Urban-Rural Wage Gaps in Developing Countries: Spatial Misallocation or Efficient Sorting?

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ABSTRACT

To what extent do the large urban-rural wage gaps in developing countries reflect a spatial misallocation of labor? We answer this question using a dynamic model of internal migration that encompasses two broad interpretations of these gaps. The first is that workers are misallocated across space due to uninsurable migration risk and incomplete markets. The second is that workers are heterogenous and sort efficiently across space given migration costs. We discipline the model quantitatively using evidence from a controlled migration experiment in Bangladesh and new survey evidence about migration opportunities for potential migrants. We then use the model to compare the status quo to the efficient spatial allocation of workers chosen by a benevolent planner. We conclude that urban-rural wage gaps mostly reflects sorting and migration costs, though improved access to financial markets would still reduce misallocation and improve living standards substantially for some workers.

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1. Introduction

In almost every developing country, there are large gaps in average income per head between rural and urban areas, or relatedly, between agricultural and non-agricultural workers (see Young (2013) and Gollin, Lagakos, and Waugh (2014) for recent evidence). One perspective on these gaps is that they represent a misallocation of resources, whereby the movement of workers out of unproductive rural agricultural activities could yield substantial welfare gains. An alternative perspective is that these gaps reflect efficient outcomes, driven by the sorting of heterogenous workers across space, or the disutility associated with migrating from rural to urban areas.

Recent empirical evidence has provided support for both perspectives at least to some extent. For example, a recent randomized controlled trial by Bryan, Chowdhury, and Mobarak (2014) shows that a small cash payment to rural Bangladeshi villagers, conditional on migrating, substantially increases consumption among those induced to migrate. This study suggests potentially large unexploited gains from migration, and points to uninsurable migration risk as a likely culprit. On the other hand, workers in urban areas tend on average to be those with more education and higher scores on tests of cognitive ability (Miguel and Hamory, 2009; Young, 2013; Lagakos and Waugh, 2013; Herrendorf and Schoellman, 2011; Gollin, Lagakos, and Waugh, 2014). These facts point to an important role for sorting. Finally, evidence shows that migration may lead to a loss of access to village risk sharing networks, which is a substantial cost of migrating (Morten, 2013; Munshi and Rosenzweig, 2013).

In this paper we ask how much of the urban-rural income gap in developing countries is due to misallocation, and how much is an efficient allocation of workers across space. To do so, we build a dynamic model of internal migration that combines sorting by heterogenous workers as in Roy (1951), with uninsurable income risk, as in Bewley (1977), Aiyagari (1994) and Huggett (1996). Our model also allows for temporary and permanent migration, following Kennan and Walker (2011), and seasonal variation in expected productivity, which is a key feature of the income process in the developing world. The migration process in our model is similar to that of Kaplan and Schulhofer-Wohl (2015), in which workers take search frictions in labor markets into consideration when deciding whether to migrate.

To discipline the model, we draw on three broad types of evidence. The first is the experimental evidence from Bryan, Chowdhury, and Mobarak's (2014) in Bangladesh. As part of our calibration strategy, we replicate the experiments of Bryan, Chowdhury, and Mobarak's (2014) within our model, and require that the model's outcomes quantitatively match the experimental data. To our knowledge, we are the first to target moments of a controlled experiment in order to quantitatively discipline a dynamic general-equilibrium model. The second type of evidence we use is new surveys of potential migrants about responses to hypothetical migration opportunities. In short, these surveys provides a wealth of evidence on the wage premiums individuals would have to accept, all else equal, to migrate from their rural areas to an urban area. Finally, we draw on nationally representative cross-sectional survey evidence that allows us to measure average wages and other characteristics in rural and urban areas.

Once parameterized, our model matches several key aggregate moments of the Bangladeshi data, including the average urban-rural wage gap, the fraction of workers in urban and rural areas, the ratio of average assets to income, and the fraction of all workers that migrate temporarily in a given year. We also match the main experimental moments of the Bryan, Chowdhury, and Mobarak's (2014) study, including the average experimental gains from migration, the fraction that end up with lower-than-average income after migrating and the fraction of workers induced to migrate that migrate again in a subsequent year without any intervention.

We then use the model to conduct quantitative experiments. Our main experiment is to compare the market allocation, i.e. the status quo, to the allocation of workers chosen by a benevolent social planner, who maximizes average welfare across all workers. We compare the urban-rural wage gap under the market allocation to the ratio of average marginal products of labor in the urban to rural area. We find that the planner's allocation also features a large gap in average marginal products, though not as large as the gap under the existing (market) allocation. The planner chooses to put substantially more workers in the urban area relative to the existing allocation, which shows that there is indeed a spatial misallocation of workers. We conclude that the urban-rural wage gap mostly reflects sorting and migration costs, though there is still room for improved resource allocation across space, at least in Bangladesh. Policies that improve access to financial markets, for example, allow workers to build up more savings and better insure themselves against migration risk. This in turn improves income and well-being of workers near the margin of migration.

Our paper contributes to the large and growing literature on misallocation and aggregate productivity (Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009). Our focus is on spatial misallocation of labor, following the work of Vollrath (2009); Young (2013); Hnatkovska and Lahiri (2013); Gollin, Lagakos, and Waugh (2014); Fajgelbaum, Morales, Serrato, and Zidar (2015) and others. The study by Bryan and Morten (2015) is perhaps the closest in this vein to ours: like us, they use a migration model to decompose regional wage differences into various fundamentals, including selection, migration costs and amenities. In addition, they also consider agglomeration economies and measure changes over time in fundamentals, which our study does not, while their study does not include the role of risk, as we do.[1] Our work is also related to the

[1]Of course, the role of risk in explaining urban-rural wage gaps dates back many years to Harris and Todaro (1970), and has been explored since by others such as Fields (1975), who allows for an urban traditional sector, and Rauch (1993), who links the risk of urban underemployment to overall income inequality. None of these studies have had the benefit of experimental data on migration, however, to guide their answers, as we do.

paper by Bazzi, Gaduh, Rothenberg, and Wong (2014), who consider the gains from a large-scale migration policy in Indonesia, and conclude that the gains are smaller than suggested by regional income differences, since many workers have skills that are not easily transferable across locations.

To be sure, several prior studies have used longitudinal data that track rural-urban migration to document the effects of migration on income and consumption. Beegle, De Weerdt, and Dercon (2011) use data from the Kagera province of Tanzania to show that those that migrated from Kagera between 1994 and 2004 experienced much larger consumption increases than those that stayed behind. Of course, these gains are observational, and include both a gain from migration and a selection effect based on unobserved worker characteristics. McKenzie, Gibson, and Stillman (2010) provide an experimental estimate of the gains from *international* migration for Tongan migration-lottery winners that move to New Zealand. Even after controlling for selection, they find large gains from migration, but they conclude that not controlling for selection can lead to seriously over-estimated gains from migrating.

2. Model

This section presents our dynamic model of migration and regional wage gaps. The model generates a positive urban-rural wage gap for three reasons: sorting of heterogenous workers, disutility of migrating from rural to urban areas, and migration risk, which induces workers to forgo migration even though it would raise their income.

2.1. Economic Environment

Preferences and Endowments. Households are infinitely lived and maximize expected discounted utility

$$\mathtt{E}\sum_{t=0}^{\infty}\beta^t u(c_t) \tag{1}$$

where β is the subjective discount factor and $\mathtt{E}$ is the expectation operator. Households have preferences over consumption of the form

$$u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma}. \tag{2}$$

where σ controls the level of risk aversion. Households supply one unit of their labor inelastically with efficiency units that vary across time and across locations as in Roy (1951). Households differ in permanent productivity with z_r and z_u is permanent productivity in the rural and urban area. The vector $z = \{z_r, z_u\}$ is drawn from distribution $G(z)$.

Households also experiences transitory shocks for each location. We define s_r and s_u as being the transitory productivity shocks in the rural and urban area. The vector of shocks $s = \{s_r, s_u\}$ evolve according to a finite state Markov chain with $\mathcal{P}(s'|s)$ being the transition matrix that describes the probability a household transits to state s'.

Production. There is one homogenous good produced in both locations. Locations differ in the technologies they operate. The rural technology features decreasing returns to scale (due to a fixed factor land):

$$Y_r = A_r^i N_r^{\alpha}, \tag{3}$$

where N_r are the effective labor units working in the rural area and A_r^i is rural productivity indexed by season i. Seasonality is modeled with the rural area experiencing deterministic, seasonal fluctuations. Specifically, rural productivity takes two values: $i \in \{g, \ell\}$ with productivity values satisfying $A_r^g > A_r^\ell$, where if current rural productivity is A_r^g, then the economy transits to productivity state A_r^ℓ next period. Superscript g is for "growing" season, and superscript ℓ is for "lean" season. The urban technology is

$$Y_u = A_u N_u \tag{4}$$

where N_u are the effective labor units supplied by households working in the urban area. Notice that N_u and N_r do not sum to one, due to the Roy assumptions on individual productivity, and in general depend on the temporary shock realizations and the entire allocation of workers across sectors.

Wages. In season i, with N_r workers in the rural area, wages per efficiency unit are

$$\omega_r(i, N_r) = \alpha A_r^i N_r^{\alpha-1} \quad \text{and} \quad \omega_u = A_u. \tag{5}$$

Agents working in a particular location receives wages that are the product of (5) and the number of their efficiency units (both in permanent and transitory terms). We denote the labor income a household with with permanent state $z = \{z_r, z_u\}$ and transitory state $s = \{s_r, s_u\}$ receives as for working in location i as:

$$w_r(z, s, i, N_r) = z_r s_r \omega_r(i, N_r) \quad \text{and} \quad w_u(z, s) = z_u s_u \omega_u, \tag{6}$$

which depends on the product of a households permanent and transitory productivity and wages per efficiency unit described in (5).

Location Options. Households have choices about where to locate/reside and work. Households in the rural area have three options. First, they can work in the rural area. Second, they can pay the fixed cost m_T and work in the urban area for one period. This is temporary migration in the model: a one-period working spell in the urban area by a rural resident. Third, the household can pay the fixed cost $m_P > m_T$, and work in urban area for the indefinite future. This is permanent migration: a move that enables the mover to permanently work in the urban area.

Households residing in the urban area have similar options. They can work in the urban area. Or they can pay fixed cost m_p and work in rural area for the indefinite future. This latter option allows for rural to urban and then urban to rural moves as a household's comparative advantage changes over time. The one option that we do not allow for is temporary urban to rural migration.

Migration Risk and Migration Experience. We allow for moving risks and for workers to become experienced, or better suited to migration, after having migrated. Rural households contemplating a move (either temporary or permanent) face "unemployment" risk as in Harris and Todaro (1970). We operationalize these moving risks by assuming that with some probability migrants receive no job in the urban area and are only able to replace their income by some fraction b.

Unemployment risk differs across rural households and depends upon their migration history. Rural households are two types, "inexperienced" or "experienced." If an inexperienced households migrates, its probability of not finding a job is $\lambda < 1$. If an inexperienced migrant is successful, it becomes an experienced migrant. An experienced migrant's probability of not finding a job is $\mu < \lambda$. The lower probability of not finding a job is the sense in which migrants accumulate experience about finding jobs in the urban area and, thus, face high job finding rates.

Finally, experience is not permanent. Each period, these links are destroyed in two ways. First, with probability δ, experienced become inexperienced again. This ensures that there households that only migrate very infrequently, are inexperienced. Second, if an experienced rural household does not find a job, the household becomes inexperienced again.

Permanent rural to urban migrants are different in several ways. First, if they initially end up in the unemployment state, there is a chance they remain in unemployed state next period with probability λ. Permanent movers always have the option to escape this unemployment state and return to the rural area at cost m_P.

Asset Choices. Households can accumulate a non-state contingent asset, a, with gross rate of return, R. Asset holdings are restricted to be non-negative and, thus, there is no borrowing. Second, we assume that R is exogenous.

2.2. Optimization

Before describing the value functions of a household, it is important to have a complete accounting of the state space. The state variables for a household can be divided into things that are permanent, transitory, depend upon past choices, and depend on aggregate effects.

- **Permanent state variables.** Each household is endowed with a vector z of location specific productivity $z = \{z_r, z_u\}$. This is the "static Roy model" component of things.

- **Transitory state variables.** Each household is subject to transitory productivity shocks described by the vector $s = \{s_r, s_u\}$. A household is also subject to "unemployment risk," which leaves her with income b. To conserve on notation, the value functions will indicate b only if a household is in this state.

- **Endogenous state variables.** There are two endogenous state variables. The first is the household's asset holdings, a. The second is a composite variable which describes the household's location and labor market situation, in particular whether the household is experienced at migration and, in the urban area, whether the household is unemployed. For expositional purposes, we'll refer to this second state variable as the household's "location." The possible location states are: rural-inexperienced, r^n, rural-experienced, r^e, urban-employed, u, and urban-unemployed, u^b .

- **Aggregate state variables.** There are two aggregate state variables: the total number of workers (efficiency units) in the rural area, N_r, and the season, $i \in \{g, \ell\}$. These two state variables determine the current and future productivity in the rural area, and the current wage per efficiency units as in equation (5). We combine these two into a vector, which we denote $\omega_r^i \equiv \{i, N_r\}$, for expositional purposes, to highlight that the aggregate state captures the current market price for rural efficiency units.

To summarize, the state of a household is an asset holding, location, permanent shock realization, transitory shock realization and an aggregate state. So for example, $\{a, r^n, z, s, \omega_r^i\}$ is the state vector for an inexperienced worker in a rural area in season i with a wage of $\omega_r(i, N_r)$ per efficiency unit in the rural area. The notation, $\{a, u^b, z, s, \omega_r^i\}$ is the state vector for a worker in the urban area who does not have a job, in season i, with a wage of $\omega_r(i, N_r)$ efficiency units in the rural area.

Below we dedicate attention to the most relevant problems, i.e. that of a rural inexperienced households and that of a rural experienced household. The value functions associated with the urban and urban unemployed are described below, and presented in detail in the Appendix.

Inexperienced Rural Households. An inexperienced household in the rural area solves the following problem:

$$v(a, r^n, z, s, \omega_r^i) = \max\left\{v(a, r^n, z, s, \omega_r^i|\text{ stay}),\ v(a, r^n, z, s, \omega_r^i|\text{ perm}),\ v(a, r^n, z, s, \omega_r^i|\text{ temp})\right\} \tag{7}$$

where a household chooses between staying in the the rural area, temporarily moving, and permanently moving. Conditional on staying in the rural area, the value function is

$$v(a, r^n, z, s, \omega_r^i|\text{ stay}) = \max_{a' \in \mathcal{A}}\left[u(Ra + w_r(z, s, i, N_r) - a') + \beta \sum_{s'} \mathcal{P}(s'|s) v(a', r^n, z, s', \omega_r^{i'})\right]. \tag{8}$$

which says the household chooses asset holding to maximizes current and expected future utility. The asset holding must respect the borrowing constraint and, thus, must lie in the set $\mathcal{A}$. Given asset choices, a household's consumption equals the gross return on current asset holdings Ra plus labor income $w_{ri}(z, s, N_{ri})$ in the rural area minus asset purchases. Next periods expected value function is (7) evaluated with the new asset holdings, the next season, and integrating over the different possible transitory shocks.

Conditional on a permanent move, the value function is:

$$v(a, r^n, z, s, \omega_r^i|\text{ perm}) = \max_{a' \in \mathcal{A}}\Bigg[u(Ra + w_r(z, s, i, N_r) - a' - m_P) + \tag{9}$$
$$\beta(1-\lambda)\sum_{s'} \mathcal{P}(s'|s) v(a', u, z, s', \omega_r^{i'}) + \beta\lambda \sum_{s'} \mathcal{P}(s'|s) v(a', u^b, z, s', \omega^{i'})\Bigg].$$

While similar to the staying value function, there are several points of difference. First, the agent must pay m_p to make the permanent move and this costs resources. Second, continuation value functions denote the household's location changes from the rural area to the urban area. Third, there is moving risk. Because this household is inexperienced, with probability $1 - \lambda$ the household finds work in the urban area; with probability λ it is unemployed.

The value function of a temporary move is the expected value of a successful temporary move and an unsuccessful temporary move. The value function associated with a successful temporary move is:

$$v(a, r^n, z, s, \omega_r^i|\text{ temp, emp}) = \max_{a' \in \mathcal{A}}\Bigg[u(Ra + w_u(z, s) - a' - m_T) +$$
$$\beta \sum_{s'} \mathcal{P}(s'|s) v(a', r^e, z, s', \hat{w}_{i'})\Bigg]. \tag{10}$$

The key things to notice about a the temporary move are that it imposes a resource cost of

m_T and the rural household receives labor income $w_u(z,s)$ from the urban area. Finally, the continuation value reflects the change from inexperienced to experienced. Thus, subsequent moves by this household now experience lower moving risks.

The value function associated with an unsuccessful temporary move is

$$v(a, r^n, z, s, \omega_r^{i'} | \text{ temp, unemp}) = \max_{a' \in \mathcal{A}} \Big[u(Ra + b - a' - m_T) + \beta \sum_{s'} \mathcal{P}(s'|s) v(a', r^n, z, s', \omega_r^{i'}) \Big]. \quad (11)$$

Here the household pays the moving cost m_T, but is unable to find work and, thus, receives fraction b of its rural labor income. The next period the household is still an inexperienced rural household. Combining (10) and (11) gives the expected value of a temporary move

$$v(a, r^n, z, s, \omega_r^i | \text{ temp}) = (1-\lambda) v(a, r^n, z, s, \omega_r^i | \text{ temp, emp}) + \lambda v(a, r^n, z, s, \omega_r^i | \text{ temp, unemp}). \quad (12)$$

The value function of a household in the rural area is then the max over his different location choices: state given in (8), permanently move to the urban area given in (9), or temporarily move given in (12).

Experienced Rural Households. An experienced household in the rural area solves the same basic problem as inexperienced households as in (7). That is they chose between staying, permanently moving, and temporarily moving. Conditional on staying in the rural area, an experienced household's value function is:

$$v(a, r^e, z, s, \omega_r^i | \text{ stay}) = \max_{a' \in \mathcal{A}} \Big[u(Ra + w_r(z, s, i, N_r) - a') + (1-\delta)\beta \sum_{s'} \mathcal{P}(s'|s) v(a', r^e, z, s', \omega_r^{i'}) + \delta\beta \sum_{s'} \mathcal{P}(s'|s) v(a', r^n, z, s', \omega_r^{i'}) \Big], \quad (13)$$

similar to the the inexperienced household's in (8). The difference is that experienced households have a lower probability of unemployment after migration, of either a temporary or permanent nature. Specifically, their unemployment probability is μ which is less than the λ probability for inexperienced migrants.

The value function for permanent migration for these experienced households is the similar to (9), only with μ replacing λ. For temporary migration, their value function is again the probability weighted average of a successful temporary move and an unsuccessful temporary move. An unsuccessful temporary move results in unemployment and leaves the worker inexperienced again. This is meant to capture the loss of a network or connections at the destination.

Urban Households. Urban households can choose to stay in the urban area or (permanently) migrate to the rural area. Urban can be in one of two states: employed and unemployed. Urban employed workers uncertainty only from their temporary shocks s. If they choose to migrate to the rural area, they pay the permanent moving cost m_P and become experienced rural households. Urban unemployed workers that stay in the urban area face a probability λ of staying unemployed, and a probability $1 - \lambda$ of becoming employed. While unemployed, they receive a fraction b of the wage for their effective labor input.

2.3. Illustration of How the Model Works

To give a sense about how this model works and the key issues, this section talks through the lives of different types of agents and the choices that they make. The results below come from sample paths from the stationary distribution associated with our calibrated model.

First, consider the temporary migration decision. Given permanent type $z = \{z_r, z_u\}$, policy functions for temporary migration take the form of thresholds in: a household's transitory comparative advantage s_r vs. s_u, the season, and an agents asset holdings. To see how these different thresholds fit together, below we walk through some sample time paths for different types of agents.

Figure 2(a) plots sample time paths for an agent who has a very strong permeant comparative advantage in the rural area. The left-axis and blue line repots this agents total comparative advantage. That is the log of the ratio of wages that this agent can earn in the urban area relative to the rural area. When this value floats above zero, this indicates that the agent could earn more in the urban area realative to the rural area. The right-axis and orange line repots the location.

A couple of things to notice. First, most the time the agents comparative advantage lies below zero. This is because we are looking at some one who has a strong permanent comparative advantage in the rural area, so we should expect it to lie below zero. Second, an agents comparative advantage features a "jagged-teeth" like pattern. This is seasonality. When the rural area experiences a lean season, wages drop in the rural area and hence and agents comparative advantage in the urban area spikes. Finally, this guy only temporarily migrated to the urban once in period 15 which also corresponds with the time in which his comparative advantage in the urban area was high enough to make this move worth it.

Figure 2(b) plots sample for an agent who has no strong permanent comparative in rural or urban area. Again, to orientate yourself, note that most the time the agents comparative advantage lies often around zero. This reflects the fact that this agent is often on the margin between earning more in the rural area or urban area. This agent often temporarily migrates a lot and almost exclusively in the lean season.

One interesting episode in this agents life is a comparison between period 25 and period 39. In these two periods, the agent had the same exact comparative advantage. Yet in period 39 the agent migrated and in 25 he did not. Why? In period 25, this agent did not have a sufficient amount of assets to insure against the risks associated with that move. To see this Figure plots the asset holdings of this agent. Going into period 25, this agent had a sequence of unfavorable income shocks and had very few assets. In contrast, in period 39, this agent had a sufficient amount of assets to pay for the cost of a temporary move and allow for a buffer against a possible bad outcome associated with the move.

Figure also highlights the importance of temporary migration as a income smoothing device. In particular, note in Figure in the time periods 5-12, this agent is able to smooth his income and avoid seasonal fluctuations; this in turn allows the agent to better smooth consumption and accumulate assets.

3. Parameterizing the Model

Before we delve into details, discuss two broad sources of information that we use to discipline the model. The first is the controlled migration experiment of Bryan, Chowdhury, and Mobarak (2014), which we replicate on the agents of the model. The second is a new survey we conducted on migration decisions when facing hypothetical migration opportunities. We then discuss how we use this information to parameterize the model.

3.1. Parameterization: Pre-Assigned Parameters

Pre-assign some parameters, e.g. time period, discount factor, risk aversion, real interest rate.

Remaining parameters picked to match data and model moments. Specifically, aggregate moments: Wage gap, fraction of rural residents, cross-sectional variance in income in each location, seasonal gap. Then micro moments: Perform the Bryan, Chowdhury, Mobarak (BCM) (2014) field experiment in the model.

We begin by parameterizing the Talent Distribution and Transitory Shocks

Permanent talent distribution

$$\log z_r = 0, \text{ and } \log z_u \sim \mathcal{N}(0, \sigma_{zu}) \tag{14}$$

Note that. One-sided selection in permanent types. Why? Old calibration typically pushed us there. The transitory shocks (in logs) follow independent, AR(1) process

$$\log s_{\ell,t+1} = \rho \log s_{\ell,t} + \epsilon_{\ell,t+1} \quad \text{with} \quad \epsilon_{\ell,t+1} \sim \mathcal{N}(0, \sigma_{s\ell}). \tag{15}$$

3.2. Performing the Bryan, Chowdhury, Mobarak (2014) Experiment in Model

Randomly sample rural households in the stationary distribution. Assign half to a control group. The other half to treatment. Treatment group offered m_T, if they move. Solve for optimal policies, treating this offer as one-time, unanticipated, with no general equilibrium effects. Compute take up of offer. Compare with control group.

4. Quantitative Analysis of Model

TO BE COMPLETED

5. Conclusions and Future Work

TO BE COMPLETED

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Tables and Figures

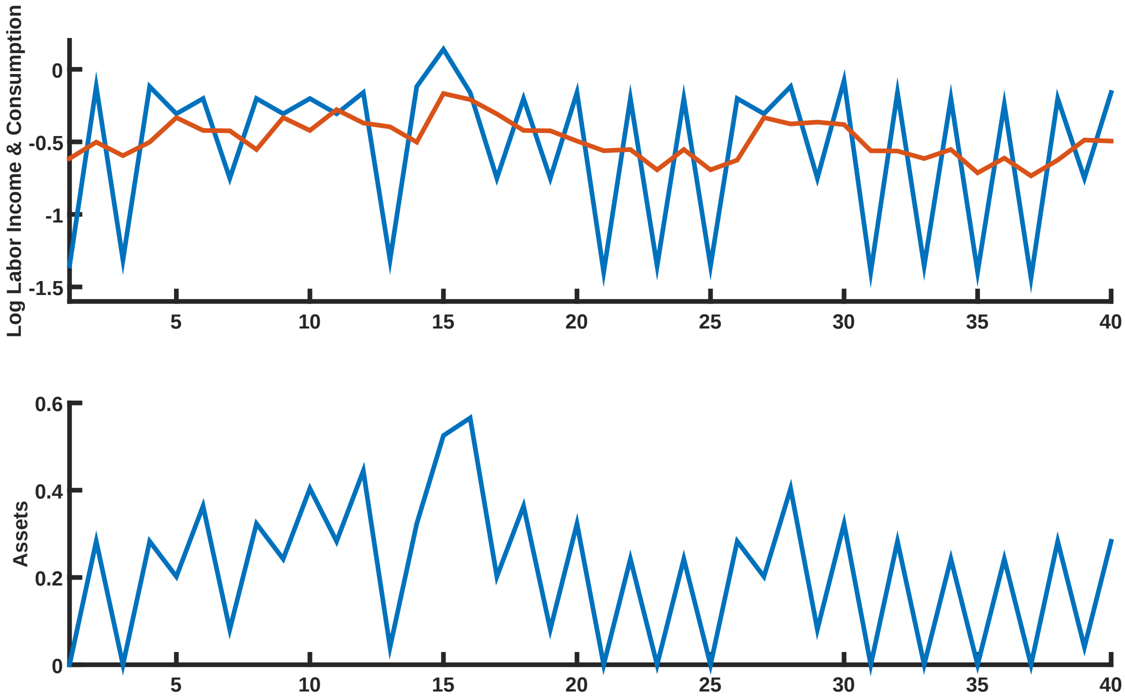
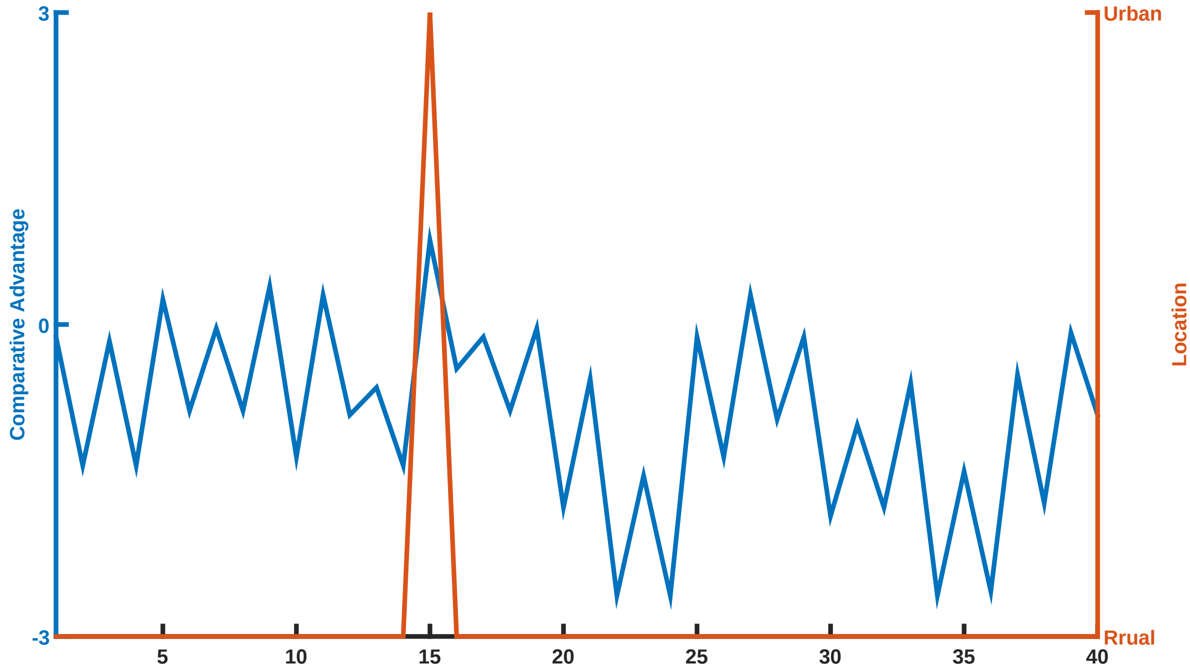
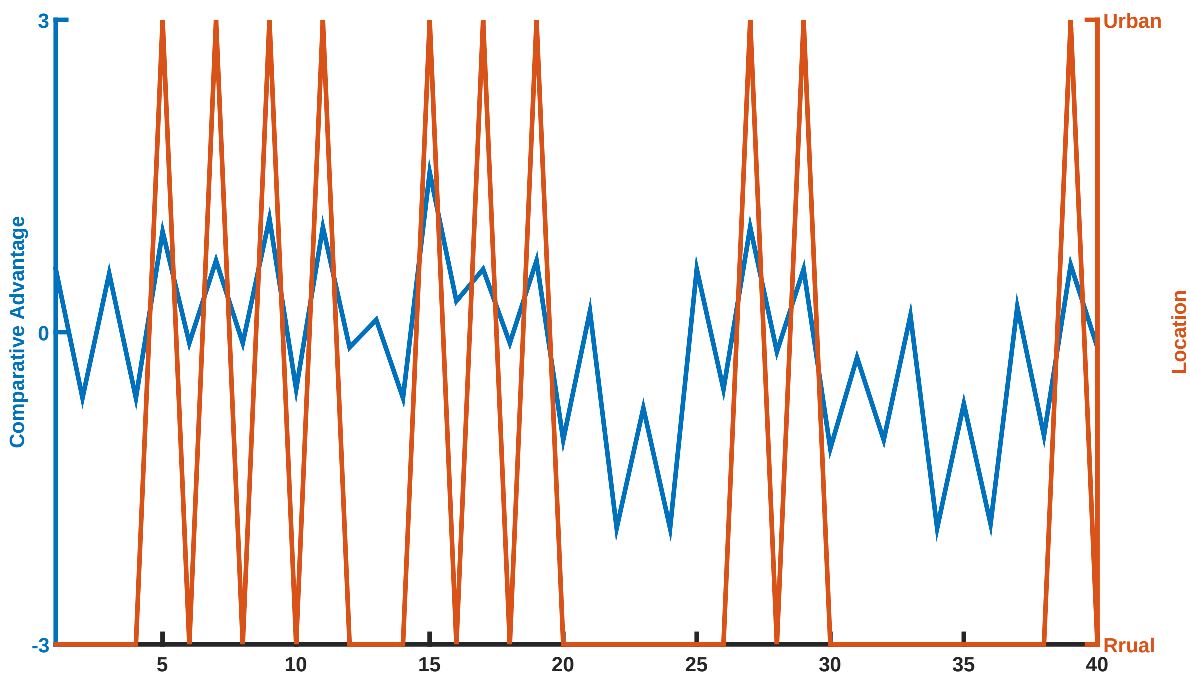


Figure 1: Sample Path for Income, Consumption and Assets



(a) Worker with Strong Permanent Comparative Advantage in Rural Area



(b) Worker No Strong Permanent Comparative Advantage

Figure 2: Sample Path for Temporary Migration Choices

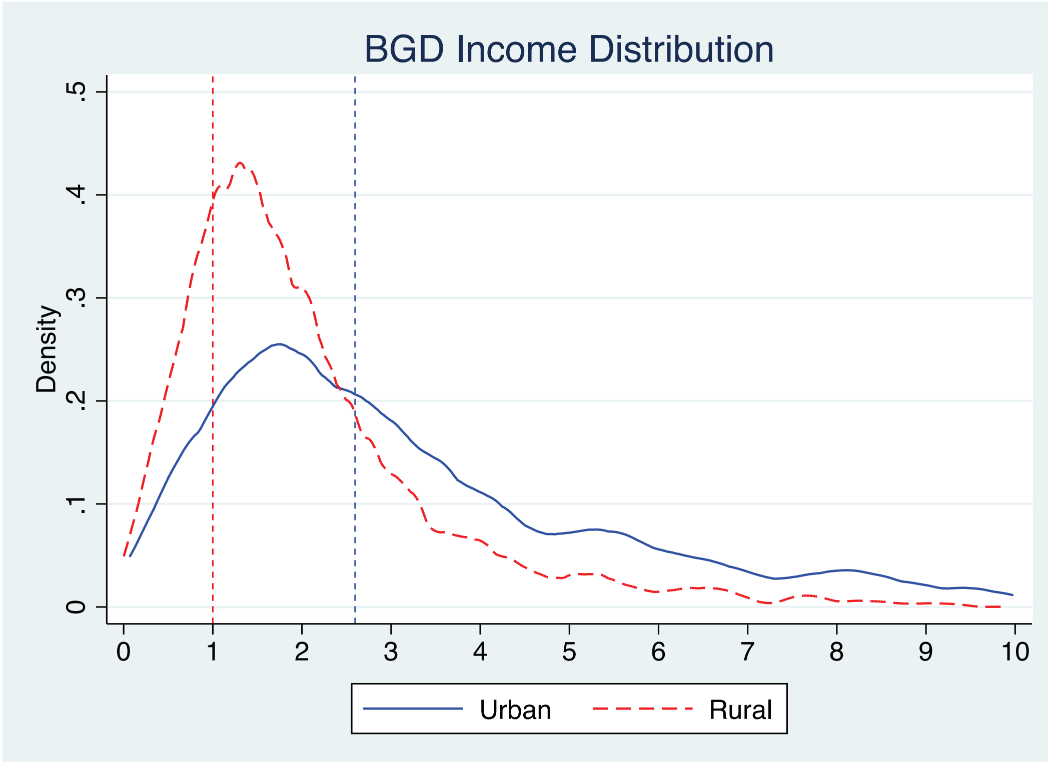


Figure 3: Wage Distribution in Bangladesh by Area

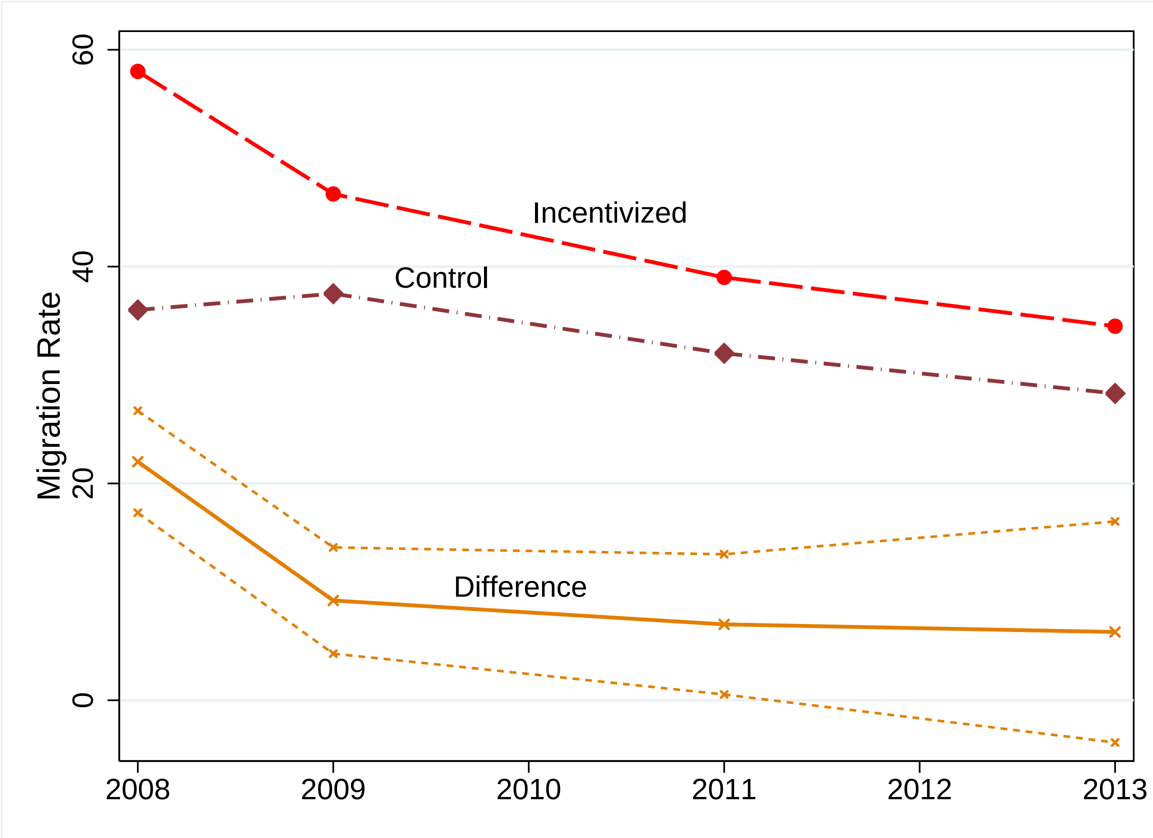


Figure 4: Migration Rates: Five Years Since 2008 Experiment

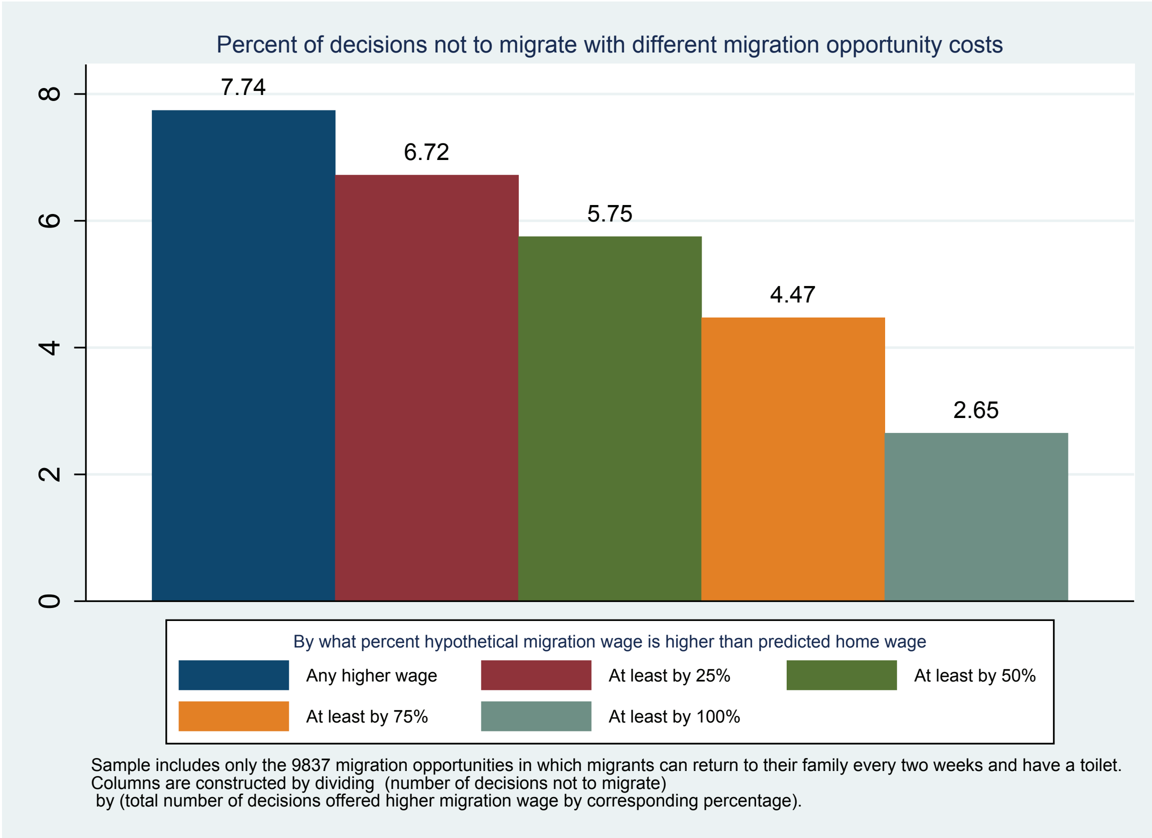


Figure 5: Percent Deciding Not to Migrate, High Amenities, by Expected Wage

Table 1: Pre-Assigned Parameters

Parameter	Value	Source
Time period	Half year	BCM (2014)
Risk aversion, γ	1.0	—
Discount factor, β	0.90	—
Median rural productivity	1.0	—
Gross real interest rate, R	1.0	—
Returns to scale in rural area, α	0.82	Herrendorf and Valentinyi (2008)
Temporary moving costs, m_T	10 % of rural income	BCM (2014)
Permanent moving costs, m_p	$2 \times m_T$	—

Table 2: Moments in Data and Model

Moments	Data	Model
Urban-Rural wage gap	2.62	2.62
Percent in rural	63	62
Variance of log income in rural	0.43	0.37
Variance of log income in urban	0.68	0.68
Rural high-low season income gap	2.00	2.00
Percent of temporary migrants in control	38	36
Percent of temporary migrants in treatment	58	54
Ratio of income in control to treatment	1.20	1.20
Percent of rural households with no liquid assets	47	34

Appendix (for Online Publication)

A. Model Appendix

In this section, we spell out all the value functions that were described in the text but not specified completely.

Experienced rural households. Recall that experienced rural households are those that have had recently migrated successfully. These households can choose to stay in the rural area, migrate permanently or migrate temporarily. The value function associated with permanent migration is:

$$v(a, r^e, z, s, \omega_r^i | \text{ perm}) = \max_{a' \in \mathcal{A}} \Big[u(Ra + w_{ri}(z, s, N_{ri}) - a' - m_p) + \beta(1-\mu) \sum_{s'} \mathcal{P}(s'|s) v(a', u, z, s', \omega_r^{i'}) + \beta\mu \sum_{s'} \mathcal{P}(s'|s) v(a', u^b, z, s', \omega_r^{i'}) \Big]. \tag{16}$$

Relative to the same value function for inexperienced households, (16), the experienced household has the lower unemployment probability μ replacing the higher value of λ present in (16).

The value function associated with a temporary move is the probability-weighted average of the value of a successful temporary move and an unsuccessful temporary move. This is similar to the inexperienced households, only with a lower probability of unsuccessful migration. The value function associated with a successful temporary move is:

$$v(a, r^e, z, s, \omega_r^i | \text{ temp, emp}) = \max_{a' \in \mathcal{A}} \Big[u(Ra + w_u(z, s) - a' - m_T) + \beta \sum_{s'} \mathcal{P}(s'|s) v(a', r^e, z, s', \omega_r^{i'}) \Big], \tag{17}$$

and the value function associated with an unsuccessful temporary move is:

$$v(a, r^e, z, s, \omega_r^{i'} | \text{ temp, unemp}) = \max_{a' \in \mathcal{A}} \Big[u(Ra + b w_{ri}(z, s, N_{ri}) - a' - m_T) + \beta \sum_{s'} \mathcal{P}(s'|s) v(a', r^n, z, s', \omega_r^{i'}) \Big]. \tag{18}$$

Note that here an unsuccessful move results in a loss of connection becomes inexperienced again. Combining (17) and (18) gives the expected value of a temporary move

$$v(a, r^e, z, s, \omega_r^i | \text{ temp}) = (1-\mu) v(a, r^e, z, s, \omega_r^i | \text{ temp, emp}) + \mu v(a, r^e, z, s, \omega_r^i | \text{ temp, unemp}). \tag{19}$$

Urban households. Urban households can choose to stay where they are or (permanently) move to the rural area. Urban households can either be employed or unemployed. For employed urban households, their value function is:

$$v(a,u,z,s,\omega_r^i) = \max \Big\{ v(a,u,z,s,\omega_r^i|\text{ stay}),\ v(a,u,z,s,\omega_r^i|\text{ move}) \Big\}. \tag{20}$$

Conditional on staying in the urban area, their value is:

$$v(a,u,z,s,\omega_r^i|\text{ stay}) = \max_{a'\in\mathcal{A}} \left[u(Ra + w_u(z,s) - a') + \beta \sum_{s'} \mathcal{P}(s'|s) v(a',u,z,s',\omega_r^{i'}) \right], \tag{21}$$

and conditional on moving to the rural area, their value is:

$$v(a,u,z,s,\omega_r^i|\text{ move}) = \max_{a'\in\mathcal{A}} \left[u(Ra + w_u(z,s) - a' - m_p) + \beta \sum_{s'} \mathcal{P}(s'|s) v(a',r^e,z,s',\omega_r^{i'}) \right]. \tag{22}$$

In both cases, the uncertainty they face comes through temporary shocks, s, rather than "unemployment," which is about the risk of rural-urban migration. Also note that these households become experienced households in the rural area if they choose to migrate.

For unemployed urban households, their value function is:

$$v(a,u^b,z,s,\omega_r^i) = \max \Big\{ v(a,u^b,z,s,\omega_r^i|\text{ stay}),\ v(a,u^b,z,s,\omega_r^i|\text{ move}) \Big\}, \tag{23}$$

which is a choice between staying and waiting for employment or returning to the rural area. Conditional on staying in the urban area, their value is:

$$\begin{aligned} v(a,u^b,z,s,\omega_r^i|\text{ stay}) = \max_{a'\in\mathcal{A}} \Bigg[& u(Ra + bw_u(z,s) - a') + \beta(1-\lambda) \sum_{s'} \mathcal{P}(s'|s) v(a',u^b,z,s',\omega_r^{i'}) \\ & + \beta\lambda v(a',u,z,s,\hat{w}_{i'}) \Bigg]. \end{aligned} \tag{24}$$

where with probability λ they become employed. If they decided to move back, the value is:

$$v(a,u^b,z,s,\omega_r^i|\text{ move}) = \max_{a'\in\mathcal{A}} \left[u(Ra + b - a' - m_p) + \beta \sum_{s'} \mathcal{P}(s'|s) v(a',r^n,z,s',\omega_r^{i'}) \right]. \tag{25}$$

Note that these workers become inexperienced in the rural area.

B. Surveys of Hypothetical Migration Outcomes

This section provides more detail about the surveys of hypothetical migration outcomes we conducted. Figure B.1 provides one sample migration opportunity that was presented to some subset of survey respondents.

S.1.C.2

Given the attributes below, which option do you choose?
Please evaluate each new pair of migration options independent of the ones you saw earlier.

	Choice #1: Migration	**Choice #2: Migration**	**Choice #3: No Migration**
Chance of Employment	33%	33%	N/A
Daily Wage (Taka)	270	340	Wage at Home in November
Latrine Facility during Migration	Pucca Latrine in Residence	Walk to Open Defecate or Public Pay Toilet	N/A
Family Contact	See Family Every Month	See Family Every 2 Month	N/A
s16bq2_1 Your Choice *(Tick Single Box)*	☐	☐	☐

Figure B.1: Sample Migration Opportunity