Econometrica Supplementary Material

SUPPLEMENT TO "UNDERINVESTMENT IN A PROFITABLE TECHNOLOGY: THE CASE OF SEASONAL MIGRATION IN BANGLADESH"

(*Econometrica*, Vol. 82, No. 5, September 2014, 1671–1748)

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APPENDIX E: RISK AVERSION, INSURANCE, AND BASIS RISK

THIS APPENDIX PROVIDES a simple model of basis risk based on Clarke (2011) and uses it to argue that our 2011 insurance experiment can be used to test whether migration is risky and migrants are risk averse.[1]

There are two payoff-relevant states $\{L, H\}$ which lead to income at the destination $y_L \leq y_H$. We assume $\text{pr}(H) = \pi_y$. There are two rainfall states $\{R_L, R_H\}$ and rainfall insurance makes a payment of p in state R_H and costs c in state R_L. We denote $\text{pr}(R_L) = \pi_R$. This setup leads to four possible states of the world: $\{LR_L, LR_H, HR_L, HR_H\}$. Following Clarke, we parameterize basis risk with a variable $r = \text{pr}(LR_L)$—that is, the probability that income is low but that the insurance contract does not pay out and is in fact costly.[2] This implies that the remaining probabilities are

$$\big\{\text{pr}(LR_H) = 1 - \pi_R - r; \text{pr}(HR_L) = \pi_R - r; \\ \text{pr}(HR_H) = \pi_y - \pi_R + r\big\}.$$

We assume that r depends on the characteristics of the migrator. In particular, we assume:

1. basis risk is larger for farmers than for non-farmers: $r_F > r_{NF}$; and
2. basis risk is smaller for those that are more likely to migrate to Bogra: $r^B < r^{NB}$.

We make the first assumption because the insurance contract pays in a high rain situation. High rain is likely to reduce income of day laborers who work, for example, pulling rickshaws. For agricultural laborers, however, high rain is potentially advantageous, as it is likely to increase work. We make the second assumption because the rainfall data are collected in Bogra and will be less accurate in other destinations. This leads to the possibility that we record high rainfall, but there is in fact low rainfall in, for example, Dhaka. We make no assumption about the relative basis risk for those that are farmers going to Bogra versus non-farmers that are not going to Bogra.

We are interested in deriving the relative impact of the provision of insurance on the migration rate. To do so, we suppose that potential migrators all

[1] See also Bryan (2012) for an application of the model presented here.

[2] Recall that our insurance project pays out in the high rainfall state.

 DOI: 10.3982/ECTA10489

face the same (expected) income given migration (i.e., there is no heterogeneity in the migration process except for r), but that potential migrators are heterogeneous with respect to their returns to remaining at home.[3] In particular, we assume that the expected utility of remaining at home is migrator specific and given by h_i, which we assume to be distributed according to F.

Given these assumptions, the portion of potential migrators that migrate without insurance is given by

$$F\big(\pi_y u(y_h) + (1-\pi_y)u(y_L)\big),$$

and with insurance by

$$F\big(ru(y_L - c) + (1-\pi_R - r)u(y_L + p) + (\pi_R - r)u(y_H - c) + (\pi_y - \pi_R + r)u(y_H + p)\big).$$

If F does not depend on the type of migrator except, perhaps, through purely horizontal shifts, then the change in the probability of migration (or, equivalently, the portion of the population migrating) is proportional to

$$\big(ru(y_L - c) + (1-\pi_R - r)u(y_L + p) + (\pi_R - r)u(y_H - c) + (\pi_y - \pi_R + r)u(y_H + p)\big) - \big(\pi_y u(y_H) + (1-\pi_y)u(y_L)\big). \tag{1}$$

Given this setup, we say that migration is risky if $y_H > y_L$. The model implies the following.

PROPOSITION 1—Basis Risk Is Only Relevant if Migration Is Risky: *The portion of people induced to migrate by insurance is decreasing in r if and only if migration is risky and migrators are risk averse.*

PROOF: The "only if" follows because r drops out of (1) when migration is not risky. The "if" follows because an increase in r is a mean-preserving spread, so the left-hand side of (1) must be decreasing in r so long as migrators are risk averse. *Q.E.D.*

This proposition, combined with our assumptions on r, leads to the following joint test:

HYPOTHESIS 1—Basis Risk Implies Migration Is Risky: *If migration is risky, then rainfall insurance will increase migration rates more for those that are migrating to Bogra and more for non-farmers.*

[3] This is easily generalized and our regressions presented in the main text allow for differences in the return to migration for farmers, non-farmers, and those that are going to Bogra.

The nature of this hypothesis is that, if the model of basis risk is correct, and our assumptions about the relative amounts of basis risk are correct, then we can infer that migration itself is risky from the results of our insurance experiment. In our empirical implementation, we argue that we have plausibly exogenous variation in the propensity to migrate to Bogra. We can also split the sample into farmers and non-farmers, but we see this comparison as more speculative, as it is less plausible to argue that the difference is exogenous.

APPENDIX F: CALIBRATION APPENDIX

In this appendix, we explore two additional versions of our calibrated model. The results help to understand why the model cannot match the experimental results.

First, we consider a completely static model, where households do not save for migration and do not consider the benefits of ongoing migration when they make their initial migration choice; that is, they are myopic past the current migration period. Appendix Figure A.6 shows results for this static model: the Panel A shows the portion of migrants that would be induced assuming no repeat migration and the Panel B shows the number of induceable migrants as a function of the time period. Consider first the Panel A. The model predicts that with a risk aversion level of $\sigma \approx 1.15$, the incentive would induce about 20% of households to migrate—consistent with our experimental findings. Further, the cash and credit incentives have the same effect, again consistent with our experimental findings. However, the UCT and incentive treatments have similar effects for low levels of risk aversion, and this is not consistent with our results.

The Panel B shows that we need to assume a slightly higher risk aversion level to rationalize the data if we account for repeat migration. With a risk aversion level of about 1.65, 40% of the population is induceable after 8 seasons (or 4 years), which corresponds to a 20% treatment effect if the model applies to the poorest half of the sample. If we allow 10 prior years of migration activity, the model suggests that $\sigma \approx 1.7$ would be required to rationalize our treatment effect.[4]

For our second calibration, we continue to assume that there is no savings, but allow households to be forward-looking. This has a strong impact on the propensity to migrate. The Panel A of Appendix Figure A.7 shows the results for the fraction of households induced to migrate by different treatments. Comparing this figure to the Panel A of Appendix Figure A.6 shows that, for low levels of risk aversion, our incentive is actually better at inducing migration when we account for forward-looking behavior. This is because, without

[4]This result is very sensitive to the assumption about the distribution of background risk. If we have underestimated the background risk, then greater risk aversion would be needed to rationalize the data.

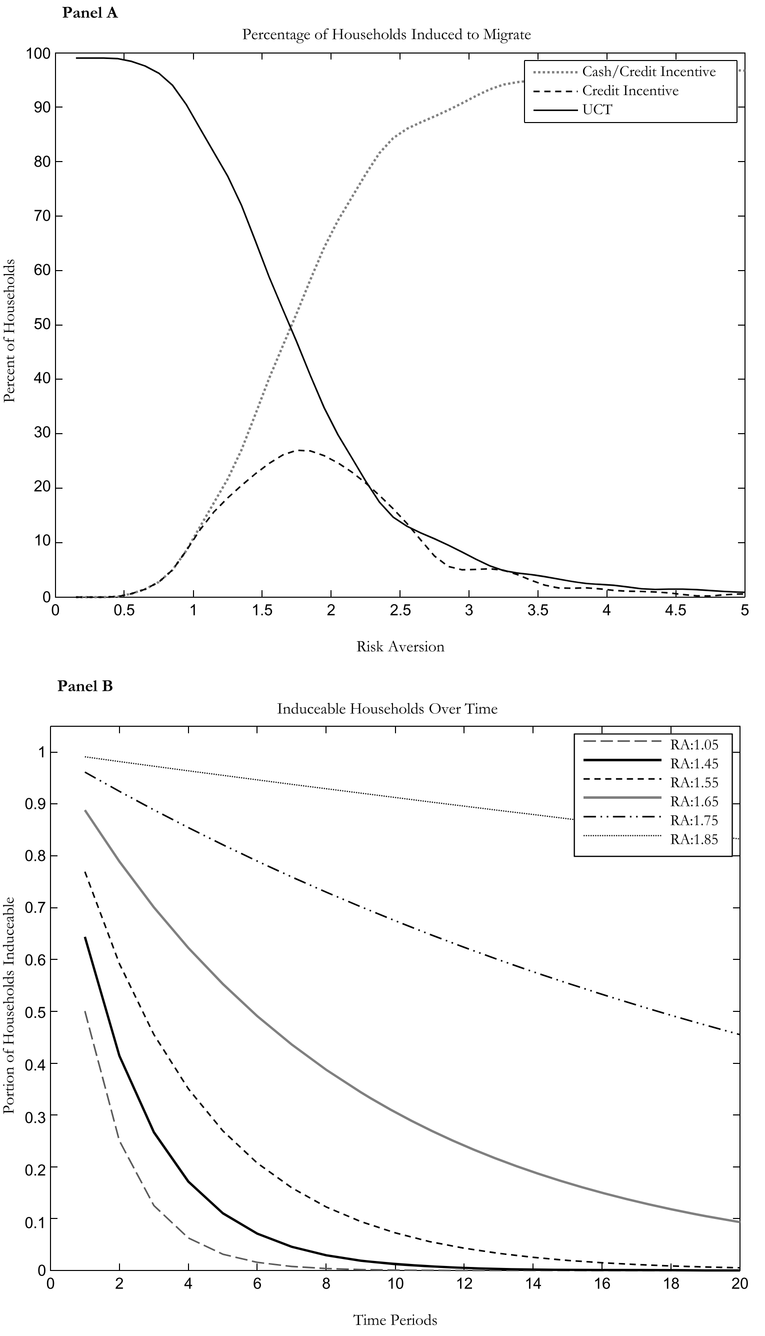

FIGURE A.6.—Static model with myopic agents.

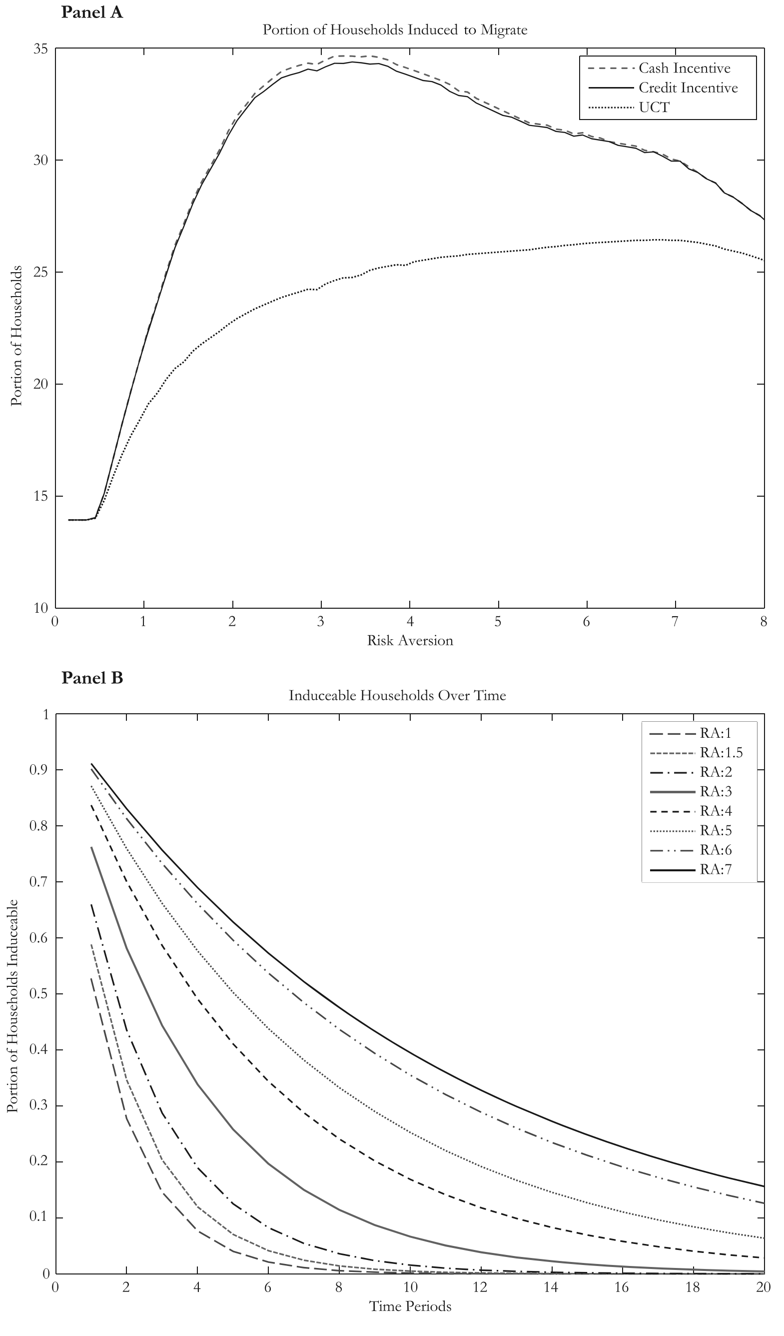

FIGURE A.7.—Forward-looking agents, but no savings.

the repeat migration effect, our incentive does not induce all households to migrate. At higher levels of risk aversion, this difference is no longer relevant and the repeat migration incentive leads to higher levels of baseline migration and a smaller impact of our incentive. The hump shape occurs because, as risk aversion increases, the value of migration as a risk mitigation activity increases. The figure shows that, at some point, this effect dominates the other impact of risk aversion, which is to make experimenting with migration less tolerable. The figure suggests that a risk aversion level of 1 is required to rationalize the data if we do not consider the repeat migration effect.

The Panel B of Appendix Figure A.7 shows the fraction of induceable migrants when households are forward-looking, but cannot save up. The hump in the portion of induced migrants in the Panel A implies that we need not consider risk aversion levels above about 7—as σ increases past this point, risk aversion in fact reduces the propensity to migrate.[5] After 4 years, 40% of the sample will be induceable if risk aversion is as high as 5. If we consider longer time horizons, such as 10 years, then the figure implies that no level of risk aversion is high enough to allow for a large number of induceable migrants.

The results in Appendix Figure A.7 may, however, overestimate the importance of migration. Because we do not allow savings, households are unable to buffer, and the value of migration as a risk mitigation strategy is increased. Figure 6 shows the results for the full model, where we allow both for buffer stock savings, and for the agent to save up for migration. The Panel A confirms the intuition that savings reduces the value of migration. The Panel B, however, shows that the ability to save up dominates: once we allow for savings, we would need a risk aversion of 11.5 to replicate our treatment effects allowing 4 years of migration activity, and if we allow 10 years of migration activity, even a risk aversion level of 20 is insufficient to rationalize the results.[6]

APPENDIX G: EXTENSIONS APPENDIX

This appendix provides additional details on alternative explanations that we have considered.

[5]The hump in the Panel A is based on the empirical distribution of consumption levels. For the simulations shown in the Panel B, we make use of our assumed distribution which leads to a maximal effect of the incentive at a risk aversion level of 7.

[6]These results assume that households begin time with no assets and the lowest possible income shock. We use the model to generate policy functions as well as cutoff values. We then simulate the model for 10,000 households and ask what portion of those 10,000 households have not migrated after t periods. Another way to summarize the results is to say that the distribution of cash on hand implied by the model is insufficiently close to subsistence to support the experimental results.

G.1. *Alternative Specifications of the Returns to Migration*

It seems clear that the migration process is risky, and m is likely stochastic even for good migrators. To assess the importance of this possibility, we resimulated the model with the assumption that m was normally distributed around the mean of 550, with a standard deviation of 100. This additional risk does not appreciably alter the results presented in Figure 6.

We also explored a slightly different model, in which migration truncates the distribution of income below, rather than adding to it. We draw on Figure 3 to assume that migration truncates the distribution at around 1100 Taka per household member per month. This model does not perform very differently from our baseline model: it explains the data better if we ignore savings, but once savings is accounted for, the results are similar.

G.2. *Lowering the Discount Factor*

Lowering the discount factor decreases both the willingness to save up for migration, and the extent to which future migration outcomes affect the current choice to migrate. Appendix Figure A.8 shows the set of induceable migrants using the full model and setting $\delta = 0.8$. The figure shows that if we are willing to assume a risk aversion level of about 7, we can rationalize the data

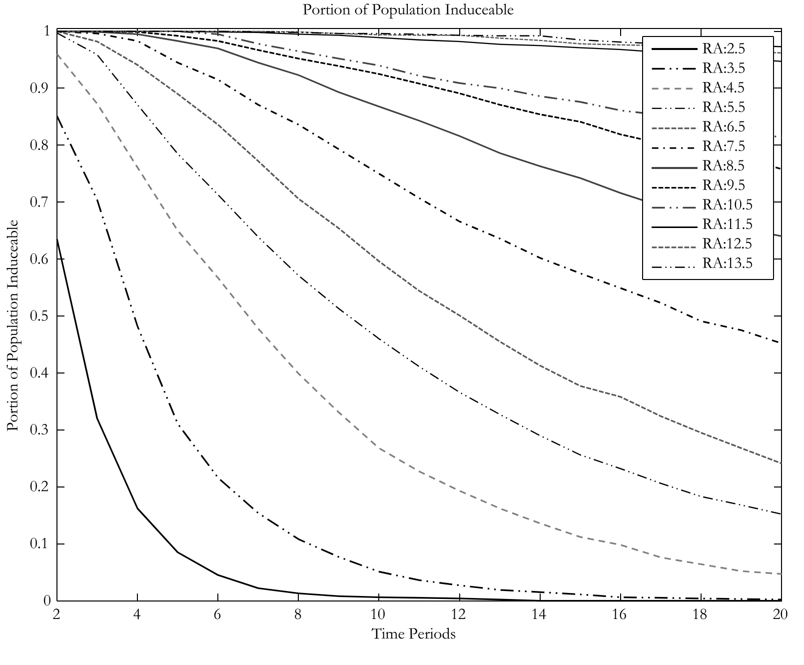

FIGURE A.8.—A higher discount rate.

even with a time horizon of 10 years. Lowering the discount factor even more would allow us to match the experimental results for any level of risk aversion. A similar effect can be achieved if we allow for depreciation in the status of being a good migrator due, for example, to random breakdowns of connections at the destination. However, if we bound the depreciation rate to allow for the small drop in migration rates that we observe between 2008 and 2011, it is still the case that very high levels of risk aversion are required to rationalize the data.

G.3. *Disutility From Migration*

Seasonal migration is probably a somewhat unpleasant experience, because it requires migrants to be separated from family, and share more congested space with other men in cities, often in or around slums with poor access to public services. If this utility cost of migration (not captured in our consumption and earnings data) is high enough, it could explain the initial reluctance to migrate. To assess this possibility, we asked 1600 households in our sample a stated preference question in 2011: "Would you prefer to stay at home and earn 70 Taka per day, or to migrate and earn $\times$ Taka." We asked for $x \in \{90, 110, 130, 150\}$, and the fraction of respondents who stated they were willing to migrate were $\{58, 77, 83, 91\}$, respectively. Their responses imply that for every Taka increase in earnings per day at the destination, migration probability increases by 0.5 percentage points. Extrapolating, the respondents would have to be compensated Tk. 15,000 to induce them to migrate for 75 days (which is the average length of migration).[7] These results suggest quite a high utility cost of migration.[8] To incorporate these figures into our quantitative analysis, we take a very simple approach: we reduce the return to migration to $m/2$—an assumption consistent with 70 Taka at home being worth 140 away, toward the high end of the answers we received. The results do not change drastically in the full model (with savings) under this assumption. Migration continues to be a good way to mitigate risk, and households will want to save up for it.

[7]We also estimate this "demand curve for staying at home" with a revealed preference approach, using the fact that re-migration in 2009 was strongly responsive to migration earnings in 2008. That analysis suggests that re-migration probability increased by 1.7 percentage points for every 1000 Taka increase in migration earnings. Under some mild assumption, this implies that migrants induced by our treatment in 2008 would have to be compensated Tk. 21,700 to induce them to re-migrate in 2009.

[8]Banerjee and Duflo (2007) arrived at a similar conclusion while describing the lives of the poor—"*Why Don't the Poor Migrate for Longer … given that they could easily earn much more by doing so?*" "*The ultimate reason seems to be that making more money is not a … large enough priority to experience several months of living alone and often sleeping on the ground somewhere in or around the work premises*."

G.4. *Heterogeneity*

Heterogeneity does not seem to be a particularly attractive way to accommodate the data. For example, if we imagine that some households have a high m and some a low m, this helps us to rationalize the lack of migration for the low m households, but makes it even more difficult for the high m households.

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Manuscript received December, 2011; final revision received May, 2014.