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Are smartphones smart for economic development?

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HIGHLIGHTS

- Household survey data from the Southeast Asian Mekong region.
- Two-equation estimation with endogenous treatment effects.
- Significant increase in per capita income via smartphone ownership.
- Need for support of modern communication technologies for economic development.

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ABSTRACT

Smartphones' independence of landline networks qualifies them for communication and Internet access in rural areas of developing countries. Drawing upon rural Southeast Asian survey data, this research provides probably the first econometric indication for smartphones' contribution to households' income.

1. Introduction

The worldwide spread of mobile phones has been an unprecedented technological success story. So far, the literature on developing countries has identified efficiency gains via mobile phone-based information exchange, which reduces search costs and promptly provides data on market prices (Jensen, 2007; Aker, 2010; Aker and Fafchamps, 2015; Tadesse and Bahiigwa, 2014), job opportunities, the weather, epidemics or riots (Aker and Mbiti, 2010). Furthermore, mobile devices may generate income gains by easing management and learning, enabling financial transactions, providing technical and medical consultation services, strengthening social networks and reducing the exposure to risk (Aker and Mbiti, 2010).

Meanwhile, the second generation of mobile devices, particularly smartphones, extends these possibilities via wireless Internet access and software applications ("apps").[1] The independence of landline data networks and electricity grids qualifies them for Internet access even in remote rural areas. Whether the advantages of smartphones contribute to rural techno-economic development is an open question. The following paper provides a first positive answer by studying the impact of smartphone ownership on rural households' income and modeling smartphone ownership as an endogenous treatment effect. It draws upon novel data from rural Southeast Asian[2] households.

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[1] Worldwide quarterly smartphone sales grew from 36 million to 300 million between 2009 and 2014 (Gartner Statista, 2015). Today half of the earth's adult population owns a smartphone; this figure is expected to increase to 80% by 2020 (The Economist, 2015).

[2] Thailand, Vietnam, Laos and Cambodia.

The paper contributes to the literature on the determinants and effects of mobile phones in developing countries, which has so far focused on Africa (e.g. Buys et al., 2009; Muto and Yamano, 2009; Howard and Mazaheri, 2009; Heeks, 2010) by introducing smartphones and Southeast Asia as novel aspects.

2. Model

We intend to explore whether a household's smartphone ownership can generate an income gain. Smartphone ownership is treated as endogenous, because it likely depends on households' wealth and other socio-economic and technological determinants. Therefore, we define two equations. The first equation describes the probability of smartphone ownership based on the following cross-sectional probit (treatment or selection) model:

$$S_h = \begin{cases} 1 & \text{if } \alpha_0 + \alpha_1 \cdot \bar{S}_d + \alpha_2 \cdot N_v + \underline{\alpha}_3 \cdot \underline{X}_h + \sum_p \gamma_{1p} + \varepsilon_{1h} > 0 \\ 0 & \text{otherwise.} \end{cases} \quad (1)$$

The index h denotes a household. S_h is a binary variable with $S_h = 1$ implying ownership of at least one smartphone. We define two instruments that fulfill the exclusion restriction and do not appear in the second equation, i.e., they do not affect households' income. First, we model rural technology diffusion via spatial correlation as the unweighted mean of smartphone ownership ($0 \leq \bar{S}_d \leq 1$) within administrative districts, d.[3] Second, we include the share of households with Internet access, N_v, in all households of the village, v, the household resides in. $\underline{X}_h$ represents a column-vector of control variables, which enters both equations. We estimate the overall constant, α_0, the coefficients, α_1, α_2, and $\underline{\alpha}_3$ (a row-vector), as well as the binary variables, γ_{1p}, defined for each province, p. ε_{1h} is the first error term.

The second equation explains the impact of smartphone ownership on households' income based upon the following linear, cross-sectional (outcome) model:

$$\log I_h = \beta_0 + \beta_1 \cdot S_h + \beta_2 \cdot M_h + \underline{\beta}_3 \cdot \underline{X}_h + \sum_p \gamma_{2p} + \varepsilon_{2h}. \quad (2)$$

I_h signifies the per capita value of a household's annual net income, which enters the equation in natural-logarithmic form. S_h is the endogenous smartphone variable explained above. We add a binary variable M_h with $M_h = 1$ implying ownership of at least one mobile phone. This allows us to test the advantages of smartphones in addition to mobile phones.[4] We estimate β_0, β_1, β_2 and $\underline{\beta}_3$ (a row-vector), as well as the province-specific effects, γ_{2p}. ε_{2h} is the second error term.

The vector $\underline{X}_h$ contains control variables. We expect household size to affect per capita income negatively. The need for possessing a smartphone, however, may rise in larger households. We add the average household age: whereas young people tend to generate low income, they tend to show high technological affinity. We also include the highest number of years spent on education by any household member. We reckon that better education improves skills and knowledge and hence raises income and technology (smartphone) affinity. Furthermore, we take affiliation to an ethnic majority into account to capture possible social or political privileges. We assume that households' standard occupation is subsistence farming and control for the number of household members engaged in off-farm- or self-employment with regard to possible income effects or the occupational use of smartphones. Available technologies, represented by the share of households with access to the electricity grid in all households in the village, v, may affect income and smartphone ownership (charging the smartphone). We utilize three wealth indicators to address possible endogeneity of smartphone ownership with respect to income. First, we include the total value of tangible assets (excluding any mobile phones). Second, households' self-judgment of their wealth relative to other households in the same village is measured with an index that increases in relative wealth. Third, we define a binary variable, which equals "one" when a household's income is above the average income of smartphone owners. With respect to income and smartphone ownership, we presume a positive effect of these three wealth indicators.

3. Data

We use novel data from household surveys in the rural Southeast Asian Mekong region referring to the time frame May 2012–April 2013. Besides three provinces in Thailand and three in Vietnam (Hardeweg et al., 2012), our data cover one province in Laos and one in Cambodia as new research areas. We include all four countries in our regressions and leave out one country at a time in a robustness check (Supplements A, E, see Appendix A). The data cover over 5000 households living in about 500 villages, which were selected via two-/three-stage stratified random sampling. The overrepresentation of poor households in Vietnam and Laos is corrected via sampling weights.

The survey data cover mobile phone ownership as well as the age and the value of the most recently bought mobile phone. This information allows us to determine whether a mobile phone belongs to the category of smartphones. We use the average price for smartphones fabricated in China including tariffs and taxes, equivalent to 2014-US[5]-$159, as the standard threshold price, above which a new mobile phone is deemed to be a smartphone. We explore a lower threshold price of 2014-US-$50 and an upper price of 2014-US-$253 as well (Supplement C, see Appendix A). The district average of smartphone ownership and the average income of smartphone owners are adjusted to the particular definition of smartphones.

The data show that smartphone ownership covers all survey regions and the sample's whole income distribution except very low incomes. The share of smartphone owners among all households based on the standard definition is two percent, whereas it is 12% based on the lower bound definition and below one percent based on the upper bound definition (Supplement A, see Appendix A, for descriptive statistics). In comparison, 88% of all households own a regular mobile phone (including smartphones). Drawing on our standard smartphone definition, smartphone-owning households receive an average annual income of 2005-PPP-$4672 per capita, whereas non-smartphone owners receive 2005-PPP-$1898.[6] We use a binary control variable for income to address this aspect (see Section 2).

4. Estimation

We check for correlations between regressors to be sufficiently low (Supplement B, see Appendix A). We find that the criteria for

[3] When calculating the district mean, we exclude the single household under scrutiny.

[4] Mobile phone ownership is excluded from the treatment equation, because it incorporates smartphone ownership per definition.

[5] United States (of America).

[6] The difference is significant with $p \approx 0$ according to a t-test.