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# Mobile Infrastructure and Rural Business Enterprises

## Evidence from Sim Registration Mandate in Niger

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## Abstract

Business enterprises and non-agricultural startups in rural economies play crucial roles in ending the vicious cycle of poverty. The propagation of business enterprises are, however, subject to a high degree of institutional frictions and vacuums e.g., information; but mobile infrastructure which has the externality of flowing information can help overcome most of these vacuums through reduced fixed costs, lower cost of information or search, and outreach to a broader customer base. This paper studies the effects of mobile infrastructure ("mobile use activity") on propagation of rural business enterprises in Niger. Instrumental variable estimates exploit the exogenous introduction of the 2013 national mandatory SIM registration reform which provides a quasi-experimental set-up for mobile use and activity. The mandate deactivated about one-third of all existing prepaid SIMs and led to a remarkable decline in mobile use activity. The results suggest that there is economically substantial effect of mobile infrastructure on propagation of business enterprises. Moving a household with mobile use activity to a no mobile use activity environment due to SIM deactivation results in roughly 33.1 percent points decline in the likelihood of engaging in non-agricultural business enterprises. Most of this effect come from three major sources: households' ownership of a business service or center; ownership of small income generating activities; and involvement in the transformation of agricultural products. There is suggestive evidence that the reform's impact is disproportionately larger for women. With the expansion of mandatory SIM registration reforms in developing countries, the findings have extended implications in these contexts.


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# MOBILE INFRASTRUCTURE & RURAL BUSINESS ENTERPRISES: EVIDENCE FROM SIM REGISTRATION MANDATE IN NIGER

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"These requirements present real 'access' difficulties for the most economically vulnerable individuals."

- **Regulatory Affairs' Head for Africa at Millicom International Cellular speaking about Africa's SIM registration revolution.** Donovan and Martin (2014).

## 1 INTRODUCTION

Examining the impacts of infrastructure e.g., road network, mobile telephony, freight railways, and other public and private services on economic and development outcomes in general can be challenging (Hansen et al. 2013; Tompsett 2013) for many reasons. First, the location and roll out of many infrastructure services are nonrandom and largely driven by the implied costs, demand side aspects and in some cases potential gains to the provider. For instance, locations with higher "potential" demand for mobile infrastructure are more likely to receive first hand network coverage in the case of mobile infrastructure. Similarly, central planners are more likely to provide public services e.g., dams, to denser areas first conditional on the suitability of the underlying engineering processes. Second, once an infrastructure service is provided, the adjacent and nearby areas are more likely to receive the next service since expansion costs can be cheaper (Klonner and Nolen 2010).

In rural economies, households' engagement in business enterprises play crucial role in their ability to deal with unexpected shocks and poverty outcomes. For instance about 16% of the time, Nigerien households rely on non-agricultural business enterprises and incomes as a coping mechanism in the wake of shocks and extreme events that tend to shape households poverty status (World Bank 2016; Annan and Sanoh 2016). The propagation of business enterprises are, however, subject to a high degree of institutional frictions and vacuums[2] e.g., information (Klonner and Nolen 2010) but mobile phones/infrastructure which has the externality of flowing information can help overcome most of these vacuums through reduced fixed costs, lower cost of information or search, and outreach to a broader customer base.

[2] The broader notion of frictions/imperfections in markets across various contexts and their consequences has received significant attention in the economics literature (see e.g., Akerlof 1970; Rothschild and Stiglitz 1976; Giné and Mazer 2016; Giné et al. 2008 and references therein); interested readers are directed to this rich and growing literature.

With these in mind, this paper takes advantage of the quasi-experimental variation created by the plausibly exogenous introduction of the 2013 mandatory SIM[3] registration reform in Niger. This variation allows us to quantify mobile use and activity's causal impact on the propagation of business enterprises and poverty among households. The SIM mandate deactivated about one-third of all existing prepaid SIMs and made it harder to use newly purchased mobile SIM cards, which led to a remarkable decline in mobile use activity over the period. Most mobile phones were rendered defunct and lesser incentive was created for households to acquire new phones due to the mandate. Mandatory SIM registration reforms are common in sub-Saharan Africa. But despite how widespread these policies are, there is scant bottom-up evidence about their actual effects on households. Our paper makes progress in first evaluating SIM mandates and second in understanding the induced-impact of access to mobile infrastructure on household behavior and welfare.

## Related Literature

This paper contributes to several strands of inter-related literatures. First, a related body of research is concerned with investigating the economic impacts of information disseminated through mobile information technologies in poor and low-income economies. This literature examines impacts on economic growth (e.g., Waverman et al. 2005; Sridhar et al. 2004), agricultural markets (Aker 2010; Goyal 2010; Fafchamps and Minten 2012), fishing markets, (e.g., Jensen 2007), electoral participation and fraud (e.g., Aker et al. 2016; and Gonzalez 2015), migration and migrant remittances (e.g., Batista and Narciso 2016) and household savings and labor markets (e.g., Klonner and Nolen 2010; Aker et al. 2011).

Second, there is a burgeoning literature investigating mobile innovation and infrastructure in development. This literature has appealed to low transaction costs of mobile financial services to document the impact of innovative services on mobile platforms on development. Fueled by the remarkable increase in mobile technology and adoption, innovative products/services have emerged including Mobile-Money and Mobile-Insurance. In theory, low transaction costs can foster development through various channels including the incentives to increase economic activity, and informal risk sharing and insurance mechanisms. Mbiti and Weil (2013), Jack and

[3] SIM: Subscriber Identity Module

Suri (2014), and Suri and Jack (2016) document the revolution of Mobile-Money, M-PESA in Kenya. Jack and Suri (2014) estimate the effect of Mobile-Money on households' consumption smoothing via risk sharing: based on variations in Mobile-Money agent networks and difference-in-differences strategy, the authors document significant effects on the ability of households to spread risk. More recently, Blumenstock et al. (2016) examined risk sharing on mobile phones: the authors provide empirical evidence that people used the mobile phone network to transfer airtime to those affected by an unexpected shock, 2008 Lake Kivu earthquake in Rwanda.

Third, is the broader literature linking access to public infrastructure services and development. Studies have linked expansions in road infrastructure and connectivity on agricultural and labor markets (e.g., Dinkelman 2011; Banerjee, Duflo and Qian 2012), dams, local economy and agricultural production (e.g., Duflo and Pande 2007), and transport or engineering infrastructure and growth (e.g., Tompsett 2013; Banerjee, Duflo and Qian 2012; Ansar et al. 2016).

Our paper can be placed at the intersection of these literatures. The combination of rich panel data sets and quasi-experimental variation from a SIM mandate enables us to quantify the impact of mobile infrastructure on two development outcomes which are important in thinking about the vicious cycle of poverty and how to deal with poverty. We ask whether the 2013 SIM registration mandate in Niger impacted mobile use and activity, and then how the exogenous variation in mobile use activity created by such mandate can be used to credibly identify mobile infrastructure's impact on poverty and propagation of local business enterprises. Identification of effects come from the SIM mandate, so we are able to evaluate the (un)intended impacts the SIM mandate simultaneously. We find evidence of the following. First, our analysis indicate that the SIM mandate led to a significant distributional shift in mobile use activity over the period, indicating a substantial drop in mobile activity. Second, there is economically large effect of mobile infrastructure on the propagation of rural business enterprises. The drop in mobile use activity induced by the mandate resulted in about 33.1% points decline in the likelihood of households' engaging in non-agricultural business enterprises. We explore the mechanisms underlying our results and find that most of the effect come from three major sources: households' ownership of a business service or center; ownership of small income generating activities; and involvement in the transformation of agricultural products. In addition, there is suggestive evidence of gender differentiated impacts of the reform. The decline in the likelihood

of engaging in non-agricultural enterprises is larger (but statistically insignificant) for women compared to their male counterpart households. The results have extended impacts on poverty.

## Mandatory SIM Registration Revolution

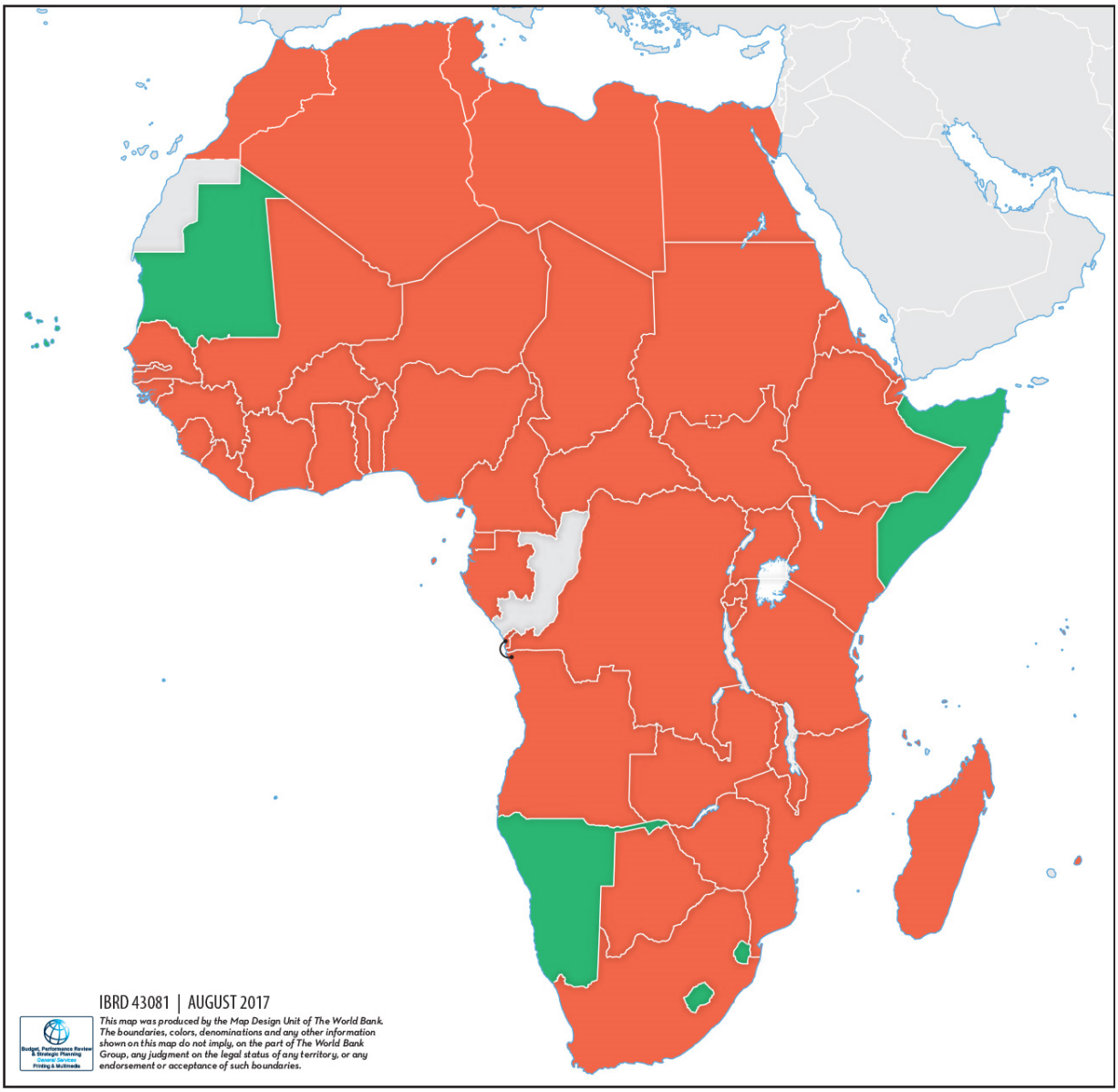


**Figure 1: Distribution of SIM Registration Mandates**

*Notes*: Figure is due Donovan and Martin 2014. (see web–link-here); which is in turn based on data from multiple sources: research conducted by *MobileActive* (an advocacy group), Steve Song of Village Telco; Jentzsch 2012; and the authors' own data collection. Where: red and green correspond to countries where SIM registration is required and not required, respectively, as of February 2014. The list of countries where SIM registration policy has not been introduced as of February 2014 include: Cape Verde, Lesotho, Mauritania, Namibia, Somalia and Swaziland.

**AFRICA'S CASE:** Mobile infrastructure has expanded rapidly across sub-Saharan Africa and other emerging countries. Africa's mobile phone penetration rate is estimated to be around 67% of the total population (The Guardian 2015). The widespread penetration of mobile phones across the region has in turn been accompanied by the imposition of various communication regulations and practices such as data retention (Whitley and Hosein 2005); use of call and mobile device location by law enforcement agencies (Donovan and Martin 2014). Because mobile platforms have become a conduit for crime and major fraud issues, many governments have responded through the imposition of SIM registration mandates. In the past, such registration arrangements were not available. Figure 1 illustrates the spatial surge in SIM registration mandates across the region.

None of the countries in sub-Saharan Africa had a SIM registration up until 2006. In such era, people or households across the region were able to buy a SIM card and anonymously use it. The first SIM registration mandate in sub-Saharan Africa was introduced in 2006; others followed thereafter. As displayed in Figure 1, SIM registration requirements are now in force in the majority of countries. Registration require users to provide details about their personal identification in order to purchase and use a SIM card. Existing SIMs are also required to be registered, similarly. In principle, these SIM registration reforms are justified to combat crime or fraud and to support anti-Money Laundering and the Combating of the Financing of Terrorism AML/CFT (Jentzsch 2012). But in practice, there is limited/no evidence regarding the efficacy of SIM registration exercises for security or commerce (Martin et al. 2009; Donovan and Martin 2014).

**NIGER'S CASE:** In November 2013, Niger deactivated a third of its mobile phone connections as a result of lack of registration (AFP 2013; Donovan and Martin 2014). As highlighted in Figure A.1 of the Appendix, other media organizations and blogs gave similar account of the 1/3 cut in existing SIM lines in Niger to stop crime. Stories about implications of the mandatory SIM registration policies on mobile phone use and penetration have been told. For example, there are media reports suggesting that SIM registration exercises might negatively affect the growth in mobile subscriber base. In addition, the registration can lead to the disconnection of millions of existing SIM cards. Negative impacts on MNOs revenues have also been discussed within various circles. Mandatory registration leads to major temporal drop in the number of active

prepaid SIMs once the SIM registration deadlines passes or kicks in. Studies (e.g., Southwood 2011; Jentzsch 2012) have also shown the likely slowdown in the growth of mobile penetration due to SIM registration measures. Most arguments underlying these implications are tied to the lack of necessary formal identification documents among affected populations for the SIM registration process. A summary of the mandate's timeline is provided in Figure 2. This paper will investigate the response of mobile use and activity to the 2013 registration in Niger that led to massive disconnection of mobile subscribers, and then the implied linkages with the local economy.

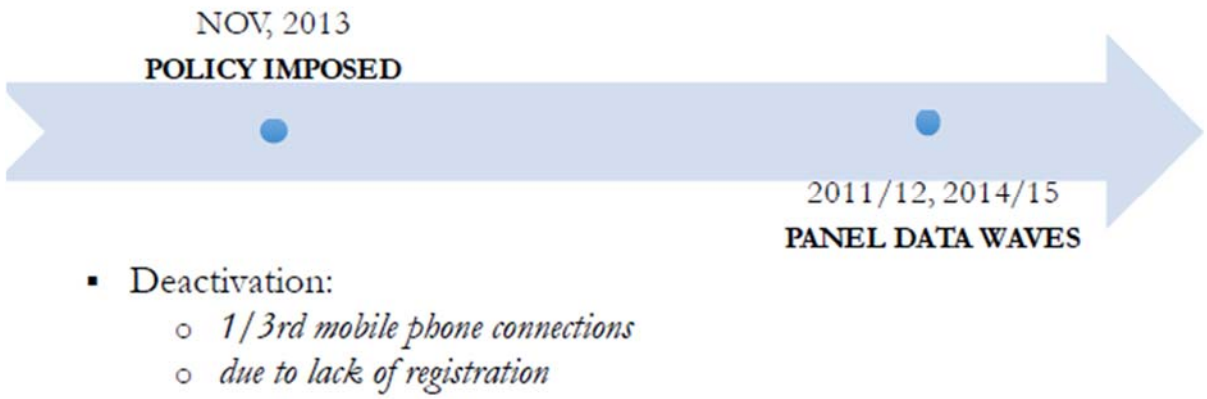


**Figure 2: Timelines of Policy Mandate**

*Notes*: This SIM deactivation exercise came to effect following earlier national registration campaigns. As in other countries, the goal was to curb criminal activity. The mandate is still in force, requiring that new SIMs be registered. These registration requirements uniquely bind in the case of Niger because most of the Nigerien poor lack formal identification proofs, thus limiting the effectiveness of SIM registration campaigns.

## 2 DATA AND SUMMARIES

Our analyses rely on rich and new panel data sets collected in Niger between 2011/12–2014/15. One crucial aspect of the data is that it covers a period before and after the policy mandate, with no overlaps. The panel data come from joint data collection efforts between the World Bank WB and the National Statistical Office NSO of Niger, collected through sample surveys of households, and other business establishments over the period. The data is rich in content, where in each survey year two waves of data collection are carried out spanning three broader areas: individual households, agriculture and livestock holdings, and community level records.

The summary statistics of all relevant variables in our sample are reported in Table 1. The first two moments and order statistics of each variable are displayed.[4] As shown, the data is made up of two sampling years: 2011/2012 and 2014/2015. Considerable variations exist among the variables which we shall exploit for identifying variation. Our main outcomes of interest are binary, denoted "Business Enterprise" and "Poor". Business Enterprise is based on whether households are engaged in any form of non-agricultural business enterprise within the past 12 months. In our sample, about 22% of households are engaged in some form of business enterprises. Summaries about various aspects/dimensions of business enterprises are displayed in the bottom panel. Poor is an indication of whether a household is classified as either poor or not poor. Poverty classification of households uses Niger's 2011 National Absolute Poverty Line NAPL of 189233 CFA. The sample suggest overall absolute poverty rate of about 40.2%.

**Table 1: Data and Summaries, 2011/12-2014/15**

| | OBS (N) | Mean | SD | Min | Max |
|---|---|---|---|---|---|
| Business Enterprise | 7,590 | 0.220 | 0.414 | 0 | 1 |
| Mobile use and activity | 2,788 | 0.223 | 0.417 | 0 | 1 |
| **1** [Sex = female] | 7,072 | 0.229 | 0.458 | 0 | 1 |
| **1** [Married = Yes] | 7,072 | 0.629 | 0.483 | 0 | 1 |
| Age (years) | 7,072 | 35.30 | 20.57 | 18 | 95 |
| Educational level+ | 1,466 | 3.281 | 1.752 | 1 | 7 |
| 1 [Education = notNil] | 4,399 | 0.999 | 0.037 | 0 | 1 |
| Poor++ | 6866 | 0.402 | 0.459 | 0 | 1 |
| Year | 7,781 | - | - | 2011 | 2014 |
| Transform Agr. Product | 7,590 | 0.160 | 0.366 | 0 | 1 |
| Make clothing | 7,590 | 0.040 | 0.197 | 0 | 1 |
| Own construction | 7,590 | 0.039 | 0.195 | 0 | 1 |
| Any profession for own | 7,589 | 0.039 | 0.195 | 0 | 1 |
| Own business service | 7,589 | 0.047 | 0.212 | 0 | 1 |
| Own commercial transport | 7,589 | 0.024 | 0.154 | 0 | 1 |
| Own restaurant /bar | 7,589 | 0.015 | 0.123 | 0 | 1 |
| Own small activity | 7,589 | 0.160 | 0.366 | 0 | 1 |

*Notes*: Table reports summary statistics of sample variables including: household's ownership of business enterprise; mobile use and activity in the sampling year; gender of respondents and other demographic information. +For education: 1=None, 2=primary, 3=secondary first cycle-general, 4=secondary first cycle-technical & professional, 5=secondary second cycle-general, 6=secondary second cycle-technical & professional, and 7=superior levels. ++While our sample suggests about 40.2% overall absolute poverty rate, rates reported elsewhere can be around 48%.

[4] Data is harmonized and matched across two survey years to obtain the panel. While the the main data frame houses many variables' information; we restrict attention to those relevant to our empirical analysis.

The mobile infrastructure variable is denoted in Table 1 as "Mobile use and activity". This derives from whether households utilized mobile phone within the past 30 days. This is regardless of personal ownership and hence allows for the possibility of sharing mobile phones, common in low-income environments. The overall mobile use activity is 22.3% with a standard deviation about 0.42. Table 1 also reports the gender of respondents/households and other demographic information. About 22.9% of respondents are females; 62.9% are married; and more than 99% had some form of education. The average age of respondents is approximately 35 years with a maximum of 95 years. Education is coded in 7 Likert levels, in increasing order. Average educational level is around the 3.2 Likert level. Empirical analysis to follow combine these variables along with plausible assumptions and the exogenous variation induced by the 2013 SIM mandate.

## 3 EMPIRICAL APPROACH

In an ideal experiment designed to quantify the impact of mobile infrastructure: mobile use activity on economic outcomes: business enterprises and poverty, we would observe outcomes for two identically distributed households, then randomly introduce a mobile usage activity to the environment of one and compare outcomes across these "treatment" and "control" conditions. The 2013 national SIM mandate helps to mimic such conditions. The policy mandate deactivated some existing lines and made it harder to use newly purchased mobile SIM cards, which lead to a remarkable decline in mobile use activity over the period. In principle, the unaffected households after the policy can be considered a "control" for the same households just after the policy "treatment." Here, the impact of the policy reform is identified as any response in household outcomes that occur due to the mandate via mobile use and activity. Our goal is exploit this policy and mobile use conditions to quantify the direction and extent of such responses.

### Constructing "Policy Instrument" and Model

For household *i* in cluster *c* in year *t*, the simplest panel model of mobile use and activity that we estimate is:

$$\text{MOBILE}_{ict} = \mu_i + \delta_t + \epsilon_{ict}$$

Figure 3a displays the distribution of households' mobile use and activity after household-level fixed effects are removed from the data (i.e., distribution of $\delta_t + \epsilon_{ict}$). This is shown for the period before and after the 2013 SIM mandate. The figure demonstrates that the SIM mandate

had a large effect on mobile use and activity. Mobile use likelihoods dropped remarkably following the policy, as demonstrated in the distributional shifts. Exploiting the quasi-random nature of the policy, we construct an instrument for use and activity of mobile telephony in Niger as:

$$\text{PolicyInstrument}_{ct} = \mathbf{1}[Time > 2013] \times \sum_{i \in c} \text{MOBILE}_{ict}$$

where **1**[A] is an indicator function that is equal to one if the expression A is true, and equal to zero otherwise. The instrument essentially interacts the policy change with average mobile use and activity across all households in a cluster $c$. A given cluster $c$ houses several households such that an individual household's endogenous mobile use decision will not significantly matter (in the spirit of Duflo and Pande 2007; Klonner and Nolen 2010). A variation is created across clusters, which we combine with the policy change variable to construct the instrument. We exploit the induced policy variation to estimate a panel instrumental variable regression that links business enterprise and poverty outcomes $y_{ict}$ to mobile use and activity $\text{MOBILE}_{ict}$:

$$y_{ict} = \mu_c + \delta_t + \beta \text{MOBILE}_{ict} + \gamma \mathbf{W}_{ict} + \varepsilon_{ict}$$

where the $\text{PolicyInstrument}_{ct}$ is used to instrument for $\text{MOBILE}_{ict}$ controlling for both cluster and year fixed effects $\mu_c$ and $\delta_t$ respectively. All relevant control variables are housed in the vector $\mathbf{W}_{ict}$: respondents level of education, gender, marital status, and age. First, it is crucial that the policy instrument be related to mobile use and activity (i.e., a relevance requirement). Even without any rigorous analysis, it is straightforward to discern relevance from Figure 3a. The figure demonstrates that access and use of mobile phones dropped remarkably in the sample years as result of the National reform.[5] This is because the SIM reform made it harder to use new SIM cards and deactivated some existing SIM lines. Such observed changes in mobile use activity support from the data is consistent with discussions in SIM Registration section.

Next, the identifying assumption underlying the research design is that the exact timing of the announcement of the mandatory SIM reform was not anticipated before it came to play. If households anticipated the announcement, they might have started to alter their SIM and mobile

[5] Figure 3b shows the growth/changes in average mobile use likelihoods across regions following the SIM deactivations, which suggests considerable variations that we shall exploit in our analysis to estimate the implied effects.

use activity prior to the 2013 mandate. But if this were true, it would likely cause us to under-estimate any true effect that the mandate might have had because pre-reform mobile use and activity would look more similar to post-reform mobile use behavior.

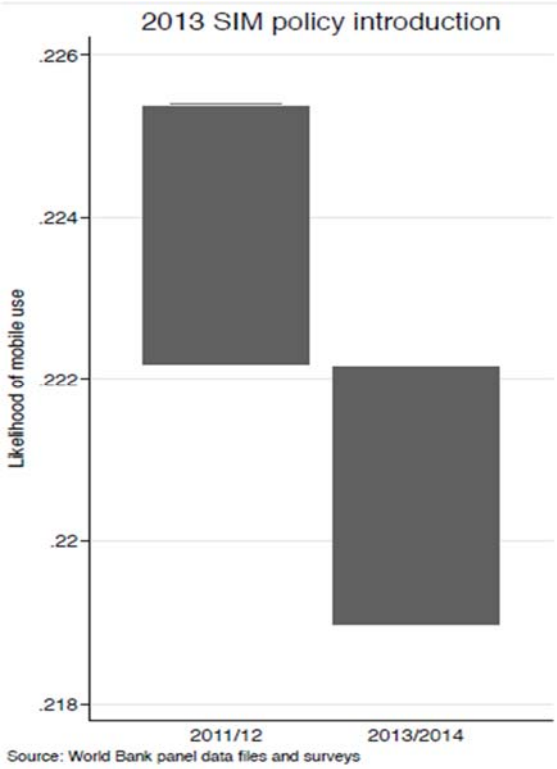


**Figure 3a: Effect of the 2013 SIM Mandate on mobile use and activity**

*Notes*: Figure reflects the raw annual distribution of the likelihood or probability that households' use mobile phones (i.e., MOBILE) after household-level fixed effects are removed from the data. The figure is shown for the period before and after the National policy reform. The sample includes all randomly selected households. Boxes show inter-quartile ranges and whiskers contain inner 1.5×inter-quartile range of the observations (Turkey 1977).


**Figure 3b: Growth in average mobile use likelihood across regions following mandate**

*Notes*: Figure displays the growth in average likelihoods that households use mobile phones (i.e., MOBILE) by region after household-level fixed effects are removed from the data. The sample includes all randomly selected households.

While households' anticipation of the mandate is unclear, we provide partial evidence in favor of our assertion. Note that in the spirit of regression discontinuity RD set up, we consider time as a running variable and show that household characteristics are insignificantly different before and after the SIM reform (Lee and Lemieux 2010; Kothari and Warner 2006; Imbens and Lemieux 2008). Observable household characteristics reflect potential adjustments through which households might anticipate and respond to the SIM reform.

**Table 2: Anticipation of reform**

| **Regime** | Statistic | Educational level | **1** [Educ.,= notNil] | **1** [Married = Yes] | Age |
|---|---|---|---|---|---|
| Pre-reform | Mean | 3.400 | 0.991 | 0.853 | 45.445 |
| | SD | (1.815) | (0.180) | (0.354) | (14.537) |
| Post-reform | Mean | 3.010 | 0.986 | 0.4101 | 44.826 |
| | SD | (1.601) | (0.117) | (0.501) | (19.861) |
| P-value: Equal Means | | 0.999 | 0.142 | <0.05 | 0.123 |
| Density: *# of Observations* | | | | | |
| Pre-reform | 4005 | | | | |
| Pre-reform | 3968 | | | | |

*Notes*: Table reports moments of the various observable household characteristics before and after the 2013 SIM mandate; and the density of time variable which in this case is the number of observations across the two regimes.

The illustration in Table 2 partly supports the underlying argument. Changes in distributional moments of the various observable household characteristics before and after the 2013 SIM mandate are reported in Table 2. We expect to see significant changes in the relevant characteristics if households anticipated and reacted to the mandate before it came to effect. With the exception of the proportion of married respondents, the moment estimates in the table suggest no detectable evidence of reform anticipation as pre-reform moments are statistically similar to post-reform. Note that the analyses will directly control for all these observables to soak-up any potential adjustments to the reform. Thinking of time as a running variable, we would expect changes in the density of time if households significantly anticipated the un-intended effects of the mandate (e.g., in the spirit of McCrary Test; McCrary 2008). We do not find evidence of this as the number of observations in the sample across the two regimes are similar. Significant differences in the number of observations before and after the 2013 mandate could have threaten the internal validity of the policy instrument and research design since the instrument interacts the change in policy with average mobile use activity.

## 4 RESULTS

This section reports and discusses the main empirical estimates that quantify the sign and magnitude of business enterprises and poverty responses to changes in mobile use activity. We estimate our main Equation using OLS and 2SLS. $\beta$ is our main parameter of interest. This captures the sign and size of the above outcome responses to the mobile infrastructure. While the

2SLS estimates are based on the policy instrument, those from the OLS reflect endogenous linkages from mobile use activity.

**Table 3: OLS: Effect of mobile use and activity on business enterprise**

| DV: **Business Enterprise** | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| MOBILE use activity | 0.086***(0.023) | 0.089***(0.023) | 0.089***(0.023) | 0.094***(0.023) | 0.110***(0.028) |
| **1** [Sex = female] | | 0.016(0.021) | 0.021(0.021) | 0.026(0.023) | -0.055(0.036) |
| **1** [Married = Yes] | | 0.051**(0.024) | 0.060**(0.027) | 0.060**(0.024) | 0.018(0.034) |
| Mobile X **1**[Sex = female] | | | | -0.018(0.046) | 0.027(0.059) |
| Age in Quantiles | No | No | Yes | Yes | Yes |
| Any Education? | | | | | Yes |
| Constant | 0.189***(0.014) | 0.182***(0.030) | 0.180***(0.048) | 0.179***(0.048) | 0.337*(0.198) |
| R–squared (%) | 1.07 | 1.44 | 1.74 | 1.74 | 2.58 |
| # of Households/OBS | 2,163 | 2,163 | 2,163 | 2,163 | 2,007 |
| Fixed Effects | hh+Time | hh+Time | hh+Time | hh+Time | hh+Time |

*Notes*: Table reports estimates from regressions of "engagement in non-agricultural business enterprises" on mobile use and activity. Columns differ based on the combination of model type and fixed effects included. All standard errors are clustered at the region level and shown in parentheses. Significance levels are indicated by *** 1%, ** 5%, * 10%. Unit of Analysis: **household-level**

### Main estimates

We begin with results from the OLS. Those pertaining to business enterprises are contained in Table 3. We expect positive relationship between mobile activity and propagation of business enterprises. Different columns correspond to different model specifications. All five specifications presented include household and year fixed effects. Column 1 excludes all control variables, while 2 adds gender and marital status. Column 3 flexibly adds age in quantiles to specification 2. Column 4 replicates 3 but includes an interaction between MOBILE and gender; while column 5 additionally control for whether respondents have some form of education. The coefficient on mobile activity MOBILE is positive and significant at conventional levels in all specifications. The OLS estimates range between 0.086 - 0.110; with an average estimate of about 0.101. An average OLS estimate of 0.101 implies that shifting a household with no mobile use activity to a mobile usage activity environment will result in about 10.1% points increase in the likelihood of engaging in some form of non-agricultural business enterprise. These estimates

may suffer from omitted variable bias and so should be interpreted with much caution and as mere correlations.

**Table 4: OLS: Effect of mobile use and activity on business enterprise**

| DV: **Business Enterprise** | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| MOBILE use activity | 0.064** (0.021) | 0.067**(0.022) | 0.069**(0.022) | 0.070**(0.025) | 0.082**(0.028) |
| **1** [Sex = female] | | 0.012(0.021) | 0.012(0.021) | 0.014(0.023) | -0.053(0.036) |
| **1** [Married = Yes] | | 0.044*(0.023) | 0.044*(0.025) | 0.044*(0.025) | 0.009(0.034) |
| Mobile X **1**[Sex = female] | | | | -0.007(0.044) | 0.029(0.058) |
| Age in Quantiles | No | No | Yes | Yes | Yes |
| Any Education? | | | | | Yes |
| Constant | 0.200*** (0.014) | 0.182***(0.030) | 0.172***(0.048) | 0.172***(0.048) | 0.392*(0.194) |
| R–squared (%) | 1.05 | 1.44 | 1.70 | 1.70 | 2.50 |
| # of Clusters/OBS | 258 (1294) | 258 (1294) | 258 (1294) | 258 (1294) | 251 (1294) |
| Fixed Effects | Cluster+ Time | Cluster+Time | Cluster+Time | Cluster+Time | Cluster+Time |

*Notes*: Table reports estimates from regressions of "engagement in non-agricultural business enterprises" on mobile use and activity. Columns differ based on the combination of models type and fixed effects included. All standard errors are clustered at the region level and shown in parentheses. Significance levels are indicated by *** 1%, ** 5%, * 10%. Unit of Analysis: **cluster-level**

Next, results from 2SLS estimations that pertains to business enterprises are reported in Table 5.[6] We expect negative and sizable effects of the SIM mandate since the reform resulted in much less mobile use and activity over the period. Similarly, results displayed in the different columns correspond to the different models. The estimate on mobile activity MOBILE is negative and significant across all model specifications. The average 2SLS estimate across specifications is about -0.331, which is about 3.3 times the size of the average OLS estimate. This suggests that the bias of the OLS estimation is downward, an attenuation. The 2SLS results imply that, on average households affected by the SIM mandate have lower likelihoods of engaging in some form on business enterprise all things being equal. A 2SLS estimate of -0.331 implies that moving a household with mobile use activity to a no mobile use activity due to the SIM reform

[6] Table 4 replicates OLS estimations reported in table 3 but with the unit of analysis now being cluster level. OLS results are similar across the two different unit of analysis. All 2SLS estimations are carried at the cluster level.

results in about 33.1% points decline in the chance of engaging in non-agricultural business enterprise.

**Table 5: 2SLS: Effect of mobile use and activity on business enterprise**

| DV: **Business Enterprise** | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| MOBILE use activity | -0.339** | -0.351*** | -0.3364*** | -0.321** | -0.318** |
| | (0.097) | (0.099) | (0.102) | (0.129) | (0.129) |
| **1** [Sex = female] | | 0.041 | 0.046 | 0.056 | 0.060 |
| | | (0.042) | (0.042) | (0.187) | (0.069) |
| **1** [Married = Yes] | | -0.018 | -0.031 | -0.032 | -0.030 |
| | | (0.035) | (0.035) | (0.034) | (0.035) |
| Mobile X **1**[Sex = female] | | | | -0.040 | -0.048 |
| | | | | (0.187) | (0.187) |
| Age in Quantiles | No | No | Yes | Yes | Yes |
| Any Education? | | | | | Yes |
| Constant | 0.256*** | 0.239*** | 0.228**(0.098) | 0.225** | 0.047 |
| | (0.039) | (0.066) | | (0.102) | (0.134) |
| R–squared (%) | 23.81 | 24.83 | 25.33 | 25.34 | 25.40 |
| # of Clusters/OBS | 231 | 229 | 229 | 229 | 229 |
| | (1337) | (1294) | (1294) | (1294) | (1294) |
| Fixed Effects | Cluster+ Time | Cluster+Time | Cluster+Time | Cluster+Time | Cluster+Time |
| 1st Stage Estimates [-0.052,-0.125]** | | | | | |
| n X R-squared ≥ 51.6 √ | | | | | |
| No evidence of *"weak instruments"* | | | | | |

*Notes*: Table reports estimates from regressions of "engagement in non-agricultural business enterprises" on mobile use and activity. Columns differ based on the combination of models type and fixed effects included. All standard errors are clustered at the region level and shown in parentheses. Significance levels are indicated by *** 1%, ** 5%, * 10%. Unit of Analysis: **cluster-level**

Most of the control variables included in the various regressions have their expected signs; but not all are precisely estimated. In the OLS, the gender variable which is equal to one if the survey respondent is a female and zero otherwise is positive throughout all specifications. This implies that female run households are more likely to engage in business enterprises compared to their male counterparts; highlighting the gender aspects and vital role that women play. But this estimate is not significant. Marital status which takes a value equal to one if the survey respondent is married is positive and statistically significant at 5% in all but the last specification. The implication is that the married are more likely to engage in non-agricultural enterprises than the unmarried households. Column 4 examines heterogeneous responses across gender by interacting MOBILE with the gender variable. The estimate of the interaction is negative but indistinguishable from zero, suggesting limited evidence in favor of heterogeneous

gender effects of mobile use activity on non-agricultural enterprises. In the 2SLS, gender is also positive and insignificant while marital status is negative and insignificant. Estimate for the interaction between MOBILE and gender is similar and insignificant. While the estimate for the interaction between MOBILE and gender (i.e., female) is not significant, the negative sign highlights that women have been more vulnerable to the mandatory SIM registration exercise. This can be explained by the fact that women tend to disproportionally work in non-farm self-employments.

**Table 6: OLS: Effect of mobile activity on aspects of business enterprise**

| DV | (1) Transform Agr. product | (2) Make clothing | (3) Own construction | (4) Any profession for own | (5) Own bus service | (6) Own commercial transport | (7) Own restaurant or bar | (8) Own small activity |
|---|---|---|---|---|---|---|---|---|
| MOBILE | 0.0319* | 0.00286 | 0.00313 | -0.00180 | 0.0142 | -0.00975 | -0.00262 | -0.0338* |
| | (0.0173) | (0.0105) | (0.0105) | (0.00740) | (0.00970) | (0.00597) | (0.00540) | (0.0189) |
| Constant | 0.188*** | 0.0348*** | 0.0375*** | 0.0329*** | 0.0277*** | 0.0181*** | 0.0158*** | 0.223*** |
| | (0.0150) | (0.00588) | (0.00555) | (0.00482) | (0.00462) | (0.00440) | (0.00424) | (0.0167) |
| # of OBS | 2,785 | 2,785 | 2,785 | 2,785 | 2,785 | 2,785 | 2,785 | 2,784 |
| # of Clusters | 258 | 258 | 258 | 258 | 258 | 258 | 258 | 258 |
| Controls | No | No | No | No | No | No | No | No |
| Cluster FEs | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FESs | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes*: Table reports estimates from regressions of the various aspects of engagement in non-agricultural business enterprises on mobile use and activity. Columns differ based on the combination of the dependent variable, model type and fixed effects included. All standard errors are clustered at the region level and shown in parentheses. Significance levels are indicated by *** 1%, ** 5%, *10%. *Unit of Analysis*: **cluster-level**.

**Table 7: OLS: Effect of mobile activity on aspects of business enterprise**

| DV | (1) Transform Agr. product | (2) Make clothing | (3) Own construction | (4) Any profession for own | (5) Own bus service | (6) Own commercial transport | (7) Own restaurant or bar | (8) Own small activity |
|---|---|---|---|---|---|---|---|---|
| MOBILE | 0.0284* | 0.00432 | 0.00302 | -0.000682 | 0.0137 | -0.0132** | -0.00447 | -0.0362* |
| | (0.0169) | (0.0106) | (0.0108) | (0.00765) | (0.00986) | (0.00613) | (0.00532) | (0.0200) |
| Constant | 0.147*** | 0.042*** | 0.0454*** | 0.0204** | 0.0190 | 0.0138* | 0.0197** | 0.184*** |
| | (0.0227) | (0.0112) | (0.0113) | (0.0103) | (0.0154) | (0.00723) | (0.00832) | (0.0289) |
| # of OBS | 2,677 | 2,677 | 2,677 | 2,677 | 2,677 | 2,677 | 2,677 | 2,676 |
| # of Clusters | 258 | 258 | 258 | 258 | 258 | 258 | 258 | 258 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Cluster FEs | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FESs | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes*: Table reports estimates from regressions of the various aspects of engagement in non-agricultural business enterprises on mobile use and activity. Columns differ based on the combination of the dependent variable, model type and fixed effects included. All standard errors are clustered at the region level and shown in parentheses. Significance levels are indicated by *** 1%, ** 5%, *10%. *Unit of Analysis*: **cluster-level**.

## Exploring Mechanisms

So far, we have been working with a general definition of business enterprises i.e., households engagement in any form of non-agricultural business or startup over the period. This abstracts from multiple aspects, which we shall explore to explain the mechanisms underlying our baseline results. Engagement in business enterprises takes several forms including households' ownership of a business service or center (e.g., a Mobile-Money center); ownership of a commercial transport business; ownership of a restaurant or bar; ownership of other small income generating activities; the ownership of a construction establishment; involvement in the making of clothing; involvement in the transformation of any agricultural products; and having any non-farm profession. Our panel surveys provide information about these aspects.

**Table 8: 2SLS: Effect of mobile activity on aspects of business enterprise**

| DV | (1) Transform Agr. product | (2) Make clothing | (3) Own construction | (4) Any profession for own | (5) Own bus service | (6) Own commercial transport | (7) Own restaurant or bar | (8) Own small activity |
|---|---|---|---|---|---|---|---|---|
| MOBILE | -0.178* | -0.0932* | -0.105** | 0.00611 | -0.125** | -0.0434 | -0.00434 | -0.147* |
| | (0.0954) | (0.0550) | (0.0501) | (0.0431) | (0.0633) | (0.0440) | (0.0409) | (0.0763) |
| Constant | 0.437*** | 0.286*** | 0.0605** | 0.374*** | 0.0550** | 0.0160 | -0.00378 | 0.0668** |
| | (0.0378) | (0.0218) | (0.0279) | (0.0175) | (0.0255) | (0.0175) | (0.0164) | (0.0325) |
| # of OBS | 1,337 | 1,337 | 1,337 | 1,337 | 1,337 | 1,337 | 1,337 | 1,337 |
| R-squared (%) | 25.20 | 18.50 | 18.50 | 19.00 | 19.80 | 18.90 | 21.70 | 31.90 |
| Controls | No | No | No | No | No | No | No | No |
| Cluster FEs | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FESs | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 1st Stage Estimates [-0.052,-0.125]** n X R-squared ≥ 51.6 √ No evidence of *"weak instruments"* | | | | | | | | |

*Notes*: Table reports estimates from regressions of the various aspects of engagement in non-agricultural business enterprises on mobile use and activity. Columns differ based on the combination of the dependent variable, model type and fixed effects included. All standard errors are clustered at the region level and shown in parentheses. Significance levels are indicated by *** 1%, ** 5%, *10%. *Unit of Analysis*: **cluster-level.**

Tables 6-9 replicate previous estimations, but separately for each aspect of household business enterprises. All dependent variables are binary, and the columns reflect specified models. The OLS estimates are reported in Tables 6 and 7, while those from our preferred 2SLS are presented

in Tables 8 and 9.[7] Note that results displayed in Tables 7 and 9 include all relevant control variables; Tables 6 and 8 omit the controls.

**Table 9: 2SLS: Effect of mobile activity on aspects of business enterprise**

| DV | (1) Transform Agr. product | (2) Make clothing | (3) Own construction | (4) Any profession for own | (5) Own bus service | (6) Own commercial transport | (7) Own restaurant or bar | (8) Own small activity |
|---|---|---|---|---|---|---|---|---|
| MOBILE | -0.191* | -0.105* | -0.108** | 0.0166 | -0.141** | -0.0553 | -0.0114 | -0.169** |
| | (0.0994) | (0.0578) | (0.0508) | (0.0458) | (0.0660) | (0.0471) | (0.0465) | (0.0759) |
| Constant | 0.326*** | 0.292*** | 0.0665** | 0.372*** | 0.0487 | 0.0448* | -0.00152 | 0.0457 |
| | (0.0601) | (0.0294) | (0.0299) | (0.0247) | (0.0339) | (0.0265) | (0.0218) | (0.0487) |
| # of OBS | | | | | | | | |
| R-squared (%) | 26.70 | 19.70 | 23.60 | 18.80 | 20.90 | 19.80 | 22.80 | 23.70 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Cluster FEs | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FESs | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 1st Stage Estimates [-0.052,-0.125]** n X R-squared ≥ 51.6 √ No evidence of *"weak instruments"* | | | | | | | | |

*Notes*: Table reports estimates from regressions of the various aspects of engagement in non-agricultural business enterprises on mobile use and activity. Columns differ based on the combination of the dependent variable, model type and fixed effects included. All standard errors are clustered at the region level and shown in parentheses. Significance levels are indicated by *** 1%, ** 5%, *10%. *Unit of Analysis*: **cluster-level.**

The 2SLS estimates on mobile activity MOBILE are mostly significant and negative, as we would expect. Effects are large under the following 3 aspects: households' ownership of a business service or center (-0.125); ownership of small income generating activities (-0.147); and involvement in the transformation of agricultural products (-0.178). These are then followed by households' engagement in any sort of construction enterprises and the making of clothing for local sale. We do not find any effects for the other aspects, e.g., having own profession and ownership of a commercial transport business, which we do not find surprising. Most of the Nigerien households are agrarian, which helps to explain why the transformation of agricultural products will show the largest mobile activity impact. Next, households' ownership of a business service or center is also expected to be largely affected by the SIM deactivation exercise since most of these service centers operate directly on the mobile infrastructures, e.g., the recent and

[7] The OLS results are included here for mere display, we shall focus discussions below on the results from our preferred 2SLS/Policy Instrument.

growing Mobile-Money services across sub-Saharan Africa (The Economist 2013; Jack and Suri 2014; Suri and Jack 2016).

### Business enterprises and household welfare

Earlier, we emphasized that business enterprises and non-agricultural startups in rural economies shape poverty inclinations. This section descriptively analyze this belief by exploring whether households' involvement in the various business enterprises play any role in observed household welfare/poverty.

**Table 10: Exploring linkages between household poverty and business enterprises**

| DV | (1) Absolute poor | (2) Absolute poor | (3) Absolute poor | (4) Absolute poor | (5) Absolute poor | (6) Absolute poor |
|---|---|---|---|---|---|---|
| Business Enterprise | -0.0234* | -0.0231* | -0.0717** | -0.0722** | -0.0771*** | -0.0767*** |
| | (0.0139) | (0.0140) | (0.0290) | (0.0291) | (0.0287) | (0.0287) |
| MOBILE use activity | | | -0.0466 | -0.0453 | -0.0569* | -0.0560* |
| | | | (0.0334) | (0.0334) | (0.0336) | (0.0336) |
| Bus. Enterprise X MOBILE use | | | 0.00856 | 0.00605 | 0.00622 | 0.00443 |
| | | | (0.0502) | (0.0503) | (0.0502) | (0.0501) |
| Female | | | | | -0.0522* | -0.0450 |
| | | | | | (0.0273) | (0.0276) |
| Married | | | | | 0.0240 | 0.0253 |
| | | | | | (0.0379) | (0.0380) |
| Constant | 0.00351* | 0.00145 | 1.3EXP-13 | 1.3EXP-16 | 0.0347 | 0.0554 |
| | (0.00208) | (0.00551) | (<0.001) | (<0.001) | (0.0645) | (0.0691) |
| # of Observations | 6,859 | 6,859 | 2,471 | 2,471 | 2,367 | 2,367 |
| R-squared (%) | 27.00 | 27.00 | 25.20 | 25.30 | 27.10 | 27.20 |
| Cluster FEs | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FEs | No | Yes | No | Yes | Yes | Yes |

*Notes*: Table reports estimates from regressions of household poverty status on their engagement in non-agricultural business enterprises and in some cases mobile use and activity. Columns differ based on the combination model type and fixed effects included. All standard errors are clustered at the region level and shown in parentheses. Significance levels are indicated by *** 1%, ** 5%, * 10%. *Unit of Analysis*: **cluster-level.** MOBILE use activity is hardly significant once households' engagement in business enterprises is controlled for.

Table 10 reports results based on OLS regressions of household poverty on business enterprises. Results from 6 models are presented; in some versions of the poverty–business relationship, we directly control for mobile use activity. But as expected, mobile use is hardly significant once households' engagement in business enterprises are controlled for, highlighting the dominant role of business enterprises. The coefficient on "Business Enterprise is negative and significant across the wide range of models. These range between a -0.023 to -0.077; implying that households who engage in non-agricultural business enterprises are about 2.3% to 7.7% points

less likely to become absolute poor compared to households that do not engage in some form of business enterprise. While results from Table 10 document the vital role of business enterprises in household poverty, the estimates should be interpreted with caution in that they likely suffer omitted variable biases.

## 5 CONCLUSION

The aim of this paper has been to exploit the quasi-experimental variation created by the exogenous introduction of the 2013 mandatory SIM registration reform in Niger to document the impact of mobile use activity on propagation of business enterprises and poverty among households. We leverage new rich data sets on various aspects of business enterprises, use of mobile telephony along with a policy instrument based on the SIM mandate/deactivation process. Our analysis document two important results. First, the SIM mandate lead to a remarkable decline in mobile use activity over the period. Second, there is economically large effect of mobile infrastructure on propagation of rural business enterprises. The drop in mobile use activity induced by the mandate resulted in about 33.1% points decline in the likelihood of households' engaging in non-agricultural business enterprises, which has extended impacts on poverty. There is suggestive evidence that the reform's impact is disproportionally larger for women. Exploring the potential mechanisms underlying our results, we find that most of the effect come from three major sources: households' ownership of a business service or center; ownership of small income generating activities; and involvement in the transformation of agricultural products.

These results have important policy implications. Mandatory SIM policies meant to curb crime have become popular across sub-Saharan Africa. First, the soundness of these policies require much broader Benefit-Cost assessments, which in turn have led to various policy discussions across various circles. The findings provide evidence in favor of ongoing policy debates and arguments suggesting that mandatory SIM policies can generate un-intended consequences on the local economy among poor populations e.g., Niger. Second, given the large documented un-intended negative effects of Niger's SIM mandate, we will need fuller assessment of such registration exercises across the spectrum for security or commerce moving forward to justify them.

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# 6 APPENDIX

PHYS.ORG Nanotechnology Physics Earth Astronomy & Space Technology Chemistry

Home » Technology » Telecom » November 27, 2013

**Niger cuts off third of mobile phones to stop crime**

November 27, 2013

A man uses his telephone on a market place in Agadez, northern Niger, on September 26, 2010

Niger has deactivated a third of its mobile phone connections to curb anonymous phone calls used for criminal activity, the country's telecoms regulator has announced.

**Figure A.1: Extract about Niger's SIM deactivation in the news**