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Does mobile phone technology reduce agricultural price distortions? Evidence from cocoa and coffee industries

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Abstract

Agricultural price distortion which is the discrepancy between world market price of agricultural produce and price received by farmers as a result of market interventions by governments, either through subsidies or taxes or even trade protection systems, has received rare attention in the cocoa and coffee sub-sectors. This study examines the contribution of mobile phone technology in reducing price distortions in cocoa and coffee production. In addition, we tested stylized facts such as the development paradox, resource abundance, and group-size effect in agricultural price distortions literature. The findings suggest that access to mobile phones reduces the extent of price distortions. The effect of mobile phone usage on the extent of price distortion, the nominal rate
of assistance, and relative price margin is conditional on internet connectivity. Whereas our results support the development paradox and group-size effect hypotheses, the resource abundance hypothesis is not supported. Based on our results, policies that seek to reduce the cost of telecommunication, increase competition in the telecommunication industry, and increase economic growth would go a long way to reduce price distortion in the cocoa and coffee industries.

Keywords: Price distortion, Nominal rate of assistance, Relative price margin, Mobile phone, Cocoa, Coffee, JEL code, Q1, Q17, E64

Background

The aim of this study is to analyze the determinants of agricultural price distortions with a particular focus on the role of mobile phone usage, using cocoa- and coffee-producing countries as the case study. According to Anderson (2013), agricultural price distortions are the discrepancies between world market prices of agricultural produce and prices received by farmers as a result of market interventions by governments, either through subsidies or taxes or even trade protection systems. Agricultural revenue in developing and emerging countries has been severely distorted by exogenous shocks, countries' tax, and subsidy policies (Anderson 2013). Coupled with these, the state of institutional quality in these countries, in addition to natural factors such as climate change and vagaries of pests and diseases, can also constitute to price distortion in the agricultural sector. For instance, the level of infrastructure deficits have constrained the availability and access to productive inputs as well as the

commercialization of agricultural production in Africa and this may create price distortions as farmers become less efficient (Moyo et al. 2015). In addition, small farmers in developing countries have little resilience to weather shocks making them vulnerable (Niles and Salerno 2018).

Most farmers in developing and emerging countries depend on the proceeds from their agricultural activities as the main source of livelihood, and such distortions in prices create uncertainty for farmers. Although there have been significant progress to reduce these distortions through improved infrastructure and favorable trade policies which have resulted in a decrease in the wedge between farm gate prices and world prices, many welfare and trade-reducing processes remain huge challenges in the agricultural sector in developing countries (Anderson and Valenzuela 2008). Anderson (2013) postulates that information communication technology (ICT) has the potential of reducing agricultural price distortions. However, ICT penetration is low in developing countries[1] compared to the developed world where almost everyone can easily access and use ICT services, such as having access to farming and market price information. Low or nonexistence of telecommunication services in rural areas in developing countries have exposed farmers to highly inefficient and information asymmetric markets (Fafchamps and Minten 2012; Aker and Fafchamps 2014). This creates uncertainty and also increases the risk of doing business (Abraham 2007).

In addition, farm households in developing countries face unstable and distorted market prices due to poor access to information; this raises production cost and worsens their welfare (Geertz 1978). Thus, farmers in developing economies are likely to face price differentials due to inefficient and information asymmetric markets. Abraham (2007) argues that the development of telecommunication services plays an important role in reducing price differentials between markets of homogenous products. Therefore, the use of instant telecommunication services would improve market information access on prices, quantities, and potential market uncertainties of all kinds.

In spite of the enormous benefits from mobile phone technology, empirical studies on the effects of mobile phone usage in reducing agricultural price distortions in the area of cocoa and coffee sub-sector are rare. Existing studies have mainly focused on the impact of mobile phone use on consumers' welfare (Aker 2010; Overa 2006). Further, Klonner and Nolen (2010) looked at the impact of mobile phone technology on rural labor markets and they showed that employment increases substantially once network coverage is introduced to an area. Likewise, Chowdhury (2006) showed that having access to landline phones increases rural factor market participation by about 14% in Bangladesh. Labonne and Chase (2009) examined the effects of mobile phones on per capita consumption of farm households in the Philippines and showed that purchasing a mobile phone is associated with 11 to 17% increase in consumption. Within the agricultural price context, Aker and Fafchamps (2014) explored the relationship between mobile phones and price dispersion within millet, sorghum, and cowpea markets in Niger. They established that mobile phone reduces price dispersion. In order to fill the gap in the cocoa and coffee sub-sectors, the current study analyzes the determinants of agricultural price distortions with a particular focus on the role of mobile phone usage.

Most cocoa- and coffee-producing countries are from developing and emerging economies and these products are mostly the main foreign exchange earner for these

countries. As a result, examining the determinants of price distortions in the cocoa and coffee industries is important. The study uses the nominal rate of assistance and relative price margin as proxies for price distortions. Our analysis follows three different steps. In the first step, we estimate the determinants of the extent of price distortion. The extent of price distortion is measured by the absolute value of the nominal rate of assistance. At this stage, we seek to examine whether or not mobile phone access reduces the magnitude of price distortion. We test the *development paradox*, *resource abundance*, and *group-size effect* stylized facts as postulated by Masters and Garcia (2009) at the second stage. Development paradox comes about when developing countries tax their agricultural produce which is the main foreign exchange earner, whereas developed countries subsidize these produce (Bale and Lutz 1981; Masters and Garcia 2009). Resource abundance hypothesis stipulates that governments in land-abundant countries tend to tax more or subsidize less their agricultural sector (Bale and Lutz 1981; Masters and Garcia 2009). According to Masters and Garcia (2009), the group-size effect can affect outcomes through free-ridership in a case where individuals in larger groups have more incentive to shirk on their responsibilities. In the last step, we construct a relative price margin and analyze its determinants.

This study contributes to the literature in three ways. First, unlike Aker and Fafchamps (2014) who focused on millet, sorghum, and cowpea markets in Niger, our study considers the role of the mobile phone as a means of reducing agricultural price distortions within the cocoa and coffee sub-sectors in developing and emerging economies. Second, whereas Lutz and Scandizzo (1980) and Anderson and Masters (2007) considered an aggregated analysis of price distortions for all agricultural produce, we restrict our analysis to explore the factors which influence tax imposition or subsidies in cocoa- and coffee-exporting countries. Lastly, our construction of relative price margin as a proxy for price distortion is novel as no study has used such indicator before. While the world price depends on the exogenous world economic reactions such as global supply and demand and other macroeconomic factors, the farm-gate price, however, depends on each country's trading policies and institutions (Fulginiti et al. 2004). Therefore, the gap between domestic and world market prices can be used to reflect the welfare trade effects through the so-called relative price margin, the difference between world market price and farm-gate price.

Computing relative price margin index is very useful, as it represents the relative differences between world and farm-gate prices. While the values of nominal rate of assistance account for other macroeconomic factors, the computation of relative price margin relies only on observed nominal price values. Consequently, its values change differently from one country to another based on how trade policies and institutions are structured for specific governments. This implies that enhanced institutional quality (such as trust, property right, rule of law, ease of information access, etc.) would reduce trade cost and eventually reduce price distortions. In this study, we show that relative price margin is positively related to nominal rate of assistance.

The remainder of the study is organized as follows: "Development of agricultural price distortions" section discusses the development of agricultural price distortions. In "Literature review" section, we review relevant literature pertaining to the subject matter. The conceptual framework, method, and estimation techniques are discussed in "Methodology and estimation technique" section. Whereas, "Results and discussion"

section presents and discusses the results, "Concluding remarks" section provides concluding remarks and relevant policy implications of the findings from the study.

Development of Agricultural price distortions

Market intervention policies, by governments, have been influential in distorting agricultural crop prices. In developing countries, usually, the governments levy taxes on farm production while in developed nations, the governments usually subsidize it. This tendency has been substantially documented, notably by Bale and Lutz (1981), Anderson and Hayamis (1986), Krueger (1980), and Krueger et al. (1988) among others. In their studies, the common argument is that most of the developing countries, especially in Sub-Sahara Africa, levy taxes on the agricultural sector either directly or indirectly through government policies thereby reducing the incentives to invest, hence a potential decline in the growth of the sector (Magrinia et al, 2014; Akanegbu, 2015).

For instance, while more than 60% of Sub-Saharan Africa's workforce still engaged in agriculture sector and more than 80% of the region's poor households depend mainly on farming for their livelihoods, agricultural and trade policies remain key influences on the pace and directions of change in Africa (World Bank 2007; Chen and Ravallion 2007). Concerning cocoa-producing countries, farm policies have changed frequently over the years in different countries and the resulting distortions have heavily affected small-holder farmers in cocoa production. The policy mix of direct and indirect taxes through fiscal policy, marketing boards, trade barriers, foreign exchange restrictions, and other development policies imposed a significant burden on farmers (Anderson and Masters 2007). These policies surely are of great concerns, especially in developing countries where a huge number of poor families depend mostly on agricultural activities (Anderson 2010). Furthermore, price-depressing policies contribute to overall global poverty and high inequalities (Anderson et al. 2010).

As far as coffee price distortion is concerned, the interventions of producing countries in domestic markets have been prevalent in many countries through parastatals that controlled marketing and trade in the coffee industry. The coffee market may have been subject to supply controls longer than any other important commodity. Domestic policies in producing countries remain sensitive and hugely dependent to international developments as well as to local pressures, and consequently, distortionary domestic policies appear in many countries, especially in Sub-Saharan Africa (SSA) countries where coffee sector accounts for a big share of national gross domestic product (GDP) (Baffes et al. 2005).

For instance in Sub-Saharan Africa, governments in countries like Côte d'Ivoire, Cameroun, Nigeria, and Ghana consistently followed a set of policies aimed at encouraging the expansion of cocoa and coffee production, while at the same time taxing small-holders heavily for capital accumulation and investment elsewhere in the economy (Anderson and Masters 2007). In addition, although the cocoa export volume grew steadily since 1960, with a plateau from 1987 until 1994, and another plateau after 1999, throughout these periods there was never a sustained increase in farm-gate prices (Maizels et al. 1997; Hecht 1983, p. 26). The countries' agricultural policies to tax cash-crop exports have been substantial, and from 1961 to 2004, the nominal rate of assistance for cocoa and coffee showed an average effective taxation of 44 and 55% respectively (Anderson and Masters 2007).

Agricultural policies in Ghana have induced an important contribution to the general setting of national economic policy, and shifts in sectoral policy have generally matched reorientations in overall policy. In particular, policy toward the cocoa sector has gone through dramatic changes, which have had a huge influence on the country's collapse and subsequent recovery of the economy. Specifically, Ghana's cocoa policy, one of the biggest export earners, has been a significant element of its overall economic policy and has changed quite often along with the general orientation of economic policy over time (Brooks et al. 2007).

It becomes clear that the government's trade policies in Ghana have had an important impact on the price incentives faced by the farmers. The cocoa sector was heavily mismanaged, and only a minor share of the export price was returned to the producer. While initially set up to protect farmers from price volatility, the monopolized marketing boards like the Cocoa Marketing Board (CMB) and Ghana Cocoa Board (COCOBOD) gradually turned into an instrument of public taxation. In this respect, the rents were always extracted by keeping producer prices well below the world price, and by using an over-valued exchange rate to make payments to farmers (Brooks et al. 2007). These were mainly caused by lack of efficiency, corrupted marketing monopolized boards, the increasingly poor state of roads, and the shortage of spare parts. With the aim of generating revenues, the government in Ghana has been creating cocoa price distortions due to the wedge between the actual domestic prices and what those prices would be under free market (Anderson et al., 2008).

Further, in East Africa, agricultural policies have also induced severe implications on price distortions (an example is Uganda and Ethiopia). In addition to other policies, the countries in East Africa have also used exchange rate margins between the official and parallel market rates (in Uganda and Ethiopia), pan-territorial pricing, parastatal system, and cooperative system (in Tanzania) as prevailing mechanisms to control agricultural markets (Anderson and Masters 2007). Coffee is the main cash crop in all these countries, and over a long time, the agricultural boards in these countries were always responsible for marketing, processing, and exports. Owing to these monopolies, coffee faced relatively high negative nominal rate of assistance, due to high taxes, and during this period of high state control, producers received only 30% or less of the reference price. For instance, in Ethiopia, the coffee taxation in the 1980s and 1990s accounted for 11–27% of the farm gate prices. In addition, the government collected progressive taxes based on the international price of coffee (Zewde 2002).

In southern America, specifically in Brazil, economic restructuring process in the 1990s has resulted in dramatic changes in economic policies including the agricultural policy reforms. Countries started carrying out many agricultural policy transitions from farm policies with substantial state interventions designed for a closed economy to a new regime tailored to an open economy and a curtailed role of the state. In particular, the coffee trade liberalization took place in the context of the economy-wide reforms of the late 1980s and early 1990s. The sector benefited from a rapid fall in industrial protection and from the elimination of taxes and quantitative restrictions on agricultural exports. As a result, the coffee export tax which had been as high as 50% a decade earlier was reduced to 37% in 1996 due to trade reforms by the government which saw a removal of 13% value-added tax. This was in order to ease balance of payments pressures without a devaluation.

Unlike the unsuccessful agricultural policies in Sub-Saharan Africa, agricultural policy reforms in Southern America, (e.g., Brazil in the 1990s) appear to have generally been well integrated with international agricultural markets in the sense that the long run trends in prices are broadly similar (Helfand 2003). Therefore, this can indicate that since the dramatic agricultural trade reforms, the coffee prices have not been very distorted in the country. This has positively resulted in drastic reduction of poverty in Brazil as farmers started to gain from the trade reforms. The percentage of the rural population in poverty and the total number of poor people in rural areas significantly reduced since 1990s (Helfand 2003).

The agricultural trade policies in South-East of Asia, however, present different features compared to the one in Southern America. For example, Indonesia, one of the leading cocoa producers in the world, has opted to impose cocoa beans export tax with the aim of supporting the downstream of cocoa processing industries (Permani 2013). Although, the policy was established to promote investments in downstream value-added activities in Indonesia, unfortunately, the cocoa export tax have caused serious decline of cocoa production. For example, the export values of cocoa beans and cocoa products from Indonesia to the world in 2009 reached US1,469,157,944 meanwhile in 2011 the number decreased to US 1,364,170,460 implying a decline of 7.15 percent over a two year period (Permani 2013; Rifin and Nauly 2013). It is noteworthy to mention that the effects of these agricultural reforms hit the farmers who only have limited alternatives to sell the cocoa beans.

Figures 1 and 2 depict the nominal rate of assistance for cocoa and coffee in selected countries. Nominal rate of assistance (NRA) is defined as the rate at which governments trade policies have directly raised or lowered farm gross income above or below what they would be without government interventions (Anderson and Valenzuela 2008). Whereas the positive value of the nominal rate of assistance signifies subsidy, negative values denote taxes. Zero value of the nominal rate of assistance signifies no government intervention, and the market price is synonymous to perfect competitive price.

Figures 1 and 2 show that over the period of 20 years, all cocoa- and coffee-trading countries mostly impose tax on cocoa and coffee prices since the nominal rate of assistance is mostly negative (with the exception of Brazil). However, the magnitude of the tax differs across countries over time. The deviations in both figures are very uneven, and do not follow any clear trend. This implies a high level of distortion in products prices and farmers' income have been unstable and unpredictable.

Literature review

Most of the economic policies in developing countries have modestly contributed to agricultural growth and in some cases these depression policies hampered the efforts to reduce poverty in rural areas. There are cases where sector-specific pricing and tax policies have eventually resulted in substantial discriminations against agriculture (Gillis et al. 1992; Anderson and Masters 2007). Further, there are instances where agricultural policy interventions at all stages of production, markets, and consumption, with the aim of improving market efficiency, have typically induced greater inefficiencies and lower outputs and farm incomes (Bates 2014). As a result, farm incomes in many of the developing countries, especially in Sub-Saharan Africa, are stagnating and the contribution made to overcome poverty is very unsatisfactory.

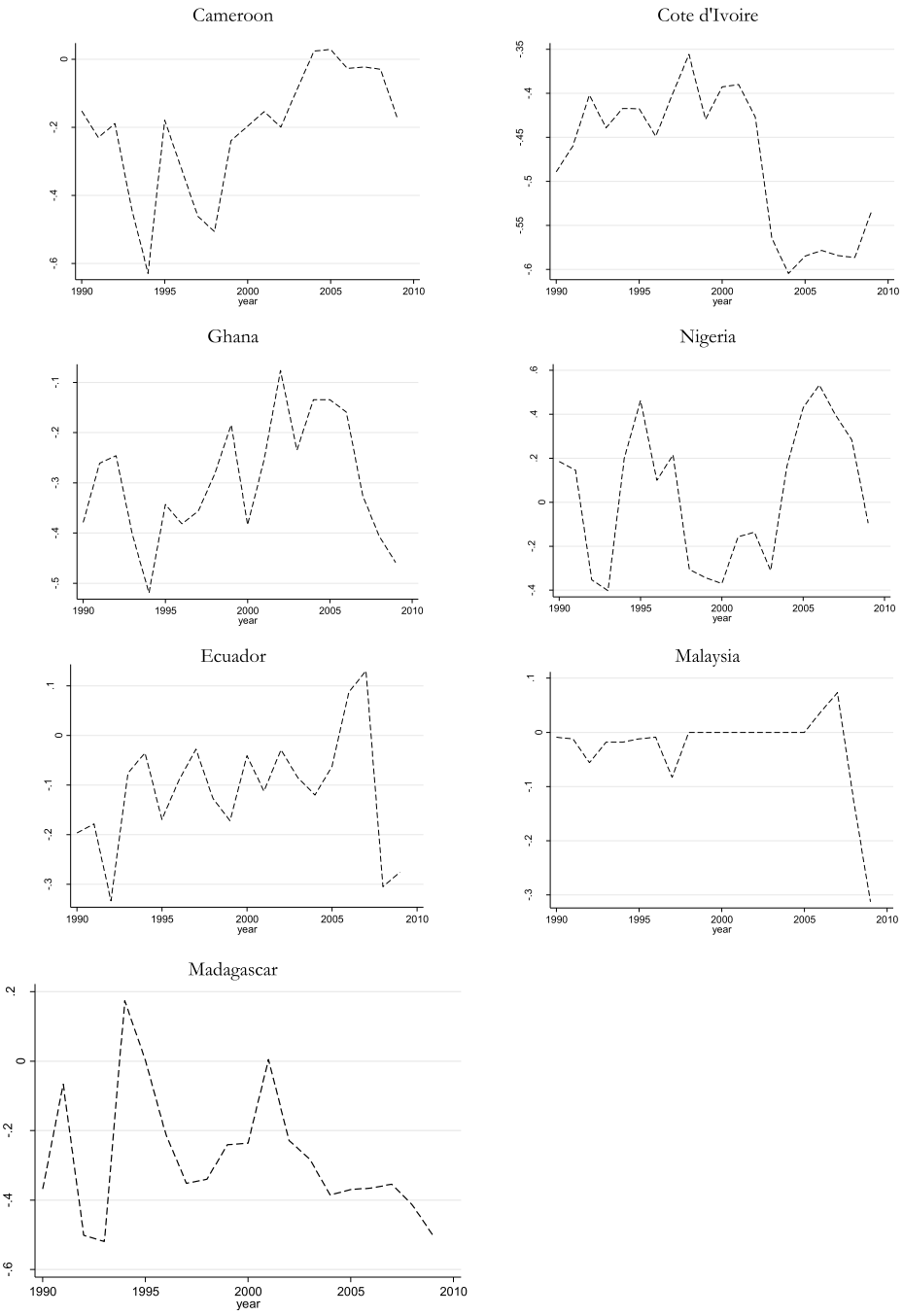

Fig. 1 Graphical trend of NRA for cocoa-producing countries

A significant number of studies have empirically brought forward the effects of these market price policies. Lutz and Scandizzo (1980) in their study on bias against agriculture found that government interventions in agricultural commodity markets severely distort market prices, farm incomes, and exchange rate as well. Different reasons have been identified why governments in developing countries levy heavy taxes on agricultural market commodities. One of such reasons is to raise revenue to finance government expenditure. The second motive of agricultural market intervention in developing

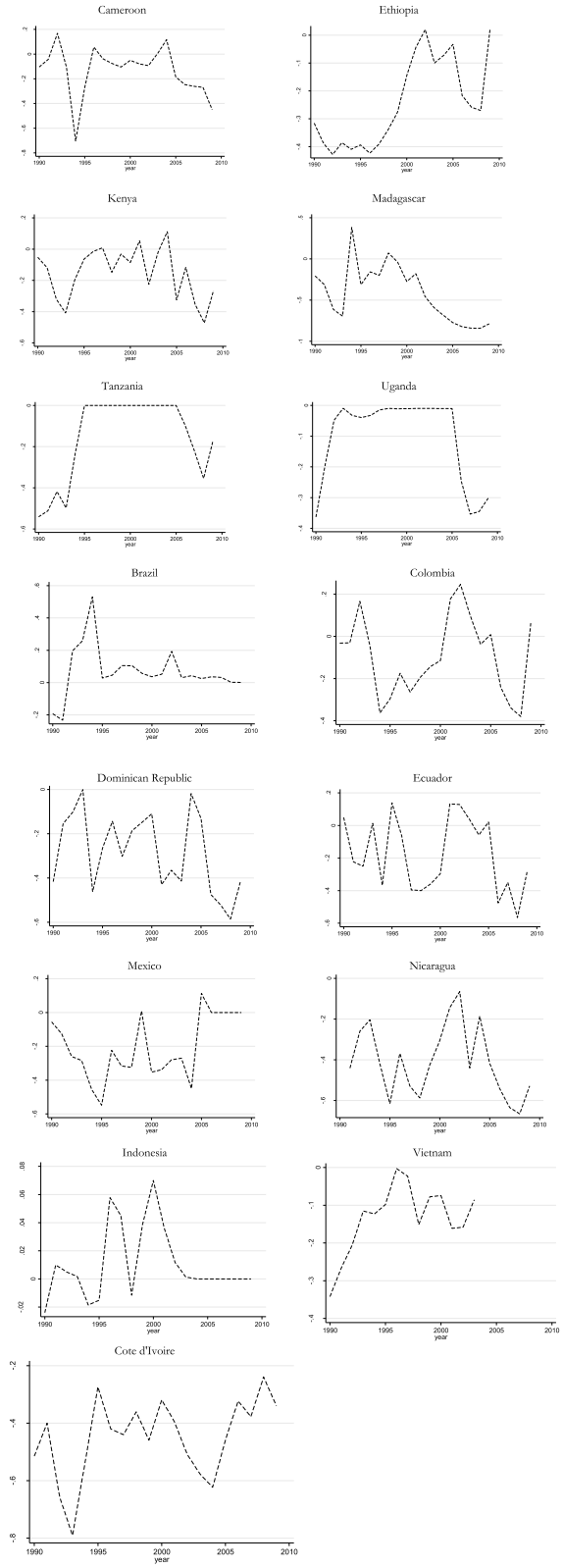

Fig. 2 Graphical trend of NRA for coffee-producing countries

countries is to stabilize internal market prices. Thus, by achieving price stability via intervention policies, government insulates local prices from unstable world market prices. These policies, however, create distortions in the market.

Furthermore, Bale and Lutz (1981) observed that in developing countries, there are welfare losses resulting from government intervention. The authors revealed that distortions from governments' price policies affect both poor producers and consumers as prevailing price deviates from the competitive market price. In another study, Isham et al. (2005) found that countries with natural resource endowment are likely to secure revenues from extraction and exploitations. Similarly, Masters and Garcia (2009) showed that countries with abundant resource endowment tend to impose huge agricultural taxes and with less subsidization policy option. Using land per capita to analyze the effects of land resource endowment on market price distortions, they find that government tend to tax landowners as land per capita increases.

Other studies have been looking at how much country's institutional structure such as social and economic institutions, infrastructural development, political and legal frameworks determine the path of economic growth and development. However, it becomes strenuous to identify which types of institutions matter and the extent of their importance. According to Brunt (2007), any country is fully independent to define its own institutions that can allow it to achieve the highest economic growth and development. The development of economic infrastructures follows a rational, well-coordinated, and harmonized system to ensure that farmers improve their production (Perkins et al. 2005). Developing countries having poor economic infrastructures and public utilities, especially in rural areas, make the cost of production high hence making their produce less competitive (Aigbokan 1999).

The provision of social and economic infrastructure can expand cocoa and coffee production. It is important to note that investment in physical infrastructure including transport services, telecommunication, power, and irrigation can improve the productivity of all inputs in the production process and allow market access facilitation that would lead to economic development. Such investment strengthens long-run growth performance by reducing farmers' transaction costs (Jimenez 1995), hence increasing the farm gate prices for the producers. In this respect, total factor productivity growth is a function of infrastructure endowment under the assumption that where infrastructure facilities are developed farmers get easy transport hence reducing the price gap. Therefore, expanding and upgrading the network of transportation, storage, and distribution services, as well as developing telecommunication networks, including mobile telephone usage, would be particularly useful in the agricultural sector to stimulate the development of efficient and competitive markets (Demurger 2001), which can be useful for farmers to resist price distortions.

However, the existing studies have yet to provide the potential nexus between ICT use and agricultural price distortions. Specifically, this study examines the extent of price distortions in coffee- and cocoa-producing countries and how the use of mobile phone and internet coverages can affect distortions. To do so, we initially identify the driving forces of coffee and cocoa price distortions in producing countries based on price depression indices: nominal rate of assistance (NRA) and relative price margin (RPM). Finally, this paper uses data from biggest cocoa- and coffee-producing countries in three tropical regions, (SSA, Southeast Asia, and Southern America) to capture

different agricultural policies across the regions. To the best of our knowledge, this is the first paper to investigate the effects of mobile phone use and internet on cocoa and coffee price distortions.

Methods

Measuring agricultural price distortions

In this study, we measure agricultural price distortions using two instruments that are framed by agricultural trade policies. These are the nominal rate of assistance (NRA) and relative price margin (RPM) of coffee and cocoa products. The latter is viewed as the proportion that explains the differences between world market and domestic farm gate prices. Thus, it defines the wedge between farm gate and border prices. The relationship between these two concepts (that is, NRA and RPM) is discussed as follows. Recall that price distortions result primarily from market interventions by governments, either through subsidies or taxes or even trade protection systems; this generates discrepancies between two sets of prices. This discrepancy is defined as:

$$y_1 = \frac{P^w - P^{wt}}{P^{wt}} \tag{1}$$

Where $y_1$stands for nominal rate of assistance for cocoa and coffee prices for a given trading country at given time, P^w and P^{wt} are the observed domestic distorted and undistorted crop prices respectively for cocoa and coffee products. This means that P^{wt} is the estimated domestic coffee and cocoa prices that would prevail in the absence of commodity market or exchange rates interventions. Therefore, the nominal rate of assistance can be viewed as the rate at which farmers' prices are distorted by exogenous market interventions, specifically by the government trade policies. The value of NRA is zero in the case of perfectly competitive market regime. It becomes positive in the case where farmers are subsidized and negative if the government policy induces farm taxes or market imperfection like weak institutions or poor communication of the farmers (limited market awareness). Assuming perfect market, we can express undistorted domestic price in terms of distorted price as:

$$P^w = P^{wt} + M \tag{2}$$

With Mbeing the interventions. Furthermore, in the case of competitive market, the world price is related to distorted domestic price in the following way:

$$P^{wt} + M = W^p - T \tag{3}$$

Where W^p and T are the world cocoa and coffee prices and transaction costs, respectively. Therefore, we can define NRA taking into consideration world prices as follows:

$$y_1 = \frac{P^w - (P^w - M)}{(P^w - M)} = \frac{M}{W^p - T - M} \tag{4}$$

From Eq. 4, the relationship between relative price margin and the nominal rate of assistance can be derived. Given that, relative price margin is defined as follows:

$$y_2 = \frac{W^p - P^{wt}}{P^{wt}} \tag{5}$$

And provided that the domestic undistorted price is related to world price as $P^{wt} = W^p - T - M$, then we can express the relative price margin in terms of world price as shown in Eq. 6;

$$y_2 = \frac{W^p}{(W^p - M - T)} - 1 \tag{6}$$

Combining Eqs. (4) and (6), we can express relative price margin in terms of nominal rate of assistance and world price as follow (see Appendix 1 for detailed derivations);

$$y_2 = y_1 \omega - 1 \tag{7}$$

Where ω is the boarder prices adjusted for transportation cost and agricultural trade government interventions expressed as follows:

$$\omega = \frac{W^p}{M} \tag{8}$$

From the expression in Eq. (7), there is a positive relationship between the nominal rate of assistance and relative price margin. However, this relationship is not one-to-one but adjusted by the world price and intervention ratio.

Conceptual and theoretical framework

The conceptual and theoretical frameworks for this study rest on perfect competition assumption of perfect information and on stylized facts in agricultural policy that relates policy choices to a commodity's direction of trade, a country's real income per capita, and its endowment of farmland per capita (Masters and Garcia (2009)). Under the perfect competitive assumption of perfect information, both buyers and sellers should be well informed about the prevailing price of the commodity and any other information about the location and quality of the product. Telecommunication in the form of mobile phone technologies (that is, phone and internet) are the means by which both buyers and sellers can have full information about the price and quality of the product. As a result, price distortions in the agricultural sector would be reduced given the information available to both buyers and sellers.

The stylized facts in agricultural policy that are of interest to this study are *development paradox*, *resource abundance*, and *group-size effect*. The development paradox postulates that developing countries tax their agricultural produces, whereas developed countries subsidize (Bale and Lutz 1981; Masters and Garcia 2009). Given that farmers form the majority and are mostly poor in developing countries, compared to their counterparts in developed countries who are mostly wealthy, it is a paradox to tax farmers in developing countries and subsidize those in developed countries. It also suggests that as real economic growth increases, countries tend to provide subsidies to farmers. According to Masters and Garcia (2009), the group-size effect can affect outcomes through free-ridership in a case where individuals in larger groups have more incentive to shirk on their responsibilities. However, opposite group-size effect arises when larger groups are more influential since they can mobilize more votes in order to affect policies. Resource abundance hypothesis stipulates that governments in land-abundant countries tend to tax

more or subsidize less the agricultural sector (Bale and Lutz 1981; Masters and Garcia 2009). Given the fact that taxes and subsidies create distortion in price, the resource abundance hypothesis is worth considering.

Empirical model specification

Our model assumes a static framework where the proxy for price distortion at a point in time is explained by several factors. The empirical model estimates the determinants of price distortion of cocoa and coffee products following the conceptual and theoretical framework discussed earlier and the study by Masters and Garcia (2009). The model is specified as follows:

$$\begin{aligned} Y_{ijt} = {} & \alpha + \beta_1 \text{GDPpercap}_{it} + \beta_2 \text{Ruralpop}_{it} + \beta_3 \text{Landpercap} + \beta_4 \text{Telecom}_{it} \\ & + \beta_5 \text{Continent} + \boldsymbol{\lambda X_{it}} + \gamma_j + \eta_i + \mu_t + \varepsilon_{ijt} \\ & \text{for } i = 1, \ldots N, j = \text{cocoa and coffee}, t = 1, \ldots T \end{aligned} \tag{9}$$

Where Y_{ijt} is the dependent variable of interest for country i and product j at time period t. We consider three different forms of the dependent variable Y_{ijt}. First, we focus on the absolute value of the nominal rate of assistance to capture the extent of the price distortions. In the second scenario, we considered both positive and negative values of the nominal rate of assistance in order to examine the policy options of government. Whereas the negative value of the nominal rate of assistance signifies imposition of taxes, the positive value indicates subsidy. The rationale of this scenario is to examine the factors which affect countries' tax and subsidy policies in relation to cocoa- and coffee-exporting countries. In the third scenario, we consider an alternative measure of price distortion (that is, relative price margin).

The term GDPpercap_{it} represents the natural log of GDP per capita for country i at time period t. The inclusion of this term in our model is to test whether or not the development paradox holds for cocoa and coffee products (Bale and Lutz 1981; Masters and Garcia 2009; Magrini et al. 2014). This suggests that a positive relationship is expected between the nominal rate of assistance and GDP per capita. Similarly, we included land per capita (that is, Landpercap) in our model to test the resource abundance hypothesis (Bale and Lutz 1981; Masters and Garcia 2009). Thus, we seek to find out whether governments tend to tax more or subsidize less when there is more land per capita.

We further test the concept of group-size effect by including the proportion of the rural population to the total population (Ruralpop_{it}) in our model, as done by Bale and Lutz (1981) and Masters and Garcia (2009). Our main variable of interest is the termTelecom_{it}, which captures telecommunication services. We expect a negative relationship between price distortion and accessibility of telecommunication services since telecommunication services make information easily accessible hence reducing transaction cost. In the analysis, we consider both mobile phone usage and internet connectivity. The inclusion of telecommunication services as a determinant of price distortion is motived by Aker and Fafchamps (2014). We also include an interaction term between mobile phone usage and internet connectivity. This is to capture the complementarity between mobile usage and internet connectivity in affecting price distortion. Thus, the total effect of mobile usage on price distortion is conditional on internet connectivity. This is expressed as follows:

$$\frac{\partial Y_{ijt}}{\partial \text{Mobilephone}_{it}} = \beta_T + \beta_{TI}\text{Internet}_{it} \tag{10}$$

Where β_T and β_{TI} is the direct and indirect effect of mobile phone usage on price distortion, respectively.

The term $\boldsymbol{X_{it}}$ in Eq. 9 represents a vector of control variables such as institutional quality, inflation and public debt. With quality institutions in place, government policies have the potential of achieving its intended outcome. Given that some elements of price distortion is due to government interventions in the form of taxes and subsidies, we expect a mixed relationship between institutional quality and price distortion (Anderson and Masters 2007). In our analysis, we use polity2 as an indicator of institutional quality. According to Anderson and Masters (2007) and Masters and Garcia (2009), government distortionary policies in the form of taxes and subsidies is dependent on the state of the macro-economy. As such, we control for the level of inflation and public debt in our empirical model. The inclusion of inflation in our analysis is to examine whether or not domestic inflation has any effect on the nominal rate of assistance and relative price margin. The level of public debt can influence the extent to which government would want to impose a tax or provide a subsidy. As a result, we seek to examine to what extent does public debt affect price distortions. There is possible non-linearity between price distortion and public debt, and as such, we include a quadratic in the estimation.

The term Continent is a categorical variable comprising of Africa, Asia, and South America. In the estimation, Africa is considered as the reference category. The inclusion of this term is to examine whether there is a significant difference in the nominal rate of assistance, tax policy, and relative price margin between Africa and the other continents. The inclusion of the continental dummy is inspired by Magrini et al. (2014). In all the estimations, we accounted for product (γ_j), country (η_i), and time (μ_t) fixed effects. The error term in the model is represented byε_{ijt}. The definition of the variables used in Eq. 9 is presented in Table A1 in the Appendix.

Estimation technique

This study makes use of fully modified ordinary least squares (FMOLS). We considered a pooled sample (that is, both cocoa and coffee) estimation. Product-specific estimations are not considered because some countries produce both products. FMOLS developed by Phillips and Hansen (1990) is a semi-parametric model that is robust to serial correlation problems. It provides consistent and efficient estimates even in the absence of cointegration relation. Further, it is robust to both stationary and non-stationary series in a single cointegration (Phillips 1995). In order to estimate the model using FMOLS, the variables are first modified and then the system estimates directly to eliminate the existing nuisance parameters. The structure of the FMOLS has a correction term for serial correlation.

Data description

The data used in this paper are from different sources. The outcome variables, the nominal rate of assistance, and relative price margins are derived from World Bank agricultural distortion database and International Cocoa/coffee Organizations

respectively. In the latter database, farm-gate and world prices are extracted for tradable cocoa and coffee products. The data spans from 1990 to 2009.[2] From the database, we retrieved 18 cocoa- and coffee-trading countries. These include African countries (that is, Cameroon, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Nigeria, Tanzania, and Uganda), Asian countries (that is, Indonesia, Malaysia, and Vietnam), and Southern America countries (that is, Brazil, Colombia, Dominican Republic, Ecuador, Mexico, and Nicaragua). Our argument to select relative price margin and nominal rate of assistance as our dependent variables is that these two variables are currently the best tools to measure the agricultural price distortions,[3] at least NRA (Anderson 2013). The explanatory variables are sourced from the World Bank's World development indicator, International Financial Statistics of IMF, FOASTAT, and the Polity IV Project.[4] Table 5 in the appendix provides details about the source of data for each variable used in the analysis. The descriptive statistics for the variables used in this study is shown in Table 1. We observed more variation in nominal rate of assistance, relative price margin, inflation, institutional quality, mobile phone usage, and internet connectivity since the standard deviation is relatively higher than the mean of these variables. The negative mean value of the nominal rate of assistance indicates that majority of countries over the years have adopted tax regime relative to the subsidy. This is supported by the mean value of subsidy, which indicates that 82% of countries over the years have imposed taxes relative to subsidies. The positive mean value of relative price margin indicates that on average world prices of cocoa and coffee are relatively higher than domestic undistorted price. Although mobile phone usage is low on average for cocoa- and coffee-producing countries, the usage of this device became very popular in the 2000s and its usage has been increasing.

Results and discussion

This section presents and discusses the main results of the study. It begins with the analysis of the determinants of the extent of price distortion (that is, the absolute value of the nominal rate of assistance) and then proceeds to test the development paradox, resource abundance, and group-size effect hypotheses. In the final section, we analyze

Table 1 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Nominal rate of assist. (NRA)	433	− 0.1934	0.23198	− 0.8426	0.53348
Absolute value of NRA	433	0.231	0.19445	0	0.8426
Subsidy (dummy variable)	405	0.1827	0.38691	0	1
Relative price margin	402	0.18402	0.36888	− 2.8304	0.85986
GDP per capita (log)	439	6.90456	1.07743	4.73512	9.02109
Inflation	420	32.3378	204.506	− 8.4842	2947.73
Public debt	428	74.6945	54.3996	9.54585	448.59
Institution (Polity2)	439	1.98633	5.71506	− 8	9
Mobile phone per 100	439	13.8604	23.7316	0	111.365
Internet connection per 100	365	4.88968	9.54438	0	55.9
% of rural population	439	56.0028	19.5705	15.956	88.924
Land per capita	439	0.4196	0.3704	0.0964	2.244

the determinants of relative price margin. It should be noted that our analyses are exploratory regressions aimed to establish the correlation between our outcome variables and the explanatory variables, and as such we claim no causality. In all cases, time and country fixed effects have been accounted for.

Table 2 Determinants of absolute nominal rate of assistance

Variables	|NRA|		
	(1)	(2)	(3)
GDP per capita	− 0.14814***	− 0.13091***	− 0.23558***
	(0.01356)	(0.01616)	(0.01156)
Inflation	0.00009***	0.00016***	0.00015***
	(0.00001)	(0.00001)	(0.00001)
Public debt	0.00088***	0.00116***	0.00098***
	(0.00012)	(0.00015)	(0.00010)
Public debt squared	− 0.00001***	− 0.00001***	− 0.00000***
	(0.00000)	(0.00000)	(0.00000)
Polity2	− 0.00142***	0.00063	− 0.00051
	(0.00039)	(0.00049)	(0.00032)
% of Rural population	− 0.01344***	−0.00354***	− 0.00469***
	(0.00083)	(0.00099)	(0.00073)
Land per capita	− 0.10229***	− 0.03101	− 0.12443***
	(0.01741)	(0.02097)	(0.01408)
Mobile phone usage	− 0.00199***		− 0.00139***
	(0.00011)		(0.00013)
Internet connectivity		− 0.00464***	0.01203***
		(0.00024)	(0.00039)
Mobile*Internet			− 0.00017***
			(0.00000)
Coffee	0.05179***	0.04412***	0.04412***
	(0.00312)	(0.00369)	(0.00244)
South America	− 0.31434***	0.17051**	0.51257***
	(0.05632)	(0.07423)	(0.05018)
Asia	− 0.03850***	0.07763***	0.12566***
	(0.01432)	(0.01729)	(0.01159)
Constant	2.08151***	1.07620***	1.77840***
	(0.12964)	(0.15022)	(0.11340)
Total effect of mobile			− 0.00223***
			(0.00013)
Observations	407	347	347
R-squared	0.36531	0.45428	0.47408
Year FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Adjusted *R*-squared	0.286	0.373	0.391
Long run SE	0.0196	0.0212	0.0140
Bandwidth (neweywest)	556.1	276.7	540

Standard errors in parentheses
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

Determinants of the extent of price distortion

In Table 2, we analyze the factors which explain the magnitude of price distortion in the coffee and cocoa industries. Due to the possible high correlation between mobile usage and internet connectivity, we dropped either mobile phone usage or internet connectivity in columns (1) and (2). Findings show a negative relationship between mobile phone usage, internet connectivity, and price distortion (see columns 1 and 2). In model 3, we find the effect of mobile phone usage on price distortion is conditional on internet connectivity. This is shown by the significant effect of the interaction between mobile phone usage and internet connectivity. The negative effect of the interaction term indicates the complementary effect of internet connectivity in reducing price distortion via mobile phone usage.

Since access to perfect information is an underlining condition for the efficient functioning of the market, mobile phone usage has the potential of providing farmers with the needed information in their operations hence reducing price distortions. Given that the effect of mobile phone usage on price distortion is conditional on internet connectivity, we compute the total effect of mobile phone usage on the extent of price distortion. The results show that a unit increase in mobile phone usage will reduce price distortion by 0.22% point on average. Given the heterogeneity across countries in terms of internet connectivity, we further calculate the total effect of mobile phone usage for each country and the result is shown in Fig. 3. The total effect of mobile phone usage on price distortion is highest in Mexico with a rate of about − 0.544% point, followed by Brazil with a rate of about − 0.317% point. Ethiopia and Madagascar were found to have the least effect of about − 0.141% point and − 0.147% point respectively.

Further, GDP per capita, inflation, public debt, and proportion of rural population significantly influence the magnitude of price distortions in the cocoa and coffee industry. With the exception of inflation and public debt, all the factors reduce the magnitude of the distortion. In the case of GDP per capita, it means that as per capita income increases, it reduces the extent to which government intervene in cocoa and coffee industry either in the form of taxes or subsidy. Thus, an increase in GDP per capita by 1% reduces price distortion by 0.236% point (see column 3 of Table 1). Higher inflation rate promotes price distortion in the cocoa and coffee industry. This suggests that in times of persistent increase in inflation, the government intervention in the

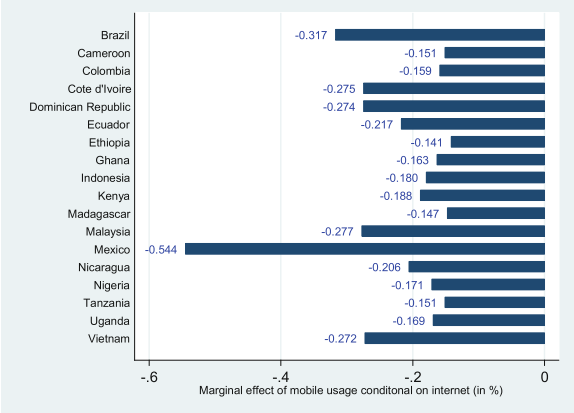

Fig. 3 Total effect of mobile phone usage on the extent of price distortion by countries

cocoa and coffee industry either in the form of tax and subsidy which ends up creating distortions in prices. An increase in inflation by 1 unit increases price distortion by about 0.02% point (see column 3). Public debt exhibits a non-linear relationship with the extent of price distortion. The coefficient of the quadratic is however nearly zero. From the linear term, an increase in public debt increases price distortions by about 0.098 % point in our pooled model (see column 3). Although institutional quality does not significantly influence price distortion in model 3, estimation in model 1 shows a significant negative effect. A good institution is expected to make information easily accessible and also reduces bottlenecks in the market hence reducing distortion.

Findings also suggest that an increase in the rural population reduces price distortion by about 0.47% point. This implies that as the rural population increases, it reduces government intervention in the cocoa and coffee industry through either taxes or subsidy. Although this result is surprising, it can, however, be explained. Given that most cocoa- and coffee-exporting countries impose taxes on the products and have most of their population in the rural area (with exception of Brazil with few populations in the rural area and also provides a subsidy to the coffee farmer), an increase in rural population may imply an increase in cocoa and coffee production. With the increase in production, the government may reduce the tax rate if the same tax revenue is to be realized or if the majority who are in the rural area negotiate for tax reduction.

The results further show that the extent of price distortion in coffee production is about 0.044 significantly higher than that of cocoa production. The extent of price distortion is South America and Asia is significantly higher than that of Africa (see column 3 of Table 2). South America is observed to have the highest level of price distortion in cocoa and coffee production.

Test of development paradox, resource abundance, and group-size effect

This section seeks to test the development paradox, resource abundance, and group-size effect hypotheses. Columns 1–3 of Table 3 shows the estimation of the nominal rate of assistance with the aim of testing the hypotheses mentioned earlier. Unlike Table 2 in the previous sub-section where the absolute value of the nominal rate of assistance was considered to analyze the extent of the distortion, Table 3 examines whether or not our explanatory variables promote tax imposition or subsidy. Our results confirm the development paradox, where developed countries tend to subsidize agricultural products and developing countries rather tax these products (Anderson et al. 1986; Krueger et al. 1991; Lindert 1991; Masters and Garcia 2009). From columns 1–3 of Table 3, as income increases, countries end up subsidizing.

In relation to resource abundance or natural resource effect, our results support the hypothesis that land-abundant countries tend to tax agricultural sector more or subsidize the sector less (Isham et al. 2005; Masters and Garcia 2009; McMillan and Masters 2003). Given that the coefficient of land per capita is positive suggests that as land becomes abundant in the sector, the government provides subsidies to landowners to encourage them to increase cocoa and coffee production. Most cocoa- and coffee-producing countries depend on these cash crops as their foreign exchange earnings and as such provides subsidies in the form of fertilizer, pesticides, and improved seeds. Our results also suggest that an increase in the share of the rural population have a positive effect on the nominal

Table 3 Testing stylized facts of total NRA

Variables	NRA		
	(1)	(2)	(3)
GDP per capita	0.35905***	0.29485***	0.46387***
	(0.01536)	(0.01890)	(0.01333)
Inflation	0.00025***	0.00019***	0.00021***
	(0.00001)	(0.00001)	(0.00001)
Public debt	− 0.00208***	− 0.00225***	− 0.00180***
	(0.00014)	(0.00017)	(0.00012)
Public debt squared	0.00001***	0.00001***	0.00001***
	(0.00000)	(0.00000)	(0.00000)
Polity2	0.00232***	− 0.00227***	− 0.00055
	(0.00044)	(0.00057)	(0.00037)
% of Rural population	0.01342***	0.00108	0.00635***
	(0.00094)	(0.00115)	(0.00084)
Land per capita	0.10445***	− 0.01826	0.11279***
	(0.01971)	(0.02453)	(0.01624)
Mobile phone usage	0.00326***		0.00314***
	(0.00012)		(0.00015)
Internet connectivity		0.00538***	− 0.01526***
		(0.00028)	(0.00045)
Mobile*Internet			0.00019***
			(0.00000)
Coffee	− 0.02974***	− 0.02908***	− 0.02908***
	(0.00353)	(0.00432)	(0.00281)
South America	− 0.21856***	− 0.60544***	− 0.91917***
	(0.06378)	(0.08683)	(0.05787)
Asia	− 0.10058***	− 0.22260***	− 0.25916***
	(0.01622)	(0.02023)	(0.01336)
Constant	− 3.20019***	− 1.73459***	− 3.18583***
	(0.14681)	(0.17570)	(0.13077)
Total effect of mob. use			0.0041***
			(0.0001)
Observations	407	347	347
R-squared	0.36657	0.45797	0.49190
Year FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Adjusted *R*-squared	0.288	0.377	0.412
Long run SE	0.0222	0.0248	0.0162
Bandwidth (neweywest)	556.5	276.6	539.6

Standard errors in parentheses
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

rate of assistance. This finding is in line with that of Masters and Garcia (2009). The positive effect implies that as rural population increases, they are able to obtain a more faviourable policy in the form of a tax cut or subsidy, hence corroborating the group-size effect hypothesis.

Similarly, the positive coefficient for mobile phone usage in columns 1–3 of Table 3 shows that as mobile phone usage increases, government policies turn out to be favorable for both cocoa and coffee farmers. The positive significant effect of the interaction between mobile phone usage and internet connectivity also corroborates the benefit of the mobile phone to farmers. From the total effect estimation, a unit increase in mobile phone usage increases the nominal rate of assistance by 0.41% point. The country level effect of mobile phone usage on the nominal rate of assistance is shown in Fig. 4. Whereas Mexico and Brazil are top on the list, Ethiopia and Madagascar have the least effect of mobile phone usage on nominal rate of assistance. From the results, whereas an increase in inflation serves as a form of subsidy for cocoa and coffee farmers in nominal terms, public debt serves as a form of tax to them. In addition, the nominal rate of assistant for coffee is about 0.029 less than that of cocoa. Moreover, the nominal rate of assistance for cocoa and coffee is significantly higher in Africa compared to South America and Asia (see column 3 of Table 3).

Determinants of relative price margin

In Table 4, we provide estimates showing an empirical relationship between the degree of trade policies through relative price margins and its respective determinants. Similar to the nominal rate of assistance, the results show a positive of income on relative price margin.

From our results, inflation and public debts are found to significantly reduce price depressions. The effect of inflation on relative price margin is in line with macroeconomic theories where it induces an increase in farm gate prices relative to world markets. The negative effect of public debt on relative price margin can be explained through the loanable funds market and the exchange rate. As countries experience increasing public debt, there are signs of high-interest rate, an increase in inflation and exchange rate in such economies as government compete with firms in the loanable firms market. The increase in general prices causes farm gate prices to also increase. Institutional quality is found to increase relative price margin. A good institution can make government policies very effective and as such policies to create a wedge between the world and domestic prices would achieve its cause.

Whereas, an increase in land per capita significantly reduces the relative price margin, increase in the proportion of rural population increases relative price margin.

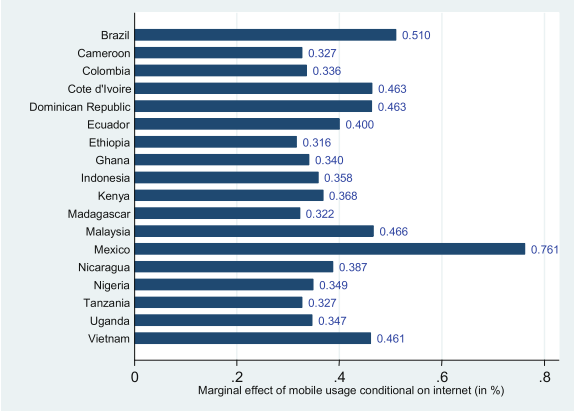

Fig. 4 Total effect of mobile phone usage on nominal rate of assistance by countries

Table 4 Determinants of relative price margin

Variables	(1)	(2)	(3)
GDP per capita	0.24624***	0.14381***	0.21119***
	(0.03428)	(0.05532)	(0.06067)
Inflation	− 0.00031***	− 0.00029***	− 0.00028***
	(0.00002)	(0.00003)	(0.00003)
Public debt	− 0.00039	− 0.00225***	− 0.00223***
	(0.00029)	(0.00049)	(0.00050)
Public debt squared	0.00000	0.00000**	0.00000
	(0.00000)	(0.00000)	(0.00000)
Polity2	0.02421***	0.03222***	0.03282***
	(0.00095)	(0.00159)	(0.00162)
% of Rural population	0.01489***	0.00629*	0.00646*
	(0.00205)	(0.00325)	(0.00366)
Land per capita	− 0.40760***	− 0.33199***	− 0.27722***
	(0.04146)	(0.06768)	(0.06979)
Mobile phone usage	0.00301***		0.00062
	(0.00026)		(0.00064)
Internet connectivity		0.00589***	− 0.00421**
		(0.00079)	(0.00191)
Mobile*Internet			0.00011***
			(0.00002)
Coffee	0.05421***	0.07431***	0.07383***
	(0.00755)	(0.01202)	(0.01217)
South America	0.54560***	0.02254	− 0.22439
	(0.13650)	(0.24765)	(0.25574)
Asia	0.09120***	0.07643	0.03850
	(0.03437)	(0.05729)	(0.05871)
Constant	− 2.45543***	−0.98560**	− 1.37800**
	(0.32398)	(0.50011)	(0.57471)
Total effect of mobile Usage			0.0012*
			(0.0006)
Observations	379	329	329
R-squared	0.31399	0.31701	0.32532
Year FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Adjusted *R*-squared	0.221	0.208	0.212
Long run SE	0.0461	0.0674	0.0682
Bandwidth (neweywest)	305.5	123	124.3

Standard errors in parentheses
***$p < 0.01$; **$p < 0.05$; *$p < 0.1$

The positive sign of the share of rural population means that farmers are unable to negotiate for higher domestic prices as the share of rural population increases. Conversely, the negative effect of land per capital on price margin implies that farmers are able to negotiate for a higher domestic price as their land ownership increases. Even though mobile phone usage has no significant effect on the relative price margin, the

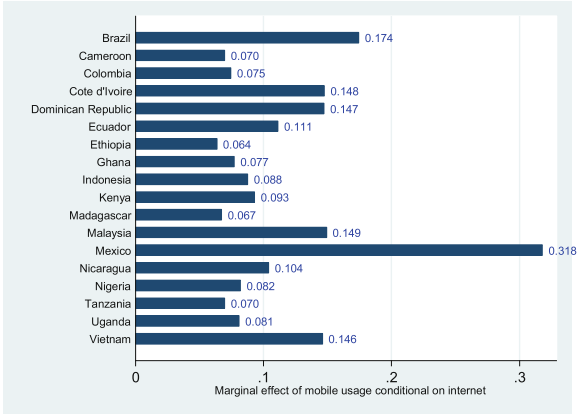

Fig. 5 Total effect of mobile phone usage on relative price margin across countries

total effect significantly increases the relative price margin since the interaction term between mobile phone usage and internet connectivity is significant. The positive sign of the total effect of mobile phone usage can be due to the positive relationship between relative price margin and nominal rate of assistance. In Fig. 5, we show the distribution of the total effect of mobile phone usage on relative price margin across countries. The trend of the effect is higher to that of the nominal rate of assistance in Fig. 4. Relative price margin for coffee is relatively higher than cocoa.

Conclusions

The main purpose of this study has been to examine the effect of mobile phone usage on the extent of price distortion in the cocoa and coffee industries. In addition, we tested the development paradox, resource abundance (or natural resource effect), and the group-size effect hypotheses. We further estimated the determinants of relative price margin. Our results corroborate all the hypotheses tested, except the resource abundance hypothesis. Inflation, public debt, mobile phone usage, and institutional quality are the key factors that affect price distortions in both cocoa and coffee industries. The effect of mobile phone usage on the extent of price distortion, the nominal rate of assistance, and relative price margin is conditional on internet connectivity. The total effect of mobile phone usage was observed to have a negative effect on the extent of price distortion measured by the absolute value of the nominal rate of assistance. In addition, we found that as mobile phone usage and internet connectivity increase, government policies turn out to be favorable for both cocoa and coffee farmers. Similarly, the total effect of mobile phone usage increases relative price margin.

Given the fact that the level of technology in the form of mobile telecommunication and diffusion of knowledge is typically less developed in developing and emerging countries relative to their developed countries counterpart (Asongu and Nwachukwu 2016), investment in the telecommunication sector will go a long way to improve the condition of farmers. The following specific policies are proffered based on our results. First, telecommunication services in the form of calls, text messages, and internet are

most expensive in developing countries (which includes most of cocoa- and coffee-producing countries) and as such operators are to be encouraged to engage in cost-efficient measures to reduce their cost of operation. The government should reduce barriers to entry into the telecommunication industry in order to encourage competition that would provide a better deal for users of the service.

Second, policies to increase economic growth are relevant to reduce the extent of price distortion. Since most government generally intervene in the cocoa and coffee industries to raise tax revenue (with the exception of Brazil), an increase in economic growth would grant countries other avenues to raise revenue. In addition, an expansion of the economy via economic growth reduces the countries public debt ratio. Furthermore, monetary and fiscal policies should aim at ensuring price stability. Economic agents are able to make informed decisions and projections when prices are stable.

Endnotes

[1]According to the African Development Bank (2013), the Sub-Sahara African countries rural population was 64% in 2012.

[2]We could not go beyond 19 years in this study, although the NRA database is updated till 2011, the data on cocoa and coffee nominal rate of assistance is only available until 2009. We consulted Kym Anderson, the responsible person at World Bank in charge of designing and compiling the dataset, however, the dataset is yet to be updated and he is not sure when this will happen.

[3]We could have used the Nominal Protection Coefficient (NPC) ratio, but since we are not deriving social welfare loss, we decide to opt for other distortions measurement tools.

[4]http://www.systemicpeace.org/polity/polity4.htm

Table 5 Definitions of the variables that are used in this study

Variable name	Definitions	Data source
RPM	The relative price margin, which is the difference between farm gate and boarder price of cocoa and coffee	Calculated by authors using from www.icco.org and www.ico.org
NRA	Nominal rate of assistance, the rate at which agricultural price is taxed or subsidized	World Bank agricultural distortions data
Institution	Proxied by polity2. The polity score is computed by subtracting the p_autocracy score from the p_democracy score	Polity IV Project[a]
Mobile phone usage	The ratio of mobile technology use per 100 persons	data.worldbank.org
Internet connectivity	The ratio of internet use per 100 persons	data.worldbank.org
GDP per capita	Gross Domestic Product per capita	data.worldbank.org
Inflation	Level of inflation, expressing annual changes of consumer prices	data.worldbank.org
Public debt	This is actual nominal public debts expressed in US dollar	IMF, 2017
% of Rural popu.	Rate of rural population as percent of total population	data.worldbank.org
Land per capita	Arable land expressed in ha divided by rural population	FAOSTAT

[a]http://www.systemicpeace.org/polity/polity4.htm

Appendix

Appendix 1: Some additional expression of NRA and RPM

Recall from Eq. 4 that $y_1 = \frac{M}{W^p - T - M}$,

This implies $\frac{y_1}{M} = \frac{1}{W^p - T - M}$ (A1)

Substituting eq. A1 into Eq. (6) gives:

$y_2 = \frac{W^p}{W^p - T - M} - 1 = \frac{y_1 W^p}{M} - 1$ (A2)

$y_2 = y_1\omega - 1$ (A2a)

Where $\omega = \frac{W^p}{M}$

Abbreviations

CMB: Ghana Cocoa Marketing Board; COCOBOD: Ghana Cocoa Board; FMOLS: Fully modified ordinary least squares; FOASTAT: Food and Agriculture Organization of the United Nations Agricultural and food statistics; GDP: Gross domestic product; ICT: Information communication technology; IMF: International monetary funds; NRA: Nominal rate of assistance; RPM: Relative price margin; SSA: Sub-Saharan Africa

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Availability of data and materials

The data for the analysis is available online with file name: "Data for analysis_Price distortion."

Author's contributions

The research idea was originally conceived by Aimable Nsabimana. The authors searched for the existing literature together. They equally contributed together in estimating and analyzing the results. Both authors discussed the results and contributed to the final manuscript. Both authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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