugalle for help with malaria data used in this paper. The standard disclaimers apply.

Introduction

Understanding the nature and implications of underdeveloped and dysfunctional factor markets has long been central to development economics (see, for example, Bardhan (1984), Hoff, Braverman and Stiglitz (1993), Ray (1998), Bardhan and Udry (1999)).[1] There is a large literature on the adverse effects of imperfect or missing credit markets, both on efficiency and equity (see, among others, Hoff, Braverman and Stiglitz (1993), Banerjee and Newman (1993), Eswaran and Kotwal (1985a), Banerjee and Duflo (2008), Ray and Mookherjee eds. (2000)). The literature on the causes and consequences of underdeveloped land and labor markets is also vast (see, for example, Bardhan (1979, 1983), Stiglitz (1974a,1974b, 1976), Eswaran and Kotwal (1985b), Dasgupta and Ray (1986, 1987), Hoff, Braverman, and Stiglitz (1993), Binswanger and Rosenzweig (1984), Foster and Rosenzweig (2004), Deininger and Feder (2001), Bardhan and Srinivasan (1971)).[2] Although factor markets are in general underdeveloped in the developing countries for structural reasons, government policies implemented during 1950s and 1960s also constrained the functioning of these markets in many countries.[3] In last couple of decades, the government policy restrictions in factor markets in developing countries have been progressively reduced under the IMF-World Bank sponsored 'structural adjustment' and liberalization programs. Following the influential work of de Soto (1989), there has been emphasis on establishing private property rights in land as a way to solve the credit market failure through creation of collateral for the poor and marginalized people.[4] However, in many countries in Asia and Africa, government policy restrictions on land and labor markets are still significant, China and India being two prominent examples. An important consequence of the restrictions in land markets is that it increases the marginal cost of migration and thus constrains labor mobility even in the absence of any explicit restrictions on labor mobility found in some countries (Hukou in China and Ho Khau in Vietnam).[5] On a priori theoretical grounds, this is likely to result in depressed wages

[1]The text books by Bardhan and Udry (1999) and Ray (1998) focus on the imperfections in land, labor and credit markets.

[2]In most of the developing countries, land market transactions are limited and formal labor market is thin.

[3]For example, there have been restrictions on labor mobility in China from 1952 (Hukou system). In many countries, government regulations restricted flexibility in the labor market. For a discussion on the labor regulations in India, see Besley and Burgess (2004).

[4]The recent evidence, however, does not lend support to the de Soto hypothesis that land titling increases access to credit. See, among others, Field (2007), Iyer et al (2009)). For an analysis of why land titling may not be effective in increasing access to credit, see Haldar and Stiglitz (2009).

[5]Yang (1997) shows that inalienability of land in rural China constrained the rural-urban migration in China

with obvious distributional consequences, as the income of landless poor households suffers. The land market restrictions may also lead to higher dispersion in equilibrium wages across sectors and geographic areas, higher than what one would expect to observe because of standard transactions and search costs in the labor market. Large dispersion in equilibrium wages can create allocational inefficiency, and adversely affect productivity by distorting technological choice and creating technological dualism. Evidence from recent studies shows that misallocation of labor – reflected in sustained differences in wages across areas and sectors– can explain a large fraction of international differences in per capita income and overall total factor productivity (Vollrath, 2008; Temple and Wobmann, 2006). In a recent paper, Hayashi and Prescott (2008) argue that the informal restrictions on land inheritance in pre-war Japan had significant negative effect on per capita income growth and employment structure.

We analyze the general equilibrium interactions between land and labor markets, with a focus on the effects of land market restrictions on equilibrium wages and its spatial distribution. There has been a growing interest in recent literature on the effects of land market restrictions on household choices and outcomes (for evidence on labor supply and savings, see, among others, Field (2007), Iyer et al (2009); for evidence on productivity see Deininger et al (2008, 2009), and for evidence on migration see Yang (1997), among others). However, to the best of our knowledge, there is no empirical analysis of the causal effects of land market restrictions on the equilibrium wage in the existing literature. Taking advantage of a quasi-experiment in historical land settlements and restrictions in Sri Lanka, we provide evidence on the effects of land market restrictions on the equilibrium wage and its spatial pattern. We use household survey data for the year 2002 (Sri Lanka HIES 2002) for our empirical analysis.

The restrictions on land sales, mortgage, and rental raise the cost of labor mobility. The inalienability of land rights implies that in the case of migration, households will lose the right to the net present value of future earnings to land. The increased migration cost leads to lower migration and thus to higher labor endowment in a location with higher incidence of land restrictions. This reduces the land-labor ratio compared to the counterfactual where there is no land restrictions. As a result, the marginal product of labor and wages remain lower in areas with

even after the Hukou restrictions were relaxed starting from mid 1980s. The young men left their family members back in rural areas to keep the entitlement to the land. See also Iyer et al (2009).

higher incidence of land restrictions. The effects of land restrictions may, however, depend on the distance of a location from the nearest urban center. A key insight from the recent migration literature is that migration costs increase sharply with an increase in traveling distance between origin and the destination. As we discuss in the conceptual framework section below, the strength of the effects of land restrictions on wages is expected to vary inversely with distance of a location from the relevant urban center. The intuition behind this interaction effect between distance and land restrictions is simple. As we move away from the urban center, more and more households optimally choose not to migrate even in the absence of any land restrictions, simply because the higher migration costs eat into the returns from migration. Thus the set of households that can potentially be impacted by the additional migration costs due to land restrictions is smaller the further is a location from the urban center. Naturally, the effects of land restrictions are also smaller. We develop a simple general equilibrium model that captures these insights (please see section 2 below). A goal of this paper is to provide evidence on possible interaction effect between distance and land restrictions: does the magnitude of the impact of land restrictions decrease with an increase in distance from the relevant urban center?

There are a number of intractable problems in identifying the effects of restrictions in the land market on equilibrium wages. First, in most of the cases, the effects of land market restrictions are confounded by other policy interventions such as product market interventions in China (grain quota), geographic mobility restrictions in China (Hukou system) and Vietnam (Ho Khau system). It is thus extremely difficult to disentangle the effects of land market restrictions on equilibrium wage. A related problem is that the land market restrictions are usually economy-wide, and thus there is no potential comparison group for empirical analysis. Second, the political economy of land policy in developing countries usually results in settlements in marginal low productivity land, and land under settlement is more likely to be affected by government restrictions on sales, mortgage and rental. When the land under policy restrictions is systematically of low quality, any negative effect on wages estimated in the micro data may be driven entirely by this negative correlation between productivity (marginal product of labor) and the likelihood of government restrictions on land. Since it is very difficult, if not impossible, to adequately control for unmeasured land productivity, estimating the causal effects of land restrictions can be challenging. In addition, the areas under land restrictions may also suffer from low human capital (low labor productivity). When the quality of the labor force is significantly lower in areas under land restrictions, the adverse effects of low land quality on the marginal product of labor will be reinforced by the low quality of labor.

As we discuss in detail later in the paper, Sri Lanka is probably among the cleanest quasi-experiments that can help address the above mentioned challenges. In Sri Lanka, a significant proportion of land has sales, mortgage, rental and inheritance restrictions; the restrictions were imposed on the land distributed under the Land Development Ordinance (henceforth LDO) of 1935.[6] The proportion of land under LDO restrictions vary significantly across different areas (maximum 63 percent and minimum 0.2 percent across sub-districts (DSDs) in our sample) making it an interesting case study.[7]

Sri Lanka is a special case in so far as land policy and settlement are concerned, because (i) land restrictions are not economy-wide (unlike China and Vietnam), (ii) there are no major confounding policy interventions in other markets, especially no direct restrictions on labor mobility (unlike China), (iii) the differences in human capital across different sub-districts (DSDs) are small because of the policy emphasis on equitable access to health and education during the decades of 1960s-80s (see, for example, Ekanayeke (1982), Sen (1983)), and (iv) most importantly, the productivity of land under government restrictions is significantly *higher*. When both the land productivity and labor quality are lower in areas under land restrictions as is usually the case, a negative coefficient on land restrictions can easily be the result of of these double negative correlations, giving rise to a spurious effect of land restrictions. The strong positive correlation between land productivity and LDO restrictions in Sri Lanka offers us a way to provide useful evidence on negative effects of land market restrictions on equilibrium wages using OLS regressions. Because, in this nonstandard case, the OLS estimates are likely to be biased against the hypothesis that land restrictions have negative causal effect on equilibrium wage, especially when we include controls for human capital, but land productivity controls are omitted from the regression. So if we find a negative effect of land restrictions in OLS regressions that omit land

[6] The land restrictions are called ‘LDO restrictions’ in rest of the paper. For a discussion of the restrictions imposed under LDO, please see section 3 below.

[7] A sub-district in Sri Lanka is called ‘Divisional Secretariat Division’ or DSD for short. In the rest of the paper we call a subdistrict a DSD.

productivity controls but include human capital controls, this can be taken as particularly strong evidence.

The OLS regressions reported later provide strong evidence of a significant negative effect of land restrictions on equilibrium wage and suggest that the magnitude of this negative effect decreases with distance. While the OLS estimates may be acceptable as credible evidence of a negative effect of land restrictions on equilibrium wage, they cannot give us an estimate of the magnitude of this effect because of the possible downward bias from omitted productivity heterogeneity. We provide estimates of the causal effect of land restrictions on the wage using an instrumental variables approach that corrects for the possible downward bias.

While the unusual positive land productivity correlation in Sri Lanka is useful for our empirical analysis, there is a second and equally important advantage of Sri Lanka as a case study to understand the effects of land restrictions. The history of malaria infestation from 16th to early 20th centuries, and the unique role it played in the land policy provides a credible source of exogenous variations in the LDO restrictions. The variations in the historical malaria prevalence across DSDs are useful especially because a nationwide malaria eradication program was implemented as early as 1947 (Brown, 1986, Lucas, 2010), long before the data used for this study were collected (we use HIES 2002). We develop an instrumental variables approach that exploits this exogenous source of variations to identify and estimate the effect of LDO restrictions on wages. To ensure the validity of the exclusion restrictions, we control for a set of covariates including current malaria parasite infection rate, individual and DSD level education, age (to capture cohort effects), and district fixed effects. In a recent paper, Lucas (2010) shows that the cohorts that were exposed to severe malaria in the late 1930s had lower schooling, and malaria eradication had had significant positive effects on the schooling of post-eradication cohorts in Sri Lanka.[8] To check whether the potential long term negative effects of early-age malaria exposure invalidate our results, we perform robustness checks with different subsamples, excluding cohorts born before 1947 (the start of a nationwide eradication campaign), 1950 and 1960 respectively.[9]

Although most of the districts were affected by the spread of malaria beginning from the 16th

[8]Note that our identification strategy does not use malaria variations across cohorts.

[9]Lucas (2010) defines the cohorts born before 1947 as exposed to historical malaria prevalence over the period 1937-1941. We also use historical malaria data for the period 1937-1941 (average).

century, malaria infestation was most severe in the districts in the dry zone. More important, there were substantial variations in the degree of malaria prevalence even within a district (Newman (1965)), and we use this within-district variations for identification. The malaria infestation led to exodus of households, especially the Sinhalese population, from the affected areas (Peebles (2006), De Silva (1981)). Most of the land in the malaria infested areas was taken over by the government, and was designated as 'crown land' during the colonial period. The crown land was later distributed to the Sinhalese population from other parts of the country through land settlements after independence in 1948. The land settlements were part of a political movement to recapture the 'cradle of ancient Sinhalese civilization', and the LDO restrictions were imposed on the settlement land. The extent of land restrictions in an area was thus primarily determined by the availability of crown land. The amount of crown land in a DSD is a positive function of the severity of malaria infestation from 16th century to early 20th century because of out-migration and abandonment of land. The variations in the intensity of malaria across different DSDs thus constitute a plausible instrument for identifying the effects of proportion of LDO land in a DSD, especially because Sri Lanka implemented a successful nationwide malaria eradication program starting from 1947 (our survey year is 2002).[10] However, unfortunately, we do not have data on historical malaria prevalence at the appropriate level of disaggregation (i.e., at DSD level); the available data are at the district level (average over the years 1937-41). The district level malaria data are not suitable for identification of the effects of LDO restrictions at the DSD level for at least two reasons. First, the district level data do not provide us with enough variations for identification of the LDO restrictions at the DSD level, as there are 243 DSDs in our data set, but we have data on average malaria prevalence before the start of the malaria eradication program for only 17 districts.[11] A second and equally important limitation of district malaria data arises from the fact that we have to use district fixed effects to control for the relevant time invariant unobserved factors, and thus it is not possible to use district level malaria data for identification. Drawing on the insights from the literature on Malaria in tropical countries, we devise a way to exploit the DSD level variations in historical malaria prevalence. We use interactions of district

[10]Note also that the historical malaria prevalence in the DSD of current residence cannot affect the health of most of the households under LDO restrictions in any significant way as they were resettled from relatively malaria free areas.

[11]The 17 districts in 2002 correspond to 15 districts in 1937-41.

level malaria data with DSD level exogenous characteristics that are likely to be informative about malaria susceptibility and transmission.

The district level malaria prevalence data are, by definition, average of the malaria prevalence across different DSDs in a district. Our approach to constructing instruments is based on the idea that if we can find indictors of susceptibility to and transmission of malaria in a DSD in a district, the interaction of district level malaria intensity with the DSD level 'malaria susceptibility indicators' will provide us with a measure of differences in historical malaria intensity across different DSDs. The 'malaria susceptibility indicators' can be thought of as the DSD specific weights one needs to recover the historical DSD level malaria prevalence from the available district level malaria estimates. Since *Anopheles* mosquito is the carrier of malaria parasites (especially Plasmodium Vivax and Plasmodium Falciparum), we use geographic features that affect the ease with which mosquitos can survive and multiply in a DSD as indicators of malaria susceptibility of a DSD. The literature on malaria transmission and prevalence identify a number of such geographic features including water body and elevation. Water body can be a fertile breeding ground for *Anopheles* mosquitos, but mosquitos find it difficult to survive in high altitude. We use proportion of land above 1000 feet elevation, and proportion of land under water in a DSD as indicators of malaria susceptibility of a DSD. Thus the interaction of district level malaria with 'inland water' in a DSD is expected to have a positive sign in the first stage regression for LDO incidence, while the sign of the interaction of district malaria with elevation should be negative. We control for water body and elevation directly in the IV regressions to make the exclusion restrictions imposed on the interactions with district malaria prevalence more credible. Since we control for current malaria parasite infection (data for the year 1999) across DSDs, the historical malaria prevalence cannot pick up the effects of recent malaria incidence. Note also that we use district fixed effects, and thus do not need to control for the historical district level malaria prevalence directly.

An important implication of our theoretical model is that the effects of land restrictions gradually die out with an increase in the distance from urban center. For identification of this interaction effect between land restrictions and distance from the urban center, a critical issue is whether distance (travel time) to the urban center is potentially endogeneous in the wage regressions. There are good reasons to expect that geographic location may, in fact, be enodegenous.

For example, if the urban centers historically emerge around villages with better economic potential, then distance (travel time) and wages will be negatively correlated in the data even in the absence of any causal relation. This spurious negative correlation is likely to bias the estimate of the interaction effect. To address the potential endogeneity bias arising from travel time, we rely on the exogeneous variations in travel time created by variations in topography. This is motivated by a large body of transport engineering literature on the effects of topography on road placement and travel time (see, for example, Myer, 2004, American Association of State Highway and Transportation Officials, 2001). We use deviation of slope of a DSD from the average slope of *other* DSDs in a district as an instrument for travel time. The results do not depend on whether we control for the own slope of the DSD itself in the IV regressions. The interaction of land restrictions with travel time is thus instrumented with the interaction of the instrument for travel time (deviation in slope) with an instrument for land restrictions (inland water*malaria). For a detailed discussion of the identification strategy, please see section (4) below.

The IV results show that the effect of the land restrictions on the equilibrium wage is substantial; a one percent increase in the incidence of land restrictions reduce the wage by about 6.6 percent (average of different IV estimates and evaluated at the median). The interaction effect between land restrictions and location of a sub-district (DSD) is also important; the negative effects of land market restrictions become smaller as we move away from the urban center. A one percent increase in the land under LDO restrictions leads to a reduction in equilibrium wage by about 8.5 percent when the DSD is located about half an hour from the relevant urban center, but it declines to 4 percent when the DSD is about three and a half hours away from the urban center. The effects of land restrictions become effectively zero after about 6 hours of travel time.

The rest of the paper is organized as follows. Section 2 provides the main conceptual framework for the empirical estimation. Section 3 gives a brief discussion of the history of land tenure in Sri Lanka from the colonial period. Section 4 discusses the empirical strategy adopted in the paper for identification and estimation of the effects of land market restrictions on wages. Section 5 provides description of the data. Empirical results are presented in section 6. The paper ends with a concise summary of the results in conclusion.

(2) The Conceptual Framework

Wage Determination Under Land Market Restrictions

We use a simple wage determination model to generate testable predictions regarding the effects of land restrictions on wages. Consider a local economy (called k) with a continuum of households indexed $h \in [0,1]$ and CDF $F(h)$. $d_{ku} \geq 0$ is the distance of the location k from the urban center U. The equilibrium wage in the urban center is w^u. Household h is endowed with 1 unit of labor and supplies it inelastically. Each household also owns T units of land and K units of capital. For simplicity heterogeneity is captured only in terms of migration costs across households. A household in location k incurs a cost of migration as follows:

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

where π_{kh} is a dummy that takes on the value of 1 when a household is under LDO restrictions and M_{kh} is a vector of household specific determinants of migration decision. Following Hayashi and Prescott (2008) and Yang (1997), we assume that inability to sell the land and threat of losing the rights to future earning from it increases migration costs for the households. Thus the following holds:

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

We assume that M_{kh} is increasing in h and φ_{kh} is increasing in d_{ku} and M_{kh}.

Now consider the initial equilibrium in location k without any land restrictions. Denote the equilibrium wage rate in the local labor market by w^0_k, then the following condition holds:

$$w^0_k = w_u - \varphi^0_{kh^*} \tag{3}$$

So h^* is the threshold value such that all $h \leq h^*$ decides to migrate and the local labor market clearing implies the following:

$$\int_{h^*}^{1} dF(h) = D_k(w^0_k; \bar{T}, \bar{K}) \tag{4}$$

where $D_k(.)$ is the demand for labor which is determined by CRS technology given the endowments, and $\bar{T}$ and $\bar{K}$ are the aggregate land and capital endowments. Equations (3) and (4) above simultaneously determine the equilibrium values w_k^0 and h^*. We are now ready to consider the effects of land restrictions on the local labor market equilibrium. Let θ_k denote the proportion of households under LDO restrictions in location k. The first thing to note is that given the initial equilibrium wage w_k^0, for a household $h > h^*$ the imposition of land restrictions has no effect on its migration decision. However, facing land restrictions and associated higher migration cost φ_{kh}^1, a household $h \leq h^*$ might find it no longer profitable to migrate. We assume that the imposition of land restrictions is not contingent on household characteristics. Denote the distribution of households conditional on land restrictions as $F(h \mid \theta_k)$ and the new equilibrium local wage as $w_k^*(\theta_k)$. So after the imposition of land restrictions on θ_k proportion of households, the equilibrium is characterized by the following:

$$\int_{\hat{h}}^{1} dF(h) + \int_{h_1}^{h_2} dF(h \mid \theta_k) = D_k(w_k^*; \bar{T}, \bar{K}) \Longrightarrow$$

$$\int_{h^*}^{1} dF(h) - \left[\int_{h^*}^{1} dF(h) - \int_{\hat{h}}^{1} dF(h)\right] + \int_{h_1}^{h_2} dF(h \mid \theta_k) = D_k(w_k^*; \bar{T}, \bar{K}) \quad (5)$$

$$w_k^*(\theta_k) = w_u - \varphi_{kh_1}^1 = w_u - \varphi_{k\hat{h}}^0 \quad (6)$$

where $\hat{h}$ is the threshold that defines the subset of households who did not migrate before the restrictions, and also do not migrate after the restrictions. h_2 is the highest h valued household among the subset of restricted households that decides not to migrate under land restrictions but found migration profitable in the initial equilibrium (i.e., without the restrictions), and $h_2 > h_1 \geq \hat{h}$. Thus h_1 is the threshold among the subset of restricted households such that all $h < h_1$ choose to migrate even with additional migration costs due to land restrictions. The third term on the left hand side of equation (5) is the additional supply of labor to the local market as a result of land restrictions, and it is a positive function of the extent of restrictions in the village economy θ_k under the assumption that all households are equally likely to be affected by the land restrictions. Also, note that $\hat{h} > h^*$, because as local wage is depressed by the additional labor supply due to the restrictions, some of the free households that chose not to migrate before (facing the benefit of migration $(w_u - w_k^0)$) now find it profitable to migrate (facing $(w_u - w_k^*(\theta_k))$). This implies that the second term inside the bracket in equation (5) is positive which represents the leakage of labor from location k as a result of lower local wage after the imposition of land restrictions. The equilibrium conditions (5) and (6) imply that the additional supply of labor as captured by the third term in equation (5) always dominates the leakage effect due to migration induced by lower local wage. The intuition behind this result is that if the leakage effect dominates, then the total labor supply is smaller in the local market after the imposition of the restrictions. Thus the equilibrium wage has to be higher, *ceteris paribus*, a contradiction, because with higher wage there cannot be any leakage effect. Also, as the proportion of households under restrictions increases, we expect that the equilibrium wage rate in the local labor market will decrease.

An important implication of the new economic geography literature is that in addition to the factors mentioned so far, economic density will also influence wages, where economic density is determined by the proximity of the location to the urban centers. Agglomeration economies tend to raise the equilibrium wage in a location, but agglomeration economies become weaker as we move away from the urban center. The distance to the urban center d_{ku} thus plays an important role in our formulation, as it also captures the strength of agglomeration economies arising from possible increasing returns in activities such as manufacturing in a given location k. The discussion so far shows that the equilibrium wage in village k varies inversely with distance from urban center and with share of land under sales restriction. An interesting implication of our model is that the effects of land restrictions depend on the distance d_{ku}, i.e., there is an interaction effect between distance and incidence of land restrictions. As d_{ku} increases, more and more households find it optimal not to migrate even in the initial equilibrium (i.e., without land restrictions) as the benefit from migration $\left(w_u - w_k^0\right)$ is a negative function of d_{ku}. As a result when land restrictions are imposed, the segment of population that can be potentially affected is smaller (i.e., h^* is smaller) the higher is the distance from the urban center, and thus the potential labor supply effect is smaller. This implies that the same land restrictions will depress wage less when a location is remote from the urban center. This can be seen most transparently by considering the polar case when migration cost due to distance is prohibitively high. In this case, even in the initial equilibrium, no household migrates to the urban center (i.e., $h^* = 0$), and land restrictions have no additional impact on the local labor market through the migration channel emphasized in our simple model. However, in a more realistic setting, wages may still respond negatively to land market restrictions, especially to rental market restrictions because of moral hazards involved with hired labor. But the magnitude of the wage effect is likely to be much smaller. The above discussion leads to the following specification of the equilibrium wage that incorporates possible interaction between distance and land restrictions:

$$w_{ik} = \beta_0 + \beta_1\theta_k + \beta_2 d_{ku} + \beta_3\theta_k d_{ku} + Z_{ik}^{'}\Gamma + \nu_{ik} \tag{7}$$

Where subscript i refers to individual i, Z_{ik} is a vector of observed individual characteristics and ν_{ik} is the error term. Equation (7) forms the basis of our empirical analysis.

(3) Land Market Restrictions in Sri Lanka: Historical Background

The present day land tenure system in Sri Lanka is largely an outcome of colonial laws and its subsequent amendments. During the early colonial period, the Crown Lands Encroachment Ordinance of 1840 transferred all lands without private title—unoccupied or uncultivated land (abandoned due to malaria), forests and waste land– to State. As a result of this Ordinance, the British Crown became the owner of nearly all lands, as landownership in Sri Lanka was governed by local customs and few in the peasantry possessed clear formal titles (De Silva,1981; Peebles, 2006). Between 1840 and 1870, Crown land suitable for coffee plantation were purchased rapidly by British officials and investors as well as some wealthy Sri Lankans.[12] After the complete demise of coffee crop due to leaf disease by 1875, plantations diversified into other crops such as tea, rubber etc. The expansion of plantations on the basis of Crown lands subsided by the 1920s.[13] The point to emphasize here is that purchase of Crown lands by private individuals/plantation owners during the late 19th and early 20th century was driven by suitability of land for coffee production, a crop which had virtually disappeared from Sri Lanka.[14]

The Land Development Ordinance (LDO for short) of 1935 initiated a program of making

[12]Peebles (2006) states that land in Kandyan hills were particularly suitable for coffee plantation. This land was reclaimed from the Kandyan peasantry regardless of the status of their titles and was to be sold to plantation owners later on.

[13]The larger plantations were nationalized during the early 1970s, and are now run by private companies under long-term lease arrangements with the government.The importance of plantation crops in Sri Lankan economy today has also declined substantially with an increasing share of land going to paddy and other field crops. Indeed, the estate/plantation sector now accounts only for 5.5 percent of Sri Lanka's population in 2006. Only 8.6 percent of our sample comes from estate/plantation areas. We use a dummy for estate sector in our regressions.

[14]The coffee land (hilly land) are not necessarily considered as particularly suitable for paddy and other field crops which are now the mainstay of Sri Lanka's smallholder agriculture.

Government-owned agricultural land available for private household use. The State introduced a system of protected tenure under which recipients of LDO land had the right to occupy and cultivate the land in perpetuity subject to restrictions imposed on sale, leasing and mortgaging, and conditions related to abandoning or failing to cultivate the land. While subsequent amendments have weakened some conditions on mortgage (allowed only for loan from public banks) and limited transferability (with permission from Government), the basic provision of unitary succession and ban on subdivision and sales of plots and land rental remain largely intact (see Peebles, 2006; De Silva, 1981; World Bank, 2008 for the history of land reforms). Distribution of LDO land took place mainly after Sri Lanka's Independence in 1948 and much of the land was distributed under various settlement schemes. The settlement schemes brought landless Sinhalese people from the relatively malaria free south to the historically malaria infested DSDs in the dry zone. The LDO leases today coexist with complete private holding in the same location (World Bank, 2008). The share of land under LDO leases varies significantly across areas in our sample (the maximum is 63 percent and minimum 0.2 percent) which is critical for estimation of the effect of LDO restrictions on equilibrium wages.

(4) Empirical Strategy

As discussed in the introduction, identification and estimation of the impact of LDO restrictions on wages are challenging because of several reasons. We discuss the identification issues and our approach to solving them in greater details in this section. The most important concern is that the areas with higher percentage of land under LDO restrictions may be deficient in some other dimensions as well that can influence the marginal product of labor and thus equilibrium wage. The estimated negative effect of LDO incidence may reflect these adverse traits in the absence of adequate controls. In addition to worries about low land productivity and human capital, these areas may also have weaker transport infrastructure and poorer provision of public services. This, however, is not the case in Sri Lanka, a country which placed enormous emphasis on equitable access to education, health and other social services and transport infrastructure for its citizens regardless of their location. As a result, road density in Sri Lanka is among the highest in South Asia and high by international standards. For instance, Sri Lanka has 5 kilometers of roads per 1000 inhabitants compared with 3 km/1000 people in India. There is very little variation in access to schools and health facilities across areas. A typical household lives within 1.4 km of a basic health clinic, and 4.8 km of a government sponsored free health facility (World Bank, 2010). A typical household also lives with 10 minutes travel time of a primary school.[15] To account for any remaining variations in location specific amenities and services, the regressions include district level fixed effect, and also estate dummies. Note that the district dummies also sweep off any time invariant land or labor productivity differences across districts arising, for example, from agro-climatic factors such as rainfall, temperature, and soil quality. Thus we need to worry only about the productivity variations across DSDs in a district. We use a set of human capital indicators including individual and DSD level measures of education and religion/ethnicity dummies.

Probably the most important challenge to identification and estimation arises from the fact that land under restrictions are usually of lower agricultural potential as historically private title initially emerges in the more productive lands. Even with good information on land productivity, it is impossible to adequately control for such productivity differences. The omitted productivity differences can produce a spurious negative coefficient of percentage of land under LDO leases in the OLS regression when there is no causal effect of LDO restrictions on equilibrium wages. The history of land reforms and LDO leases in Sri Lanka indicates that if anything, the correlation between land quality and LDO leases is likely to be positive and the evidence clearly shows that this in fact is the case. The higher productivity of the LDO land is partly due to the extensive irrigation investment by the government to make the settlements attractive.[16]

Panel A in Table 1 reports results from simple regressions of *potential* yields of a number of field crops on percentage of area under LDO leases and distance of an area from large urban centers. The potential yield data at sub-district level (i.e., DSD level) are derived from the IFPRI SPAM model for Sri Lanka. The potential yields are determined on the basis of soil quality, moisture level, rainfall and other land quality and climatic variables. The potential yields assume an ideal amount of labor to be applied irrespective of prevailing wages. The yield regressions also include a district level fixed effect to control for factors such as infrastructure, other services and demand conditions. As noted before, the district fixed effects also wipe off any time invariant land or

[15] Even before the eradication, the education and health programs were comparable or even better in the malarious regions (Ekanayeke, 1982; Lucas, 2010).

[16] An example of massive infrastructure and irrigation investment in the historically malaria prone Dry zone is Sri Lanka's renowned Mahaweli Development program.

labor productivity differences across districts. The results reported in Panel A of Table 1 show that, in a given district, yields are significantly higher in DSDs with higher percentage of land under LDO restrictions for 11 out of 12 field crops considered. For 'other oilseeds', the estimated coefficient is positive but not estimated with precision. One might worry that the potential yield does not give us a complete picture regarding differences in productivity as the LDO areas might have different levels of human capital (health and education), and as a result the actual (ex post) productivity of land might be systematically different. Panel B in table 1 reports the estimates for actual yield which can be treated as a summary measure of all the different factors affecting productivity including differences in human capital and cultural norms regarding work across different DSDs. It is reassuring that the regression results for actual yield confirm the conclusions based on potential yield in Panel A of Table 1. The evidence in Table 1 is thus very strong in favor of the conclusion that the LDO lands are more productive compared to the other lands in Sri Lanka and that any possible adverse effect of low labor quality is clearly dominated by strong positive correlations between land productivity and incidence of LDO restrictions in a DSD.

The evidence in Table 1 is also consistent with the evidence on overall crop yields at the district level reported by the Statistical Abstracts of Sri Lanka. According to Statistical Abstract, 2009, paddy yields during the monsoon season in Mahaweli system H in the Dry zone is about 30 to 40 percent higher than average yield in Sri Lanka. Mahaweli annual reports also indicate significant productivity advantage of settlement schemes for nearly all field crops.[17]

The striking productivity advantage of the LDO areas implies that the OLS estimate of the effect of LDO restrictions on wages is likely to be biased downward toward zero. This bias would be especially pronounced when we control for labor quality across DSDs in the regression, but the land quality controls are omitted.[18] Thus a statistically significant and negative coefficient on percentage of area under LDO leases in the OLS regression that include labor quality controls but omits land productivity controls is strong evidence in favor of an adverse effect of LDO leases on wages. If OLS estimate is biased toward zero due to productivity advantage of LDO land, then adding controls for area productivity should lead to an increase in the magnitude of estimated effect (negative) of LDO incidence. This provides us with a falsification test.

[17]The crop productivity statistics in Mahaweli area are posted in http://www.mahaweli.gov.lk/.
[18]The potential and actual yield data used in Table 1 and discussed above are not available for the full sample.

Instrumental variables Approach

The unusual productivity distribution across land with and without restrictions allows us to provide credible evidence on possible negative effects of land market restrictions on equilibrium wages in Sri Lanka. It, however, does not give us an estimate of the magnitude of the effects of the land restrictions. We are confident that the OLS estimate is biased towards zero, but have little idea about the extent of this bias. To correct for the endogeneity bias due to omitted productivity traits of land (and possibly of labor), we utilize instrumental variables strategy. However, in addition to land restrictions, we also need to consider potential endogeneity of the distance to the nearest urban center for identification of the interaction effect. We thus have the following three potential endogenous variables, although our focus is on the first two: percentage of land under LDO restrictions, interaction of land restrictions with travel time to urban center, and travel time to the urban center on its own.

To identify the casual effect of LDO restrictions, we need an exogenous source of variations in percentage of land under LDO restrictions in a DSD. The unique role played by malaria infestation starting from 16th century till early twentieth century in the history of land policy of Sri Lanka offers such an exogenous source of variations. The results from a regression of LDO incidence on district level malaria provides a coefficient equal to 0.16 with a *'t'* statistics of 37.65 after we control for province fixed effects. Even with only 15 data points on district level malaria prevalence, the results thus show a clear positive correlation between malaria intensity and LDO incidence. As noted before, we cannot use this correlation directly to identify the effects of LDO restrictions on wages, especially because we rely on the district fixed effects in the estimation.[19] Since data on malaria prevalence from pre-eradication era (before 1945) are not available at the DSD level, we devise an alternative way to exploit DSD level variations in LDO restrictions due to differences in historical malaria prevalence.

[19]Note that even though the partial correlation between the district level malaria and LDO incidence seems strong, it is not enough for identification. Because, to achieve identifications, what is important is the power of malaria variations across districts in explaining DSD level LDO incidence after controlling for all other regressors including the district fixed effects.

Identifying Instruments for Land Restrictions: Interaction of District Level Malaria with DSD Level Geographic Characteristics

There were significant variations in the historical malaria prevalence across different DSDs within the same district, and it is only natural that the district level average by itself would be of little help in understanding the variations across DSDs. 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). Our approach to constructing instruments that represent historical DSD level malaria incidence is to find DSD characteristics that can essentially be used as "weights" to recover the variations in malaria prevalence across different DSDs within a district from the district average malaria data. For this purpose, we use proportion of land above 1000 feet elevation, and a measure of inland water in a DSD. The higher elevation of a DSD makes it less susceptible to malaria as it is difficult for anopheles mosquitos, the carrier of malaria parasite, to survive and breed in high altitude. For example, in Badulla district of Sri Lanka, historically the mountainous region was effectively malaria free, but the low lying area was infested with highly endemic malaria (Newman, 1965, P. 35). The spleen rates reported in Rustomjee (1944) show the effect of altitude clearly; the average spleen rate for 1938-41 was 2.5 percent for areas above 3000 feet and the corresponding figure for the areas below 1500 feet was 43.7 percent. The water body, especially stagnant water, on the other hand is very suitable breeding ground for anopheles mosquitos. We interact district level malaria estimate (Gabaldon's "endemicity index" based on the enlarged spleen rates from table 4, page 34 in Newman (1965)) with the elevation and inland water to create instruments for the proportion of LDO land in a DSD.[20] Since the effect of higher elevation is negative on malaria infestation, we expect the interaction of district level malaria with elevation to be negative in the first stage regression of LDO restrictions. The sign of the interaction between district level malaria with inland water, on the other hand, is expected to have a positive sign in the first stage regression of LDO incidence at the DSD level.

We believe that, conditional on the set of covariates, the exclusion restrictions imposed on the interactions of historical malaria with elevation and inland water are credible. As noted

[20] Gabaldon's endemicity index is the lowest spleen rate recorded in the previous five years, divided by 5. Gabaldon (1949) suggests that an endemic index of over 10 indicates highly severe malaria, and an index of less than 3 very low endemicity.

before, the set of covariates includes current malaria infection rates at the DSD level, education at individual and DSD levels, age and district level fixed effects. As additional precautions, we also control for the direct effects of inland water and elevation of a DSD in the IV regressions. Note that since we use district fixed effects, we do not need to control for historical district level malaria prevalence itself in the regressions. To allay any concern about possibly residual effects of early-age malaria exposure, we provide a set of results using alternative sub-samples that exclude cohorts born before 1947, 1950, and 1960 respectively.

Instrument for the Interaction Effect Between Land Restrictions and Travel Time:

As discussed before, to identify the effects of the interaction between land restrictions and travel time, we have to address the potential endogeneity of travel time in the wage regressions. To this end, we use an identification strategy motivated by the transport engineering literature. There is a large literature in transport engineering that identifies topography as an important exogeneous factor in the placement of roads (see, for example, Myer, 2004, American Association of State Highway and Transportation Officials, 2001).[21] In a level surface, a straight line road can minimize the cost while ensuring traffic safety. However, the variations in slope caused by, for example, hills and mountains along the linear route means that an optimal route may have to deviate from the straight line design. Higher slope means greater grade resistance i.e., the additional force required to move a vehicle (particularly trucks) due to the presence of a grade. Most countries set limit on the maximum grade allowed under different design speeds for different types of roads. This maximum road grades are based primarily on the ability of trucks and other heavy vehicles to maintain an efficient operating speed. For instance, grades of 5 percent are considered maximum for the design speeds in the range of 70 miles per hour. For lower speed roads in the range of 25 to 35 miles per hour, grades in the range of 7 to 12 percent may be appropriate (Wolshon, 2004). In terms of construction cost, higher grade means a shorter road segment to be built, requiring less earth and drainage work and hauling. Given the limit on maximum grade, the optimal route in an area with steep slope requires construction of a longer road to reach a given elevation as curves are added to ensure gentler grade. Very steep slope may also require cuts and fills which add substantially to road construction costs. Slope of an

[21] For a recent example of identification strategy that exploit topography to estimate the effects of distances on economic outcomes, see Emran and Hou (2009).

area thus affects placement and design of roads, providing an exogenous source of variation in the travel time. One can thus plausibly use a measure of DSD level slope as an instrument for travel time. To make the exclusion restriction as clean as possible, instead of own slope of a DSD, we use the deviation of own slope from the average slope of other DSDs in the district as an instrument for travel time. Identification of the effect of travel time is thus based on the variations in travel time that arises solely from exogeneous variations created by differences in the slopes. One might argue that we need to control for the own slope of a DSD so that the difference in slope cannot pick up any potential direct effect of the slope of a DSD on labor market equilibrium. On a priori grounds, this would make the exclusion restriction imposed on the difference of slopes more credible. However, perhaps somewhat surprisingly, the empirical results later show that adding own slope as a conditioning variable actually affects the Hansen's J statistics adversely, and it has no explanatory power in the wage regressions. So we report results both with and without 'own slope' as a control variable in the IV regressions. Following the literature, the interaction of travel time and incidence of LDO restrictions is instrumented by interaction of the instrument for travel time with one of the instruments for LDO incidence. More specifically, we use the interaction of difference in slopes (instrument for travel time) with 'district malaria* inland water' (instrument for LDO incidence) as an instrument for the interaction effect.

(5) Data

The main data source for the estimation of the wage regressions is the Household Income and Expenditure Survey, 2002 (HIES, 2002). We use the rural sub-sample of Sri Lanak 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).[22] The DSD identifier in the HIES (2002) allows us to examine the behavior of wages at a more disaggregated geographical level. From the 16,924 households in the survey, about 25,886 individuals participated in the labor force. Our sample consists of adults (age 21 to 65 years) who are labor force participants in the rural subsample consisting of 243 DSDs. The HIES 2002 has complete employment, wage and other information for 22,323 individuals in this age range. Our estimation is based on the

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

rural sample consisting of 12363 individuals. In addition to employment and wages, the survey collected information on education, age, gender, ethnicity and religion. The HIES 2002, however, has only limited information on farming (farm size and income only).

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 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.

Sri Lankan provinces differ considerably in terms of access to large urban centers (with population equal to or more than 100 thousand).[23] The average travel time to the urban center is 2.50 hours in our sample.

(6) Empirical Results

(6.1) OLS Results

We start with results from OLS estimation of the wage equation which controls for urban and estate dummies and indicators of sectoral composition along with land endowment, but no human capital or productivity controls are used.[24] The results are presented in column 1 of Table

[23]Sri Lanka has 7 cities with population more than 100 thousand. These are Colombo, Kandy, Dehiwala, Jaffna, Kote, Moratuwa and Negombo. Except for two cities (Kandy and Jaffna), all other large urban centers are clustered around Colombo, and in the Western coast.

[24]Note that we do not control for population in a DSD in any of the regressions. Because historical data on DSD level population are not available from the period before LDO restrictions were imposed. Since the main channel through which the land restrictions affect wage in our general equilibrium model is migration and effective labor endowment, any variable capturing effective labor endowment is thus a 'bad control' in the terminology of Angrist and Pischke (2009).

2. Consistent with the theoretical model in section (2) above, the coefficient of percentage of area under LDO restrictions is negative, and the coefficient of its interaction with travel time to urban center is positive. Both of the coefficients are significant at 1 percent level. All standard errors reported in this paper are corrected for clustered sampling design of the HIES 2002 survey.

The second column in Table 2 reports the estimation results when we include a set of measures of human capital both at the individual and DSD levels. The DSD level variables are percentage of labor force with primary or more schooling, and a measure of current malaria parasite infection rate (Plasmodium Vivax, the most common malaria parasite for human infections in Asia). The individual level controls include education, age (as a measure of experience and cohort effect), gender dummy, and etnicity/religion dummies.[25] The gender dummy may capture possible gender based division of economic activities, ethnicity/religion is used as a control for cultural norms regarding work ethic, and marital status is used as a proxy for differences in motivations and preferences. The estimated coefficient on LDO restrictions become numerically smaller (from -0.49 to -0.37) which is consistent with the idea that the estimate in column (1) of Table 2 might have partially captured the negative correlation between human capital and LDO restrictions. The interaction effect has the right sign. Both of the coefficients are statistically highly significant (at 1 percent or lower level). As discussed before, a negative effect of LDO restrictions in this specification can be interpreted as strong evidence, as the estimated effect is likely to be significantly biased towards zero. The evidence from this specification that both the direct effect of LDO restrictions, and its interaction with travel time are statistically significant at 1 percent level with right signs provides strong support to the predictions from our general equilibrium model. The marginal effect of LDO restrictions is -0.19 indicating a substantial effect of land restrictions even in this very conservative specification.

Column (3) in table 2 shows the results when we add two variables capturing productivity of land in a DSD to specification (1), i.e., excluding the human capital controls. The land productivity controls are percentages of land of excellent and very good quality for paddy cultivation in a DSD.[26] The estimated effects of LDO restrictions increases from -0.49 to -0.54 and is sta-

[25]The omitted category for the ethnicity (religion) dummies is Sinhalese. About 84 percent of Sri Lanka's population are Sinhalese.

[26]We cannot use the potential yield data as a control because the data are available only for a limited subsample.

tistically significant at 1 percent level. The interaction effect has the expected positive sign and is significant at 1 percent level. This provides support to the idea that the positive correlation between productivity and LDO restrictions causes significant downward bias in the estimated effect of LDO restrictions on wages (i.e., towards zero). But does the productivity correlation matter more than the omitted human capital controls? Since we have an interaction effect in the specification, the estimated coefficients are not very informative in terms of understanding the 'full effects' of land restrictions on the equilibrium wages. The marginal effect is a better metric for understanding the sensitivity of the effects of land restrictions with respect to human capital and productivity controls. The estimated marginal effects corresponding to columns 1-3 in Table 2 provide interesting evidence; the decline in marginal effect due to human capital controls in column (2) is much smaller in magnitude (less than half) when compared to the increase in the marginal effect after we add productivity controls. This can be interpreted as strong evidence in favor of the claim that the omitted productivity is the main source of omitted variables bias in our regressions. The results in the last two columns of Table 2 present additional supports for this conclusion.

Column (4) reports the estimates from a specification that includes both the productivity and human capital controls. Both the direct effect of LDO restrictions and the interaction effect are slightly smaller than the estimates in column (1). However, the marginal effect of LDO restrictions is slightly larger than the marginal effect implied by estimated coefficients in column (1). While the results in columns (1)-(4) are interesting and informative, one can argue that a more convincing test of the proposition that land productivity dominates human capital as a source of omitted variables bias would be to include appropriate fixed effects which will control for *all* the time invariant land and labor productivity differentials across DSDs. If the omitted human capital variables captured by the district fixed effects are dominated by the omitted land productivity, then the marginal effect of LDO restrictions should go up significantly after we use district fixed effects. On the other hand, if the omitted land productivity is dominated by human capital, only then we should observe a significant decrease in the effects of LDO restrictions after district fixed effects are used. We implement this idea in column (5) of Table 2. The evidence shows that the marginal effect of LDO restrictions becomes more than double compared to the estimate in column (2), and is significantly larger than the marginal effect in column (1). This provides strong evidence that unobserved productivity is the dominant source of omitted variables bias in our regressions.

(6.2) Estimates from Instrumental Variables Approach

The results from the instrumental variables strategy are reported in Tables 3 and 4. Table 3 reports the first stage regressions. The instruments used are difference in slopes, interaction of district malaria prevalence (Gabaldon's Endemicity index) with proportion of land at higher than 1000 feet in a DSD, and with inland water in a DSD. The first column presents the estimates for our focus variable, i.e., proportion of LDO land in a DSD. The coefficient on interaction of district malaria prevalence with proportion of land above 1000 feet has a negative sign while the coefficient on the interaction of malaria with inland water is positive, consistent with a priori expectations as discussed in section (4) above. Both of these instruments have significant power in explaining variations in the proportion of LDO restrictions across different DSDs; they are significant at 1 percent level. Interestingly, the other two instruments are also useful in predicting incidence of LDO restrictions (significant at 1 percent level). As formal test of relevance, we report Angrist-Pischke first stage χ^2 and F statistics. The value of the Angrist-Pischke first stage χ^2 for proportion of land under LDO restrictions in a DSD is 29.48, while the F statistic is 14.73 which is larger than the Bounds et al rule of thumb critical value of 10. The instruments thus do a reasonably good job in explaining the LDO restrictions.

The second column in table 3 presents the estimated first stage for travel time to the nearest urban market. As discussed before, travel time is instrumented by difference in average slope of a DSD from the average slope of all other DSDs in the district. According to the regression results, travel time increases significantly with an increase in the average slope in a DSD relative to the surrounding DSDs. It is a powerful variable for explaining variations in travel time with a t statistic of 6.50. The Angrist-Pischke $\chi^2 = 43.36$ and $F = 21.59$ providing convincing evidence of the strength of the instruments in identifying the effects of travel time.

For the interaction of LDO incidence and travel time, the interaction of the instruments has very high explanatory power, the t statistic is 10.05 in the first stage regression (see column 3 in Table (3)). The difference of slope has a positive and significant (at 1 percent) effect. The

Angrist-Pischke $\chi^2 = 44.62$ and $F = 22.22$, indicating that the instruments do not lack power in explaining variations in the interaction of LDO incidence and travel time. As additional evidence, we report the Kleibergen-Papp F statistic that test for weak identification of the wage equation as a whole (see Table 4). The high values of Kleibergen-Paap F statistics in Table 4 shows that the wage equation does not suffer from weak identification.

The IV estimates of our parameters of interest are reported in Table 4 along with formal diagnostic test for the exclusion restrictions. An important point that comes across from the columns (3-5) in Table 4 is that the overidentification tests cannot reject the null of valid instruments across the board; the P-value of Hansen's J being consistently high (the lowest P-value is 0.32). The instruments thus comfortably satisfy formal tests of relevance and exclusion.

The first column in Table 4 reports the main IV estimates corresponding to the instruments set discussed in Table 3. The first thing to notice in column (1) is that the estimates of the coefficients on LDO restrictions and its interaction with travel time have increased substantially in magnitude compared to the OLS estimates in Tables 3. This is not surprising given the evidence in Table 2 that the estimate of the LDO restrictions on wages in OLS regression is underestimated because of unobserved land productivity. The estimates of the parameters of our interest are significant at 1 percent level.

The rest of the columns in Table 4 reports results from a set of robustness checks. The second column shows the results of a just identified model where the set of instruments consists of (i) difference in slope, (ii) interaction of district malaria with inland water in a DSD, and (iii) interaction of the above two instruments. The evidence from just identified model may be useful as a robustness check. As emphasized by Angrist and Pischke (2009), the just identified model is a good robustness check as the weak IV bias tends to zero in this case. The estimates show a numerically larger direct effect of LDO restrictions on equilibrium wage while the estimate of the interaction effect does not change in any appreciable way. As a result, the implied marginal effect is also somewhat larger compared to that in Column (1) of Table 4. The third column reports results from IV regressions when we include average slope of a DSD as an additional control and the full set of instruments. As discussed before, one might expect that controlling for the direct effect of DSD slope will make the exclusion restriction imposed on the difference of the slope of a

DSD from its neighbors in the same district more credible. Somewhat unexpectedly, the Hansen's J statistic becomes significantly worse as we add 'own DSD slope' to the set of controls; the P-value declines dramatically from 0.62 to 0.36. Interestingly, the estimates of the direct effect of LDO and its interaction both are somewhat smaller in magnitude; but the marginal effect of land restrictions on wages is virtually unchanged when compared to the estimate in column (1). Column (4) in Table 4 shows the estimates from a specification where we use an alternative measure of current malaria infection (Plasmodium Falciparum instead of Plasmodium Vivax infection).[27] The estimates are similar to the ones in column (1) of Table 4 with a slightly larger marginal effect of land restrictions. The last column reports results where we use an alternative measure of education at the DSD level (average years of schooling instead of proportion of people with primary or more schooling) along with the original measure of current malaria infections (i.e., Plasmodium Vivax). The estimates of the LDO restrictions and its interaction with travel time are somewhat smaller in magnitude, but they remain both statistically significant and numerically substantial. It is reassuring that the coefficients of the two endogenous variables under focus (i.e., land restrictions, and its interaction with travel time) remain reasonably stable across the different columns in Table 4.

The estimated coefficients for percentage of land under LDO restrictions, and its interaction with travel time are substantially larger in magnitude in the IV regressions in Table 4 compared with the respective OLS coefficients reported in Table 2. To provide a sense of magnitude of LDO's 'full effect' on wages implied by the IV and OLS estimates, we turn to the the marginal effects in Table 2 and Table 4 (evaluated at the median). The marginal effects confirm the conclusion that the IV estimates of the effects of the land restrictions on wages are substantially larger compared to the OLS estimates; the marginal effects are -0.46 (OLS, column (5) Table 2) and -1.41 (column (1) in table 4). This substantial increase in the estimated effect of land restrictions on wages after instrumentation is indicative of the importance of unobserved positive productivity as the main source of omitted variables bias as discussed in details earlier.

Additional Robustness Checks: Can Long Run Adverse Effects of Early-Age Malaria Exposure Drive the Results?

[27] Plasmodium Falciparum is more virulent and among the most devastating pathogens. It causes severe malaria.

Although we control for education, age, and current malaria infection rates in the IV regressions, one might still worry that they might not be adequate controls for potential long term effects of early-age malaria on health and education. For example, if a significant proportion of the individuals in our sample belong to age cohorts that were affected by malaria prevalence during 1937-1941, then they are likely to have lower educational attainment and adverse health status. We have reasonably good controls for education, as both individual and DSD level indicators of education are used in the IV regressions. However, the Sri Lanka HIES 2002 lacks good measures of health of the individuals. To check if our results are driven by long term negative effects of early-age malaria, we perform robustness checks by excluding early age malaria cohorts from the sample, those born before 1947, 1950, and 1960 respectively. The oldest person in our sample is born in 1937 and the youngest in 1981. The results from estimating the IV regressions using the three subsamples are reported in Table 5. It is reassuring that the estimates are consistent with the results reported earlier in Table 4 using the full sample. Both the direct effect of land restrictions and the interaction with travel time are statistically significant at 5 percent or lower level. The IV diagnostics are favorable, the lowest P-value for Hansen's J statistics is 0.24. The implied marginal effects are also comparable to the estimates in Table 4.

The Importance of Distance in Determining the Effects of Land Restrictions

An interesting prediction from our simple general equilibrium model is that the effects of land restrictions will die down with an increase in the distance of a village from the nearest urban center. Consistent with the prediction of the theoretical model, our estimates show that the interaction effect of land restrictions and travel time has a positive sign and the effect is statistically significant. To get a better sense of the role played by distance, we report estimates of marginal effects and elasticities using the IV results in Column (1) of Table 4 for different values of travel time (see Table 6 and Figure 3). The results are similar if we use the other IV specifications in Tables 4 and 5.

The first column in Table 6 reports the marginal effect and second the elasticity estimates (evaluated at median LDO incidence). When travel time increases from 0.57 hours to 1.88 hours, the marginal effect declines from -1.84 to -1.41, it declines further to -0.86 as we reach 3.58 hours of travel time. The elasticity estimates follow a similar pattern. According to the elasticity estimates, a one percent increase in the land under LDO restrictions leads to a reduction in equilibrium wage by about 9 percent when the DSD is located about half an hour from the relevant urban center, but it declines to 4 percent when the DSD is about three and a half hours away from the urban center. Our estimates indicate that the effects of land restrictions on equilibrium wage become insignificant after about 6 hours of travel time.

Conclusions

A significant body of economic literature analyzes the effects of restrictions affecting alienability and/or security of property rights in land on agricultural productivity, incentives to undertake agricultural investment (see, for example, Besley (1995), Jacoby et al (2002), Goldstein and Udry (2008)) and access to credit (see, for example, Field (2007), Do and Iyer (2008)). However, the implications of policy restrictions in land market for the labor market have been relatively neglected in recent research; only a handful of recent papers analyze the possible labor market effects of restrictions in the land market (Hayashi and Prescott , 2008; Field, 2007, Iyer et al (2009)). To the best of our knowledge, there is no work in the existing literature that examines the impact of policy restrictions in land market on equilibrium wage and its spatial distribution.

Under the Land Development Ordinance (LDO) leases, private farmers in Sri Lanka can cultivate publicly-owned land in perpetuity. But these leases come with restrictions on sales, mortgage, and rental. As LDO leases coexist with fully privately owned and cultivated agricultural land in most of the sub-districts, we utilize the spatial variations in the incidence of LDO leases to estimate the impact on equilibrium wages and its spatial pattern.

Contrary to the standard case where land under policy restrictions is of low quality, the land under LDO restrictions in Sri Lanka is of higher productivity compared to other land within the same sub-district (DSD). This unusual positive correlation between land productivity and incidence of land restrictions implies that if we find a negative effect of restrictions on equilibrium wage using simple OLS regression without controls for land productivity (but including human capital controls), it can be taken as particularly strong evidence. Because the OLS estimates are likely to be biased downward towards zero in this nonstandard case. The OLS estimates from this conservative specification show that the coefficient of incidence of land restrictions is, in fact, negative, numerically substantial and statistically significant. This constitutes strong evidence of a negative effect of land market restrictions on equilibrium wage.

To provide estimates of the magnitude of the causal effect of land restrictions, we use an instrumental variables approach. We exploit a historical quasi-experiment in Sri Lanka that allows us to use variations in malaria prevalence across DSDs from 16th to early 20th centuries to identify the effects of land restrictions on wages. For identification of the interaction with distance (travel time) to the urban center, we rely on the insights from the transport engineering literature on the role of topography in road placement and in determining travel time. The instrumental variables estimates show that the effect of LDO restrictions on wages is substantial; a one percent increase in the proportion of land under LDO restrictions in a DSD reduces the wage by about 6.6 percent (average of the estimates from different IV specifications in Tables 4 and 5, and evaluated at the median). The effects of land restrictions depend on the location of a DSD, a one percent increase in the land under LDO restrictions leads to a reduction in equilibrium wage by about 8.5 percent when the DSD is located about half an hour from the relevant urban center, but only to about 4 percent reduction when the DSD is about three and a half hours away from the urban center (again, averaging over the different IV results in Tables 4 and 5). We are not aware of any other paper in the literature that provides evidence on general equilibrium effects of land market restrictions on wages and its spatial distribution.

References

1. American Association of State Highway and Transportation Officials, 2001, *A Policy on Geometric Design Highways and Streets*, Washington DC.

2. Angrist, J, and S. Pischke (2009): *Mostly Harmless Econometrics*, Princeton University Press.

3. Bardhan, P (1984), *Land, Labor and Rural Poverty*, Columbia University Press.

4. Bardhan, P (1983), "Labor Tying in a Poor Agrarian Economy: A Theoretical and Empirical Analysis", Quarterly Journal of Economics, August 1983.

5. Bardhan, P (1979), "Wages and Unemployment in a Poor Agrarian Economy", Journal of Political Economy, June 1979.

6. Bardhan, P and T. N. Srinivasan (1971): "Cropsharing Tenancy: A Theoretical and Empirical Analysis", American Economic Review, March 1971.

7. Besley, T (1995): "Property Rights and Investment Incentives: Theory and Evidence from Ghana." Journal of Political Economy, 103, 5, 1995: 903-937.

8. Besley, T and R. Burgess (2004): "Can labor regulation Hinder Economic Performance? Evidence from India", Quarterly Journal of Economics, February, 2004.

9. Brown, P. J, 1986, "Socioeconomic and Demographic Effects of Malaria Eradication: A Comparison of Sri Lanka and Sardinia," *Social Science and Medicine*, vol 22(8), p.847-859.

10. Dasgupta, P and D, Ray (1986), "Inequality as a Determinant of Malnutrition and Unemployment: Theory", Economic Journal.

11. Dasgupta, P and D, Ray (1987), "Inequality as a Determinant of Malnutrition and Unemployment: Policy", Economic Journal.

12. Deininger, K, Jin, S, and H. Nagarajan (2009), "Determinants and Consequences of Land Sales Market Participation: Panel Evidence from India", World Development, February, 2009.

13. Deininger, K, Jin, S, and H. Nagarajan (2008), "Efficiency and Equity Impacts of Rural Land Rental Restrictions: Evidence from India", European Economic Review, July 2008.

14. Deininger, Klaus & Songqing Jin & Adenew, Berhanu & Gebre-Selassie, Samuel & Demeke, Mulat, 2003. "Market and non-market transfers of land in Ethiopia - implications for efficiency, equity, and non-farm development," Policy Research Working Paper Series 2992, The World Bank.

15. De Silva, K. M., 1981, *A History of Sri Lanka*, London, C. Hurst Publisher.

16. Do, Quy-Toan and Lakshmi Iyer, 2008, "Land Titling and Rural Transition in Vietnam," *Economic Development and Cultural Change*, Vol 56 (3), p. 531-579.

17. Ekanayeke, S. B (1982), National Case Study: Sri Lanka, UNESCO Regional Office for Education in Asia and Pacific, Thailand.

18. Emran, M. Shahe and Zhaoyang Hou (2009): "Access to Markets and Household Consumption: Evidence from Rural China", Working paper, George Washington University and Singapore National University.

19. Eswaran, M and A. Kotwal (1985a), "A Theory of Contractual Structure in Agriculture", American Economic Review, June 1985.

20. Eswaran, M and A. Kotwal (1985b), "A Theory of Two-tier Labor Markets in Agrarian Economies", American Economic Review, March 1985.

21. Field, Erica, 2007. "Entitled to Work: Urban Property Rights and the Labor Supply in Peru," *Quarterly Journal of Economics*, Vol. 122(4), p1561-1602.

22. Foster, A. and M. Rosenzweig, 2004, "Agricultural development, industrialization and rural inequality," *mimeographed*, Harvard University.

23. Gabaldon, A (1949), "The Nation-Wide Campaign Against Malaria in Venezuela", Transactions of the Royal Society of Tropical Medicine and Hygiene, 43, pp. 113-164.

24. Goldstein, M and C. Udry (2008): "The Profits of Power: Land Rights and Agricultural Investment in Ghana", Journal of Political Economy, 2008.

25. Haldar, A and J. Stiglitz (2009): The Analytics of Formality and Informality, Working Paper, Columbia University and Cambridge University.

26. Hayashi, Fumio and Edward C. Prescott, 2008. "The Depressing Effect of Agricultural Institutions on the Prewar Japanese Economy," *Journal of Political Economy*, vol. 116(4), pages 573-632.

27. Hellmann, T , K, Murdock, and J. Stiglitz (1998), Financial Restraint: Toward a New Paradigm, chapter 6 in Aoki, Kim and Okuno-Fujiwara, ed., *The Role of Government in East Asian Economic Development*, Oxford University Press.

28. Hoff, K, A. Braverman, and J. Stiglitz (1993): The Economics of Rural Organization: Theory, Practice and Policy, Oxford University Press.

29. Iyer, Lakshmi, Xin Meng and Nancy Qian, 2009, "Unbundling Property Rights: The Impact of Urban Housing Reforms on Labor Mobility and Savings in China," *mimeo.*

30. Jacoby, H, Guo, L, and S. Rozelle (2002), "Hazards of Expropriation: Tenure Insecurity and Investment in Rural China", American Economic Review, December, 2002.

31. Lucas, Adrienne, 2010, "Malaria Eradication and Educational Attainment: Evidence from Paraguay and Sri Lanka," *American Economic Journal-Applied Economics*, Vol. 2, p.46-71.

32. Newman, P (1965): Malaria Eradication and Population Growth: With Special Reference to ceylon and British Guyana, School of Public Health, University of Michigan.

33. Peebles, Patrick, 2006, *A History of Sri Lanka*, Greenwood Publishing Group.

34. Peebles, Patrick, 1990, "Colonization and Ethnic Conflict in the Dry Zone of Sri Lanka," *Journal of Asian Studies*, Vol. 49 (1), pp30-55.

35. Ray, D (1998): Development Economics, Princeton University Press.

36. Rustomjee, J (1944): Observations Upon the Epidemiology of Malaria in Ceylon, Sessional Paper 24, 1944, Government Press, Colombo.

37. Stiglitz, J (1974a): "Incentives and Risk Sharing in Sharecropping", Review of Economic Studies, April, 1974.

38. Stiglitz, J (1974b): "Alternative Theories of Wage Determination and Unemployment in L.D.C.'s: The Labor Turnover Model", Quarterly Journal of Economics, 88(2), May 1974, pp. 194-227.

39. Stiglitz J (1976): "The Efficiency Wage Hypothesis, Surplus Labor and the Distribution of Income in L.D.C.'s" , Oxford Economic Papers, 28(2), July 1976, pp. 185-207.

40. Temple, Jonathan R. W. and Wößmann, Ludger (2006), "Dualism and cross-country growth regressions", Journal of Economic Growth, September 2006, 11(3), 187-228.

41. Yang, Dennis, 1997. "China's land arrangements and rural labor mobility," *China Economic Review*, vol. 8(2), pages 101-115

42. Vollrath, Dietrich, 2009. "How important are dual economy effects for aggregate productivity?" *Journal of Development Economics*, vol. 88(2), pages 325-334.

43. Wolshon, Brian, 2004, "Geometric Design of streets and Highways", in Myer Kutz ed. *Handbook of Transportation Engineering*, McGraw-Hill publishers: New York.

44. World Bank, 2008, *Land Reforms in Sri Lanka: A Poverty and Social Impact Analysis*, South Asia Region.

45. World Bank, 2010, Sri Lanka: Connecting People to Prosperity, South Asia Region

Table 1: Crop Yields and Land Under LDO Restrictions

Panel A: Potential yield

	Rice	Maize	Millet	Sorghum	Sweet Potato	Cassava
% Area Under LDO	3,841.460	5,391.475	6,538.496	5,093.550	7,234.107	6,852.160
	(3.88)***	(3.34)***	(2.66)**	(2.85)***	(3.98)***	(3.92)***
Travel Time to Large City	2.268	2.100	-0.727	1.352	3.800	3.420
	(2.54)**	(1.50)	(0.30)	(0.78)	(2.41)**	(2.23)**
Constant	2,406.270	2,649.598	321.399	-36.057	4,058.798	4,375.430
	(3.57)***	(3.42)***	(0.18)	(0.04)	(3.21)***	(2.44)**
District Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	124	82	46	32	107	118
R-squared	0.49	0.83	0.38	0.88	0.62	0.31

	Banana	Soybean	Bean	Other pulse	Ground Nut	Other Oilseeds
% Area Under LDO	3,456.569	1,982.288	2,254.279	1,710.232	1,632.559	1,491.524
	(2.28)**	(2.94)***	(3.09)***	(3.86)***	(3.06)***	(1.63)
Travel Time to Large City	-1.801	0.708	0.784	1.003	0.820	-3.123
	(1.55)	(1.14)	(1.17)	(2.50)**	(1.66)	(3.76)***
Constant	5,653.358	6.995	8.051	689.853	454.588	5,542.838
	(6.25)***	(0.02)	(0.02)	(2.02)**	(0.89)	(5.57)***
District Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	101	63	63	132	85	130
R-squared	0.29	0.38	0.38	0.33	0.40	0.39

Panel B: Actual Yield

	Rice	Maize	Millet	Sorghum	Sweet Potato	Cassava
% Area Under LDO	2,372.102	1,042.140	614.788	-70.490	1,043.829	2,970.653
	(3.02)***	(1.11)	(1.91)*	(0.18)	(0.25)	(1.32)
Travel Time to Large City	0.800	0.271	-0.328	-0.226	-2.533	3.551
	(1.07)	(0.33)	(1.03)	(0.59)	(0.70)	(1.80)*
Constant	1,392.330	6.511	65.248	183.046	1,424.177	9,483.472
	(1.64)	(0.01)	(0.28)	(0.89)	(0.49)	(4.11)***
District Fixed Effect	158	82	46	32	107	118
Observations	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.39	0.83	0.38	0.76	0.62	0.31

	Banana	Soybean	Bean	Other pulse	Ground Nut	Other Oilseeds
% Area Under LDO	7,774.127	945.411	940.833	725.325	508.961	2,598.704
	(2.25)**	(2.78)***	(2.86)***	(3.42)***	(2.14)**	(2.14)**
Travel Time to Large City	-4.171	0.352	0.339	0.387	0.015	-3.257
	(1.57)	(1.12)	(1.12)	(2.01)**	(0.07)	(2.96)***
Constant	11,597.539	22.398	21.880	924.925	215.110	5,843.857
	(5.61)***	(0.11)	(0.11)	(5.65)***	(0.94)	(4.42)***
District Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Observations	101	63	63	132	85	130
R-squared	0.29	0.38	0.38	0.33	0.40	0.39

Absolute value of t statistics in parentheses

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

Table 2: Land market restrictions and wages

OLS Regression Results

	Real Annual wage				
	1	2	3	4	5
% Area Under LDO	-0.493	-0.366	-0.542	-0.435	-0.633
	(3.07)***	(2.53)***	(3.37)***	(3.02)***	(4.18)***
Area LDO*Travel Time	0.135	0.094	0.122	0.095	0.093
	(3.90)***	(2.90)***	(3.51)***	(2.92)***	(2.69)***
Marginal Effects (at median)					
% Area Under LDO	**-0.24**	**-0.19**	**-0.31**	**-0.26**	**-0.46**
Individual controls	no	Yes	Yes	Yes	Yes
Education controls	no	Yes	no	Yes	Yes
Land quality Controls	no	no	Yes	Yes	Yes
Sectoral Composition + Area	Yes	Yes	Yes	Yes	Yes
District Fixed Effect	no	no	no	no	Yes
Observations	12363	12363	12363	12363	12363

Robust t statistics in parentheses. Standard errors corrected for clustering

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

Table 3: First Stage Regressions

	% of Area under LDO	Travel time to urban Centers	Area under LDO* Travel Time
Instruments			
Malaria*Inland water	0.015	-0.145	-0.007
	(3.70)***	(1.91)*	(0.34)
Malaria*% of area above 1000 feet of elevaton	-0.067	1.215	-0.111
	(3.44)***	(1.91)*	(1.36)
difference in slope	0.003	0.094	0.007
	(3.78)***	(6.50)***	(2.46)**
difference in slope*malaria*water	-0.004	-0.081	-0.035
	(5.74)***	(6.99)***	(10.05)***
District Fixed Effect	Yes	Yes	Yes
Individual & area controls	Yes	Yes	Yes
Relevance of Instruments			
Angrist-Pischke χ^2	29.48	43.36	44.62
P-value	0.00	0.00	0.00
Angrist-Pischke F-statistics	14.73	21.59	22.22

Robust t statistics in parentheses. Standard errors corrected for clustering

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

Table 4: Land market restrictions and wages

IV Regression Results

	Real Annual wage				
	1	2	3	4	5
% Area Under LDO	-2.030	-2.328	-1.873	-1.808	-2.109
	(2.93)***	(2.74)***	(2.43)**	(2.60)***	(2.92)***
Area LDO*Travel Time	0.328	0.347	0.262	0.298	0.329
	(2.73)***	(2.80)***	(1.70)*	(2.43)**	(2.71)***
Marginal Effects (at median)					
% Area Under LDO	**-1.41**	**-1.67**	**-1.38**	**-1.25**	**-1.49**
Log(slope)	no	no	Yes	no	no
Area controls	Yes	Yes	Yes	Yes	Yes
District Fixed Effect	Yes	Yes	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes	Yes	Yes
Sectoral Dummies	Yes	Yes	Yes	Yes	Yes
IV Diagnostics					
Weak Identification Test					
Kleibergen-Paap wald F	30.32	19.71	38.22	31.31	28.52
Stock-Yogo 5% maximal IV rel. bias	9.53	9.53	9.53	9.53	9.53
Hansen's J Statistics (Overidentication test)	0.25		0.84	0.52	0.32
P-Value	0.62		0.36	0.47	0.57

Robust t statistics in parentheses. Standard errors corrected for clustering

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

Col1: instruments: Malaria Endemicity* % area under inland water, Malaria Endemicity*% of Area above 1000 feet of elevation, difference in slope, difference in slope*malaria Endemicity*inland water

Col2: drops % of area above 1000 feet elevation from instrument set

Col3: same instruments as in column 1, but adds log(slope) as an additional control

Col4: same instruments as in column 1, use Plasmodium Falciparum cases as malaria control instead of Plasmodium Vivax cases.

Col5: same instruments as in column 1 but has average years of education in the DSD as a control instead of % of labor force with education level primary or above.

Table 5: Land market restrictions and wages: Further Robustness Checks

IV Regression Results

	Real Annual wage		
	Year of Birth After		
	1947	1950	1960
% Area Under LDO	-1.841	-1.740	-1.939
	(2.66)***	(2.51)**	(2.41)**
Area LDO*Travel Time	0.305	0.283	0.307
	(2.56)**	(2.47)**	(2.58)***
Marginal Effects (at median)			
% Area Under LDO	**-1.27**	**-1.21**	**-1.36**
Area controls	Yes	Yes	Yes
District Fixed Effect	Yes	Yes	Yes
Individual controls	Yes	Yes	Yes
Sectoral Dummies	Yes	Yes	Yes
no. of observations	11416	10658	7542
IV Diagnostics			
Weak Identification Test			
Kleibergen-Paap wald F	70.85	62.71	31.47
Stock-Yogo 5% maximal IV rel. bias	9.53	9.53	9.53
Hansen's J Statistics (Overidentication test)	0.84	1.40	0.15
P-Value	0.36	0.24	0.70

Robust t statistics in parentheses. Standard errors corrected for clustering

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

Instruments: Malaria Endemicity* % area under inland water, Malaria Endemicity*% of Area above 1000 feet of elevation, difference in slope, difference in slope*malaria Endemicity*inland water

Table 6: The Importance of Interaction Effect

Travel Time Percentile	Travel time (hour)	Marginal Effect	Elasticity
p20	0.57	-1.84	-8.8%
p30	0.93	-1.72	-8.3%
p40	1.40	-1.57	-7.5%
p50	1.88	-1.41	-6.8%
p60	2.32	-1.27	-6.1%
p70	3.01	-1.04	-5.0%
p80	3.58	-0.86	-4.1%
p90	5.89	-0.10	-0.5%

Table A.1: Summary Statistics

	Mean	Median	standard Dev.	Minimum	Maximum
Real annual Wage (Rs/year)	57065	44871	48982	421	1576665
% Area Under LDO	0.097	0.048	0.122	0.002	0.626
Travel Time to Large City (hour)	2.479	1.883	2.348	0.078	15.182
Area LDO*Travel Time	0.350	0.087	0.617	0.001	4.947
Area of DSD (0000 sqkm)	0.015	0.011	0.013	0.002	0.087
% area >1000 feet of elevation	0.090	0.000	0.232	0.000	1.000
Gabalon's Malaria Endimicity Index	3.407	1.480	3.410	0.340	11.500
Plasmodium Vivax (000 cases)	0.040	0.009	0.107	0.000	0.959
Plasmodium Falciparum (000 cases)	0.013	0.004	0.030	0.000	0.368
% of lab. Forc. w. education>= primary	0.675	0.674	0.151	0.293	0.961
% of area under inland water bodies	0.066	0.000	0.157	0.000	0.960
Land quality (% Excellent)	0.040	0.000	0.148	0.000	1.000
Land quality (% Very good)	0.044	0.000	0.146	0.000	0.990
Average Slope (%)	11.303	8.420	9.283	0.186	33.100
Log(Education Level (yr))	2.037	2.303	0.683	0.000	2.833
Log(Age)	3.604	3.638	0.289	3.045	4.174
Male	0.693	1.000	0.461	0.000	1.000
Married (yes=1)	0.756	1.000	0.430	0.000	1.000
Christian (yes=1)	0.055	0.000	0.229	0.000	1.000
Muslim (yes=1)	0.033	0.000	0.179	0.000	1.000
Buddist (yes=1)	0.782	1.000	0.413	0.000	1.000
Moor (yes=1)	0.032	0.000	0.177	0.000	1.000
Estate (yes=1)	0.150	0.000	0.357	0.000	1.000
Manufacturing (yes=1)	0.233	0.000	0.423	0.000	1.000
Unskilled Services (yes=1)	0.192	0.000	0.394	0.000	1.000
Skilled Services (yes=1)	0.287	0.000	0.453	0.000	1.000
Share of agri in total employment (%)	0.333	0.331	0.211	0.008	1.000

TableA.2: Land market restrictions and wages:
OLS Regression Results

	Real Annual wage				
	1	2	3	4	5
% Area Under LDO	**-0.493**	**-0.366**	**-0.542**	**-0.435**	**-0.633**
	(3.07)* **	**(2.53)** **	**(3.37)*** **	**(3.02)*** **	**(4.18)*** **
Area LDO*Travel Time	**0.135**	**0.094**	**0.122**	**0.095**	**0.093**
	(3.90)* **	**(2.90)*** **	**(3.51)*** **	**(2.92)*** **	**(2.69)*** **
Travel Time to Large City	-0.049	-0.042	-0.046	-0.042	-0.042
	(8.25)***	(6.94)***	(7.62)***	(6.95)***	(6.10)***
Area of DSD	2.667	2.886	2.149	2.695	2.048
	(2.44)**	(2.67)***	(2.02)**	(2.48)**	(1.74)*
% area >1000 feet of elevation	0.180	0.163	0.211	0.174	0.062
	(3.95)***	(3.58)***	(4.44)***	(3.74)***	(0.75)
P. vivax (current malaria cases)		0.043		0.061	0.193
		(0.42)		(0.61)	(1.58)
% of lab. Forc. w. education>= primary		0.378		0.372	0.187
		(3.84)***		(3.75)***	(1.68)*
% of area under inland water bodies	0.138	0.121	0.142	0.129	0.093
	(2.65)***	(2.47)**	(2.71)***	(2.62)***	(1.72)*
Land quality (% Excellent for paddy prod.)			0.116	0.101	0.055
			(1.85)*	(1.79)*	(0.63)
Land quality (% Very good for paddy prod.)			0.037	0.057	0.058
			(0.69)	(1.14)	(0.88)
Log(Education Level (yr))		0.224		0.224	0.224
		(16.73)***		(16.77)***	(17.12)***
Log(Age)		0.007	-0.085	0.009	0.014
		(0.32)	(3.70)***	(0.40)	(0.59)
Male		0.208	0.224	0.209	0.208
		(15.10)***	(15.93)***	(15.12)***	(15.26)***
Married (yes=1)		0.150	0.150	0.148	0.145
		(10.24)***	(10.05)***	(10.17)***	(10.04)***
Christian (yes=1)		0.029	0.113	0.021	-0.032
		(0.65)	(2.48)**	(0.47)	(0.69)
Muslim (yes=1)		-0.153	-0.073	-0.161	-0.218
		(1.25)	(0.58)	(1.31)	(1.78)*
Buddist (yes=1)		-0.049	0.060	-0.055	-0.074
		(1.33)	(1.56)	(1.49)	(2.07)**
Moor (yes=1)		0.201	0.191	0.200	0.231
		(1.66)*	(1.55)	(1.65)*	(1.91)*
Estate (yes=1)	0.033	0.070	0.072	0.067	0.072
	(1.06)	(1.80)*	(1.74)*	(1.72)*	(1.86)*
Manufacturing (yes=1)	0.466	0.390	0.458	0.390	0.398
	(18.71)***	(16.09)***	(18.23)***	(16.07)***	(16.73)***
Unskilled Services (yes=1)	0.148	0.086	0.108	0.084	0.107
	(5.64)***	(3.43)***	(4.10)***	(3.38)***	(4.38)***
Skilled Services (yes=1)	0.946	0.784	0.927	0.783	0.796
	(40.18)***	(32.83)***	(38.63)***	(32.76)***	(33.57)***
Share of agri in total employment	-0.191	-0.047	-0.291	-0.045	-0.051
	(2.97)***	(0.57)	(4.14)***	(0.54)	(0.58)
Observations	12363	12363	12363	12363	12363
District Fixed Effect	no	no	no	no	Yes

Robust t statistics in parentheses. Standard errors corrected for clustering

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

Table A.3: Land market restrictions and wages

IV Regression Results

	Real Annual wage		
	1	2	3
% Area Under LDO	**-2.030**	**-2.328**	**-1.873**
	(2.93)* **	**(2.74)*** **	**(2.43)** **
Area LDO*Travel Time	**0.328**	**0.347**	**0.262**
	(2.73)* **	**(2.80)*** **	**(1.70)* **
Travel Time to Large City	-0.073	-0.064	-0.048
	(2.86)***	(2.09)**	(1.97)**
P. vivax (current malaria cases)	0.266	0.283	0.233
	(2.08)**	(2.15)**	(1.71)*
Area of DSD	2.302	2.329	2.126
	(1.57)	(1.58)	(1.48)
% of lab. Forc. w. education>= primary	0.108	0.089	0.108
	(0.90)	(0.70)	(0.90)
% of area under inland water bodies	0.153	0.169	0.138
	(2.37)**	(2.47)**	(2.04)**
Land quality (Excellent)	0.167	0.184	0.115
	(1.49)	(1.55)	(0.96)
Land quality (Very good)	0.173	0.184	0.126
	(1.95)*	(2.01)**	(1.36)
Share of area above 1000 feet of elevation	0.092	0.110	0.106
	(0.83)	(0.97)	(1.01)
Log(slope)			-0.021
			(1.10)
Log(Education Level (yr))	0.224	0.224	0.224
	(16.80)***	(16.80)***	(16.84)***
Log(Age)	0.014	0.013	0.014
	(0.62)	(0.57)	(0.60)
Male	0.207	0.208	0.208
	(15.14)***	(15.10)***	(15.19)***
Married (yes=1)	0.142	0.142	0.143
	(9.85)***	(9.79)***	(9.86)***
District Fixed Effect	Yes	Yes	Yes
Religion & Ethnicity dummies	Yes	Yes	Yes
Sectoral Dummies	Yes	Yes	Yes
Weak Identification Test			
Kleibergen-Paap wald F	30.32	19.71	38.22
Stock-Yogo 5% maximal IV rel. bias	9.53	9.53	9.53
Hansen's J Statistics	0.25		0.84
P-Value	0.62		0.36

Robust t statistics in parentheses. Standard errors corrected for clustering

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

Figure 1: Percentage of Area Under LDO Restrictions

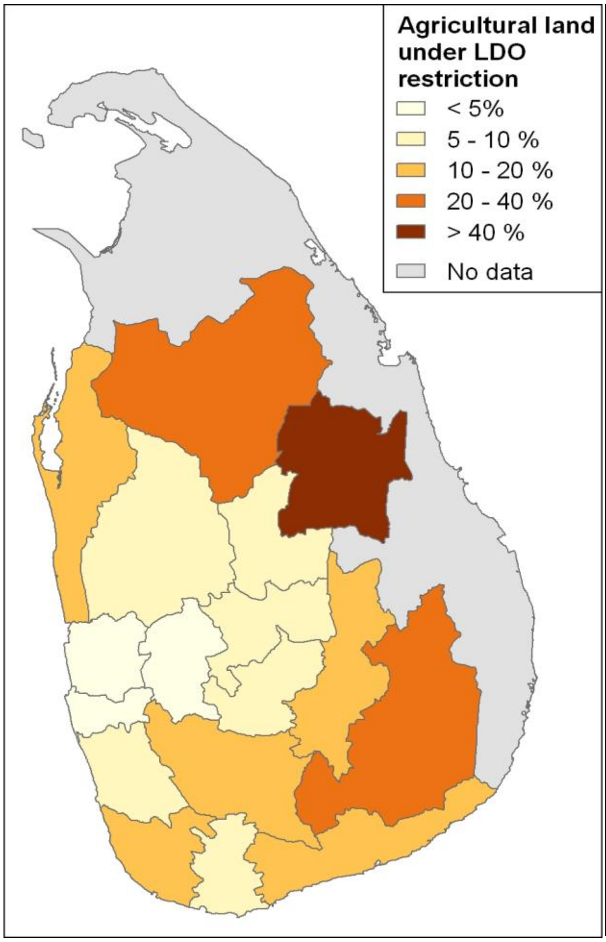

Figure 2: Malaria Endemicity in Sri Lanka, 1937-41

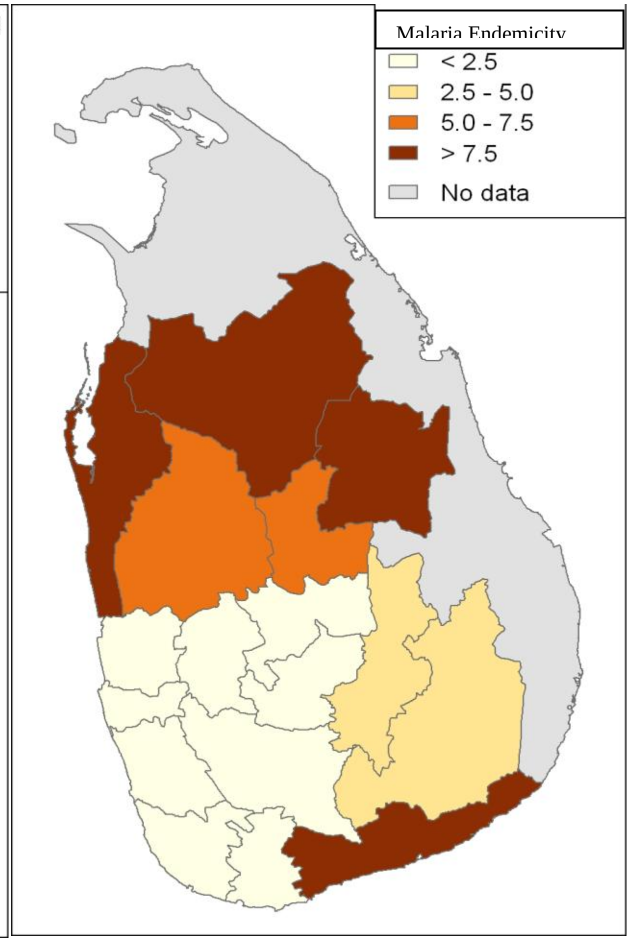

Figure 3: Effect of LDO Restrictions on Wage at Different Travel Time