Natural Disasters and International Labor Migration: Empirical Evidence from Nepal's Earthquake

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Abstract

A sudden environmental disaster can trigger internal household displacement, internal labor migration, international migration, and return migration. Some argue that environmental disaster triggers security and psychological factors for people to decide international migration. In contrast, others debate that rescue and reconstruction work entails physical labor leading to return migration and migration reduction. We empirically test these hypotheses exploiting Nepal's 2015 7.8 Richter scale magnitude earthquake. We employ various Difference-in-difference frameworks with fixed-effects and interactive fixed-effects with spatial variations. We use the National Reconstruction Authority's (NRA) definition of severely affected districts as the treatment group and other least affected districts as the comparison group. Using several robustness, placebo, and falsification tests, we find a reduction in international labor migration, which is more pronounced among Nepalese males than females.

Keywords: Disaster-Induced Migration, Gender, Nepal Earthquake 2015
JEL Classification: J44, I18, H75

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1 Introduction

Recent data from the Center for Research on the Epidemiology of Disasters (CRED) indicate that 7,348 natural disasters were recorded worldwide over the last twenty years, claiming approximately 1.23 million lives and causing economic losses of US$2.97 trillion There exists well-documented evidence on the linkage between environmental shocks and human migration (Berlemann and Steinhardt, 2017; Hunter, 2005). Broadly, prior literature relates environmental migration to internal household displacement, international migration, internal labor migration, and return migration.[1] However, empirical evidence of a clear relationship between natural disasters and migration patterns remains inconclusive because some environmental changes such as droughts take place gradually over a long period of time, while others such as storms, floods, and earthquakes occur suddenly. Although researchers have pointed out that international labor migration can be one of the post-disaster adaptation strategies to recover from disaster-induced income loss and seek better employment opportunities (de Moor, 2011b; Thornton, 2011; de Moor, 2011a; Henry et al., 2004), there exists a dearth of rigorous empirical evidence of migration in response to large earthquakes in the developing world.

This study examines the impact of the 2015 earthquake in Nepal on international migration. The 2015 earthquake affected approximately 8 million people, resulting in an economic loss of US$ 10 billion, equivalent to about half of Nepal's Gross Domestic Product (GDP) (Goda et al., 2015). Our focus on Nepal, a disaster-prone and labor exporting developing country in South Asia, is unique for two important reasons. First, Nepal ranks 11th among the world's most earthquake-prone countries, fourth in terms of vulnerability of climate change, and thirtieth on flood risks (UNDPR, 2009; IoM, 2018; NEMRC, 2020). Second, remittances contributed to over a quarter of Nepal's GDP, accounting at $8.79 billion in 2019 (MoLESS, 2020). We exploit the plausibly exogenous incidence of the 2015 April earthquake of 7.8 magnitudes in Nepal and apply

[1] See Black et al. (2011); Landry et al. (2007); Koubi et al. (2016); Queiroz et al. (2019); Mallick and Siddiqui (2015); Paul (2005); Paul and Routray (2010); Raleigh et al. (2008); Sagynbekova (2017); Castles and Miller (2009); Parnell and Walawege (2011); Neumann and Hilderink (2015) for more details.

the difference-in-differences research design to evaluate changes in international labor migration per capita between severely-affected districts ("treatment") and unaffected counterparts ("control"). Our treatment group includes 14 districts classified by the National Reconstruction Authority (NRA) as severely affected by the earthquake, while the comparison group includes the rest of the remaining 61 districts (NRA, 2020).[2] To quantify changes in international labor migration per capita, we make use of district-level work permits issued by Nepal's Department of International Employment (DoFE) to citizens for international labor migration from Nepal.[3] Our empirical research design accounts for potential unobserved heterogeneity, omitted variable bias, and nationwide time trends. We also conduct additional placebo tests to show that our estimates from the double differences approach are robust and statistically significant.

Results indicate that the number of work permits issued for international migration decreased significantly among severely-affected districts in the aftermath of the 2015 earthquake. Specifically, the earthquake led to a 37.85% reduction in the number of international labor work permits per capita among districts severely affected by the earthquake compared to unaffected counterparts. Findings further show that the effect of the earthquake on international work permits among males is statistically significant and negative, while the impact among females is not significant. For example, the number of work permits for international migration issued to Nepalese males in severely-affected districts decreased by 49.33% after the earthquake. Our finding on gender disparities is in line with a study by Henry et al. (2004), which documents a reduction in international temporary migration among males in response to a severe rainfall deficit in Burkina Faso.

We attribute this heterogeneity across gender to economic disruptions created by the earthquake.[4] According to Sijapati et al. (2015), the nature of employment generated

[2]Severely affected districts are Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, Nuwakot, Okhaldhunga, Ramechhap, Rasuwa, Sindhuli, and Sindhupalchok (NRA, 2020).

[3]As Nepal shares open borders to India, citizens from both countries do not need work permits or work-related visas for employment. Our analysis doesn't include international labor migration to India (DOFE, 2014)

[4]There exists well-documented evidence of how natural disasters may widen gender disparities across a range of outcomes. For example, Paudel and Ryu (2018) document large gaps in human capital between

in the home country in reconstruction was physically intensive and thus more attractive to men compared to women. Uddin (2016) points out that robbery cases increased significantly in the temporary shelters after the earthquake, raising privacy and security concerns among women and causing males to guard the shelters at nights. Finally, several migrant-sending households reported dwindling cases of male migrants leaving the country (Sijapati et al., 2015). This provides evidence of factors that likely affected prospective male migrants more than female counterparts in deciding against foreign labor migration in the aftermath of the earthquake.

This study contributes to an influx of recent empirical work exploring the linkage between natural disasters, labor market responses, and migration-related decisions (Gröger and Zylberberg, 2016). More recently, Spitzer et al. (2020) conclude that the Messina-Reggio Calabria Earthquake, one of the devastating natural disasters in Europe, did not have a significant economic impact on emigration or its composition. Their finding on attachment to land as "an impediment to reacting to the disaster through migration" appears to be consistent with our findings in Nepal's context. In a different study, Mahajan and Yang (2020) find that adverse environmental shocks in origin countries such as hurricanes increase migration to the United States. Within the United States, Boustan et al. (2020) explore natural disasters from 1920 to 2010 and report that large disasters increase out-migration rates at the county level by 1.5 percentage points. Our results also contribute to several studies that find an insignificant or negative impact of natural disasters and other environmental shocks on international migration (Beine et al., 2019; Cattaneo and Peri, 2016; Gröschl and Steinwachs, 2017; Halliday, 2006).

This study is broadly related to a growing number of quasi-experimental research design-based studies focused on evaluating a large earthquake's economic impact in South Asia. The majority of studies exploring the exogenous shock of earthquake incidence have investigated subsequent effects on foreign aid, health, and education-related outcomes (Paudel and Ryu, 2020; Nandi et al., 2018; Andrabi and Das, 2017). More recently,

male and female infants exposed to the 1988 earthquake in Nepal.

Eichenauer et al. (2020) show that the allocation of aid in Nepal is positively correlated with the 2015 earthquake damage, but it is not reflective of socioeconomic and physical vulnerabilities. Relatedly, Spoon et al. (2020) provide evidence of difficulty in disaster recovery among displaced households relying on agro-pastoral livelihoods in the aftermath of the 2015 earthquake in Nepal. Policymakers focused on designing sustainable recovery programs from large natural disasters can use our findings on migratory response induced by the earthquake to better understand the economic cost of natural disasters across different settings.[5]

The remainder of the paper is structured as follows. Section 2 presents a comprehensive literature review on the relationship between natural disasters and migration. Section 3 provides a detailed background of Nepal's earthquake and labor migration. Section 4 explains data used in the study and Section 5 describes the econometric strategy. Section 6 presents the main results and Section 7 concludes.

2 Literature review

2.1 Disasters and international labor migration

Policymakers, public institutions, and scholars on environmental migration argue that a sudden environmental event can, directly and indirectly, induce exposed populations to migrate. However, some call attention towards the possible influence of various non-environmental variables in explaining migration decisions (Castles and Miller, 2009; Parnell and Walawege, 2011; Black et al., 2011). Amidst the debate, recent studies argue that the interaction of both environmental and non-environmental factors determines migration-related outcomes.[6] Other studies suggest that economic motives drive labor migration decisions, but they can also induce individuals not to leave because of the in-

[5] According to Acosta et al. (2020), a comprehensive understanding of population distribution in a region affected by a large environmental shock has implications for resource allocation to affected communities.

[6] For example, Black et al. (2011) identifies five families of drivers which affect migration decisions: economic, political, social, demographic and environmental drivers.

creasing employment opportunities in the home country, especially in the reconstruction and rebuilding phase (Pereira, 2009; Noy and Vu, 2010; CBS, 2011). Additionally, prior literature has documented varieties of human migration decision patterns[7] have been well-documented (Neumann and Hilderink, 2015; Pathak et al., 2016; de Moor, 2011b; Sijapati et al., 2015; Thornton, 2011; de Moor, 2011a).

Although researchers have explored environmental migration responses in the form of internal household displacement, international migration, internal labor migration, and return migration (Black et al., 2011; Landry et al., 2007; Koubi et al., 2016; Queiroz et al., 2019; Mallick and Siddiqui, 2015; Paul, 2005; Paul and Routray, 2010; Raleigh et al., 2008; Sagynbekova, 2017; Castles and Miller, 2009; Parnell and Walawege, 2011; Neumann and Hilderink, 2015), only a limited number of studies have concentrated on international labor migration. For example, prior literature sheds light on the relationship between the environment and the international labor migration through qualitative methods (de Moor, 2011b; Thornton, 2011; de Moor, 2011a). Previous studies indicate that international labor migration is a potential disaster recovery strategy in a developing country setting. Nevertheless, they still do not explain how human decisions on potential international labor migration may be affected in such contexts. Furthermore, they do not provide evidence of differential impact of environmental shocks on migration across gender in labor exporting, disaster-prone country settings. Whether international labor migration is a demand/citizen-centric post-disaster employment policy solution remains an open question. This existing gap in knowledge implies that there is no clarity on how a developing country may prepare in terms of labor market management and facilitation before and after the incidence of an environmental disaster. This study attempts to determine how a disaster-prone, labor exporting developing country might respond in such a scenario.

[7]For instance, some people might just walk a few yards through refuging with their friends or relatives, while some might cross the international boundaries to flee disaster in the extreme case (Queiroz et al., 2019), or some may respond with return-migration (Landry et al., 2007).

2.2 Neo-classical economic viewpoint

Neo-classical economists argue that environmental migration, in general, is a survival strategy in the post-disaster period (Myers and Kent, 1995; Paul, 2005; Walsham, 2010; Koubi et al., 2016; Sagynbekova, 2017; Thornton, 2011). Migration can also be a risk minimizing strategy, allowing for diversification of the livelihood options among the affected population (Myers and Kent, 1995; Paul, 2005; Koubi et al., 2016; Sagynbekova, 2017; Thornton, 2011; de Moor, 2011b,a). As the 2015 earthquake disrupted almost all sectors of the economy causing a spike in inflation, [8] one expected a surge in labor outflow from the country. However, the surprising decline in emigration left many questions unanswered.

One argument to explain this change from the economic viewpoint is that the immediate financial loss may have triggered a priority shift. Consistent with this viewpoint, a report concludes that building a new house and accumulating necessary goods and items to get back to the everyday life was a major priority among earthquake victims (Sijapati et al., 2015). For an average Nepali citizen, international labor migration is often costly because of visa costs, ticket fares, and other immigration procedures involved. Though it is often against the policy in the home countryDOFE (2015), data suggests that migrant workers from Nepal and some other developing countries often bear high recruitment cost depending upon various destinations and job types (MDP, 2020). This suggests that investment for migration overseas can be a low priority among families struggling to recover from substantial economic loss (Sijapati et al., 2015).

Opponents argue that sudden environmental disasters can attract new employment and income opportunities disaster-afflicted areas. Such opportunities entail creation of more jobs, especially in the relief works, reconstruction and rebuilding (Pereira, 2009; Noy and Vu, 2010; NPC, 2015).[9] In the context of Nepal, a robust economic growth of

[8] Figures from January 2016 show that Nepal's inflation picked at 12 percentage, pushing up to 1 million Nepalis into poverty in the FY2015/16 (World Bank, 2016).

[9] For instance, there is a historical evidence of European countries signing new bilateral labor agreements, to fulfil their increased labor demand for the rebuilding on the post World War (Wickramasekara, 2015).

7.1% in 2019 (Ezemenari and Joshi, 2019) followed a sudden decline in economic growth at 2.7% in 2016 World Bank (2016). A recent report published by the Government of Nepal concludes that the reconstruction works contributed to increasing the country's GDP by 4.5 percentage points, after the earthquake(NRA, 2019).

Finally, the economic argument supports the role of remittance in the post-disaster rescue, rebuilding, and livelihood (Savage and Harvey, 2007). Remittance flows to Nepal increased significantly by 27.6% in three months after the earthquake compared to the same period last year (World Bank, 2016).[10] Literature suggests that flow of remittance might have insured individuals against the severity of the post-disaster shock. This implies that aspiring migrants from the remittance-receiving households are likely to give up their dreams of working in a foreign country. Similarly, the role of foreign aid in supporting victims after a major disaster cannot be understated (Paul, 2005). There are records of Nepalese receiving an unprecedented amount of technical, financial and humanitarian aid from around the world (Eichenauer et al., 2020; NPC, 2015).

2.3 Analysing multi-causal influences

Recent studies on environmental migration have explored the impact of disasters on individual's migration decisions from a multi-disciplinary perspective. Some key determinants of environmental migration include security, political, psychological, social and demographic factors (Koubi et al., 2016; Paul, 2005; Walsham, 2010; Raleigh et al., 2008; Queiroz et al., 2019; Mallick and Siddiqui, 2015; Neumann and Hilderink, 2015; Black et al., 2011). In the context of Nepal, security and psychological factors are likely to influence labor emigration.

The Nepalese context indicates that the impact of the earthquake on migration-related outcomes may be heterogenous between male and females. A lot of rescue and reconstruction work in the aftermath of the earthquake entails physical labor, which is often

[10]This was an exception because the inflow of remittance in other South-Asian countries declined during the same period. In 2017, Nepal became the fourth highest remittance recipient country as a percentage of GDP in the world DOFE (2017).

perceived as a man's job in a male-dominated Nepalese society. Culturally, men are trusted with the responsibilities of protecting vulnerable elderly, children, and women in the family at the time of crisis (Sijapati et al., 2015; Gurung, 2018).[11] Relatedly, a report suggests that migrant-sending families felt the absence of male migrants more (around 71 percentage) than the absence of female migrants (about 21 percentage) (Sijapati et al., 2015). Similarly, Sijapati et al. (2015) provides evidence of return migration in Nepal in spite of the complicated and expensive procedures. Additionally, a significant number of individuals fail to return despite their strong desire to come back. These circumstances might have influenced aspiring male migrants to reconsider their migration decisions, which have possible effects on emigration (Sijapati et al., 2015).

The political factor plays an important role in the Nepalese setting (Paudel and de Araujo, 2017) For instance, a study conducted in 2018 suggests that bureaucratic hurdles, political transition, and weak governance kept the victims waiting for relief packages up to three years after the shock (Sharma et al., 2018; Titz and Krüger, 2015). In the context of our study, it is likely that potential migrants might have decided to stay to ensure the safety of their vulnerable families.

Finally, lifestyle, culture, and some location-specific factors may have influenced decisions to choose to live under the continued vulnerabilities, causing subsequent effects on trends in labor emigration. Since generations, the majority of rural Nepalese households have relied on family-owned small scale agricultural farms for their livelihoods (Paudel and Crago, 2017). Some reports suggest that the newly built settlements by the government and humanitarian actors faced the design failure because they could not understand and address these unique needs (Lal, 2019). This implies that victims chose to live on their original place of their habitat under the existing vulnerabilities despite being offered a new house on a community settlement free of cost [12] (Lal, 2019).

[11] Temporary shelters also faced various security threats such as robbery and reports of inadequate privacy and security among women. This resulted in men guarding the temporary shelters at nights (Uddin, 2016).

[12] Association of the Nepalese living abroad spent 350 million in building Gupswe Pakha Settlement but have failed to convince the families to live (Lal, 2019).

3 Institutional background on Nepal's earthquake and labor migration

Nepal is a disaster prone, labor exporting developing county in South-Asia. Nepal experienced a massive earthquake exceeding 7.5 magnitudes in 2015.[13] The earthquake claimed around 9,000 lives and injured more than 22,000 individuals, while damaging approximately 712,000 homes and physical infrastructure. While there is no evidence suggesting international displacement after the shock (IoM, 2018), reports indicate that the earthquake forced around 2.6 million people to flee their homes (Bilak et al., 2016).

Nepal's nationwide labor migration outflow exhibited an increasing trend until the end of 2014 followed by a significantly decreasing trend in the post-earthquake period MoLESS (2020). District-level database from earthquake-affected areas also indicates the similar pattern.[14] Predictably, several studies have been carried out in the post-earthquake Nepal exploring the topic of disaster-induced internal migration (He et al., 2018; Pathak et al., 2016; Uddin, 2016; Wilson et al., 2016; NPC, 2015). Yet, a few post-earthquake reports published by the local governmental, non-governmental as well as some international aid organisations (Gurung, 2018; Maharjan et al., 2016; DOFE, 2017; Sijapati et al., 2015) attempt to establish both direct as well as an indirect multi-causal relationship to explain the sudden change. Arguments presented in such reports range from economic reasons and security issues to political and psychological perspectives.

[13]The first earthquake was followed by more than 300 aftershocks over 4.0 magnitude, another 6.8 magnitudes earthquake stroke Nepal after 17 days with the epicenter near the Mount Everest(NPC, 2015).

[14]While 5268 labor permits were issued to prospective migrants labors from the 14 severely affected districts in two months before the shock, the number decreased by 15 per cent to 4480 by mid-May, 2015 (Sijapati et al., 2015).

3.1 Disruption in existing procedure versus robust GDP growth

The government of Nepal introduced a policy called "free visa, free ticket" in July 2015 for those migrating as international laborers in seven destinations countries.[15] The new policy mandated the employing companies to bear the cost of visa fees and ticket fare of potential migrant workers. However, this resulted in a dispute between the Government of Nepal's Department of Foreign Employment and the foreign employment recruitment agencies, primarily because the policy curtailed benefits for recruitment agencies. In response, a national strike was called for 18 days, thus disrupting the established operational procedure for out-migration (DOFE, 2015). When foreign labor migration started to become increasingly difficult, evidence indicates the creation of new economic opportunities in the home country around the same period. Nepal has experienced robust economic growth since 2016, while reaching 7.1% in 2019 (Ezemenari and Joshi, 2019).[16] A recent preliminary report associates this change with increased economic activities in the reconstruction sector. On average, reconstruction works in the aftermath of the earthquake increased the country's GDP by 4.5 percentage points (NRA, 2019). A different nationwide survey carried out in 2017 reports that one in seven Nepalese citizens and one in five male Nepalese citizens were involved in construction-related works (CBS, 2018). This suggests that Nepal's significant economic growth might have contributed to new employment opportunities within the country, while inducing people not to migrate.

3.2 New constitution 2015 and elections 2017

In September 2015, Nepal promulgated a new constitution for the Federal Republic of Nepal. It proposed a multiparty federal decentralised parliamentary system with three levels of governance for the first time in the country's history. Some claim that this event

[15]Those countries include Malaysia and six others from the Gulf Cooperation Council (GCC): Saudi Arabia, Kuwait, the United Arab Emirates, Qatar, Bahrain, and Oman. Until 2014, around 85% of the migrant laborers from Nepal worked in these countries DOFE (2014) and this trend continues till date(MoLESS, 2020).

[16]The earthquake suppressed the projection of 4.6 percent GDP growth for 2015 by over 1.5 percentage points (NPC, 2015) but the growth significantly increased after that (Ezemenari and Joshi, 2019).

signaled hope for a stable elected government, localised development, the end of feudalism and the beginning of democratic socialism (Bhattarai, 2015). In 2017, Nepal held three tiers of elections under the provisions of the "Constitution of Nepal-2015" to elect thousands of representatives for local government, provincial assembly and the federal parliament (Khalid and Chughtai, 2017). After the long history of monarchy and the decade-long Maoists insurgency period, this new phase increased hope for lasting peace, effective decentralisation, robust governance, increased rights and liberty, massive political reform and restructuring (Dahal, 2017). This political transformation, in conjunction with a hope for change, likely affected migration decisions among the aspiring Nepalese youth.

3.3 Economic blockade 2015

Amidst the new hope for change, Nepal's new constitution was also criticised for not addressing the demands of marginalised Madhesis and Tharus. This triggered the Madhesh Movement, a general strike across Indian borders. Stating security concerns, the Government of India exerted a pressure on the Government of Nepal to comply with the terms demanded by the protesting groups. However, Nepal perceived this step as "an external interference in internal affairs" and accused India of an unofficial economic blockade. Consequently, more than two months-long unrest in the border area from the strike, and Nepal- India diplomatic turmoil led to a severe national crisis (Sood, 2016). Most importantly, the top 10 origin districts[17] of Nepalese international migrant workers were also in the same region. In 2015, these ten districts accounted for 36.2 percent of all labor permits issued in the past seven years (DOFE, 2015). Given that Nepal is a landlocked country and is dependent on India for petroleum, the general strike affected the transportation sector the most (Sood, 2016). It was therefore impossible to travel to the country's only international airport in the capital city of Kathmandu without any

[17]Dhanusa, Jhapa, Mahottari, Morang, Siraha, Nawalparasi, Sunsari, Saptari, Rupandehwe and Sarlahi

transportation. In addition, fulfilling responsibilities of the women, children and older adults during the time of such political uncertainty and civil unrest might have influenced potential male migrant's decision to stay inside the country.

3.4 Weak oil price and trouble in Malaysia

On one hand, the global crude oil price fell sharply from 2015 to 2016. This weakened the economy of major remittance-sending Gulf countriesWorld Bank (2016), increasing the probability of restricted hiring and even repatriation of the existing international workers from these countries (World Bank, 2016; DOFE, 2017). On the other hand, Malaysia received the highest number of Nepalese migrants in 2014, comprising of a 42.14% share of the total number of labor permits issued (DOFE, 2015). However, this share drastically dropped to 14.62% in 2016 (MoLESS, 2020). According to DOFE (2017), this sudden drop on labor outflow to Malaysia is a direct consequence a bilateral labor agreement between Malaysia and Bangladesh in 2016 (DOFE, 2017). Nepal did not have such an agreement until 2018 MoLESS (2020), causing Malaysian employers to prefer migrant laborers from Bangladesh (DOFE, 2017). Additionally, poor working conditions and exploitation of Nepalese migrant laborers in Malaysia could be another reason for the drop. A survey among returnee migrants from Malaysia, India, and GCC countries reports that the highest number of Malaysia returnees cite disability, injury or sickness, and removal from work as three primary reasons for their return in 2018 (CBS, 2018). Moreover, among all destination countries, Malaysia reported the highest number of deaths from suicide and heart attack (MoLESS, 2020).

4 Data

Nepal's Ministry of labor Employment and Social Security published detailed reports on the status of Nepalese international migrant workers for four years: 2014, 2015, 2017 and 2020. The Department of international Employment (DoFE) under the ministry is

an authorised institution for the issuance of work permits to Nepalese citizens willing to work abroad (DOFE, 2014, 2015, 2017; MoLESS, 2020). District-level data on work permits issued from the year 2010/11 to 2016/17 has been collected and compiled from the series of these reports.

National Reconstruction Authority, an autonomous body, established in the aftermath by the government of Nepal, has published data covering all aspects of the 2015 earthquake on its official website (NRA, 2020). According to NPC (2015), 14 districts (out of a total of 77 districts) were "severely affected" by the earthquake. Our binary treatment variable, takes a value of '1' indicating a severely affected district and '0' otherwise.

In November 2012, the government of Nepal, National Planning Commission Secretariat and Central Bureau of Statistics[18] jointly published a national report titled "National population and housing census 2011" (CBS, 2011). We compile data on the district-level population projection from this report. Our migration-related outcome variable includes the natural logarithmic transformation of international labor migration per 100,000 population for each district.

5 Models

5.1 Difference-in-differences method (DID)

We begin the analysis by explaining the difference in change in international labor migration between severely affected districts and the remaining unaffected districts. We estimate the difference-in-differences method (DID) with district and year fixed-effects (FE DID) in the following equation:

$$Y_{it} = \delta D_{it} + \alpha_i + \varsigma_t + \varepsilon_{it} \tag{1}$$

[18]The Central Bureau of Statistics, Nepal is a central governmental agency for the collection, processing, analysis, publication, and dissemination of official statistics in Nepal. It is also primarily responsible for the publication of "National Population Census of Nepal" in every ten years. The 2011 census is the most recent of all (CBS, 2020).

where index i and t represents district and year. Y_{it} is the outcome variable of interest, which is the logarithmic transformation of international labor migrants per 100,000 population for each district i in year t. D_{it} is the binary treatment indicator, which takes a value of 1 for a severely affected district by the April 2015 earthquake and 0 otherwise. γ is the parameter of interest that explains the change in international labor migration in a severely affected district compared to the unaffected comparison district after controlling for time and district-invariant unobserved heterogeneity. α_i and ς_t are additive district-specific and year-specific fixed-effects.

We want to control the possible variables that could affect or covaries with the outcome variable (note treatment variable is exogenous). However, such an endeavor is infeasible in our study because the district level panel-data is unavailable for Nepal. Hence our estimates can be contaminated by omitted variables, resulting in an omitted variable bias. However, in the panel-data set, at least the two-way fixed-effects allow absorbing unobserved heterogeneities invariant to each district and each year. Hence, controlling for year-specific fixed-effects and district-specific fixed-effects is essential to absorb the shocks whose impact is restricted to a given year and district.

5.2 Interactive fixed-effects

One of the main challenges of our research is the time-varying unobserved heterogeneity. Note that unobserved time-varying heterogeneity should not be confused with time-specific fixed-effects. Time-specific fixed-effects are shocks whose impact is restricted to a given time. Allowing unit-specific trends control for the exogenous trend in the dependent variable is not explained by other variables. For example, there are national trends in Nepal's international labor migration, and only the earthquake does not entirely drive international labor migration.

A possible solution is to directly impose unit-specific linear or quadratic time trends in conventional two-way fixed-effects models. However, we allow a flexible and explicit modeling non-linear time-varying heterogeneity using a two-way fixed-effect model aug-

mented with interactive fixed-effect models (IFE) (Bai, 2009). IFE model allows us to control for the nationwide time trends in the international migration per capita, which may vary across districts depending on their unobserved characterstics.

$$Y_{it} = \gamma + \delta D_{it} + \alpha_i + \varsigma t + \lambda_{it} F_{rt} + \epsilon_{it} \tag{2}$$

where F_{rt} is an unobserved factor common across all districts in each year t. λ_{it} represents district factor loading, which is constant over time and means how susceptible each district is to international labor migration. δ is the average treatment effect that explains the changes in international labor migration in the severely affected district compared to the remaining unaffected districts after controlling for time and district-invariant unobserved heterogeneity and time-varying unobserved heterogeneity. All remaining notation has the same interpretation as in equation (1).

In equation 1 and 2, we consider three types of international labor migration. These are the logarithmic transformation of the total, male, and female international labor migration per 100,000 population. **Consistent with X, Y, and Z theory,** one should expect a negative and significant value of δ, γ, and δ, which would suggest the earthquake of April 2015 has a role in reducing international labor migration. However, a positive and significant δ can provide evidence that sudden events like the earthquake of April 2015 can increase the international labor migration, **consistent with theory A, B, C**.

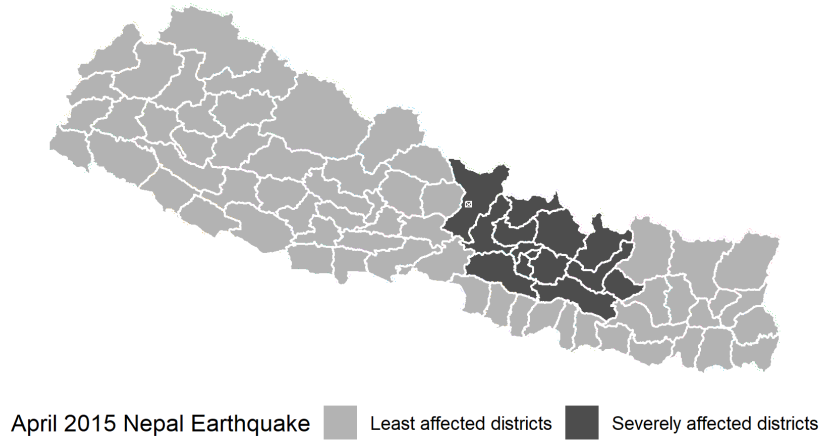
All of the regression presented in this section have clustered standard errors at the district level to allow for an arbitrary auto-correlation process within the district (Bertrand et al., 2004). Furthermore, the standard errors are robust to heteroskedasticity. These estimates are cluster-robust and therefore highly conservative.

6 Results

6.1 Descriptive analysis

We begin this analysis by presenting a cheolerpetra map of severely affected and least affected districts from the April 2015 earthquake in Figure 10. The Nepal government's NRA (2020) defines the district-level severity of Nepal's April 2015 earthquake. The white dot mark, in Figure 10, is the epicenter of the April 2015 Nepal Earthquake in the eastern side of Gorkha District at Barpak, Gorkha. Districts in the south-east proximity of the epicenter are severely affected by the April 2015 earthquake of Nepal.

Figure 1: Severely affected districts from April 2015 Nepal earthquake

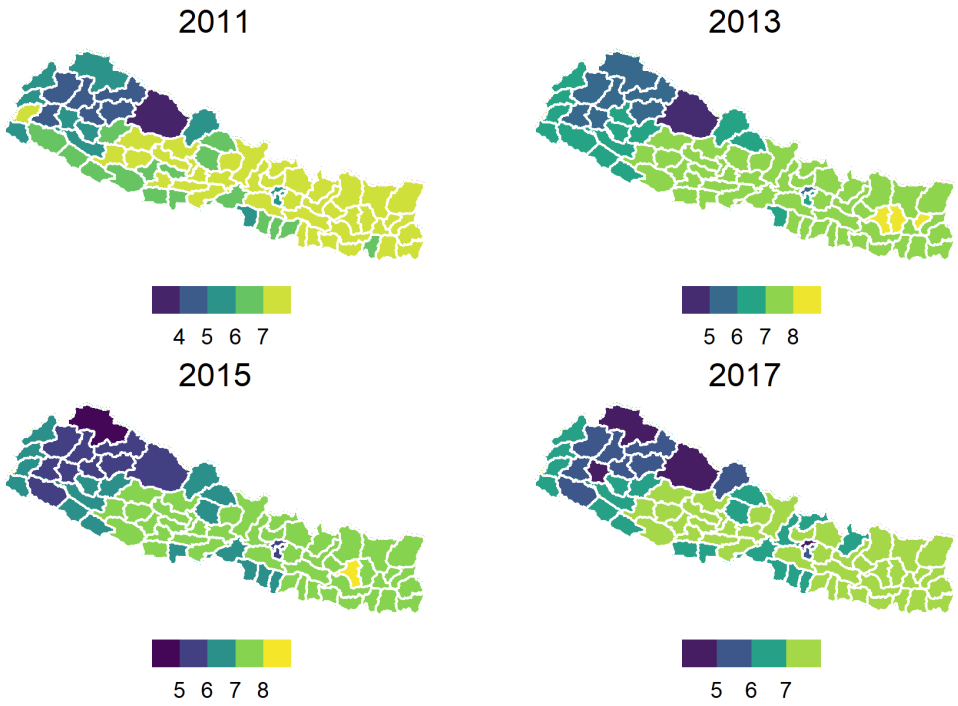


Notes: White dot marks the epicenter of April 2015 Nepal Earthquake in the eastern side of the Gorkha District at Barpak, Gorkha. Nepal government NRA (2020) lists the severely affected districts as Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, Nuwakot, Okhaldhunga, Ramechhap, Rasuwa, Sindhuli, and Sindhupalchok. The top points toward North direction.

In Figure 2, we present the spatio-temporal variation of logarithmic transformation of the ratio total international labor migration per 100,000 population. Figure 2 comprises four panels for 2011, 2013, 2015, and 2017. The north-western districts and three main districts in the Kathmandu valley (including Kathmandu, Bhaktapur, and Lalitpur) have less international labor migration compared to the eastern part of Nepal. We also develop a similar plot for male and female international labor migration in Appendix A.

In Figure 2, compared to 2011, there is an increase in total international labor migra-

Figure 2: Spatio-temporal variation of total international labor migration to the 100,000 population



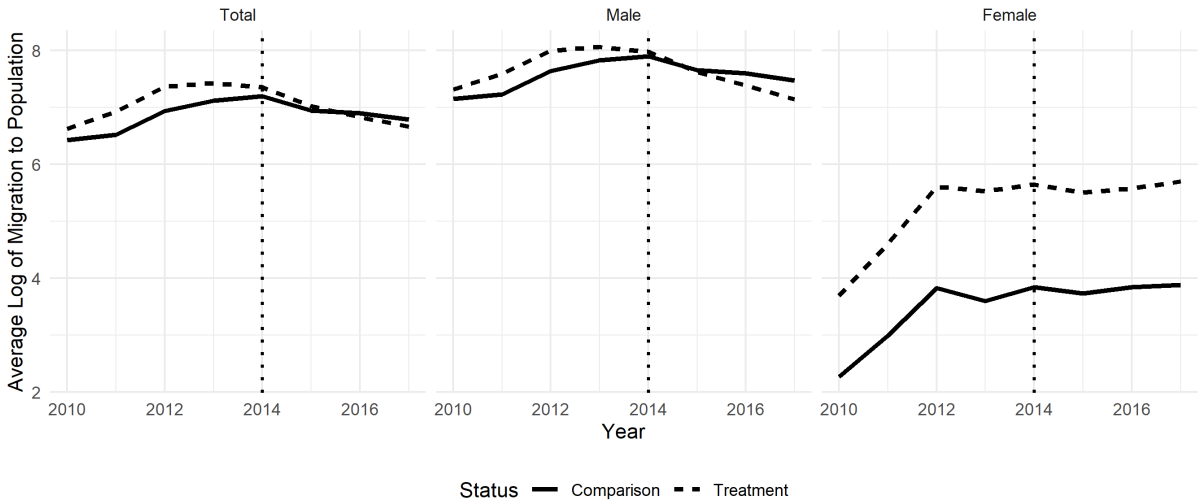
Notes: The top points toward North direction.

tion per 100,000 population in 2013. There are district-level heterogeneities. For years 2015 and 2017, we observe a decline in total international labor migration. Potentially, two explanations might explain such trends. The first explanation is the change in population size compared to the labor migration. The World Bank reports negative annual population growth rate of Nepal for year 2012 (-2%), 2013 (-1%), 2014 (≈0%) and positive annual population growth rate for year 2015 (0.4%), 2016 (0.9%), 2017 (1.3%). The second explanation is that the migration rate itself is declining over time.

In Figure 3, we show how the average trend of international labor migration among districts severely affected by the 2015 earthquake (treatment districts) is different from the other remaining unaffected districts (comparison / control districts).

Figure 3 exhibits the ratio of the average of the log of the total, male, and female migration to total, male, and female population (per 100,000) for both treatment districts and comparison districts from 2010/11 to 2016/17 Nepalese year. The dotted vertical

Figure 3: General trend of international labor migration per 100,000 population



Notes: Nepal government's NRA (2020) lists the severely affected districts as Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, Nuwakot, Okhaldhunga, Ramechhap, Rasuwa, Sindhuli, and Sindhupalchok. We define the severely affected districts as the treatment group and the remaining districts as the comparison group. The dotted vertical line represents the fiscal year 2014/15, and the earthquake occurred in June 2015.

line represents the fiscal year 2014/15, and the earthquake occurred in June 2015. Figure 3 exhibits the parallel trend of migration for treatment and comparison districts for the pre-earthquake period. However, in post-earthquake periods, there is some divergence of overall and male migration. The female migration does not appear to be affected by the earthquake. We further examine these relationships with the DID FE and IFE models in the next Table 1.

6.2 Main results

Table 1 provides three panels, each representing the estimates of the impact of the 2015 Nepal earthquake on total migration (Panel A), male migration (Panel B), and female migration (Panel C). Each panel comprises two different models. First is the difference-in-difference model with district and year level fixed-effects (DID FE), and second is the interactive fixed-effect model (IFE) in columns (1) and (2), respectively. Treatment indicator or the post-earthquake is represented as D as shown in equation 1 and 2. To account for the intra-district correlation, we clustered the standard error at the district

Table 1: Effect of earthquake in international labor migration per 100,000 population

Variables	Panel A Total Migration		Panel B Male Migration		Panel C Female Migration	
	DID FE (1)	IFE (2)	DID FE (1)	IFE (2)	DID FE (1)	IFE (2)
D	-0.321***	-0.378***	-0.401***	-0.414**	0.096	-0.164
	(0.057)	(0.074)	(0.061)	(0.112)	(0.070)	(0.120)
Intercept		6.922***		7.613***		3.838***
		(0.100)		(0.103)		(0.160)
District FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Factor		1		1		1
HC Robust SE	✓		✓		✓	
Bootstrap SE		✓		✓		✓
Observations	600	600	600	600	600	600

Notes: Nepal government's NRA (2020) lists the severely affected districts as Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, Nuwakot, Okhaldhunga, Ramechhap, Rasuwa, Sindhuli, and Sindhupalchok. We define the severely affected districts as the treatment group and remaining 61 districts of Nepal as comparison group. The dependent variable is logarithmic transformation of the ratio total international labor migration per 100,000 population, hence estimates can be interpreted as $\%\Delta y = (e^{\delta} - 1) \times 100$.

level for all models. The standard errors are also robust to heteroskedasticity for DID FE. However, we generate standard errors based on nonparametric bootstraps (blocked at the district level) of 2,000 times for IFE. In the IFE model, the intercept shows the average value of migration among the comparison district. In contrast, the treatment effect shows how much the migration level differs in treatment districts regarding comparison districts.

The DID FE estimates in Panel (A) column (1) exhibit a treatment effect of -0.321, which translate $\approx (e^{-0.321} - 1) \times 100 \approx -27.458\%$ overall reduction of total international labor migration per 100,000 population in the post-earthquake period among treated districts to comparison districts.

The 1996 Moist civil war induces international labor migration in Nepal, along with the country's week economic performance and substantial cheap labor demand by Malaysia, Singapore, and other countries. Hence there is a natural trend or inertia in the migration. **(Subuna Check this and put some context and stats here.)**

We can consider this nationwide natural trend or inertia in the migration as time-varying unobserved heterogeneity in our data. We can use the IFE model to capture such a national trend in migration in which different districts are either more or less susceptible, depending on the unobservable characteristics of those districts. The IFE estimates projects slightly more robust estimates than the DID FE but in the same direction. The IFE estimates in Panel (A) column (2) provides estimates of $-0.378 \approx (e^{-0.378} - 1) \times 100 \approx -31.477\%$, suggesting a reduction of total migration per 100,000 population in the severely affected district from earthquake compared to comparison districts. We have made further analysis of nationwide natural trend or inertia in the migration and district-level susceptibility to such a national trend in Figure 4 and 5.

Second, migration varies structurally between males and females in Nepal. Male are primary breadwinners, and women have equally important household chores and care for the family, mainly children and the elderly. For this matter, we produce Panel B and Panel C to investigate how male and female international labor migration are affected. The table structure is the same as Panel A.

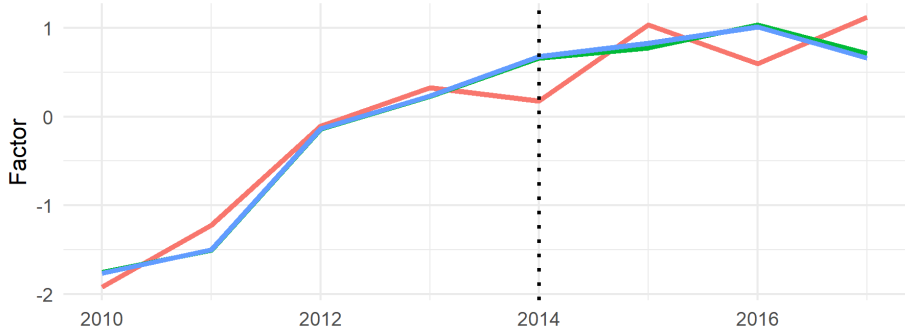
Panel B provides estimates of male international labor migration estimates. The DID FE and IFE converge to the statistically significant similar estimate of $-0.40 \approx (e^{-0.40} - 1) \times 100 \approx -32.968\%$, indicating a considerable reduction of male international labor migration per 100,000 population in the severe earthquake-affected district compared to a comparison district. However, the results in Panel C, in which estimates of female international labor migration are inconsistent with DID FE and IFE being statistically insignificant, suggesting that female labor migration possibly remains unaffected.

6.3 Nationwide non-linear trend and district-level intercepts

In each IFE model in Table 1, we try to capture nonlinear nationwide natural trend or inertia in the migration and the district level susceptibility to such a nationwide trend. we explain these concepts further in Figure 4 and 5 respectively.

Figure 4 presents the nonlinear nationwide trend in the total, male, and female inter-

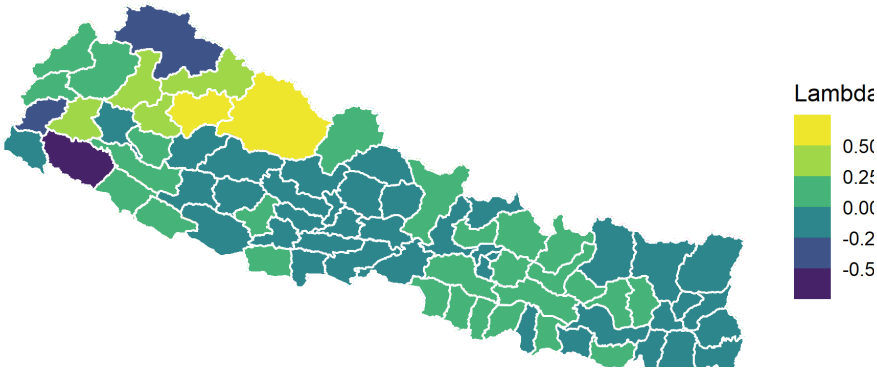
Figure 4: Factor: nationwide non-linear trend of international labor migration



Notes: Nepal government's NRA (2020) lists the severely affected districts as: Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, Nuwakot, Okhaldhunga, Ramechhap, Rasuwa, Sindhuli, and Sindhupalchok. We define the severely affected districts as treatment group and remaining districts as comparison group. The dotted vertical line classify before- and after-2015 earthquake.

national labor migration per 100,000 population. It appears these trends are increasing at a decreasing rate. The female international migration trend seems to follow annual cyclical behavior. However, total and male international labor migration appears to follow the same trajectory. Though there is this national trend, different districts are differently susceptible to the national trend, see Figure 5.

Figure 5: Lambda: district-level intercept of the nationwide non-linear trend of total international labor migration per 100,000 population



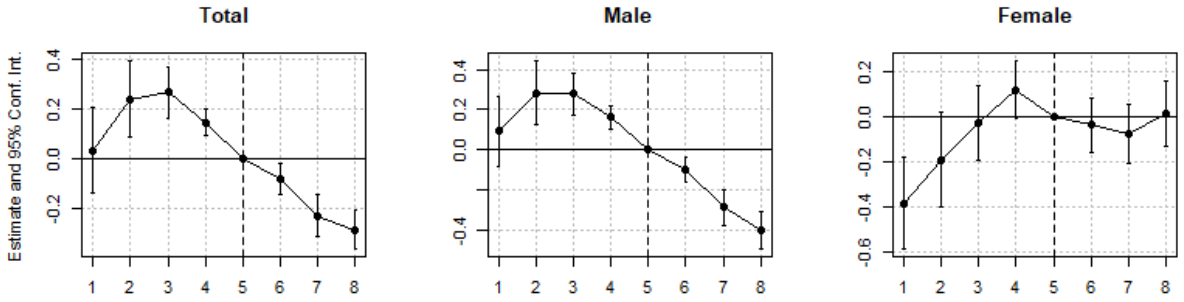
Notes: Nepal government's NRA (2020) lists the severely affected districts as Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, Nuwakot, Okhaldhunga, Ramechhap, Rasuwa, Sindhuli, and Sindhupalchok. We define the severely affected districts as the treatment group and remaining districts as a comparison group.

Figure 5 provides a cheolerpetra map of district-level susceptibility to the nonlinear

national trend in migration. These are in relative scales. District with darker/lighter color is less/more susceptible to the nationwide trend depending upon the district level unobservables.

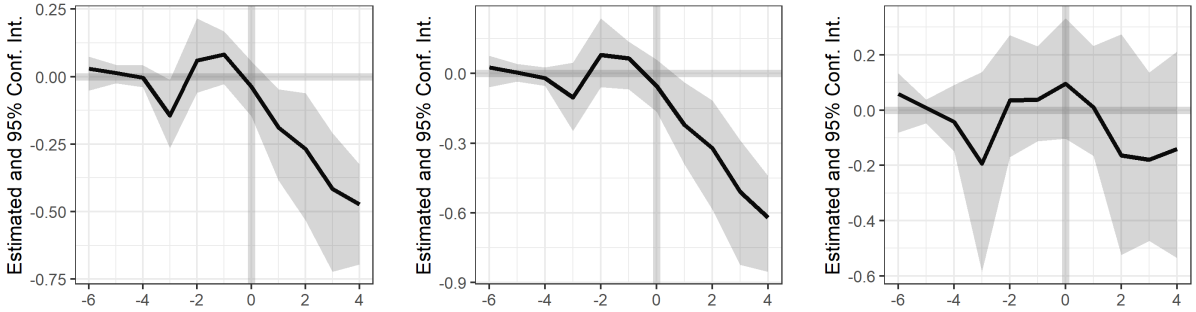
6.4 Event study

Figure 6: General trend of international labor migration per 100,000 population, Event-study (total female same, mistake



Notes: Nepal government's NRA (2020) lists the severely affected districts as Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, Nuwakot, Okhaldhunga, Ramechhap, Rasuwa, Sindhuli, and Sindhupalchok. We define the severely affected districts as the treatment group and the remaining districts as the comparison group. The dotted vertical line represents the fiscal year 2014/15, and the earthquake occurred in June 2015.

Figure 7: Event Study with Interactive Fixed Effect



(a) Total **(b)** Male **(c)** Female

Notes: Nepal government's NRA (2020) lists the severely affected districts as: Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, Nuwakot, Okhaldhunga, Ramechhap, Rasuwa, Sindhuli, and Sindhupalchok. First-order contiguous of severely affected districts are Bara, Chitawan, Dhanusa, Khotang, Lamjung, Mahottari, Manang, Parsa, Rautahat, Sarlahi, Solukhumbu, Tanahu, and Udayapur. Second-order contiguous of severely affected districts are Bhojpur, Dhankuta, Kaski, Mustang, Myagdi, Nawalparasi, Palpa, Sankhuwasabha, Saptari, Siraha, Sunsari, and Syangja. Our analysis excludes Bhaktapur, Kathmandu, and Lalitpur districts. These districts belongs to core cities within proximity of the capital city Kathmandu, and withing Kathmandu valley.

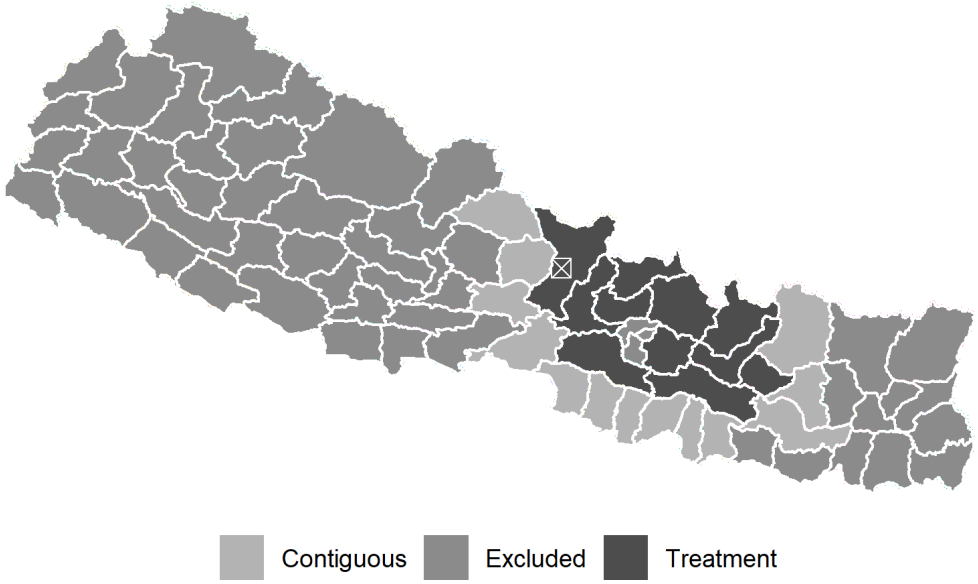
6.5 Comparing neighboring districts

In the analysis in Table 1, this identification strategy compares the international labor migration of severe earthquake-affected districts with all the remaining districts. However, the district's international labor migration far away from the earthquake epicenter is plausible to be less affected. Furthermore, this division of treatment and comparison districts are based on the NRA (2020) classification. However, the tremors of the earthquake know no district boundaries. In addition to that, Kathmandu, Bhaktapur, and Lalitpur districts are listed as severely affected districts, but these districts are less reliant on international labor migration. For that matter, in the following analyses, we try to falsify the main results. For this, we utilize a different identification strategy. Unlike in the main results, here we change the comparison and treatment district; see Figure 8.

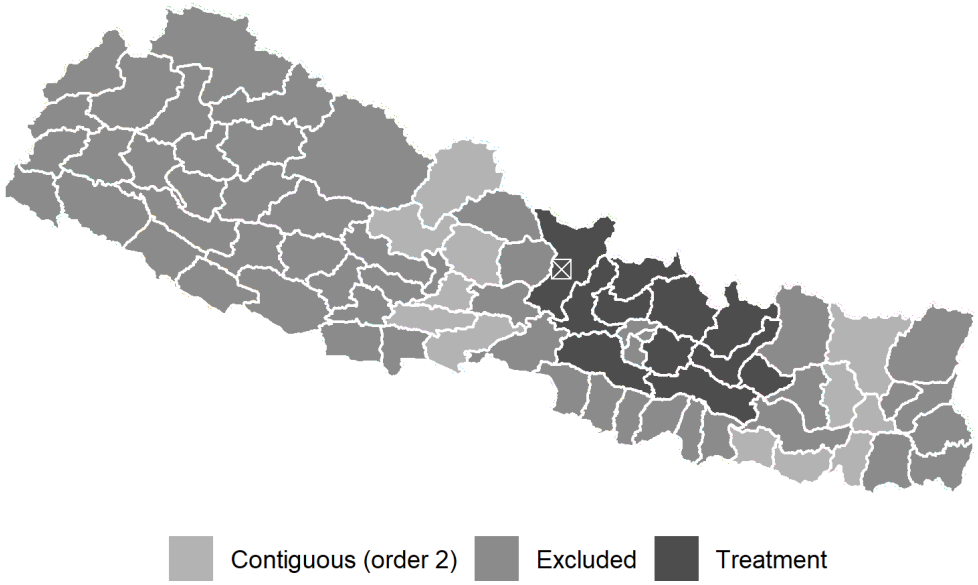
Figure 8, we graphically depict the redefinition of treatment and comparison district. Here, we define the treatment districts as per the definition of NRA (2020); however, we exclude Kathmandu, Bhaktapur, and Lalitpur districts. For the comparison, we only consider the districts contiguous with the treatment districts rather than taking the remaining districts. Then we exclude all other districts from the analysis. This allows preventing the selection bias induced either from including the district, and those are far away from the epicenter, or including districts like Kathmandu, Bhaktapur, and Lalitpur. Then we re-estimate DID FE and IFE model for total, male, and female international labor migration per 100,000 in Table 2.

Table 2 follows same structure as Table 1. The DID FE estimates for total migration and male migration are -0.245 and -0.299. Both are statistically significant, suggesting reducing the total and male international labor migration in the districts contiguous to severely earthquake-affected districts. These estimates are not as pronounced as the estimates from Table 1. Still, they are more likely to free from selection bias induced either from including the district far away from the epicenter or districts like Kathmandu, Bhaktapur, and Lalitpur. Thus, the falsification analysis seems to support the existing hypothesis, i.e., sudden environmental event reduces the outflow of international labor

Figure 8: Spatial identification strategy



(a) Comparison of severely affected districts versus. first-order contiguous district



(b) Comparison of severely affected districts versus second-order contiguous district

Notes: Nepal government's NRA (2020) lists the severely affected districts as: Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, Nuwakot, Okhaldhunga, Ramechhap, Rasuwa, Sindhuli, and Sindhupalchok. First-order contiguous of severely affected districts are Bara, Chitawan, Dhanusa, Khotang, Lamjung, Mahottari, Manang, Parsa, Rautahat, Sarlahi, Solukhumbu, Tanahu, and Udayapur. Second-order contiguous of severely affected districts are Bhojpur, Dhankuta, Kaski, Mustang, Myagdi, Nawalparasi, Palpa, Sankhuwasabha, Saptari, Siraha, Sunsari, and Syangja. Our analysis excludes Bhaktapur, Kathmandu, and Lalitpur districts. These districts belongs to core cities within proximity of the capital city Kathmandu, and withing Kathmandu valley.

Table 2: Effect of earthquake in the international labor migration, severely affected districts vs. first-order contiguous districts

Variables	Panel A Total Migration		Panel B Male Migration		Panel C Female Migration	
	DID FE (1)	IFE (2)	DID FE (1)	IFE (2)	DID FE (1)	IFE (2)
D	-0.245***	-0.275	-0.299***	-0.280	0.040	-0.010
	(0.067)	(0.323)	(0.070)	(0.311)	(0.076)	(0.181)
Intercept		7.365***		8.019***		4.711***
		(0.111)		(0.102)		(0.234)
District FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Factor		1		1		1
HC Robust SE	✓		✓		✓	
Bootstrap SE		✓		✓		✓
Observations	192	192	192	192	192	192

Notes: Nepal government's NRA (2020) lists the severely affected districts as Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, Nuwakot, Okhaldhunga, Ramechhap, Rasuwa, Sindhuli, and Sindhupalchok. We define the severely affected districts as the treatment group and remaining 61 districts of Nepal as comparison group. The dependent variable is logarithmic transformation of the ratio total international labor migration per 100,000 population, hence estimates can be interpreted as $\%\Delta y = (e^{\delta} - 1) \times 100$.

migration in disaster-prone and labor exporting developing countries like Nepal. The IFE models are less suited in this analysis because we only include the sub-sample. Hence, incorporating a nationwide trend using sub-sample analysis is not adequate.

We now incorporate second-order neighbors in the comparison group within the same logic and re-run the DID FE and IFE model. See Table 3. We see the effects are even less pronounced about -0.161 and -0.219 for total and male labor migration.

6.6 Placebo

Next, we present a placebo analysis to evaluate the significance of the results for the treated district. We randomize the treatment. Suppose the actual treatment-effect is significantly far-away from the mean distribution of the post-treatment differences of the randomized treated district (placebo district). In that case, there is strong evidence that

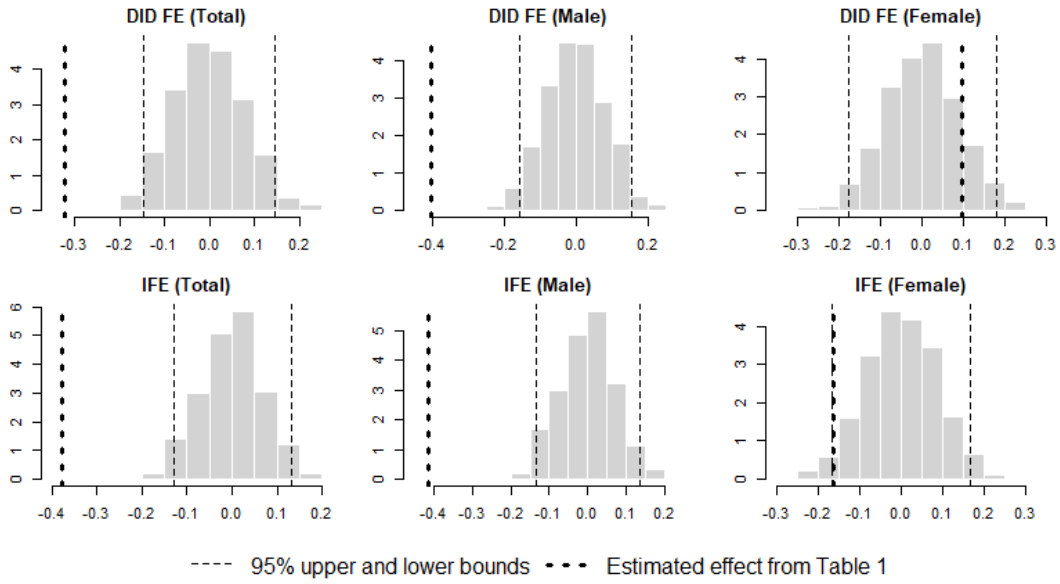
Table 3: Effect of earthquake in the international labor migration, severely affected districts vs. second-order contiguous districts

Variables	Panel A Total Migration		Panel B Male Migration		Panel C Female Migration	
	DID FE (1)	IFE (2)	DID FE (1)	IFE (2)	DID FE (1)	IFE (2)
D	-0.161***	-0.770**	-0.219***	-0.426***	0.122	0.030
	(0.057)	(0.465)	(0.057)	(0.359)	(0.110)	(0.643)
Intercept		7.187***		7.943***		4.805***
		(0.144)		(0.131)		(0.299)
District FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Factor		1		1		1
HC Robust SE	✓		✓		✓	
Bootstrap SE		✓		✓		✓
Observations	192	192	192	192	192	192

Notes: Nepal government's NRA (2020) lists the severely affected districts as Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, Nuwakot, Okhaldhunga, Ramechhap, Rasuwa, Sindhuli, and Sindhupalchok. We define the severely affected districts as the treatment group and remaining 61 districts of Nepal as comparison group. The dependent variable is logarithmic transformation of the ratio total international labor migration per 100,000 population, hence estimates can be interpreted as $\%\Delta y = (e^{\delta} - 1) \times 100$.

the earthquake had more likely affected foreign labor migration.

Figure 9: Placebo Tests



Notes: Placebo estimates are based on 999-runs, where we randomized the treatment.

We find DID FE (except for female) and IFE estimates from Table 1 are below 2.5% quantiles of placebo treatment effect distribution, suggesting strong evidence that earthquake had significantly reduced the foreign labor migration. However, the effect is not quite pronounced among females.

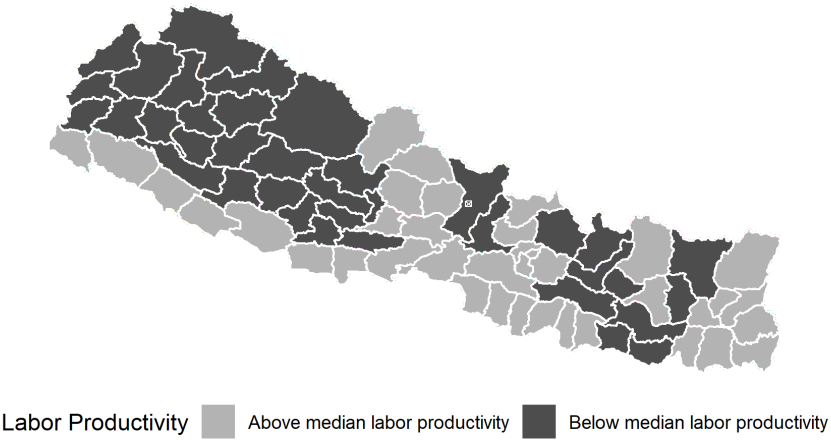
6.7 Exclusion of Terai

Table 4: Effect of earthquake in the international labor migration, severely affected districts excluding Terai districts

Variables	Panel A Total Migration		Panel B Male Migration		Panel C Female Migration	
	DID FE (1)	IFE (2)	DID FE (1)	IFE (2)	DID FE (1)	IFE (2)
D	-0.342***	-0.355***	-0.419***	-0.377**	0.043	-0.190
	(0.068)	(0.072)	(0.072)	(0.131)	(0.084)	(0.116)
Intercept		6.884***		7.574***		4.004***
		(0.131)		(0.135)		(0.202)
District FE	✓	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
Factor		1		1		1
HC Robust SE	✓		✓		✓	
Bootstrap SE		✓		✓		✓
Observations	192	192	192	192	192	192

Notes: Nepal government's NRA (2020) lists the severely affected districts as Bhaktapur, Dhading, Dolakha, Gorkha, Kathmandu, Kavrepalanchok, Lalitpur, Makwanpur, Nuwakot, Okhaldhunga, Ramechhap, Rasuwa, Sindhuli, and Sindhupalchok. We define the severely affected districts as the treatment group and remaining 61 districts of Nepal as comparison group. We exclude Terai districts of Nepal from the comparison districts as Banke, Bara, Bardiya, Chitawan, Dang, Dhanusa, JhapaKailali, Kanchanpur, Kapilbastu, Mahottari, Morang, Nawalparasi, Parsa, Rautahat, Rupandehi, Saptari, Sarlahi, Siraha, Sunsari. The dependent variable is logarithmic transformation of the ratio total international labor migration per 100,000 population, hence estimates can be interpreted as $\%\Delta y = (e^{\delta} - 1) \times 100$.

Figure 10: Labor productivity



Notes: White dot marks the epicenter of April 2015 Nepal Earthquake in the eastern side of the Gorkha District at Barpak, Gorkha. District with above median labor productivity are Banke, Bara, Bardiya, Bhaktapur, Chitawan, Dang, Dhankuta, Dhanusa, Ilam, Jhapa, Kailali, Kanchanpur, Kapilbastu, Kaski, Kathmandu, Kavrepalanchok, Khotang, Lalitpur, Lamjung, Mahottari, Makwanpur, Manang, Morang, Mustang, Nawalparasi, Nuwakot, Panchthar, Parsa, Rasuwa, Rautahat, Rupandehi, Sarlahi, Solukhumbu, Sunsari, Syangja, Tanahu, Taplejung, and Terhathum.

6.8 Triple difference-in-difference

7 Discussion and conclusion

Human migration, as a response to environmental events, has been studied and accepted by so many academics (Queiroz et al., 2019; Koubi et al., 2016; Paul, 2005; Raleigh et al., 2008). Despite the progress, the pattern of the human decision on the international labor migration as a response to sudden disasters has often been missed out from the empirical analysis on environmental migration. Because of this gap, there is only limited knowledge on "how does a sudden disaster impact on the country's existing labor outflow in general?" making it unsettling for the labor market policy planning before and in the aftermath. As a lack of availability of accurate and detailed data is a common challenge that researchers often face in the context of disaster-prone developing countries, the response pattern in those countries is even more difficult to understand.

Thus, this research gathers and analyse various related academic literature and facts and points out the complex, multi-disciplinary pattern of causality. It points out that

Table 5: Triple difference-in-difference estimates,

	Dependent variable: Average labor migration		
	Total	Male	Female
	(1)	(2)	(3)
treat	1.063***	1.028***	2.544***
	(0.350)	(0.365)	(0.470)
post	0.299	0.293	0.684**
	(0.215)	(0.224)	(0.289)
productivity	0.651***	0.606***	1.285***
	(0.213)	(0.223)	(0.287)
treat × *post*	−0.361	−0.420	0.051
	(0.494)	(0.516)	(0.664)
productivity × *post*	−0.185	−0.198	−0.064
	(0.302)	(0.315)	(0.405)
productivity × *treat*	−1.454***	−1.490***	−1.695**
	(0.494)	(0.515)	(0.663)
treat × *post* × *productivity*	0.077	0.035	0.088
	(0.698)	(0.728)	(0.938)
Intercept	6.421***	7.156***	2.521***
	(0.152)	(0.159)	(0.204)
Observations	150	150	150
R^2	0.147	0.132	0.430
Adjusted R^2	0.105	0.089	0.402

Notes: We define the severely affected districts, as identified by Nepal government's NRA (2020), as the treatment group ($treat = 1$) and remaining 61 districts of Nepal as comparison group ($treat = 0$). The dependent variable is logarithmic transformation of the ratio total international labor migration per 100,000 population, hence estimates can be interpreted as $\%\Delta y = (e^{\delta} - 1) \times 100$. We group the dependent variable before ($post = 0$) and after ($post = 1$) earthquake and took average of the dependent variable. Within these districts, we also group below median ($productivity = 0$) and above median ($productivity = 1$) labor productivity districts. The coefficient of $treat \times post$ is difference-in-difference estimates and $treat \times post \times productivity$ is triple difference-in-difference estimates.

neo-classical economic argument on environmental migration might influence, as well as discourage international labor migration. In addition, this paper also calls attention to various cross-cutting multi-causal influences on the individual's decision to post-sudden

disaster international labor migration in the context of a disaster-prone developing country. After careful considerations and critical analysis on the existing knowledge, it assumes that in overall, sudden environmental events might affect adversely rather than positively to the outflow of international labor migration especially in the case of disaster-prone labor exporting developing countries like Nepal.

To empirically test the derived hypothesis, this research gathers relevant data from various official sources and analyses three different frameworks; Difference-in-difference (DID), Difference-in-difference with district and year fixed-effects (FE DID), and Difference-in-difference with the interactive fixed-effect (IFE). With the Difference-in-difference model, first of all, it examines the simple correlation between treatment and outcome variables, and do not account for the district and year fixed-effects. Secondly, to address the lack of availability of the district-level data, it uses the Difference-in-difference technique with district and year fixed-effects (FE DID) which removes the omitted variable bias. Thirdly, it uses a two-way fixed-effect augmented with interactive fixed-effect to control for the nationwide time trends in the dependent variable. Finally, it uses all three frameworks to examine the relationship between 2015 earthquake on Nepal's total out-migration (A), male migration (B), and female migration (C) respectively.

In model (A), the Difference-in-difference technique with district and year fixed-effects (FE DID) and most importantly, a two-way fixed-effect augmented with interactive fixed-effect (IFE) showed a statistically significant relationship between the dependent and independent variables. It suggested that there was an overall reduction on the outflow of the international labor migration among highly affected districts in comparison to other remaining districts in the post-earthquake Nepal. However, the Difference-in-difference technique (DID) showed a treatment effect of 0.09 with an unexplained flip in the sign. Similarly, in the model (B), the second (FE DID) and third (IFE) techniques exhibited a considerable reduction of male international labor migration in the severely earthquake affected district compared to comparison districts. Unlike in model (A), the signs were consistent across models, but the DID estimates were statistically insignificant. In con-

trast to these, model (C) showed a statistically insignificant relationship between the variables suggesting that female labor migration remains unaffected.

Likewise, this paper provides empirical evidence on the adverse impact of a sudden disaster on and the existing international male labor migration trend, where as no significant effect on the female out-migration. labor migration is an important phenomenon in Nepal's history, and it also has a significant contribution on the country's economy. However it is a disaster-prone developing nation and have been facing big scale environmental catastrophe in the the past. These unique and crucial components made Nepal a suitable case for the study of the impact of sudden environmental events on a country's existing international labor migration trend. However, policymakers in this niche (for example many other countries in South Asia who share similar characteristics such as Bangladesh, Srwe Lanka, Pakistan, and India) can refer to the knowledge from this research, while forming post-disaster international labor migration policies.

Findings might be indicating the need for facilitation in creating in-house employment and income opportunities rather than expecting the out migration. It further suggests that these findings may apply to potential male foreign labor migrant but there must be a separate and unique approach while addressing the prospective female migrants. In the future, this research can be expanded to cross-national level, including other countries in the respective niche. Additionally, this research can be expanded across the range of other variables such as caste, ethnicity, and age group could be added to the study.

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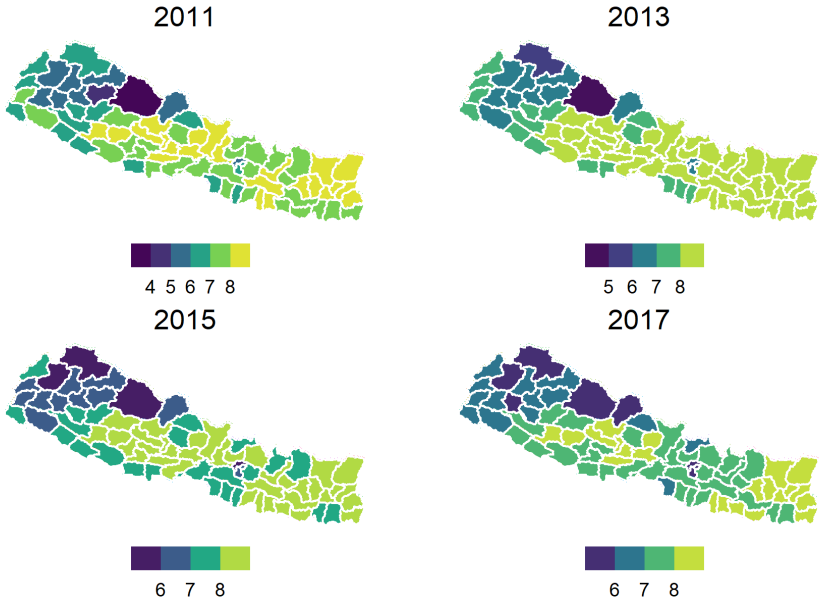
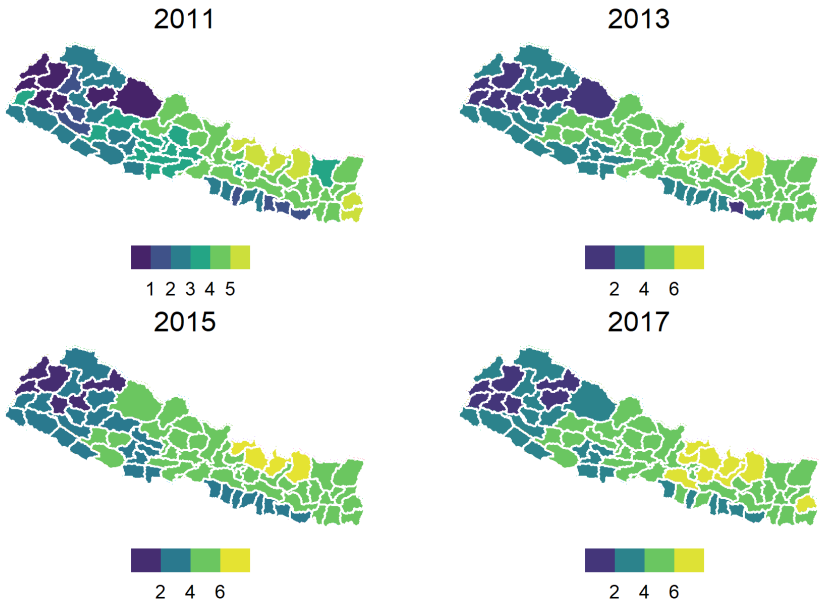
A Appendix A

Figure A1: Spatio-temporal Variation of Foreign Labor Migration (Male) to the Population



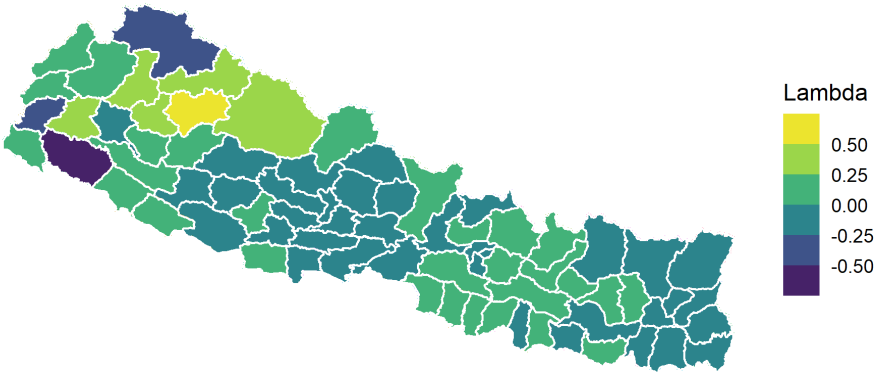
Notes:

Figure A2: Spatio-temporal Variation of Foreign Labor Migration (Female) to the Population



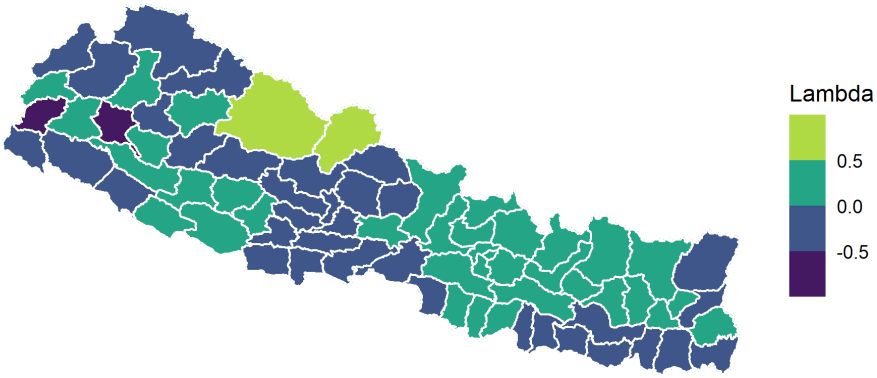
Notes:

Figure A3: Lambda: District Level Susceptibility on the Nationwide Non-linear Inertia of Foreign Labor Migration, Male.



Notes: Nepal government's NRA (2020) lists the severely affected districts as: Okhaldhunga, Dolakha, Ramechhap, Sindhupalchok, Kavrepalanchok, Sindhuli, Bhaktapur, Kathmandu, Lalitpur, Rasuwa, Nuwakot, Dhading, Gorkha, and Makwanpur. We define the severely affected districts as treatment group and remaining districts as comparison group. The Dotted horizontal line

Figure A4: Lambda: District Level Susceptibility on the Nationwide Non-linear Inertia of Foreign Labor Migration, Female.



Notes: Nepal government's NRA (2020) lists the severely affected districts as: Okhaldhunga, Dolakha, Ramechhap, Sindhupalchok, Kavrepalanchok, Sindhuli, Bhaktapur, Kathmandu, Lalitpur, Rasuwa, Nuwakot, Dhading, Gorkha, and Makwanpur. We define the severely affected districts as treatment group and remaining districts as comparison group. The Dotted horizontal line