Competition Reform and Household Welfare: A Microsimulation Analysis of the Telecommunication Sector in Ethiopia

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ABSTRACT

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This paper presents a novel method for estimating the likely welfare effects of competition reforms for both current and new consumers. Using household budget survey data for 2015/16 for Ethiopia and assuming a reform scenario that dilutes the market share of the state-owned monopoly to 45 percent, the model predicts a 25.3 percent reduction in the price of mobile services and an increase of 4.6 million new users. This reform would generate a welfare gain of 1.37 percent among all consumers. Poverty rates are expected to decline by 0.31 percentage points, driven by a reduction of 0.22 percentage points for current consumers and 0.09 percentage points among new users. Inequality would increase by 0.23 Gini points since better off consumers are more likely to reap the benefits of greater competition. This method represents a powerful tool for supporting the analysis of competition reforms in developing countries, particularly in sectors known for excluding significant segments of the population due to high consumer prices.

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1. Introduction

Broad access to information and communication technology (ICT) has great potential for poverty reduction and inclusive growth in developing countries, where ICT adoption is growing rapidly (World Bank 2016). Recent studies have shown that the expansion of broadband through fiber optics and mobile internet produces substantial benefits in household income and consumption, employment and productivity, and helps lift people out of poverty (see Bahia et al. 2020 on Nigeria, which accounts for the largest ICT market in Africa; Masaki, Granguillhome Ochoa, and Rodríguez-Castelán 2020 for Senegal; and Hjort and Poulsen 2019 on Africa). However, that ICT markets in most countries in Africa rank among the most concentrated in the world has limited the potential for equity and efficiency gains in digital technology adoption among households and firms across the region.[1] The considerable concentration in the ICT sector is linked to the fact that the region registers the highest relative economic rents per capita and the highest relative prices for ICT bundles among ICT firms in the world. Currently, 8 of the 10 most expensive countries for mobile communication services and 9 of the 10 most expensive countries in fixed broadband are in Africa.[2] The high prices of ICT services and assets translate into the allocation of large shares of household disposable income for these products, that could otherwise be used for alternative productive activities or consumption. The high prices of ICT services also reduce the potential for the adoption of digital technologies because poorer households may be priced out of these services, limiting their capacity to harness the benefits of ICT (Rodríguez-Castelán et al. 2020).

This paper introduces a novel method to estimate direct economy-wide welfare effects of expanding competition in the ICT sector, first, by estimating the welfare impacts on current consumers and, second, by identifying potential new consumers brought into the market by a reduction in market prices (due to greater competition) and then estimating the welfare impacts. This approach is applied to Ethiopia, where, until 2019, the ICT market was dominated by a monopoly.

The analysis relies on data of the 2015/16 Household Consumption Expenditure Survey (HCES) in Ethiopia (CSA 2018). The simulation follows a reform scenario whereby the mobile services market share of Ethio Telecom, the state-owned telecommunication enterprise, declines from 100 percent to 45 percent, virtually ending its monopoly. The paper then models and predicts the extent of the adoption of ICT services and the expected expenditures on mobile services among both current and new users and, thereafter, the total welfare effects among all consumers.[3] Overall, the introduction of competition in mobile services in Ethiopia would reduce poverty by 0.31 percentage points. This effect can be disaggregated into poverty reduction among current consumers and among new users. Competition in the mobile market would reduce poverty among current users by 0.22 percentage

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[1] According to data of the International Telecommunication Union (ITU 2020), the region hosts 21 of the 25 most expensive countries in mobile voice, 19 of the 25 most expensive in mobile data, and 22 of the 25 most expensive in fixed broadband.

[2] See Inclusive Internet Index 2020 (database), Economist Intelligence Unit, London, https://theinclusiveinternet.eiu.com/.

[3] This part of the analysis introduces WELCOM's Market Competition and the Extensive Margin Analysis (mcema) module (Rodríguez-Castelán et al. 2021). For WELCOM, see WELCOM Stata Tool, Global Solutions Group on Markets and Institutions for Poverty Reduction and Shared Prosperity, Poverty and Equity Global Practice, World Bank, Washington, DC, http://dasp.ecn.ulaval.ca/webwel/welcom.html.

points in the short run. In addition, the price reduction is also expected to have a positive impact on service uptake and welfare among new users. The analysis estimates that a decline in prices because of competition would also lead to a 5.2 percentage point increase in the number of users (approximately 4.6 million additional users) and a reduction in poverty among these new consumers equivalent to 0.09 percentage points. Because better-off households benefit more than poorer households from greater competition in the ICT industry, in both absolute and relative terms, inequality is expected to widen by 0.23 Gini points. The combined price drop and expansion in the number of users would generate an average relative welfare gain of 1.09 percent among current users and a 0.28 percent gain among new users, for a combined welfare gain of 1.37 percent among all consumers.

This paper contributes to the economic literature and to the development policy agenda in three ways. First, it provides a practical tool for simulating the likely welfare effects of policy reforms that promote competition in highly concentrated sectors of the economy. Estimates based on this method may be useful as inputs to motivate such reforms in developing countries. Second, this method and this empirical application demonstrate the importance of analyzing the welfare effects among groups that are completely excluded from certain markets, thereby complementing studies that have focused on those households and individuals already consuming certain goods and services (Rodríguez-Castelán et al. 2019). Third, the approach is particularly useful in analyzing industries that are known for excluding significant segments of the population because of high prices and that are also relevant in enhancing the income-generating capacity of households, such as ICT, energy, and transport.

The rest of this paper is organized as follows. Section 2 describes the underlying model and data requirements of the proposed approach.[4] Section 3 describes the data and presents stylized facts on the ICT industry in Ethiopia. Section 4 shows results, and section 5 concludes.

2. Simulation approach, modeling alternatives, and data requirements

Greater competition in consumer markets typically benefits current consumers through lower prices, enhancements in the quality of products and services, and an overall boost in innovation. In most cases, competition also brings prices down, thereby allowing individuals and households that have previously been priced out to gain access to the more affordable goods and services. This paper proposes a new empirical approach to estimating the likely welfare effects of greater competition that involves two complementary effects: (1) direct welfare effects of the price reductions generated by the entry of new service providers on individuals already consuming certain goods or services and (2) the welfare effects on new consumers who are at the margin in the consumption of such goods or services, but had been excluded from the market by the higher prices.

The first set of effects is discussed by Rodríguez-Castelán et al. (2019), who present a simulation method to estimate the likely direct welfare effects of a price decline generated by greater market

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[4] For more details on the models available in the tool, see the WELCOM user manual at WELCOM Stata Tool, Global Solutions Group on Markets and Institutions for Poverty Reduction and Shared Prosperity, Poverty and Equity Global Practice, World Bank, Washington, DC, http://dasp.ecn.ulaval.ca/webwel/welcom.html.

competition. Using money metric measures, their method simulates the change in welfare among households with positive consumption. The approach proposed in this paper complements Rodríguez-Castelán et al. (2019) by simulating the likely welfare effects of greater competition among new consumers. It accomplishes this by building on the basic setting discussed in Decoster et al. (2019), who estimate the potential uptake of competition reforms. The approach proposes to model consumer behavior, specifically the probability of adoption by new users based on observable sociodemographic characteristics and policy parameters. Subsequently, based on previous welfare gains calculated for the case of current users, the approach projects the increase in new consumers and the potential monetary gains of these consumers at the margin. The approach also allows to simulate the welfare effects if the number of new users is an exogenous parameter. Such a parameter might simply be based on the coverage targets of new service providers or might be the output of a computable general equilibrium model. The latter would be useful if the number of current users of the good or service is low and hinders the proper estimation of the extensive margin of consumption using statistical techniques that rely on current consumption. This second method might also serve as a robustness check for the results estimated through the probabilistic model.

The welfare effects on current consumers and on new consumers of any given good or service should be clearly distinguished. The welfare effects among current users or consumers is estimated as a function of the observed expenditures of these consumers on any given good (that is, the share of spending on the good relative to total expenditure) and the expected change in prices. The change in welfare among new consumers (that is, the extensive margin of consumption) is estimated in three steps. First, a probabilistic model of the likelihood of positive consumption in a good or service is estimated based on observable characteristics and policy variables. Second, the price change or an equivalent change in income because of the increase in competition is applied to estimate the change in the probability of using or consuming the good or service. Third, the change in welfare is estimated as the product of the estimated change in the probability of consumption and the expected consumption. This change in welfare can be used to estimate the equivalent impact on poverty and inequality among new users.[5,6]

Two main pieces of data are required to estimate the extensive margin of changes in welfare. First, the model must identify the proportion of new users relative to current users. Second, the model needs to estimate the expected expenditures of the new users. This proposed approach shares similarities

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[5] In addition, the mcema module allows the expected expenditure of new consumers to be estimated using several alternative models. These approaches include simple linear estimators, such as average expenditures by population groups, random imputation techniques, nonlinear regression models, and the random imputation of residuals. See Rodríguez-Castelán et al. 2021.

[6] One way to interpret the impact of changes in prices on poverty among current users is to assume that the savings due to the lower prices are allocated on the consumption of other goods and services, thus increasing the total consumption of the household (the implicit assumption being that any savings due to lower prices is fully consumed). In the case of new users, who did not consume the good or service before the reduction in price, the intuition is not as direct. In this case we need to simulate what would had been the consumption of the good or service of interest for this cohort of individuals or households, then estimate the equivalent saving due to lower prices and lastly, estimate the potential equivalent increase in consumption.

with two-part models in the literature (for instance, see Cragg 1971; Dow and Norton 2003; Heckman 1976; Nargis et al. 2013).[7]

a. The probability model and the proportion of entrants

The proposed model exploits the variability of either prices or a welfare variable at the household level (such as consumption) to estimate a probit model of to estimate demand.[8] Assuming independent and normally distributed error terms, and because of a lack of accurate price data in the observations of individuals in household surveys, the probit model is written as follows:[9]

$$Prob(d_{h,i}) = f(\log(w_h), X_h), \tag{1}$$

where w_h denotes a welfare measure (such as income) for household h, and $d_{h,i}$ corresponds to a binary variable taking the value of 1 if household h reports positive consumption in good or service i, or 0 otherwise. For the sake of simplicity, all explanatory variables are denoted with X; the h and i indicators that identify households and goods or services are omitted; and welfare is referred to as income in the rest of this section, as follows:

$$Prob(d = 1|X) = \Phi(X'\beta), \tag{2}$$

or, alternatively, as follows:

$$Prob(use = 1) = \Phi(\beta_0 + \beta_w \ln(Income) + \cdots + u), \tag{3}$$

where $\Phi(.)$ denotes the normal cumulative distribution function (CDF). Then, the probabilistic elasticity is given by the following:

$$\varepsilon_p = \frac{\partial Prob\,(.)}{\partial Income} * \frac{\overline{Income}}{\overline{Prob}}, \tag{4}$$

where $\overline{Income}$ and $\overline{Prob}$ refer to the average welfare and average probability of positive consumption at the population level (individual of reference), respectively.

Taking derivatives and applying the chain rule on the probit model specification, it is possible to rewrite equation (4) as follows:[10]

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[7] The literature on two-part Heckman models focuses on estimating population statistics, such as the change in average quantity, the price elasticity, and so on. In contrast, the proposed framework focuses on the distributional impact of price changes on well-being. Using a Taylor approximation approach, the estimation of the impact on current consumers does not require additional estimates because the necessary information on the expenditures of this group and on price changes is available. However, to estimate the impact on the extensive margin, the consumption decision is modeled conditional on the positive quantities of the good consumed.

[8] In Stata, the stepwise prefix can be used to perform the selection of explanatory variables automatically according to significance levels.

[9] If information on the price of the item of interest is available, mcema enables the user to adjust the probability unit model to include price thereby causing the probability of use to be equal to a function of welfare, price, and household characteristics (Rodríguez-Castelán et al. 2021).

[10] For more information on price elasticity and the two-part Heckman models, see, for instance, Saha, Capps, and Byrne (1997).

$$\varepsilon_p \quad = \quad \frac{\partial \Phi(XB)}{\partial(XB)} \frac{\partial(XB)}{\partial \ln(Income)} \frac{\partial \ln(Income)}{\partial(Income)} \frac{\overline{Income}}{\overline{Prob}},$$

$$= \quad \phi(.)\beta_w \left(\frac{1}{\overline{Income}}\right)\frac{\overline{Income}}{\overline{Prob}} \tag{5}$$

where $\phi(.)$ denotes the normal probability density function (pdf). This gives the following:

$$\varepsilon_p \quad = \quad \frac{\partial Prob}{\partial Income} \frac{\overline{Income}}{\overline{Prob}}$$

$$= \quad \frac{\partial \Phi(XB)}{\partial(XB)} \frac{\partial(XB)}{\partial \ln(Income)} \frac{\partial \ln(Income)}{\partial(Income)} \frac{\overline{Income}}{\overline{Prob}} \tag{6}$$

$$= \quad \phi(.)\frac{\beta_w}{\overline{Prob}},$$

The estimation of the probabilistic income elasticity does not require the observation of final incomes (that is, the variability in income across households is exploited). The absolute change in probability is denoted by the following:

$$A_p \quad = \quad \frac{\partial Prob}{\overline{Income}} dIncome$$

$$= \quad \frac{\partial \Phi(XB)}{\partial(XB)} \frac{\partial(XB)}{\partial \ln(Income)} \frac{\partial \ln(Income)}{\partial(Income)} dIncome \tag{7}$$

$$= \quad \phi(.) * \beta_W * dIncome$$

Because the expenditure shares on a specified item might vary across the income distribution, it is important to control for consumer characteristics. The added value of this model is that it allows the calculation of income elasticities across different groups of consumers and, thus, a determination of the distributional effects of income variations considering heterogeneous consumption patterns.

After estimating the proportion of entrants in the total population, the analysis assumes that the change in the probability of a representative household or individual (assigned using the mean household or individual characteristics) represents the proportion of new entrants. As discussed above, one may evaluate the change in the probability of the reference individual as follow:[11]

$$A_p = \phi(\overline{X}\beta) * \beta_w * dIncome \tag{8}$$

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[11] Another method to estimate the proportion of entrants is to calculate the expected change in probabilities. On nonlinearity, equation 8 may be less precise. An alternative approach is to compute the difference between the averages of the predicted probabilities with initial and final welfare (which might lead to more accurate estimates), resulting in an estimated proportion of entrants. Formally, the change in the probability of use of the household h is as follows:

$$A_{p,h} = Pr_h(use = 1|X'_h) \text{ - } Pr_h(use = 1|X_h)$$

The expected change in probability is equal to the expected predicted probability after the increase in welfare (X'), minus the expected probability under the initial values of welfare. The advantage of this second method is that the density for the reference individual does not need to be evaluated, thereby giving more accurate result because the two measurements capture the main part of the change in probability.

b. Expenditure estimates[12]

In addition to estimating the proportion of entrants, it is necessary to estimate expenditures on the relevant product among new consumers or users. The estimation of consumption expenditure among new entrants is conditioned on the probability or likelihood of consumption and is modeled as $E[e \mid e > 0]$, where e denotes expenditure. The unobserved expenditures of entrants are treated similarly to missing values, where these missing values are the unobserved expenditures of entrants. To address the non-randomness of the decision to consume, the analysis assumes that, at the margin, the new consumers of the product share observable characteristics with current consumers.[13]

The suggested approach relies on the first-order Taylor approximation to measure the welfare of current users.[14] The Taylor approximation allows an assessment of the impact of price changes on well-being under the assumption of a given basket of goods. Following a first-order Taylor approximation, the impact of price changes on well-being can be approximated as follows:

$$dw = -e_i * dp_i, \tag{9}$$

where dw denotes the change in well-being, e_i the expenditures on the good i, and dp_i the observed proportional change in the price of good i. For instance, if the price increases by 1 percent, well-being decreases by $0.01 * e_i$.

In addition to measuring the impact of price changes on the welfare of current consumers, the analysis must also include the changes in the well-being of entrants to measure adequately the welfare impacts of competition. The average expected expenditures on good i among new consumers in group g (for example, decile 2) is denoted by $e_{g,i}^{new}$, and the average expected expenditures of current consumers in the same group is denoted by $e_{g,i}^{current}$.[15] If the estimated proportion of entrants in group g is denoted by $\pi_{g,i}$ (estimated using a probabilistic model), then the following is true:

$$e_{g,i}^{new} = \pi_{g,i} e_{g,i}^{nonusers} \tag{10}$$

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[12] See the mcema user manual for more information (Rodríguez-Castelán et al. 2021). A detailed discussion on the implications of the availability of price data on the items of interest is also presented in the manual.

[13] The mcema module for Stata allows a selection among six methods to estimate the expenditure of new entrants: (a) imputation using average expenditures (unconditional mean imputation), (b) random imputation using the expenditures of current users, (c) imputation based on expenditure models and linear regressions (regression, conditional mean imputation), (d) imputation using an expenditure model and the random imputation of residuals (stochastic regression imputation), (e) imputation based on an expenditure model and quantile regressions, and (f) imputation using a quantile regression model and a random imputation of residuals.

[14] Jackson (1984) introduces the foundations of the hierarchic demand system whereby the change in a bundle of goods can be modeled. In what follows, a selective demand model is introduced to link the selection of goods with real income. There are two hot deck approaches. The first is the distance function approach, and the second is the pattern matching approach. The first imputes the missing value based on the smallest squared distance statistic to the case with the missing value. The matching pattern method used here assumes that the sample can be stratified into separate homogenous groups and that imputation can be performed randomly within each group (Fox-Wasylyshyn and El-Masri 2005). See also Ahmad and Stern (1984, 1991); Araar (1998); Araar and Paolo (2016); Creedy (1998); Newbery (1995); Yitzhaki and Lewis (1996).

[15] Current users are users with positive expenditure under a concentrated market (status quo). Nonusers would then be the remaining users who do not exhibit positive expenditures under a concentrated market (status quo).

If the exogenous total number of entrants by region is available, then:

$$e_{g,i}^{new} = \frac{\sum_{h=1}^{N_g} \pi_{h,g}\, e_{g,h,i}^{nonusers}}{\sum_{h=1}^{N_g} sw_{g,h} hs_{g,h}},$$ (11)

where $sw_{g,h}$ and $hs_{g,h}$ denote, respectively, the sampling weight and the size of household h in region g.

Finally, the total change in well-being of group g is then:

$$dw_g = -e_{g,i}^{current} dp_i - e_{g,i}^{new} dp_i$$ (12)

c. Data requirements

The proposed approach may be applied to data on household consumption, typically data from household expenditure or consumption surveys. Three key variables must be drawn from the surveys: (1) a per capita welfare measure to estimate poverty (often calculated as the total consumption or income of a household, divided by the number of household members or adult equivalent members), (2) per capita consumption or expenditure on a good or service of interest, and (3) a relevant poverty line estimated according to household consumption or income.

In addition to microdata from household surveys, a minimum set of parameters defining baseline and reform scenarios of the underlying market structure or a given industry are required, including the number of new firms competing in a market and price elasticities of demand. The model for the extensive margin module that estimates new consumers also requires demographic and spatial variables derived from the household expenditure or consumption survey. The dependent variable for the probabilistic model is a binary dummy indicating whether the household or individual (denoted by h) has any positive or null consumption in the good or service of interest. The (proportional) price change dp_h and the (proportional) welfare change, $dIncome_h$, must be included, along with a set of household and individual characteristics and policy variables linked to the use or consumption of the good or service of interest (age, sex, geographical location, literacy, educational attainment, employment status, household assets, and services).[16]

3. The mobile telecommunication industry in Ethiopia

As of 2019, Ethiopia was one of the three countries in the world in which the mobile phone market was a monopoly. In 2018, among countries in Africa, Ethiopia ranked 4th lowest in mobile phone penetration (37.2) per 100 people and 12th lowest in fixed broadband subscriptions (0.05) (fFigure 1. **Access to Mobile Phones and Internet Services, 2018**

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[16] The (proportional) welfare change is calculated directly using the WELCOM Stata Tool.
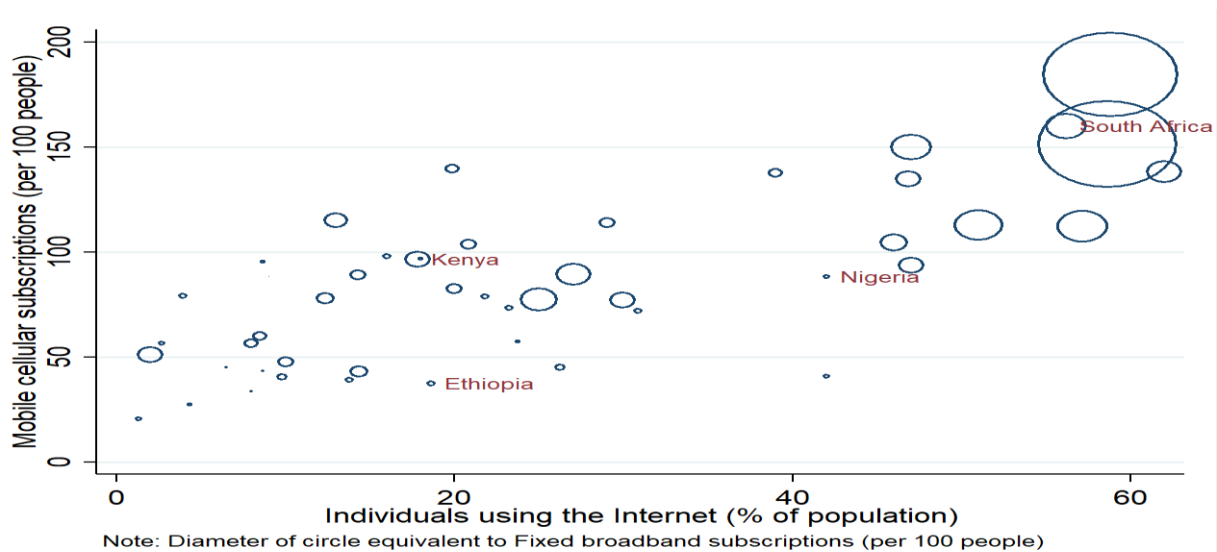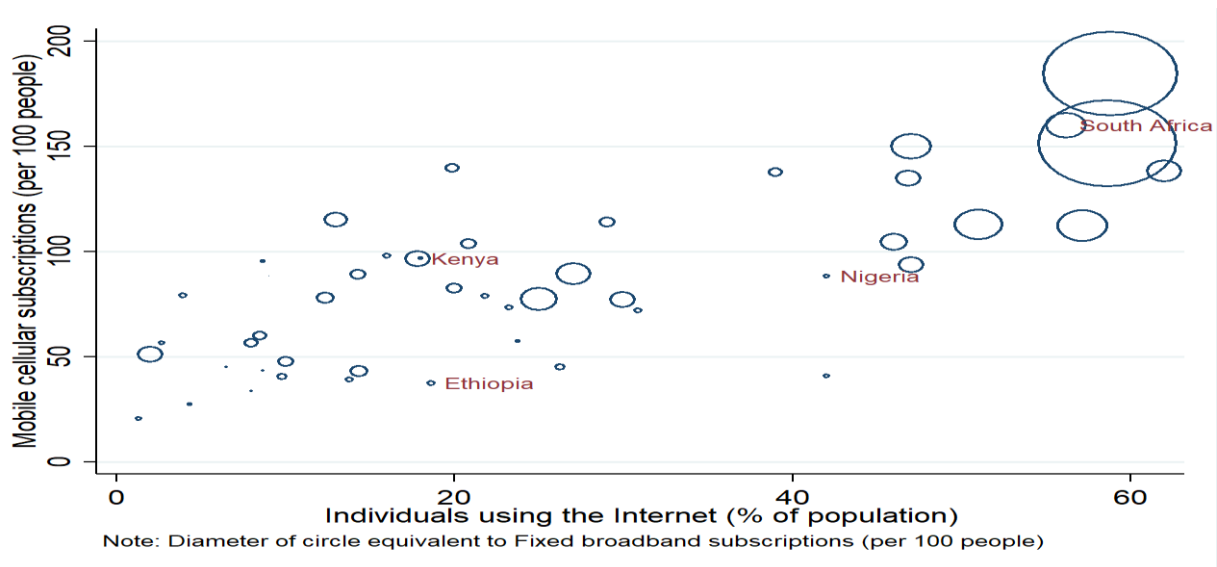
Note: Diameter of circle equivalent to Fixed broadband subscriptions (per 100 people)

Source: 2019 data of WTI (World Telecommunication/ICT Indicators database), International Telecommunication Union, Geneva, https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx.

). The government of Ethiopia is undertaking a reform to modernize the economy, including a gradual privatization of key sectors, such as the mobile phone market, which has been dominated by a state-owned monopoly, Ethio Telecom. Because of its position as a monopoly, Ethio Telecom can set prices, like in 2018 when it cut mobile and fixed telephone prices by 50 percent.[17] Traditionally, among the most expensive mobile cellular baskets in the world, Ethiopia's price basket expressed as a share of the country's gross national income per capita, declined at a rapid rate in 2015 (the year of the most recent household survey).[18]

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[17] The data are based on research of Roland Berger for the World Bank. See Roland Berger (2019).

[18] Because the data of the most recent household budget survey conducted in Ethiopia correspond to information on 2015/16, the simulation analysis in this paper coincides with a period characterized by the highest consumer prices for mobile-cellular services. The results presented may thus correspond to an upper bound of the potential welfare effects of ending the monopoly of Ethio Telecom. Annex 2 illustrates price trends in cellular-mobile services in Ethiopia between 2008 and 2019.

Figure 1. Access to Mobile Phones and Internet Services, 2018

Note: Diameter of circle equivalent to Fixed broadband subscriptions (per 100 people)

Source: 2019 data of WTI (World Telecommunication/ICT Indicators database), International Telecommunication Union, Geneva, https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx.

Through the new Communications Service Proclamation, the government decided to award two new telecommunication operator licenses thereby introducing competition in the sector for the first time.[19] Opening up the sector is expected to result in more intense competition. The analysis simulates a reduction in the share of Ethio Telecom from 100 percent to 45 percent of the market because of the entrance of two new competitors and estimates a 25.3 percent decline in prices in the short run and a 47.2 percent mobile penetration rate in 2021 (from 42.0 percent in 2015/16).[20] The magnitude of the price drop is sensible given that 2015/16 (the year of the latest available household survey) corresponds to the highest price for the mobile cellular basket. Thus, the simulation results should be interpreted as if the reform took place in 2015/16.

Data of the 2015/16 HCES show that household expenditures on mobile services in 2016 corresponded to 1.4 percent of total consumption (CSA 2018). The share was lower among households at the bottom of the income distribution. Thus, the average expenditure of the lowest income decile on mobile phone services was about Br 83 a year (US$10 a year at purchasing power parity) (table 1). This represented 0.43 percent of the decile's total consumption. Meanwhile, the top income decile spent Br 1,729 (about 2.31 percent of the corresponding decile consumption). In demand across the consumption distribution, only 14 percent of households in the poorest decile reported positive spending on telecommunication services, while the corresponding share among households in the top consumption decile was 76 percent. The low spending on mobile services may

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[19] The Communications Service Proclamation was passed by the House of People's Representatives on June 13, 2019. It created the basis for a more liberalized market environment in the mobile telecommunication sector.

[20] The data are based on research of Roland Berger for the World Bank. Evidence on Africa and Latin America shows that increases in competition in the telecommunication sector, measured according to the share of new mobile operators, is correlated with declines in the price of local calls, together with expansions in the number of landlines per capita, payphones, and connection capacity (Wallsten 2001). Faccio and Zingales (2017) discuss how procompetition government policies, such as allowing number portability to the voice over internet protocol, may have substantial impacts by reducing prices and fostering competition, while producing no negative effects on service quality.

be partially explained by the lack of adequate network infrastructure. An estimated 15 million Ethiopians are out of reach of the cellular network, and 60 million are without access to the internet. This barrier is coupled with the high costs of handsets that are driven by import duties and a concentrated retail market.

Table 1. Household Expenditures on ICT Services, by Consumption Decile, 2015/16, %

Household expenditure	All	Poorest 1	2	Consumption decile 3	4	5	6	7	8	9	Richest 10
ICT	1.456	0.427	0.663	0.882	1.020	0.947	0.928	1.185	1.331	1.628	2.314
Mobile services	1.439	0.423	0.657	0.874	1.014	0.937	0.917	1.181	1.319	1.615	2.274
Fixed line telephone services	0.016	0.004	0.006	0.007	0.006	0.010	0.011	0.004	0.012	0.012	0.036
Fixed internet services	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004
Households with positive expenditure on mobile services, %	42.05	13.99	24.97	33.46	36.30	37.79	37.41	44.60	52.74	63.18	76.06

Source: Elaboration based on data of the 2015/16 HCES; see CSA 2018.

The government has made substantial strides in poverty reduction since 2004. National estimates of the poverty headcount ratio declined from 39 percent in 2005 to 24 percent in 2015 (World Bank 2020). These gains have largely been focused in urban areas, leading to an increase in inequality, albeit the Gini index, at 35.0, is low relative to peer countries.

4. Results

This section discusses the main results of the proposed approach. First, it shows the impacts of the expected reduced concentration on current users. Second, it examines the welfare effects generated among potential new users by the estimated price declines caused by greater competition. Third, it discusses limitations of the simulation approach proposed.

4.1. Welfare effects among current users

For the simulation, the baseline scenario is a monopoly in the telecommunication industry.[21] The reform scenario simulates a shift to a competitive market through gradual steps. One way to interpret the results is to picture the perfectly competitive scenario as a long-run counterfactual and the different steps to reach that equilibrium as short- and medium-term counterfactuals.

Diluting the market share of the monopoly in ICT from 100 percent to 45 percent is expected to reduce consumer prices by 25.3 percent (table 2). In addition, the results of implementing the simulation in multiple steps suggest that the welfare impact of reducing the monopoly's market share would increase at a declining rate as new telecommunication providers enter the market (fFigure).

Table 2. Price Changes after Diluting the Market Share of the ICT Monopoly

MONOPOLY MARKET	STEP 1	COMPETITIVE MARKET
Market share(%) = 100 $\eta = -1.5$	Market share (%) = 45 $\eta = -0.81$	Market share (%) = 0 $\eta^* = -0.25$

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[21] See annex 1 for information on how the approach models the monopoly. The approach also allows the user to model oligopoly and partial collusive oligopoly.

| $p_1 = 3.0$ | $p_1 = 2.24$ | $p_0 = 1.0$ |

Source: Elaboration based on data derived from the WELCOM Stata Tool and the 2015/16 HCES; see CSA 2018.
Note: The elasticity is interpreted not only as the sensitivity of current consumers of the service, but also as the expected response to the demand of both current and new users. The changes in the value of the elasticity occur because of the simulation of a large price drop for the item of interest, resulting in a larger magnitude in the quantity demanded and a decline in the absolute value of elasticity.

All current users of ICT services across the consumption distribution are expected to benefit from greater competition in the telecommunication sector, but the gains will disproportionately benefit households in the top consumption deciles because they adopt ICTs at higher rates and spend more on the services, both in absolute and relative terms. In contrast, the effects on poverty reduction among current consumers are expected to be modest because most households at the bottom of the consumption distribution and around the poverty line exhibit low ICT adoption and low ICT expenditures.

Figure 2. The Market Share of the Telecommunication Monopoly and Consumer Prices
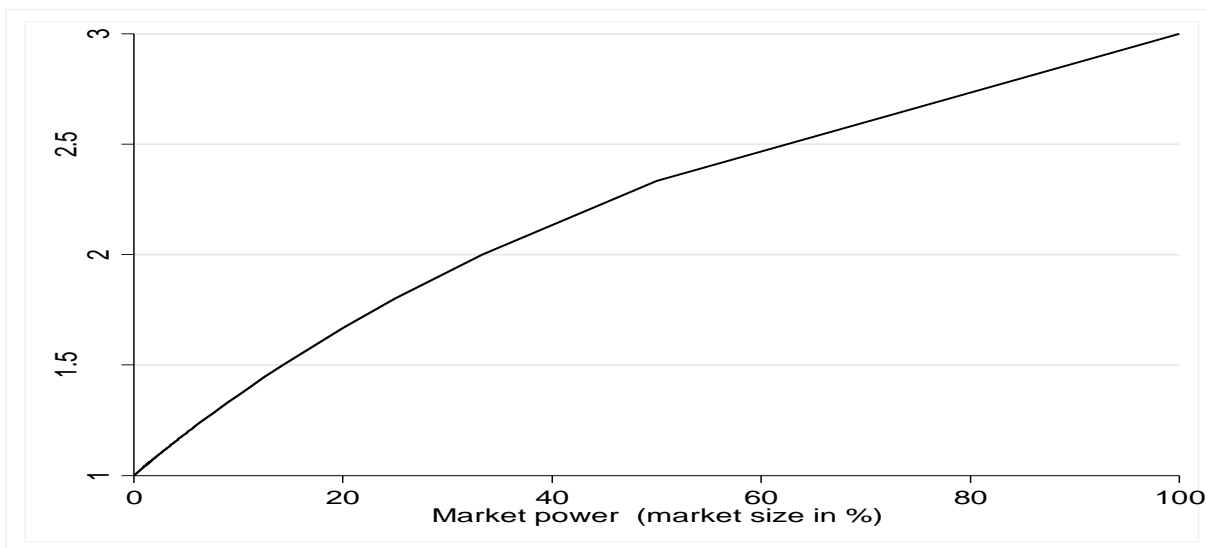
Source: Elaboration based on data derived from the WELCOM Stata Tool.

The results indicate that, based on simulating a decline in Ethio Telecom's market share in mobile services from 100 percent to 45 percent and a price elasticity of demand of −1.50, a shift to a more competitive market would induce a 0.22 percentage point reduction in poverty among current users in the short run with respect to the baseline headcount poverty rate of 24.21 percent and up to 0.80 in the long run because of the direct effect of lower prices (tTable).[22]

Table 3. Poverty and Inequality Effects, Loss of Ethio Telecom Monopoly, Current Users

Scenario	Poverty indicators			Inequality indicators		
	Headcount	*Poverty gap*	*Squared poverty gap*	*Gini*	*Atkinson (epsilon = 0.5)*	*Entropy (theta = 0.0)*

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[22] The price elasticity of demand used was −1.50 because there was no price elasticity of demand specific to Ethiopia's mobile services market (Waverman, Meschi, and Fuss 2005). This preliminary estimate should be viewed with caution because it refers to 2005 and corresponds to values obtained for a pool of developing countries. However, this solution is adequate because of the scant empirical evidence on price elasticities of demand in mobile services in developing countries, particularly in Africa.

Baseline	24.21	6.86	2.83	33.3	0.0934	0.1871
Reform scenario	23.99	6.78	2.80	33.5	0.0947	0.1898
Difference	−0.22	−0.08	−0.03	0.23	0.0013	0.0026

Source: Elaboration based on data derived from the WELCOM Stata Tool and the 2015/16 HCES; see CSA 2018.
Note: The reform scenario corresponds to a reduction in the market share of Ethio Telecom from 100 percent to 45 percent. The Gini index is based on consumption.

The results also show an average relative welfare gain of 1.09 percent among all current users of telecommunication services (tTable). The richest decile will gain Br 474.8 (in Birr of 2015) on average, relative to Br 9.8 among the poorest decile. This corresponds to a relative gain of 1.7 percent among the top decile and 0.3 percent among the bottom decile. This suggests that households in the richest consumption deciles will benefit more in both absolute and relative terms from greater competition in the ICT sector compared with the poorest households, which is consistent with an expected rise in the Gini index of 0.23 points with respect to a baseline of 33.3 (see tTable).

Table 4. Welfare Effects, Loss of Ethio Telecom Monopoly, Current Users

Consumption values	All	Poorest 1	2	3	Consumption decile 4	5	6	7	8	9	Richest 10
Annual mean per capita consumption, birr	10,111	3,062	4,775	5,928	6,908	7,867	8,806	9,851	11,621	14,779	27,525
Absolute incidence, birr	110.36	9.8	23.8	39.2	53.1	55.9	61.3	88.3	116.3	181.1	474.8
Relative incidence	1.09	0.32	0.50	0.66	0.77	0.71	0.70	0.90	1.00	1.23	1.73

Source: Elaboration based on data derived from the WELCOM Stata Tool and the 2015/16 HCES; see CSA 2018.
Note: Consumption values are in birr of 2015.

The results correspond to the potential welfare effects only among current consumers (intensive margin effects). This likely underestimates the total welfare gains derived from breaking up the monopoly in the telecommunication sector because it does not include the potential benefits among new consumers. Thus, the expectation is that the total welfare effects of greater competition in the ICT industry will become more equalizing across the consumption distribution if one also considers the likely welfare effects among potential new consumers (extensive margin effects), given the lower uptake among households at lower income deciles.

4.2. Welfare effects among new users

To test the above conclusions, the analysis next uses the change in prices deriving from the reduced market share of the dominant firm in the market to estimate the welfare effects among new users by simulating the estimated change in the uptake among users and the corresponding expected change in consumption, which represents a novelty of the approach.[23] For model selection, the analysis implements a backward stepwise probit regression on per capita consumption (in logarithmic scale) and observable household characteristics. Based on the results of this model, it applies the proportional income change to estimate the marginal effects of competition, resulting in the predicted

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[23] These extensive margin estimates have been carried out using the WELCOM mcema module. Please refer to Rodríguez-Castelán et al. 2021.

probabilities of usage.[24] For the analysis, a variable selection filter with a 5 percent threshold of statistical significance was used. Covariates in the probit model include characteristics of household heads (employment status, literacy, sex, and age) and household characteristics (access to electricity, material of dwelling's walls and floors, and household size). After estimating the predicted probabilities of demand, the analysis imputes the expected expenditures for those households that were previously priced out of the market.[25] Specifically, estimates are calculated by running a quantile regression model with a random imputation of residuals.[26]

The results show that a 25.3 percent drop in the price of mobile services would increase the uptake of mobile services by 5.2 percentage points with respect to the baseline of 42.0 percent. The increase in demand is 1.6 percentage points among households in the lowest consumption decile, while it corresponds to 6.1 percentage points among households in the top decile. The rise in the share of users because of the greater competition is then associated with an additional reduction in poverty of 0.09 percentage points with respect to the baseline 24.2 poverty rate (table 5). New users do not have a significant effect on the Gini index (which is thus not reported in table 5).

Table 5. Poverty Impacts, Loss of Ethio Telecom monopoly, New Users

Scenario	Poverty indicators	
	Headcount	Poverty gap
Baseline	24.21	6.864
Increase in new users by 5.2 percentage points	24.13	6.836
Difference	−0.09	−0.028

Source: Elaboration based on data derived from the WELCOM Stata Tool and the 2015/16 HCES; see CSA 2018.
Note: The Gini coefficient is based on consumption rather than income. Gini coefficient results were not significant for new entrants. Due to rounding the difference between the baseline and the increase in new users is not exact.

The increase in uptake is associated with an average relative impact on welfare of 0.28 percent (table 6).[27] New entrants who belong to the richest consumption decile are expected to gain an average of Br 68.8 (Bbirr of 2015), while new entrants in the bottom consumption decile will gain an average of Br 2.9. This translates into a relative gain of 0.25 percent among the top decile and 0.09 percent among the bottom decile. New entrants in the top decile will also benefit more than new entrants in the

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[24] See the WELCOM user manual at WELCOM Stata Tool, Global Solutions Group on Markets and Institutions for Poverty Reduction and Shared Prosperity, Poverty and Equity Global Practice, World Bank, Washington, DC, http://dasp.ecn.ulaval.ca/webwel/welcom.html.

[25] The mcema module allows the user to run six alternative models to estimate expenditures. See the mcema user manual for more information on each methodology.

[26] Alternatives considered but not used for this simulation involve taking the average at the level of the primary sampling unit, random imputation, linear regression imputation, stochastic regression imputation, and quantile regression imputation. For the purpose of this exercise, estimates of the random imputation and the mean of expenditures at the level of the primary sampling unit were also carried out. These serve as upper- and lower-bound measures of the relative impact on welfare.

[27] mcema allows the user to employ six different models to estimate household expenditures of those households that were previously priced out by imperfect competition. Expenditure estimates are calculated by running a quantile regression model with random imputation of residuals. using the average expenditures among primary sampling units, which give the most conservative estimates. Hot deck random imputation was also carried out to estimate expenditure; this could serve as an upper-bound estimate. Other expenditure imputation models are linear regression imputation, stochastic regression imputation, quantile regression imputation, and quantile regression with random imputation of residuals. See the mcema user manual for more information on each methodology (Rodríguez-Castelán et al. 2021). The relative impact on welfare is the average absolute impact on the average income, times 100.

bottom decile, but less than proportionately in the case of the relative welfare gains among current consumers.

**Table 6. Welfare Effects, Loss of Ethio Telecom Monopoly, New Users**

Consumption value	All	Poorest 1	2	3	4	Consumption decile 5	6	7	8	9	Richest 10
Annual mean per capita consumption, birr	10,111	3,062	4,775	5,928	6,908	7,867	8,806	9,851	11,621	14,779	27,525
Absolute incidence, birr	28.2	2.9	10.7	15.1	17.3	21.8	17.8	24.8	42.1	60.4	68.8
Relative incidence	0.28	0.09	0.22	0.25	0.25	0.28	0.20	0.25	0.36	0.41	0.25

Source: Elaboration based on data derived from the WELCOM Stata Tool and the 2015/16 HCES; see CSA 2018.
Note: Consumption values are in birr of 2015.

Despite the positive but unequalizing welfare effects of greater competition on new users, an accounting of only the welfare effects on new users shows that the relative welfare gain among households in the bottom decile of the consumption distribution is 6.9 percent, compared with an average of 4.9 percent among households in the richest decile (figure 3).

Figure 3. Relative Welfare Gains of Greater Competition in Telecommunication, New Users
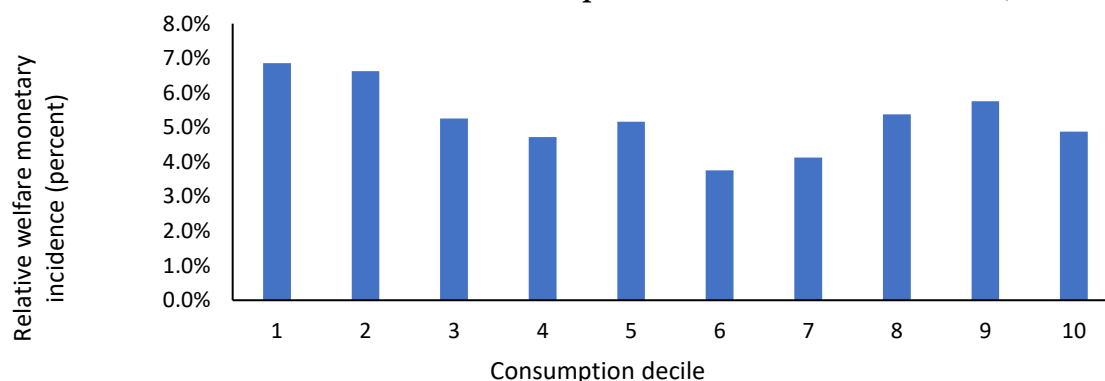
Source: Elaboration based on data derived from the WELCOM Stata Tool and the 2015/16 HCES; see CSA 2018.
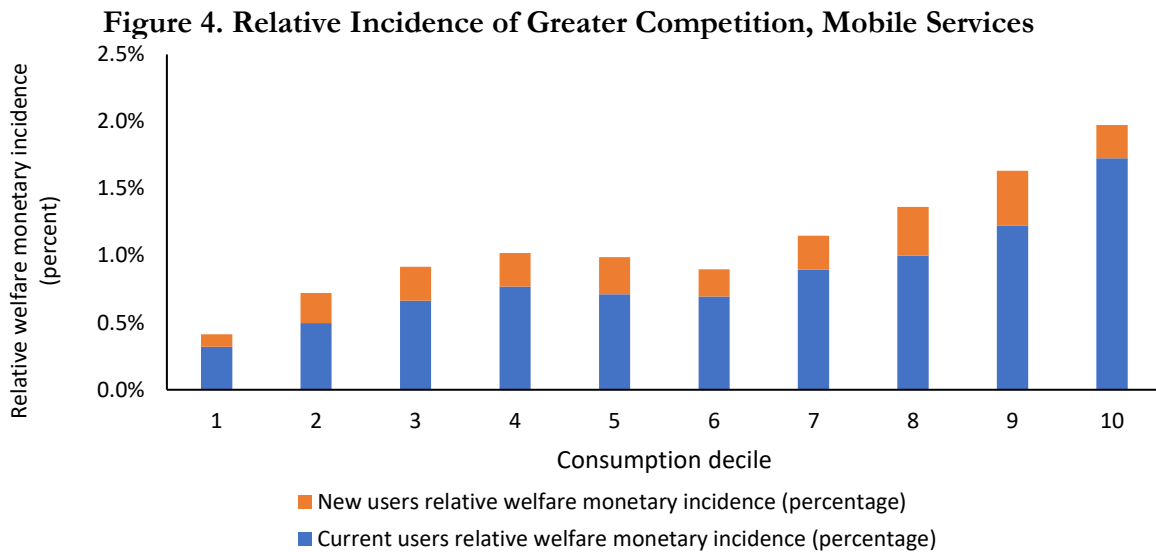*Note:* Bars show relative welfare in percentage. Relative welfare is the per capita welfare incidence divided by per capita expenditure, only for new consumers. Expenditure estimates were carried out by running a quantile regression model and random imputation of residuals.

4.3. Aggregate welfare effects of greater competition in the ICT industry

Next, the results obtained above among both current and new users, except for the Gini index, can be added linearly to calculate the aggregate welfare effects of the breakup of the monopoly power of Ethio Telecom. Thus, the relative mean aggregate welfare gains among current and new users are equivalent to 1.37 percent. Richer households in higher consumption deciles would also experience the largest gains in both absolute and relative terms in comparison with poorer households. Specifically, the combined monetary gains of the top consumption decile will be approximately 2.0 percent, compared with 0.4 percent among the lowest consumption decile (figure 4).[28] These welfare

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[28] To calculate the money metric welfare of a price decrease, the expected expenditures of new entrants are assumed to be equal to that of the current user group. See the WELCOM user manual for more information; see WELCOM Stata Tool, Global Solutions Group on Markets and Institutions for Poverty Reduction and Shared Prosperity, Poverty and Equity Global Practice, World Bank,

gains among current and new users will also translate into an overall reduction in the poverty rate of 0.31 percentage points and an expected increase in inequality of 0.23 Gini points.

Figure 4. Relative Incidence of Greater Competition, Mobile Services

Source: Elaboration based on data derived from the WELCOM Stata Tool and the 2015/16 HCES; see CSA 2018.
Note: Relative welfare is the per capita welfare incidence, divided by per capita expenditure. Expenditure estimates were carried out by running a quantile regression model and random imputation of residuals. Expenditure estimates were also carried out using random imputation and calculating the average expenditure by primary sampling unit. These serve as lower- and upper-bound estimates. These have been omitted for simplicity.

5. Conclusions

This paper proposes a practical microsimulation approach to assessing the distributional impact of enhancing market competition in key sectors of economic activity. The approach combines data from household budget surveys with the parameters of reform scenarios in selected markets to estimate the welfare gains among current and new consumers likely to benefit from enhancing competition. This novel approach is applied to the case of the mobile telecommunication market in Ethiopia, which has been dominated by a state-owned monopoly until recently. The results show that, in a reform scenario that reduces the market share of the monopoly to 45 percent would be associated with a 25.3 percent drop in the prices of mobile services and an increase the number of new users by 4.6 million. The predicted drop in prices and the increase in the number of users will generate an average relative welfare gain of 1.09 percent among current users and 0.28 percent among new users, for a total combined relative welfare gain of 1.37 percent. The combined effect on poverty is a reduction by 0.31 percentage points and a change in inequality of 0.23 Gini points.

Washington, DC, http://dasp.ecn.ulaval.ca/webwel/welcom.html. The change in well-being is equal to the negative value of the product of the estimated change in the proportion of users, the average expected expenditures among new users of the good of interest, and the observed change in price. Average expected expenditures among new users are estimated by running a quantile regression model and random imputation of the residuals for those households with positive expenditures. mcema also provides the option to run a linear regression to estimate these expenditures. Please refer to Rodríguez-Castelán et al. 2021 for a detailed discussion.

Besides these potential direct welfare gains of expanding competition in the ICT market in Ethiopia, the potential marginal effects on adoption may have additional indirect welfare implications because mobile phones are transitioning from simple communication tools to stand-alone service delivery platforms and because digital technologies have the potential of reducing significantly the costs of economic activities (Goldfarb and Tucker 2019; Rennhoff and Routon 2016). Recent research on Africa, for example, has shown the importance of internet access in poverty reduction, increasing household consumption, and improving labor market outcomes (Bahia et al. 2020; Hjort and Poulsen 2019; Masaki, Granguillhome Ochoa, and Rodríguez-Castelán 2020; Masaki, Raja, and Rodríguez-Castelán 2020). Furthermore, if complementary reforms in other sectors are undertaken, such as the financial sector, mobile devices would have the potential to enable poor people to lower transaction costs, raise access to credit, and apply risk mitigation safeguards, leading to a reduction in vulnerability and poverty (Jack and Suri 2014; Wieser et al. 2019).

The results on Ethiopia are also a useful illustration for policy makers on the potential welfare gains of competition-enhancing policies. This case study shows that breaking up monopoly power in a key sector of the economy, such as mobile services, may have substantial direct positive effects on welfare, especially among lower-income households that are often priced out of sectors that are key to boosting household productive capacity. The analysis presented in this paper can thus be easily replicated in any country in the case of other industries affected by high market concentration.

As in most simulation methods, there are areas of improvement in this proposed approach. First, the simulation is based on partial equilibrium analysis. So, it focuses on the first-order effects of competition on consumer welfare through the price channel, potentially missing other impacts through alternative channels, such as labor markets, asset accumulation, or the diversity of alternatives available in purchasing. Second, by using household budget surveys, which typically do not include detailed information on the quality or brand of the goods and services consumed, the analysis may not capture the potential welfare effects brought about by changes in quality or the effects of alternative pricing schemes. This work may be the subject of future research to improve the simulation approach, which has the potential of becoming a powerful tool to motivate competition reforms around the world.

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Annex 1. Monopolistic Structure

The extreme case of market concentration involves a single producer in the market (a monopoly) or a group of firms colluding to operate as a monopoly. (The levels of prices and quantities associated with such a market will include the subscript $MONO$.) If the market demand faced by the monopolist is a continuous decreasing function of price, then the monopolist realizes that a small price increase above the competitive level may lead only to a small increase in prices (Mas-Colell, Whinston, and Green 1995). Thus, raising prices above the competitive level is an optimal profit maximization strategy for the firm.

The decision problem of the monopolist consists in choosing the level of output that is considered desirable to sell, $q_{MONO} \geq 0$, given the inverse demand function $p(q)$—the price that must be charged to sell q units of output—and a known cost function, $c(q)$, as follows:[29]

$$\underset{q \geq 0}{\text{Max}}\, p(q) \cdot q - c(q). \tag{1.1}$$

The price change (relative) of moving from a competitive equilibrium to a monopolistic structure is therefore equal to the following:

$$dp = \frac{p_{MONO} - p_{COMP}}{p_{COMP}} \tag{1.2}$$

$$dp_{MONO} = \frac{p_{MONO}}{p_{COMP}} - 1 = (p_{MONO}) \cdot \frac{1}{p_{COMP}} - 1 = \left(\frac{\eta}{1+\eta} \cdot MC\right) \cdot \frac{1}{MC} - 1,$$

where η denotes the own-price elasticity of demand at the monopoly equilibrium. A key assumption is that the demand function is linear. The price change (in percentage share) of moving from a monopolistic structure to a competitive equilibrium will also be a function of the elasticity of demand, as follows:

$$dp_{MONO} = \frac{\eta}{1+\eta} - 1 = -\frac{1}{1+\eta} \tag{1.3}$$

In general, the observed elasticity must be higher than 1 in absolute value to maximize the profit of the monopolist (the empirical estimated elasticity is larger than -1). Moreover, similar expressions may be derived for alternative market structures, such as an oligopoly competing under Cournot.[30]

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[29] Following Mas-Colell, Whinston, and Green (1995), the monopolist faces a demand function given by $x(p)$ that is continuous and strictly decreasing at all p such that $x(p) > 0$. Then, the inverse demand function would be given by $p(\cdot) = x^{-1}(\cdot)$.

[30] For details, see the WELCOM user manual at WELCOM Stata Tool, Global Solutions Group on Markets and Institutions for Poverty Reduction and Shared Prosperity, Poverty and Equity Global Practice, World Bank, Washington, DC, http://dasp.ecn.ulaval.ca/webwel/welcom.html.

Annex 2. Trends in the Mobile Price Basket, Ethiopia, 2008–19

Figure 2.1. The Mobile-Cellular Price Basket, Low Usage (70 Minutes + 20 SMS), 2008–19
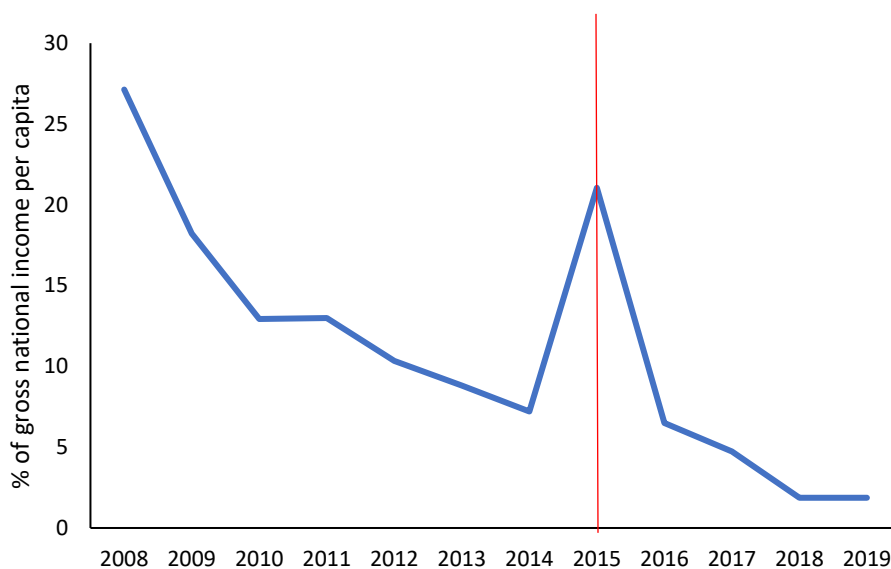
Source: Mobile-Cellular Basket Low Usage, Ethiopia Time Series, IPB (ICT Price Baskets) (database), International Telecommunication Union, Geneva, https://www.itu.int/net4/ITU-D/ipb/index.html. 2020.
Note: 2008–17 data represent a mobile cellular basket composed of a monthly usage of 30 outgoing calls (on-net/off-net to a fixed line and for peak and off-peak times) in predetermined ratios, 100 SMS messages. 2018 and 2019 represent a revised mobile-cellular low-usage basket with a monthly usage of 70 minutes and 20 SMS. The red line represents the year of the latest available household survey.