Understanding permanent migration response to natural disasters: evidence from Indonesia

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Abstract

Migration is one of the key impacts of natural disasters and climate shocks upon societies. This paper investigates how climate shocks and natural disasters shape migration choices in developing countries. We focus on the role of skill transferability at destination in facilitating permanent migration and investigate whether this mechanism is reinforced or weakened in the presence of a natural disaster. We show that in the case of slow-onset shocks such as a drought, migration closely resembles the type of investment migration aimed at improving future economic circumstances. In the case of rapid-onset shocks such as an earthquake, migrants instead choose destinations that are less suitable to their skill set. Policy effort in the wake of sudden natural disasters should, therefore, be devoted to re-training programmes at destination and to support the development of transferable skills.

Keywords: migration, skill matching, natural disasters, climate shocks, Indonesia

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1 Introduction

Migration is one of the key impacts of natural disasters and climate shocks upon societies. Understanding the nature and the amplitude of disaster-induced migration movements is, therefore, crucial to inform policy interventions in affected areas and in the receiving regions. Weather patterns and natural disasters can cause large-scale destruction of assets and livelihoods with a strong impact on

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the well-being of households (e.g., Dercon (2004), Clarke and Hill (2013)). Under such circumstances, the permanent reallocation of people from affected areas may be a promising way of responding to climate shocks and natural disasters but the implications for those that choose to migrate and their receiving counterparts require careful consideration. It is, therefore important to identify the factors affecting the spatial relocation of people in the aftermath of natural disasters and understand how their functioning might be altered to devise suitable policy instruments. We focus our analysis on Indonesia that is characterized by a diverse ethnic population and is highly vulnerable to climate shocks and natural disasters. The Asian-pacific region, in fact, is expected to experience the largest displacement effects due to the compound effect of climate changed induced shocks and non-climate related natural disasters (ADB, 2011).

The objective of this paper is to understand how climate shocks and natural disasters shape migration choices in developing countries. In particular we aim to answer the following questions: will households affected by natural disasters make migration decisions that maximize their future income outcomes? What are the implications for the receiving regions? To answer these questions we focus on permanent migration and revisit some of the crucial socio-economic determinants of migration (known as pull factors). In particular, we consider the role skill transferability at destination in facilitating permanent migration. We investigate whether this mechanism is reinforced or weakened in the presence of a natural disaster and study its joint effects on the quality of migration choices. An additional important contribution of this study is the distinction between slow (e.g. a drought) and rapid (e.g. an earthquake) onset environmental shocks that allows us to gain insights into the differential impact of natural disasters.

This paper adds to the empirical literature in several ways. The current literature on disaster-induced migration (Waldinger, 2015; Feng et al. (2010); Bohra-Mishra et al. (2014)) aims mostly at measuring the extent of migration response to natural disasters. However, little is known about the quality of migration choices which have strong implications for both migrants and receiving regions. This paper aims at addressing this gap by comparing migration choices in the presence and absence of different types of natural disasters. A growing strand of the literature investigates the impact of immigration on the local economy (Strobl and Valfort (2015)). Notably on Indonesia, Bazzi and Wong (2014) highlights the importance of matching migrants skills to destinations in designing resettlement programs in order to maximize the potential gains from migration. Kleemans and Magruder (2014) find that negative rainfall shocks induce migration that decreases employment in the informal sector at destination. An important innovation of this study is the focus on migrant choices with the explicit intention of measuring their ability to choose a suitable destination in the aftermath of an environmental shock and the distinction between the timing of realization of such event. Finally, we also contribute to the broader literature on migration and development (Fafchamps and Shilpi (2013); Kleemans (2014)) by adding some new insights into the functioning of established determinants of migration and by providing some methodological guidance for the use of climate shocks and natural disasters as predictors of

observed migration flows (Boustan et al. (2012); Maystadt et al. (2014)). In particular, we argue that disaster-induced migration differs from conventional migration not only in terms of migrants characteristics, which are often taken into consideration, but also in terms of the quality of their migration choices. In particular, we show that in the case of rapid onset environmental changes, such as earthquakes, migrants tend to choose less suitable destinations. This, therefore, raises additional concerns about their predictive capacity and should be taken into consideration.

To guide the empirical analysis we employ a simple theoretical framework that highlights the role skill transferability in attracting suitable migrants. The setting will be characterized by the presence of weak formal institutions that are compensated by the presence of social trust and local networks (Fafchamps and Minten (2002); Ahlerup et al. (2009)). We will then explore how these mechanisms interact with the occurrence of natural disasters taking into account the difference in intensity and in the timing of realization of the environmental shock. We aim at showing that a slow-onset event allows affected households to make informed decisions and choose better destinations. On the other hand, in the case of rapid-onset shocks migrants are more likely to choose less suitable destinations unless search costs are substantially low.

The key predictions from the model are then be taken to a very rich dataset that combines a panel household survey with a census of Indonesian villages and geocoded data on historical rainfalls and earthquake occurrence. Our main empirical specification aims at identifying the interaction effect between traditional pull factors, i.e. skill and ethnic proximity at destination, with the occurrence of a disaster on a household's decision to migrate. We propose a novel measure of skill transferability at destination by comparing a household main occupation and ethnicity to the available occupations and the majority ethnic group at potential destinations. Potential destinations are defined as those villages within a given distance from the household. We further restrict the pool of potential destinations by excluding villages affected by natural disasters and/or under conflict. We use these restrictions as robustness checks.

Our results show that in the case of a drought, migration closely resembles the type of investment migration aimed at improving future economic circumstances; that is the presence of a greater pool of villages with similar ethnicity and skill-compatible occupations increases the probability of migrating after a drought. In the case of an earthquake, instead, migrants choose destinations that are less suitable, that is the predictive effect of skill transferability on migration is reduced to zero. This is in line with our assumption about the complementarity between personal assets and social trust. Therefore, when assets are destroyed the relative role of social capital is diminished. The results are robust to the use of alternative indicators of disasters based on community surveys, geocoded and weather data, and to the inclusion of a rich set of control variables aimed at excluding potential confounding effects at both origin and potential destinations.

The paper proceeds as follow. Section 2 presents a theoretical model to formalise the role of skill transferability and natural disasters in determining

migration decisions. Section 3 describes the data and the construction of our main explanatory variable. Section 4 presents the empirical framework employed to test our main hypothesis. Finally, section 5 discusses the results and 6 draws some conclusions and policy implications.

2 The model

In this next section we formulate a simple theoretical model to rationalize the migration choices of households in the wake of natural disaster with the aim of exploring possible underlying mechanisms and providing some hypotheses that can be formally empirical tested.

2.1 Setting

In this model economic agents live for two periods ($t = 1, 2$). We analyze the options individuals face when confronted with a negative shock originated from a destructive natural disaster. We distinguish between two opposite types of natural disasters:"slow-onset" disasters, such as drought and "rapid-onset" disaster, such as an earthquakes, which cause immediate loss and destruction (Benson and Clay (2004)). Natural disasters can potentially affect wages (income) of farmers and their assets. Theoretically, we capture the effect of the disasters through variable A^i, $i = d, e$ (the subscript indicates the type of disaster) that can be regarded as intensity of disasters. We assume that $0 \leq A^d < 1$ and $0 \leq A^e < 1$ and the baseline situation assumes the case without disasters with $A^d = A^d = 1$.

The shock occurs in the first period, but how it affects individuals' wealth depends on the type of the shock. Specifically, we assume natural disasters are different along two dimensions: (i) timing of its impact; and (ii) intensity. Slow-onset disasters, like droughts, are assumed to affect wages in the next period, whilst rapid-onset disasters (earthquakes) immediately. Next, slow-onset disasters, for simplicity, are assumed not affect assets, while rapid-onset disasters affect assets. This is stark but simplifying (plausible) assumption that makes mechanisms clearer. There is no uncertainty in the model: individuals are aware which shock is realized in the first period.

Individuals face three possible migration options: (1) not migrating; (2) migrating anywhere; (3) migrating to destinations where either skills or ethnicity is matched (we call this migration to "better" destinations). We assume that migration option (3) requires extra information that need to be gathered on such destinations and thus is associated with costs Δ that need to be paid upfront; this migration thus can happen only in the second period.

2.2 Baseline model

The baseline model considers the situation with no disasters. It identifies key restrictions on the variables of the model to make the implications of the model

consistent with empirical facts pertaining migration decisions as in standard migration literature. Agents are endowed with assets, x; there are two sources of income: labor income and other profits (land profits or profits from enterprises). They earn wage w in origin and w_i in destination i, where $i = 1$ corresponds to migration to first (any random) destination and $i = 2$ - to migration to second destination, with better skills or ethnicity matched. In the second period, individuals earn the same wage income as in the first period, if they choose migration options (1) or (2); otherwise, they earn w_2. They maximize the utility:

$$\log(c_1) + \beta \log(c_2) \tag{1}$$

where β is a subjective discount factor, subject to budget constraint:

$$\begin{aligned} c_2 = (1+r)[w - c_1 + (w_1 - w)I_1^m + (-\Delta)I_2^m] + \\ (w + (w_1 - w)I_1^m) + (w_2 - w)I_2^m) \end{aligned} \tag{2}$$

where I_1^m (I_2^m) are indicator functions. The subscript for indicator function denotes migration destination. The subscript for consumption indicates the period t. We omit the time subscript for other variables. Before to proceed, we solve the maximization problem (1) subject to a generic budget constraint as:

$$c_2 = (1+r)[W - c_1] + y \tag{3}$$

where W is the income earned in the first period, y is income in the second period. The solution of this generic problem is given by the following equations:

$$c_1 = \frac{1}{(1+r)(1+\beta)}\left[(1+r)W + y\right] \tag{4}$$

and

$$c_2 = \frac{\beta}{1+\beta}\left[(1+r)W + y\right] \tag{5}$$

Solution of the maximization problem, described by equations (4) and (5), suggest that in analyzing which migration option leads potentially to highest utility, we need to determine which migration option is associated with highest wealth $(1+r)W + y$.

We assume that:

$$w > w_1 \tag{6}$$

and

$$w_2 - (1+r)\Delta > w_1 \tag{7}$$

Assumptions (6) and (7) imply that individuals never choose an option of migrating to any random destination. These assumption formalize in stylized way the empirical evidence that migration tend to happen to destinations either with higher wages or with better ethnicity matched. We will also demonstrate below that these assumptions are backed up by our data.

Claim 1 *Assume (6) and (7) hold. Individuals prefer either to stay or to migrate to "better" destinations. Among these two options, the latter occurs, if the net return to migration outweights the costs:* $w_2 - (1+r)\Delta > w$

Under baseline circumstances, individuals face only two options: staying or migrating to "better" destinations since return from migration to random destinations is lower relative to return from other migration options. Furthermore, the higher support from the community, the lower propensity to migrate. As in traditional migration literatire, the incentive to migrate is higher if there is higher wage differential (either through better skills or ethnicity matched) at the destination and the origin.

2.3 Model with natural disasters

In this section we examine how individuals decision to migrate are affected by natural disasters[1].

As before, individuals maximize the utility:

$$\log(c_1) + \beta \log(c_2) \tag{8}$$

If drought hits the economy, individuals face the following budget constraint:

$$\begin{aligned} &c_2 = (1+r)[w - c_1 + (w_1 - wI_1^m + (-\Delta)I_2^m] + \\ &(A^d w + (w_1 - A^d w)I_1^m) + (w_2 - A^d w)I_2^m) \end{aligned} \tag{9}$$

When earthquake hits, the budget constraint is given by equation:

$$\begin{aligned} &c_2 = (1+r)[A^e w - c_1 + +(w_1 - A^e w)I_1^m + (-1/A^e\Delta)I_2^m] + \\ &(A^e w + (w_1 - A^e w)I_1^m) + (w_2 - A^e w)I_2^m) \end{aligned} \tag{10}$$

The difference between (10) and (11) stems from our distinction between "slow-onset" and "rapid-onset" disasters, which assumes that (i) droughts affect wage income in the second period, whilst earthquake in the current period; (ii) droughts do not impact search costs, whilst earthquake does. These are simplyfing assumptions which allow to make exposition simpler and messages clearer. Of course, it would be trivial to relax these assumptions and to assume that

[1] In the framework above, we have focused on analysis of potential options individuals face following negative natural disaster shocks. In reality, however, spell of negative shock can be followed by positive shock, or could be sequence of positive shocks followed by negative shocks. We argue that for the purposes of the research question at hand, it is sufficient to consider the conceptional framework as presented above. For instance, given the assumption that earthquake destroys assets, if a sequence of positive productivity socks is followed by earthquake, the potential options as described above would not change. If, however, a sequence of positive shocks followed by drought, then it could be that the accumulation of previous positive shocks relax liquidity constraints and some households become less dependent on the network, so this could potentially change quantitatively but not qualitatively the predictions of our simple framework. Predictions of our simple theory are in line with findings in **?** who shows, using data on internal migration in Indonesia, that after an accumulation of preceding positive shocks, migration increases.

droughts also affect wage and assets in the first period with the effect of the shock being stronger in the second period. But this would generate no new insight.

2.3.1 Drought

First, we examine how the slow-onset disaster in form of drought affects migration options:

Claim 2 *In the aftermath of a drought, individuals prefer either to stay or to migrate to "better" destinations. Among these two options, the latter happens if* $w_2 - (1+r)\Delta > A^d w$*, or more likely, if either (i) the shock is severe (*$A^d \approx 0$*); (ii) costs of investing into migration with better skills or ethnicity matched* Δ *is small relative to income difference* $w_2 - A^d w$*; or (iii) wage in destination* w_2 *is high enough to offset upfront costs and income in origin.*

As in the baseline case, individuals never choose to migrate to any random destinations aftermath droughts and confront with only two migration options: staying or migrating to "better" destinations. As before, the assumption (7) is essential for this result. In that sense, drought leads to circumstances that resemble conditions under which "conventional" (baseline) migration decisions happens. Among these two migration options though, individuals prefer to migrate if the effect of the shock is more devastating. Intuitively, since drought is a slow-onset disaster and its major impact happens next period, individuals are able to escape the impact of the shock, by investing today into migration with "better" destinations.

2.3.2 Earthquake

We next examine how the rapid-onset disaster in form of earthquake affects migration decisions:

Claim 3 *The higher the intensity of the earthquake, the more likely the option of migration dominates the staying. Individuals migrate immediately if* $(1+r)w_1 > w_2 - (1+r)1/A^e\Delta - w_1$*, that is either: (i) migration costs are relatively high; (ii) the difference in wage income earned in "better " destination relative to income earned in any random destination is not so big.*

If disaster destroys network, infrastructure and farms, then it is optimal to migrate. The question is whether they migrate immediately or to "better" destinations. The latter requires upfront costs. Even though individuals lose their assets and support from the network, they can still borrow against their income in the second period, and invest into migration with better destinations. That is viable option only if wage w_2 is pretty high. The proposition also implies that the higher upfront migration costs, then, the individuals also migrate immediately.

Table 1: Characteristics of households in the sample

Variables in 2000	Did not move	Moved	Difference	All
Household size	4.39	4.94	-0.55***	4.65
	(1.87)	(2.10)		(2.00)
Age (HH head)	49.60	48.17	1.43**	48.93
	(32.16)	(13.46)		(25.21)
Education (HH head)	3.83	4.12	-0.30***	3.96
	(2.95)	(2.85)		(2.91)
Income (USD)	640.04	865.44	-225.40	745.44
	(3441.07)	(16477.46)		(11543.80)
Distance to capital	115.19	183.71	-68.53***	147.24
	(88.46)	(146.54)		(124.00)
Average distance*				152.91
				(573.92)
Observations	3,241	2,847		6,088

Source: Authors' calculations from IFLS 2000 and 2007. * Based on historical records of migration events.

3 Data

We obtain data on household migration decisions from two waves of the Indonesian Family Life Survey (IFLS) in 2000 and 2007 . We considered about 10,500 households that were found in their original location in the first 1993 survey. We consider only rural households (about 6,000 households) droughts have little relevant for the urban population. We define permanent migration as the relocation of an entire household during the period 2000-2007. We excludes relocation within the same village. The survey also contains information on the community of origin and only partially on the community of destination as limited information was collected from on out-of-the-sample communities. About 43% of households moved during the period, mostly within the same province. (28% beyond the district of origin). Table 1 reports the descriptive statistics of the main characteristics of the households in the sample. Migrant households tend to be larger, younger, more educated and richer, although the latter difference is not statistically significant. They also tend to leave further away from a district capital. Using the historical records of past migration decisions (dating back more than X years), a household travels on average 150 kilometers to settle in another location.

For each households we also observe the employment status and the main occupation of all its member. For the subsample of migrant households we then use information on the village of destination to construct a binary measure of skill-matching at destination. In particular we consider a good match a destination where the main occupation of the household head correspond to one of the main activities in the village. For example if a household was a rice producer at the origin (in 2000) it will be assign a value of one if the rice production is one of the activity available at destination. Each village is required to indicates what are the 3 main activities and also specify what are the main agricultural activities (crops or animals). When the household head

is unemployed any destination is considered a good match. For about 17% of rural migrant households the survey did not collect information at community level, so we infer the main activity from the sub-district level information.

We gather data on two types of natural disasters: earthquakes and droughts. Data on earthquakes are obtained from the community-level IFLS survey that asks community representative to indicate whether the community was affected by an earthquake in the previous 5 years. In addition we used geocoded data from USGS geocoded that collect historical information on the date, location of epicenter and magnitude of earthquakes. Similarly the community-level IFLS survey provides also information on the occurrence of droughts in the previous 5 years. This information is complemented with geocoded historical rainfall data provided by the Center for Climatic Research at the University of Delaware and available for a 50 by 50 kilometers grid. A drought is defined as annual rainfall for the growing season is below 2 standard deviations the average annual rainfall since 1950.

Table 2: Incidence of natural disasters

Variable	Sample mean
Earthquake	
IFLS - Community data	0.233
USGS - geocoded data	0.206
Drought	
IFLS - Community data	0.160
Rainfall data - geocoded	0.161

Source: Authors' calculations based on IFLS 2007, USGS, data from the Center for Climatic Research.

3.1 Ethnic and skill proximity

The household questionnaire collects information on the ethnicity of the household members. It allows household to choose from a list of 29 different ethnic groups. The ethnicity of the households is determined based on the majority ethnic group among its members. About X% of households are mono-ethnic. Similarly, community representatives are asked to indicate the 3 largest ethnic group in the village and indicate their share of the population. To measure the ex-ante quality of potential destinations we propose two measures: ethnic and skill proximity[2]. Potential destinations are defined as all villages within a certain distance from the household location. Each household location, obtained using the gps coordinates provided with the IFLS survey, is matched with surrounding villages from the 2006 village census (PODES). We are able to geolocate most of the villages in the sample by matching them with the mapping of

[2]This approach relates to that in Fafchamps and Shilpi (2013) where authors estimate the expected salary at destination by comparing migrants with district level characteristics. Unfortunately we are not able to apply the same method here for various reasons. First we do not have sufficient observations to estimate community-level effects.

village administrative borders. We then use information on the major ethnicity and activity in the village to derive measures of ethnic and skill proximity. In particular, we measure ethnic proximity by counting the number of villages that match the ethnicity of the household and located within 50 kilometers from the households and for the following ranges of distance: 50-100, 100-150, 150-200, 200-250 and 250-300 kilometers. Similar to the measure of a "good match" used in the previous section, for the skill proximity measure we count the number of villages were the occupation of the household head is indicated as one of the main economic activities in the village. When considering agriculture activities are disaggregated by type of crop. Figure 6 provides a visual example of how our proximity measures are constructed.

4 Empirical framework

The usual approach to migration decisions is to investigate the factors that affect the likelihood of selecting one of the possible potential migration destinations. This is usually estimated as a conditional logit model where a number of possible destinations and their characteristics are assigned to all individuals/households in the sample. The identification of the effects come from cross-sectional differences between destinations and by differences between the characteristics of the origin and destinations. The model assumes that a number of destinations are available for all households. These models are suitable when a limited number of aggregated destinations (countries or districts) are considered and imply loosing information at a more disaggregated level (e. g. village). To exploit the richness of our dataset that include more than 60,000 municipalities, we propose two alternative specifications to test the main predictions of the model. We first consider the households' actual destination choices. Because our focus is on destination choices rather than post-migration outcomes the analysis that follows focuses on the ex-ante characteristics of potential destinations that better resemble the information available to the household prior to its migration. We exploit the information on the new location of the household and the characteristics at the origin to construct a measure of ex-ante quality of the destination choice and estimate the following model:

$$D^q_{it_1} = \alpha + \beta \boldsymbol{I}^d_{jt_0-t_1} + \gamma X_{ijt_0} + \epsilon_i \tag{11}$$

where D^q is a binary indicator taking value one if the occupation of the household head at time t_0 matches the major activities available at destination (at time t_1 once the destination is known). This is rudimentary but we will show that our ex-ante measure of quality of destinations correlates positively with the probability of finding an occupation and earning higher income. We do consider post-migration income or employment status as dependent variables since we are interested in quality of destination choice and ex-post outcome are instead likely to be directly influenced by migrant characteristics and other factors besides their choice of a destination. The variable I^d is also binary and indicates whether the household has experienced and earthquake or a drought

during the period. This model is meant to provide some suggestive evidence on the relationship between natural disasters and the quality of the migration choices.

We then focus on the decision to migrate and relate this to the characteristics of the potential destinations. For each household we define a set of potential destinations by considering all villages within a given distance from the household. We then compute a summary measure of quality of this potential destinations (pull factors) by taking the average of the characteristics of these villages as explained above. We, then, estimate the following equation:

$$I^m_{ijt_1} = \alpha + \boldsymbol{\beta}\ \mathbf{k}_{ijt_0} + \gamma X_{ijt_0} + \epsilon_i \tag{12}$$

where $I^m_{ijt_1}$ is a binary variable and indicates whether household i in community j at time t_1 was living in a different location than in the previous wave t_0. The remaining variables, instead, all refer to pre-migration conditions and refer to household characteristics X_{ijt_0} including household size, education and age of the household head, distance from the nearest capital and a set of district fixed effects. The main explanatory variables are a vector of pull factors, $\mathbf{k}_{ijdt_0}$ that includes skill and ethnic proximity at potential destinations. To investigate how natural disasters affect the functioning of these latter drivers of migration, we interact each driver with a set of dummies indicating the type of natural disaster the household has experienced, $\boldsymbol{I}^d_{jt_0-t_1}$, during the period t_0 to t_1.

$$I^m_{ijt_1} = \alpha + \boldsymbol{\beta k}_{ijt_0} + \boldsymbol{\beta_1 k}_{ijt_0} * \boldsymbol{I}^d_{jt_0-t_1} + \boldsymbol{\beta_2 I}^d_{jt_0-t_1} + \gamma X_{ijt_0} + \mathbf{e}_i + \mathbf{e}_j + \epsilon_i \tag{13}$$

In this specification additional controls include a full set of household and community ethnicity fixed effects ($\mathbf{e}_i$ and $\mathbf{e}_j$) to deal with the potential correlation between the ethnic inclusion and proximity indicators and unobserved ethnicity-specific characteristics. It also include a full set of occupation fixed effects to avoid that our measures of skill proximity pick up occupation-specific effects. Finally it controls for past shocks that are potentially correlated with current shocks. We estimate the model using a linear probability model and cluster the standard errors at the district level.

5 Results

In this section we discuss the results of estimating equation 11 and 13.

5.1 Quality of destinations and natural disasters

In this section we present some suggestive evidence on the relationship between natural disasters and migration choices. Using information on actual migrants' destinations, we document that households affected by an earthquake tend to make worse migration decisions. Table 3 considers the impact of droughts and

Table 3: Correlation between disaster and migrants' destination choices

Dep. var:	Urban	Destination is a good match				
	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	OLS	2SLS	2SLS
Earthquake	0.486***	-0.186***	-0.197***	-0.099*	-0.201***	-0.245**
	(0.005)	(0.000)	(0.000)	(0.062)	(0.003)	(0.031)
Drought	0.017	0.170***	0.244**	0.248**	0.243**	0.241**
	(0.871)	(0.004)	(0.021)	(0.010)	(0.011)	(0.014)
Urban				-0.202***	-0.188***	-0.184***
				(0.000)	(0.000)	(0.000)
Ethnicity FE	Yes	No	Yes	Yes	Yes	Yes
Comm ethn FE	Yes	No	Yes	Yes	Yes	Yes
Occupation FE	Yes	No	Yes	Yes	Yes	Yes
HH-level controls	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Households	2481	2584	2481	2481	2413	2413
F-stat					90.790	70.513
Over-identification test p-value					0.544	0.328

Include only migrant households. Standard errors clustered at the district level in parenthesis. Other controls include the following characteristics of the household in 2000: household size, age and education of household head, distance from capital, income and whether the household belongs to the majority group in the village. The model is estimated using a linear probability model and two stage least squares (2SLS) in the last two columns. The excluded baseline includes households that did not experience a shock. In column 5 earthquake's magnitude and its square based on USGS data are used as instruments for community-reported earthquake. In column 6 drought intensity based on rainfall data is used as additional instrument for community-reported drought.

earthquake on the characteristics of the destination choices. The dependent variables, therefore, refer to the location of the households in 2007 (post-migration) considering only households that moved during the period.

In first column the binary dependent variable takes value one if the destination is urban and show that households affected by an earthquake are more likely to choose an urban destination than disaster-free migrants. No differential effect in instead observed in the case of a drought. In the second part of the table the binary dependent variable takes value one if the destination constitutes a good match in terms of a household pre-migration skill-set. This is measured by comparing the occupation of the household head with the major sectors at the destination. The dependent variable takes value one when a match is observed. The correlations show that households that migrate in the aftermath of an earthquake are less likely to choose a destination that match their original occupation, the opposite is observed for a drought. This effect persists when controlling for the occupation and ethnicity of the household (column 3) and for whether the destination is urban (column 4). The results suggest that earthquake can alter the ability of a household to choose a good migration destination. This is confirmed in column 5 and 6 were concerns about potential endogeneity of community-reported droughts and earthquake are mitigated using geocoded data on earthquake magnitude and rainfall as instruments.

Table 4: Correlation between the (ex-ante) quality of the destination, employment status and income

Dep. var:	(1) Unemployed	(2) Income (log)
Destination is a good match	-0.033**	0.517*
	(0.047)	(0.057)
Income in 2000 (log)	0.004	0.053
	(0.221)	(0.305)
Ethnicity FE	Yes	Yes
Community ethnicity FE	Yes	Yes
HH-level controls	Yes	Yes
District FE	Yes	Yes
Observations	2270	2270

Include only migrant households. Standard errors clustered at the district level in parenthesis. Other controls include the following characteristics of the household in 2000: household size, age and education of household head, distance from capital, income and whether the household belongs to the majority group in the village. The estimates are obtained using ols.

In table 4 we regress the employment status and the post-migration income on our measure of good-quality destinations, i.e. whether the occupation of the household matches the available activities at destination. The results indicate that indeed being unemployed is negative correlated with choosing a "good" destination while income is on average 50% higher for households that have chosen a good destination according to our definition.

Overall these suggestive evidence show a propensity for households affected by am earthquake to choose destinations that are less suited to their skill set leading to a lower chance of finding job opportunities and earning higher income. In the case of a drought instead households are more likely to move to more suitable locations. This evidence, however, while suggestive of a negative relationship between sudden shocks and the quality of the migration destinations, carries some concerns of self selection. Indeed it is not yet possible to distinguish whether the poorer quality of the destinations are due to wrong destination choices or unobservable differences in the type of households that are selected into migration. We deal with the concern below where we include also non-migrants in the sample and control for their characteristics.

5.2 Decision to migrate and natural disasters

In this section we first test the hypothesis that the intensity of natural disasters is positively associated with a higher propensity to migrate. Table 5 reports the estimates of the impact of earthquake, droughts and their intensity on the propensity to migrate. Column 1 shows that, on average, earthquakes do not lead to greater migration overall, actually the coefficient goes in the opposite direction. When we consider longer distance migration in column 2, however, we

do find that earthquake increases migration. An earthquake increases the probability of long distance migration by 28 percentage points. We also find support for our main hypothesis in column 3 and 4 were we employ two measure of earthquake intensity. The first one computes the magnitude (Moment magnitude scale) and weight it by the distance from the epicenter and the depth of the quake. The second measure is based on the number of infrastructure, buildings and assets destroyed as reported in the community survey. This latter measure is therefore less exogenous, nevertheless both measures of intensity show a positive association with the propensity to migrate. The last two columns focus on drought. Column 5 shows a large but not significant impact of a drought on migration. Column 6 confirms the positive association between drought severity, measured by the largest negative deviation from average rainfall, and migration probability.

Table 5: Impact of natural disaster on migration

Dep. var:	Migrate	Migrate beyond district	Migrate beyond district	Migrate beyond district	Migrate	Migrate
	(1)	(2)	(3)	(4)	(5)	(6)
Earthquake	-0.425***	0.279**				
	(0.066)	(0.123)				
Magnitude			0.131**			
			(0.061)			
Magnitude^2			-0.072***			
			(0.025)			
Destruction				0.061***		
				(0.022)		
Destruction^2				-0.010***		
				(0.003)		
Drought					0.168	
					(0.156)	
Drought severity						0.266**
						(0.122)
HH ethnicity FE	Yes	Yes	Yes	Yes	Yes	Yes
Comm ethn. FE	Yes	Yes	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4647	4647	4647	4647	4647	4647

Standard errors clustered at the district level in parenthesis. Other controls include the following characteristics of the household in 2000: household size, age and education of household head, distance from capital, income and whether the household belongs to the majority group in the village. Columns 1 to 4 control for past earthquakes columns 5 and 6 control for past droughts.

In the table 6 we test our second hypothesis and show how our two measures of skill and ethnic proximity interact with the two type of natural disaster in determining the propensity to migrate. Proximity measures are computed over different distance ranges from the household as reported in the second row of the table. The baseline effects show a positive relationship between skill proximity and the propensity of migration in the absence of a natural disaster for all distances. Similarly, also how measure of ethnic proximity predicts migration,

although the effect disappear at larger distances. The fact that we do not observe a positive effect in the first 50 kilometres can be explained by the fact that our measure could be correlated with ethnic proximity at the origin which is likely to exercise a retaining power and discourage migration.

When we consider the interaction effects we can observe how the attractive power of skill and ethnic proximity is diminished in the case of an earthquake. This is more likely observed at longer distances, which is consistent with our previous finding on the impact of earthquake on longer-distance migration. On the other hand, instead, we do not observe any significant effect of droughts on the predictive ability of skill and ethnic proximity.

Table 6: Impact of ethnic and skill proximity on the propensity to migrate and interaction with natural disasters

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var: migrate	0-50	50-100	100-150	150-200	200-250	250 300
Skill proximity	0.002**	0.002**	0.002**	0.002**	0.002**	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Skill prox # Drought	-0.001	-0.001	-0.001	-0.001	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Skill prox # Earthquake	-0.004	-0.003	-0.004**	-0.004	-0.004*	-0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Ethnic proximity	0.001	0.004**	0.004	0.020***	-0.011	-0.006
	(0.002)	(0.002)	(0.003)	(0.005)	(0.009)	(0.005)
Ethnic prox # Drought	0.004	0.001	-0.029	-0.050	0.003	-0.034
	(0.004)	(0.003)	(0.063)	(0.062)	(0.010)	(0.030)
Ethnic prox # Earthquake	-0.009**	-0.015***	-0.009**	-0.019**	0.010	-0.001
	(0.004)	(0.003)	(0.005)	(0.009)	(0.013)	(0.008)
HH ethnicity FE	Yes	Yes	Yes	Yes	Yes	Yes
Comm ethn. FE	Yes	Yes	Yes	Yes	Yes	Yes
Occupation FE	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4624	4624	4624	4624	4624	4624

Standard errors clustered at the district level in parenthesis. Other controls include the following characteristics of the household in 2000: household size, age and education of household head, distance from capital, income and whether the household belongs to the majority group in the village. All controls are interacted with natural disaster dummies.

In table 7 we provide some corroborating evidence on the predictive capacity of our measure of skill proximity. Table 7 shows that our measure of skill proximity is positively correlated with the probability of choosing a suitable location. The effect is significant for all distance ranges and indicates that greater skill proximity is associated we a higher probability of choosing a good destination.

6 Conclusions

Migration is one of the key impacts of natural disasters and climate shocks upon societies. Understanding the nature and the amplitude of disaster-induced mi-

Table 7: Correlation between the (ex-ante) quality of the destination and skill proximity

Dep. var: good match	(1)	(2)	(3)	(4)	(5)	(6)
Distance range:	0-50	50-100	100-150	150-200	200-250	250 300
Skill proximity	0.015***	0.013***	0.013***	0.014***	0.014***	0.014***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Ethnicity FE	Yes	Yes	Yes	Yes	Yes	Yes
Comm ethn FE	Yes	Yes	Yes	Yes	Yes	Yes
HH-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Village charac.	Yes	Yes	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2495	2495	2495	2495	2495	2495

Include only migrant households. Standard errors clustered at the district level in parenthesis. Skill proximity is measured based on villages within the distance range reported on column heads. All controls refer to the conditions before migration in 2000. All specifications included control for the characteristics of the villages within the distance range reported in the column heads. These include: total number of villages and number of villages with electricity, with conflict, urban and the total population.

gration movements is, therefore, crucial to inform policy interventions in affected areas and in the receiving regions. Weather patterns and natural disasters can cause large-scale destruction of assets and livelihoods with a strong impact on the well-being of households (e.g., Dercon (2004), Clarke and Hill (2013)). Under such circumstances, the permanent reallocation of people from affected areas may be a promising way of responding to climate shocks and natural disasters but the implications for those that choose to migrate and their receiving counterparts require careful consideration.

This paper has investigated how climate shocks and natural disasters shape migration choices in Indonesia. In particular, we focused on permanent migration and revisit some of the crucial socio-economic determinants of migration: ethnic and skill proximity as a measure of skill transferability at destination. We distinction between slow (e.g. a drought) and rapid (e.g. an earthquake) onset environmental shocks to gain insights into the differential impact of natural disasters.

Our results show that in the case of a drought, migration closely resembles the type of investment migration aimed at improving future economic circumstances; that is the presence of a greater pool of villages with similar ethnicity and skill-compatible occupations increases the probability of migrating after a drought. In the case of an earthquake, instead, migrants choose destinations that are less suitable, that is the predictive effect of skill transferability on migration is reduced to zero. This is in line with our assumption about the complementarity between personal assets and social trust. Therefore, when assets are destroyed the relative role of social capital is diminished. The results are robust to the use of alternative indicators of disasters based on community surveys, geocoded and weather data, and to the inclusion of a rich set of control variables aimed at excluding potential confounding effects at both origin and

potential destinations.

Our results have important policy implications. First, in the case of slow-onset environmental changes such as a drought, natural migration response should be facilitated. Consequently, our research suggests that, under these circumstances, support for reallocation might be better than support for adaptation. Policy makers thus need to be ready to make migration possible when it is an effective response to climate shocks. In the case of rapid onset disasters such as an earthquake, efforts should mainly be concentrated towards possible re-training at destination that would allow the creation of greater job opportunities for a wider variety of skills. Finally, the support for the development of transferable skills, not attached to a given location or occupation should also be encouraged.

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Appendix

Figure 1: Location of households in the sample

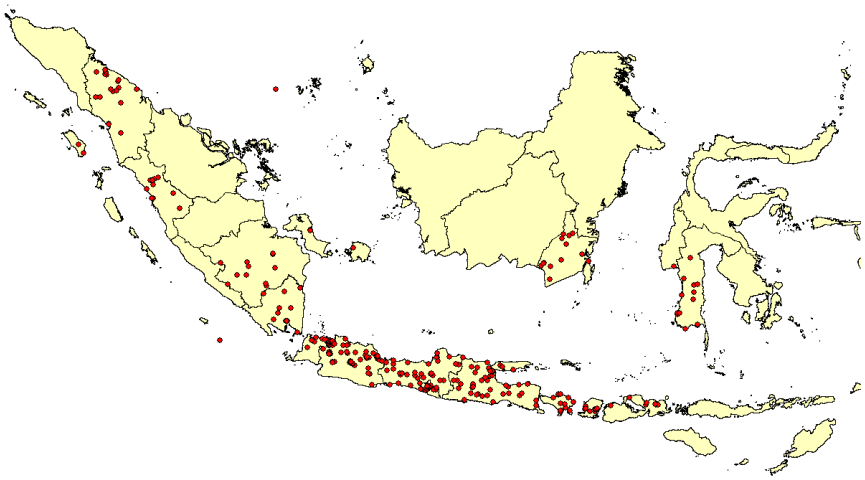

Figure 2: Source: IFLS 2000. Dots indicate the communities were households are located.

Figure 3: Construction of the ethnic and skill proximity indicator

(a) Skill/Ethnic proximity within 50 Km

(b) Skill/Ethnic proximity 50-100 Km

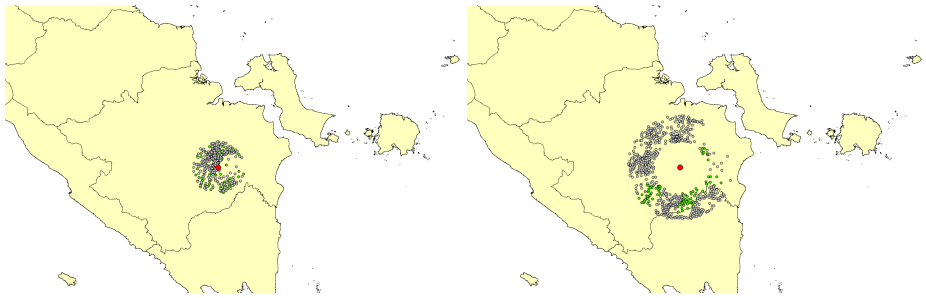

Figure 4: Based on PODES 2006 and IFLS 2000. The red spot at the center represents the location of a household, the green dots are the compatible villages with the same ethnicity/activity of the households and the grey spots are instead villages considered not to be a good match.