



# Does Migration Support Technology Diffusion in Developing Countries?

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**Summary.** — The spread of mobile phones in developing countries is a technological success story. Mobile phones' independence of landline telecommunication networks qualifies them for information exchange even in remote rural areas. Whereas technology spillovers via international trade and foreign direct investment have been widely explored by the literature, international migration and rural–urban migration have hardly been explored as vehicles for technology diffusion. Motivated by the current extent of national and international migration, this paper addresses this lacuna. It draws upon data from rural households in Thailand, Vietnam, Laos, and Cambodia and uses households' mobile phone ownership as an indicator for rural technology diffusion. Migration is modeled via an endogenous treatment regression approach. In a number of robustness checks, the variables, the sample, and the estimation technique are varied. The results provide empirical evidence for rural technology diffusion. In the survey areas, poverty-driven rural–urban migration and related technology diffusion play a more important role than technology spillovers via international migration. The results show that total emigration as well as immigration can support technology diffusion, i.e., the dispersion of mobile phones, beyond monetary remittances. When controlling for education and household age (in a squared fashion) in the main regressions and in several robustness checks, emigration as well as immigration, however, exhibit a negative effect on households' mobile phone ownership (“technology drain” or “technology impair” effect). For development policy, the results suggest investments in education and the creation of financial opportunities to support rural technology diffusion.

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**Key words** — mobile phones, rural–urban migration, international migration, technology diffusion, rural development, Southeast Asia

## 1. INTRODUCTION

The worldwide dispersal of mobile phones (Banerjee & Ros, 2004) has been an extraordinary example for fast and widespread international and national technology diffusion. This includes the African continent in particular (cf. Aker & Mbiti, 2010; Buys, Dasgupta, & Thomas, 2009; Muto & Yamano, 2009) and developing countries in general. Mobile phones enable not only communication, i.e., information exchange, but also basic financial transactions without the necessity to possess a bank account.<sup>1</sup> Their relatively low prices and their independence of landline information networks and electricity grids qualify mobile phones even for remote rural areas of developing countries. Therefore, mobile phones might enhance economic efficiency and foster rural economic development.

Against this background, this paper explores drivers of international and national technology diffusion. Technology diffusion is represented by the spread of mobile phones in the rural Mekong region. We presume that *socio-technological*<sup>2</sup> linkages via international migration and national rural–urban migration contribute to technology diffusion. Specifically, we suppose that *immigrants* who come from urban places in the same country or from abroad take new technologies or knowledge about such technologies to rural villages. Likewise, *emigrants* from rural villages who move to cities or to other countries likely stay in contact with their relatives and friends in their home villages. They are supposed to return monetary remittances which may reduce poverty and inequality in their home countries (Acosta, Calderón, Fajnzylber, & Lopez, 2008; Adams & Page, 2005; Ziesemer, 2012). They may also return non-monetary remittances which can have socio-economic impacts (Clemens, Özden, & Rapoport, 2014; Licuanan, Omar Mahmoud, & Steinmayr, 2015). In our context, non-monetary remittances can occur in the form of modern technical devices and in the form of knowledge about these devices

and their application possibilities. Specifically, we use the spread of mobile phone ownership across households as a measure for rural technology diffusion. Based on this reasoning, we hypothesize that migration may positively affect technology diffusion. On the contrary, we hypothesize that migration can also negatively affect technology diffusion when knowledgeable technology users leave a household (“technology drain” effect) or when non-technology users join a household (“technology impair” effect). In this context, *education* and technological *knowledge* as well as the age of migrants and their related rural households are supposed to affect technology diffusion. Migrants are supposed to foster technology diffusion via education, but the departure of young, educated emigrants can also create a “technology drain” or “brain drain” effect.

In the econometric model, we take possible endogeneity of migration, in particular via self-selection of migrants, into account. Furthermore, we model rural technology diffusion in the form of spatial correlation. We control for remittances in order to disentangle technology transfers and financial transfers. For the regression analysis, we draw upon novel

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survey data on rural households living in the Southeast Asian Mekong area in the countries Thailand, Vietnam, Laos, and Cambodia. We carry out a number of robustness checks with different variables, samples, and estimation techniques.

In the results, positive and highly significant spatial correlation of mobile phone ownership within districts reveals rural technology diffusion across villages and households. The results suggest that total emigration as well as immigration can support technology diffusion, i.e., the dispersion of mobile phones, beyond monetary remittances. The regional destination of rural emigrants respectively the regional origin of immigrants matter for technology diffusion. In our data, poverty-driven rural–urban migration plays a more important role than international migration. When controlling for education and household age (in a squared fashion) in the main regressions or when carrying out robustness checks, emigration as well as immigration often exhibit a negative effect on households' mobile phone ownership. This observation shows that positive technology spillovers from migration are no automatism, but depend on preconditions such as education, in accordance with the diverse findings of the related macroeconomic literature.

Compared to the literature on international technology diffusion (e.g., Mazumdar, 2001; Saggi, 2002) the following paper studies a new and apparently important transmission channel of technology diffusion in developing countries: migration. Whereas the literature has explored the interconnection between migration and social networks (cf. Boyd, 1989) as well as diaspora networks (cf. Kuznetsov, 2006; Licuanan *et al.*, 2015), the nexus between migration and technology is a new aspect (cf. the review by Clemens *et al.*, 2014). Kapur (2001) as a notable exception discusses the linkage between diasporas and technology transfer. Compared to the vast literature on the “brain drain” effect (cf. Commander, Kangasniemi, & Winters, 2004), the present paper does not study the effects of migration on human capital, national income or the like, but on practical technology use. We may call this the “technology drain” effect. With respect to technology use, the paper contributes to the literature on the determinants of mobile phone use, the spread of ICT (information and communication technologies) in developing countries and the digital divide, which has so far focused on Africa and occasionally India (Aker, 2010; Buys *et al.*, 2009; Heeks, 2010; Howard & Mazaheri, 2009; Jensen, 2007; Muto & Yamano, 2009; Tadesse & Bahiigwa, 2014<sup>3</sup>). Regarding this literature, our survey area, Southeast Asia, has hardly been researched in the context of ICT or technology diffusion (Hübler, 2015, using village-level data as an exception).

The paper proceeds as follows. Section 2 formulates testable hypotheses. Section 3 explains the econometric model that addresses endogeneity of migration with the help of a two-stage setup. Section 4 sketches country profiles and describes the household-level data collected in Southeast Asia. Section 5 explains the estimation technique. Section 6 presents and interprets the main results as well as the results of seven robustness checks. Section 7 concludes.

## 2. HYPOTHESES

The focus of the analysis is on the role of *migration in rural technology diffusion*. Migration is measured in the form of emigration or immigration including rural–urban migration (from or to an urban area, the capital city or another province) or international migration. Technology diffusion and dispersion (used as synonyms) are measured in the form of mobile phone

ownership by rural households. To this end, we formulate the following testable hypothesis.

**Hypothesis 1.** Emigration or immigration positively affects technology dispersion.

The economic rationale is that migration creates *socio-technological linkages* which support technology diffusion and dispersion. These linkages can occur via information exchange about new technologies, in this case mobile phones, between migrants and their relatives and friends at their places of origin and their destinations. From the viewpoint of a rural household, this applies to emigration as well as immigration. In this context, *education* and the age of migrants and/or their related rural households are expected to affect knowledge flows and technology diffusion. In combination with financial remittances or with other financial sources, knowledge about new technologies can be applied to purchase and utilize such technologies. Socio-technological linkages can also occur via the physical transfer of modern technologies such as mobile phones. Furthermore, the occurrence of migrants makes the ownership of mobile phones more useful, because mobile phones give migrants the opportunity to communicate with their relatives and friends at home. We call these linkages socio-technological, because a technological relation or impact is related to a social relation within a social network. Notwithstanding, migration may also exhibit detrimental effects as formulated by the following hypothesis.

**Hypothesis 2.** Emigration or immigration negatively affects technology dispersion.

Besides creating socio-technological linkages, *emigration* implies the departure of human beings together with their knowledge, abilities, and in this context especially *technologies* from their place of origin. In this way, emigration can reduce rural technology diffusion. In analogy to the “brain drain” effect of migration, let us call this relation “*technology drain*” effect. The difference to the “brain drain” effect is the focus on practical technology use, in the following specifically measured as the spread of mobile phones. As discussed above, migrants are supposed to foster technology diffusion in connection with education, but the loss of young, educated emigrants can also create a “technology or brain drain” effect. Likewise, if immigrants stem from low-income areas or countries, they may lack modern technologies. Thus, they can reduce the per capita technology use of their host households. Let us call this relation “*technology impair*” effect.

The two hypotheses contradict each other. Nevertheless, both argumentations put forward economic rationales that can be expected to coexist and to create a joint net effect. The measurement of this net effect is the empirical challenge, which the following analysis will address.

## 3. MODEL

To test the hypotheses we set up an econometric model as detailed in this section. The aim of our econometric endeavor is to show whether migration (within-country or cross-country emigration or immigration) of household members (in a wider sense) has an impact on households' mobile phone ownership (per capita). Herein, mobile phone ownership serves as an indicator for the dispersion of advanced technologies. Migration is not treated as a strictly exogenous regressor,

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