



USING MOBILE PHONE DATA AND AIRTIME CREDIT PURCHASES TO ESTIMATE FOOD SECURITY

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SUMMARY

This study assessed the potential use of mobile phone data as a proxy for food security and poverty indicators. It was conducted jointly with the UN World Food Programme (WFP), Université Catholique de Louvain in Belgium and Real Impact Analytics (a Belgian data analytics company). Data extracted from airtime credit purchases (or “top-ups”) and mobile phone activity in an East African country was compared to a nationwide household survey conducted by WFP at the same time. Results showed high correlations between airtime credit purchases and survey results referring to consumption of several food items, such as vitamin-rich vegetables, meat or cereals. These findings demonstrated that airtime credit purchases could serve as a proxy indicator for food spending in market-dependent households. In addition, models based on anonymised mobile phone calling patterns and airtime credit purchases were shown to accurately estimate multidimensional poverty indicators. This preliminary research suggested that proxies derived from mobile phone data could provide valuable real-time information on the levels of several indicators related to food security, which could be integrated with early warning and monitoring systems, filling data gaps between survey intervals, and in situations where timely data is not possible or accessible.

BACKGROUND

More reliable and timely information on food security could be valuable for addressing challenges of food availability, volatility in food prices and emergency response. This study explores the potential of using mobile phone data to develop a real-time proxy indicator of food security that can be adapted for regions where standard household surveys (or early warning indicators) are not always possible or available.

As mobile phones become ubiquitous, streams of data are being generated in new social and country contexts. Several recent studies have shown that aggregated and anonymised mobile phone data can provide proxy indicators of economic vulnerability. For example, the degree to which a user spreads their communications among many contacts (“social diversity”) was found to be a proxy for the variation of poverty levels within the UK population in a research study by Eagle et al. (2010). Correlations were observed when comparing mobility data and call volume with poverty levels in Latin American cities (Frias-Martinez et al., 2012) and Côte d’Ivoire (Smith-Clarke et al., 2012). Preliminary research has also been conducted on correlating mobile phone measures with individual level mobile phone surveys on wealth and well-being (Blumenstock, 2014).

In this research, data from anonymised and aggregated mobile phone network meta-data collected in an East African country in 2012 was compared with the results of a country-level food security survey conducted by the United Nations World Food Programme (WFP) during the same period of time, where approximately one household in five is food insecure. This study was conducted in collaboration with researchers from the Université Catholique de Louvain (UCL) and Real Impact Analytics, a Belgian big data analytics company.

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MOBILE DATA AS A PROXY INDICATOR FOR FOOD SECURITY

Data was provided by a large mobile network operator in the form of anonymised Call Detail Records (CDRs), which are digital records of mobile transactions. CDRs are automatically generated when a phone connects to the mobile network to make or receive a phone call, or uses a service such as SMS. The record is logged by the mobile network operator and provides information about phone activity within a network. For this study, six months of CDRs and airtime credit purchases (including the time, date and value of each purchase) were analysed.

Ground truth data was used from the results of a WFP survey conducted in March–April 2012 that reached 7,500 households across the country. A large correlation matrix was computed to compare 13 mobile phone variables to 232 food-related indicators to investigate which variables could be approximated to mobile phone data aggregated at a scale of 10,000–50,000 inhabitants. The Multidimensional Poverty Index, accounting for non-monetary poverty and reflecting deprivation along the education, health and standard of living dimensions, was also used for comparison.

INSIGHTS & OUTCOMES

High correlations were observed between several food consumption indicators and measures computed from airtime credit purchases, demonstrating the potential of top-up data to serve as a proxy socioeconomic indicator.

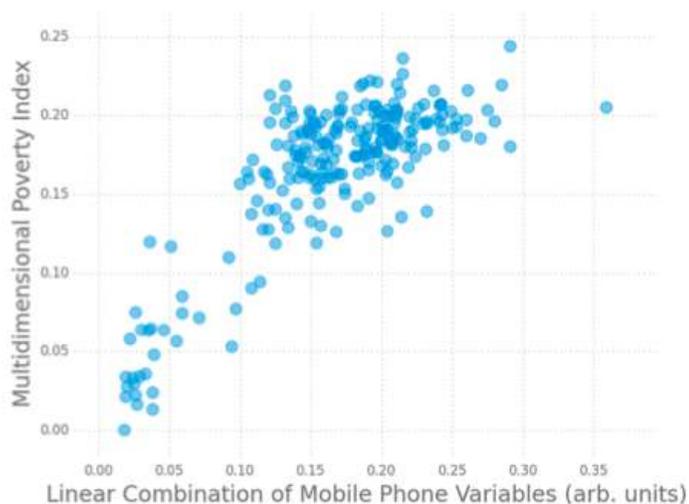
The highest correlation value (0.89) in this study resulted from comparing a model using mobile data-derived indicators and the variable of money spent on food from the household survey. In examining the relationship between the consumption of each food item and top-up expenditure (measured by the average sum of airtime expenses per user over six months), different correlation values were observed ranging from no relation to very high correlation between certain food items and airtime expenses.

In particular, the consumption of vitamin-rich vegetables, rice, bread, sugar and meat showed a very high correlation (>0.7) with airtime purchases. It is important to note that these highly correlated products are mainly bought in the market, not normally grown at home. Food items cultivated for personal consumption like cassava and beans show no relation with airtime purchases.¹

FOOD ITEM (VARIABLE)	CORRELATION RANGE
Vitamin-rich vegetables (carrot, orange, sweet potato), rice, wheat, bread, sugar, meat	[0.7–0.8]
Eggs, oil, milk, butter, organ meat	[0.5–0.6]
Sorghum, ground nuts, seeds, fish, fruits, cooking banana, green leafy vegetables, beans, peas, maize, white roots, tubers, pumpkin, squash, cassava	[0.0–0.4]
White sweet potato	-0.4

The table above shows the correlation between consumption of foods and the sum of airtime credit purchases.

This research generated a new model that provides a proxy indicator for Multidimensional Poverty Index (>0.8 correlation) based on aggregated and anonymised airtime credit purchase and mobile phone activity data.



The scatterplot graph above shows the correlation between the Multidimensional Poverty Index and a linear combination of mobile phone variables (including airtime credit expenditures).

CONCLUSIONS

This research marks the first systematic comparison between airtime credit purchases and food-related household survey data. When aggregated at the sector level (10,000–50,000 inhabitants), the results demonstrated that mobile phone expenditure could be used as a proxy for food expenditures in market-dependent households,

¹ The variable used in the analysis called “consumption of each food item” was based on results of the household survey question “How many times have you eaten [item] in the last 7 days?”

as top-up expenditures correlated with consumption and expenditures on food items bought in the market.

This study proposes a new proxy indicator for estimating non-monetary poverty. By using aggregated top-up data combined with communication data, the model overcomes a limitation found in other research methodologies by proving to be valid with only a partial view of the call network (one mobile phone carrier).

While mobile phone data analysis shows potential for real-time monitoring of vulnerable populations, there remains a pressing need to consider the risk to individual privacy. It is therefore recommended that users be spatially aggregated to prevent re-identification of individual users. Operationalizing a real-time food security monitor in direct collaboration with mobile carriers could help keep potentially sensitive personal data within the carrier company. The data could be aggregated to provide early warnings to governments and development organizations, so that sudden changes in food security could be quickly remediated.

IMPLICATIONS & RECOMMENDATIONS

- This research shows the possibility of approximating non-monetary poverty at high resolution using aggregated and anonymised airtime credit purchase and mobile phone activity data.
- This research revealed a new class of real-time proxy indicators based on mobile phone data that could fill gaps in existing information flows or be used in situations where timely data is currently not possible or accessible.
- Results of this study showed a strong correlation between airtime credit purchases and consumption of market-bought food items. Therefore mobile top-up data could be used as a proxy for food expenditures in market-dependent households and complement the current food security assessment systems.
- Further research is recommended to explore time series of mobile data-derived indicators together with food security assessments. Replicating this study in other regions could help assess the scalability of the research methodology.
- A real-time pilot is recommended, with indicators provided by the mobile network operator on a regular basis. If the pilot is successful, it is recommended that a framework be designed for continuous sharing of indicators in real-time for the public good.

REFERENCES

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THE FULL TECHNICAL REPORT ON THIS STUDY IS UNDER REVIEW:

Decuyper et al. (2015) “Estimating Food Consumption and Poverty indices with Mobile Phone Data.”