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DETERMINANTS OF DOMESTIC FOOD PRICE DIFFERENTIALS IN UGANDA:
The Potential for and Constraints on Intra-County Trade

Isaac M.B. SHINYEKWA
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ABSTRACT

This paper examines the determinants of price differentials across 79 districts in Uganda. It identifies the main production areas for key agricultural commodities and consumption destinations. In the framework of the law of one price, the paper examines the hypothesis that spatial price differentials are at least partly influenced by transportation and other transaction costs, infrastructural constraints, productivity and commodity output shocks and the purchasing power of households. This is done through an estimation of the determinants of price differentials of commodities across districts. The study notes the wide range of price differences across the country, which, to a large extent, can be attributed to the interaction between remoteness and physical infrastructure. The effect of per capita income on price differentials is relatively uniform across commodities. The findings point to the importance of strengthening the capacities of farmers and their productivity as a means of improving their livelihoods and fostering more efficient markets with faster supply responses to changes in prices. The findings further emphasize the significance of spatial dimensions and infrastructure conditions in Uganda, thus suggesting that infrastructural development must be a focus to reduce price differentials in the country.

Keywords: Commodity price differentials, infrastructure, intra-country trade, productivity, remoteness

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1. INTRODUCTION

It is generally believed that competitive and functioning markets deliver improved welfare to consumers because competition usually leads to enhanced product quality and lower prices. In addition, functional and well integrated markets enable the flow of commodities from surplus production areas to deficit areas, thus improving people's access to food commodities. Improvements in the quality of products and services translate into progress for micro- or household-level welfare, while lower prices, in turn, enable households to stretch their incomes further in terms of both consumption and time.

In the absence of well-functioning markets, and with binding constraints on domestic trade, we often witness wide-ranging variations in access to commodities and services and differentials in their prices across the same country. Dysfunctional markets may be due to a wide range of limitations, such as poor infrastructure, lack of timely information, legal impediments, and logistical and other transaction bottlenecks (Platteau, 2000). Moreover, there is empirical evidence of commodity price variability across regions and seasons in many developing countries, with significant unexploited arbitrage opportunities underscoring the low level of market integration (Abdulai 2007; Fackler & Goodwin 2001).

In the absence of binding constraints on the flow of trade within a country, there should not be significant differentials in the prices of food, other than differences due to transportation and transaction costs, storage and other overheads. Easy access to larger markets across the country can constitute a strong motivation for increased domestic production by farmers. Mosera *et al.* (2009) have observed that without access to wider national markets to absorb excess local supply, there will be no incentive to increase production, as this will only lead to lowering farm-gate prices. Lower farm-gate prices will in turn act as a disincentive to increased production and technological innovation in the agricultural production sector. In the case of Uganda, the removal of constraints, and the subsequent integration of domestic markets, could significantly contribute to the realization of the objectives of the National Development Plan (NDP) and the agriculture sector's targets of higher productivity, commercialization, and improved household welfare, as well as food and nutrition security for all.

The flow of Uganda's internal trade seems hampered, with surpluses in certain areas and deficits in others. This uneven spatial distribution of food commodities, and the resulting price differences that arise, needs to be addressed through appropriate policy measures to enable the free flow of commodities from production zones to consumption destinations in the country. Specifically, first, vibrant domestic trade can alleviate artificial spatial commodity shortages in the country by enhancing access to commodities produced in other parts of the country. Second, domestic market forces can nurture and enhance the competitiveness of the relevant production sector and, as such, constitute a basis for effective participation in international trade (MTTI 2007). It is against this background that this paper seeks to identify the underlying factors that influence food price differentials (the level of market efficiencies) across different districts in Uganda. In doing so, the paper identifies the constraints on the free flow of internal food commodity trade and potential policy options to address this problem.

The rest of the paper is organized as follows: Section 2 presents a review of the related literature; Section 3 details the methods used to achieve the objectives of the study. Section 4 presents and discusses the empirical results prior to the presentation of concluding remarks and emerging policy issues in section 5.

2. REVIEW OF RELATED LITERATURE

There is vast literature on the measurement of spatial market integration and price differentials. Market efficiency and integration are necessary for the effective transmission of price incentives in the market. Theory predicts that in well integrated and efficient markets the same commodity should trade at the same price except for the associated transaction costs. This assertion is often referred to as the Law of One Price (Persson, 2008). The single price is attained through the exploitation of arbitrage opportunities presented by spatial or temporal commodity price differentials. On the other hand, excessive variability of prices tends

to reflect a lack of spatial market integration, usually due to constraints such as inadequate transport infrastructure, lack of storage facilities, imperfect competition and institutional weakness in credit and risk management, and inefficient flow of information (Rashid & Minot, 2010).

An important theoretical issue in trade is how the associated market functions. Market functionality is important because it has a direct effect on resource allocation in production and therefore on the welfare of consumers. Efficient and competitive markets are believed to foster optimal resource allocation, better quality goods and services and lower prices for consumers. Efficient and integrated markets enable the efficient flow of commodities from areas of plenty to areas of scarcity, thereby ensuring access to goods and services at competitive prices. The dynamics of trade in an economy are dependent on a number of factors, including the structure of the market (i.e., the characteristics of the market, especially in terms of the number, size and influence of its players); the degree of integration of the market with other markets; and the efficiency with which transactions are carried out in the market, among others. Market integration and efficiency represent two key concepts that are important to understanding the dynamics of trade in a market.

Market integration refers to the linkage between two or more markets that causes prices in the markets to move in tandem (Barrett, 2005). Particularly when changes in prices in one market are mirrored by changes in the prices of similar goods in another market linked to the former through trade, then market integration is present. Markets can be integrated spatially (across space or locations) or vertically (along a supply chain). A number of studies, such as those of Gonzalo *et al*. (2012) and Rashid & Minot (2010), have examined the degree of market integration and its role in price transmission in the market[1]. On the other hand, market efficiency refers to the level of costs associated with transactions in matching supply with demand. There are two main categories of market efficiency, namely, exchange or arbitrage efficiency, which refers to a situation in which there are no unexploited opportunities for arbitrage, and operational efficiency, referring to a situation in which transfer costs cannot be reduced any lower than their current levels (Rashid & Minot 2010).

Agricultural commodity markets in much of Sub-Saharan Africa (SSA) have been heavily regulated by the State, especially in the 1960s and 1970s. The results have generally been poor, as agricultural production largely remained disconnected and unresponsive to market incentives. In view of the latter, many countries in SSA acceded to the widespread market-oriented reforms sponsored by the World Bank and International Monetary Fund in the 1980s and 1990s. A central component of these reforms was agricultural market liberalization, primarily aimed at introducing market incentives into the sector to ensure that agricultural production is responsive to market demand (Kherallah *et al.* 2000). Agricultural production that is responsive to market incentives is a critical component of an agricultural commercialisation and modernisation strategy.

Market-based agricultural modernization remains a key pillar of Uganda's own agricultural development policy (MAAIF, 2010). Agricultural market reforms in Uganda have included the phasing out of the role of state-owned enterprises that monopolized agricultural marketing; the removal of agricultural commodity price controls; and the liberalization of the foreign exchange market, among others. These reforms were expected to allow competitive market forces to influence production and supply in the sector, hence lowering agricultural commodity price differentials.

However, empirical support for such a reform-triggered supply response has been weak, as the supply responses have generally "not met expectations" (Kherallah *et al.* 2000). In addition, agricultural production continues to suffer from a wide range of production and market-related constraints, including inadequate market information, inadequate access to credit and working capital, inadequate arbitrage skills and undeveloped market relationships (Blanchard 1997, McMillan, 1995). The removal of these constraints to allow for modernisation and productivity growth in the agriculture sector constitutes a key objective in Uganda's agricultural policy (MAAIF 2010). However, in the presence of these impediments, the commercialisation and modernisation of the

agricultural sector may be far from realisation, as reflected in the significant price differentials among the different regions of the country.

Several studies exist that help to explain how given constraints determine the differences in prices across regions. Mosera *et al.* (2009) use quarterly price data on rice, and transportation costs and infrastructure availability, for nearly all of the 1,394 communes in Madagascar. They test the extent to which markets are integrated across space and compare results across different spatial scales of analysis to explain some of the factors that limit spatial arbitrage and price equalization within a country. Abdulai (2007) explains that spatial price transmission involves how prices between spatially separated markets in a country are related, citing the factors that affect this phenomenon: transport facilities and associated costs, market development, infrastructure and access to market information. Gonzalo *et al*. (2012) investigate the determinants of price differences and market integration among Indonesian provinces and conclude that price differences across provinces respond to differences in provincial characteristics such as remoteness, transport infrastructure, output of commodities, land productivity and income per capita.

In Uganda there are no specific studies of the determinants of price differentials; however, a number of studies address constraints on the movement of commodities and the impact of volatile prices. These studies emphasise patterns in food price changes since 2008, which showed extreme fluctuations throughout 2009 before falling sharply in 2010 and then reaching exceptionally high levels around the middle of 2011. Benson *et al.* (2008) argue that although the majority of Ugandans are net food buyers, the adverse impact at the household level of rising global prices is mitigated by the consumption of a range of home-produced goods. Mbowa *et* al. (2012) find that the food commodity surge in 2008 generated an increase in consumer food prices, which raised concerns about food insecurity in Uganda. They argue that high-food-production districts (regions) tend to have lower and relatively more stable prices compared to low producers. Campenhout *et al.* (2013) look at the immediate effects of price increase shocks on the poverty and well-being of households in Uganda and the economy-wide impact in the long run. They establish that, whereas in the short run, poverty increased substantially, in the long run, the welfare levels of rural farm households rose sharply.

The literature thus summarises factors that impede intra-country trade and therefore constitute constraints that need to be addressed to increase agricultural production and productivity to guarantee improved household welfare. Consequently, this paper applies these propositions to the Ugandan data by modelling determinants of price differentials.

3. METHODS

This section details the methods and analytical approaches used in the paper. It discusses the modelling and estimation procedures we have followed as well as our data sources.

3.1 Model specification

Theory suggests that, aside from transportation and other transactions costs, the same commodity should trade at the same price in efficient and well integrated markets. A corollary to the law of one price further predicts that given well-functioning markets, spatial variability is only transitory, as this would offer opportunities for arbitrage which, if exploited, would drive the system back to the one price equilibrium state (Persson, 1998) as expressed in Eq.(1):

$$p_j = p_i + t_j \qquad (1)$$

Where p_j is the price of the commodity in location j, p_i is the price in location i, *and* t_{ij} is the transport and transaction cost between locations i and j. It is hypothesized that if the difference between p_j and p_i exceeds t_{ij}, then the ratio is greater than one, which acts as an incentive to rational and well-informed traders to take advantage of profits by moving their commodities from regions with excess to those with relative scarcity. Eventually, the gap between the two regions closes, hence one price.

Following Gonzalo *et al.* (2012), spatial price differentials are modelled for selected commodities using price, infrastructure, crop yield per acre,

population and welfare data in the respective districts. In an ideal situation, the price difference for a commodity between two locations (here districts *i* and *j*) will either be less than or equal to the relevant trade costs, *t,* as expressed in Eq. (2):

$$\left|p_i - p_j\right| \leq t \qquad (2)$$

It is expected that the absolute difference between the prices in districts ***i*** and ***j*** is lower than or equal to the transportation and distribution costs*, t*. The costs play a significant role in determining the magnitudes of the differences among districts. For example, if the price of a commodity – due to the interaction of supply and demand forces – in district ***j*** is well above that in district ***i*** plus the cost associated with transport from district ***i***, then producers will send their commodity to district ***j,*** and the price in district ***j*** will be expected to go down eventually. However, if the initial difference is lower than the transportation cost then there will be no incentive for producers in district ***i*** to transport the commodity to district ***j***. Other factors that can potentially influence commodity price differences between two different locations include labour productivity, cost of inputs such as capital and land, weather conditions, consumer purchasing power and population of the districts concerned. These factors are captured in the model as drivers of commodity price differentials between two districts*,* ***i*** and ***j,*** following Gonzalo *et al.* (2012) as expressed in Eq. (3):

$$\left[p_i - p_j\right] = \beta_0 + \beta_1 \mathrm{Re}_i + \beta_2 \mathrm{Re}_j + \beta_3 \mathrm{Re}^* Inf_i + \beta_4 \mathrm{Re}^* Inf_j + \beta_5 Co_{ij} + \beta_6 \mathrm{Pr}_i + \beta_7 \mathrm{Pr}_j + \beta_8 PC_i + \beta_9 PC_j + \beta_{10} PCI_i + \beta_{11} PCI_j + \beta_{12} RC + \beta_{13} RE + \beta_{14} RN + \beta_{15} RW + e_{ij} \qquad 3$$

Where:

P_i-P_j = the price difference between districts *i* and *j* measured in Uganda shillings;

Re_i *and* Re_j = the average distance of households in district *i* or *j* to the nearest municipality weighted by the inverse of the population and multiplied by the cost of fuel, which is meant to control for transportation costs. A higher weighted distance increases transport costs and therefore increases the price difference. It is a measure of remoteness on price differentials to the extent that reducing the distance reduces the difference;

R^*Inf_i *and* R^*Inf_j = road density in districts *i* and *j*. It is expected that distance affects the price more when the quality of transport infrastructure is worse. A higher road density lowers the price difference, implying that it has a negative effect on the difference in prices. This variable is interacted with distance in the model;

Co_{ij} = dummy variable that takes value *one* if the two districts share a border and *zero* otherwise (contiguity). It is meant to capture the proximity of districts in relation to transport costs. It is expected to have a negative effect because the closeness/proximity of districts reduces the cost of transactions;

Pr_i *and* Pr_j = supply conditions measured by unit yield (productivity) of output of the commodities. Improvement in the supply condition will therefore have a negative effect on the price difference because it will reduce it;

PC_j *and* PC_i = the level of output of the commodity normalized by the population in the district. According to Goodwin & Schroeder (1991), low volume markets have "a bigger potential for exhibiting unwarranted price behaviour". In this case, high production will even the price across districts*;* and lower production will increase it. Therefore, the output level will have a negative impact on the dependent variable;

PCI_i *and* PCI_i = consumption expenditure as a proxy for welfare, which captures demand-push effects across districts. If the PCI_{ij} effect is present, a negative coefficient will be observed because high incomes

will tend to increase demand and therefore even the price;
The regional dummies RC_{ij} (Central region), RE_{ij} (Eastern region), RN_{ij} (Northern region), and RW_{ij} (Western region) demonstrate the price differences across the regions and implicitly the impact of the different constraints.

e_{ij} = an error term capturing all other factors.

3.2 Estimation procedures

The estimation is performed at the district level. We examine the extent to which the district-level heterogeneity explains price differences across districts. The average price difference between district *i* and district *j* is estimated to determine the effect of a number of covariates. Furthermore, we include regional specific dummies to capture regional variabilities.

3.3 Data sources

The paper draws on data from several sources as presented below. The Uganda Census of Agriculture (UCA) was conducted by UBoS from September 2008 to August 2009, in all 80 districts that existed at that time. Data consisted of the following: (i) the Agricultural Household and Holding Characteristics Module, which was used to collect data on the demographic characteristics of household members as well as structural data on agricultural holdings; (ii) the Crop area module captured information on holding parcels and crop plot areas; (iii) the Crop Production Module, which collected data on crop production, and (iv) the livestock module. A total of 31,340 agricultural households were sampled. The UCA captured the following data relevant for this paper: land holdings, prices, access, tenure, use and size; the demographic characteristics of households; livestock numbers; access and use of implements; agricultural credit/loans; mode of transportation; sources of agricultural information; markets and inputs. The estimated number of agricultural households was 3.95 million with 19.3 million persons. The data are a cross section for two farming seasons. Although our preference would have been for time series data, this was not possible because such data do not exist, as agricultural censuses are rarely conducted. The advantage of the current data is that it is a census representing the population and not just a sample. The average consumption expenditure at the district level, used as a proxy for welfare, is based on the Uganda National Household Survey of 2009/10, which was collected during the same time. Administrative data on population projections and area (square kilometres) were extracted from the UBoS Statistical Abstracts (2008 and 2009). Data on road density were computed from the road length data sets of the Ministry of Works and Transport.

4. EMPIRICAL RESULTS

This section first presents and discusses findings that highlight the general characteristics of the selected commodities and the other relevant variables. This is followed by a presentation and discussion of the tests undertaken, followed by the econometric results. Finally, we offer conclusions based on our results and discussion and then suggest policy implications based on our analysis.

4.1 Descriptive results

4.1.1 Commodity prices

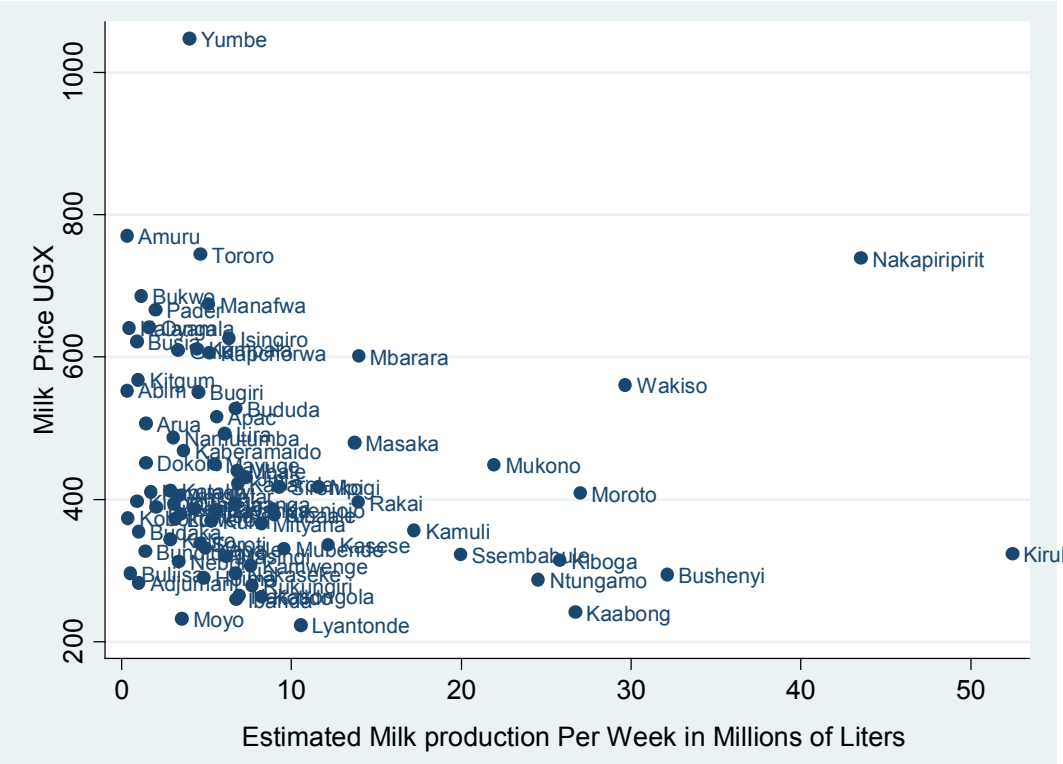
The average commodity price gives an indication of the transaction and distribution costs between two respective regions/districts. The spatial commodity price differentials thus implicitly suggest the magnitudes of the constraints that exist and bar the even distribution of given commodities in the country. Table 1 reveals significant differences in average prices across regions, with prices higher in the northern region and lowest in the central region – except for milk. By implication, consumers in the northern region's districts, on average, pay higher prices than those in the central region.

Table 1: Average prices for selected food crops by region in 2008/9, UGX/kg

Region	Maize	Bananas	S potatoes	Millet[a]	Milk per litre
Central	261	261	395	1,848	428
Eastern	422	422	325	1,562	459
Northern	533	551	405	1,623	517
Western	367	367	353	1,691	355
National	396	400	370	1,681	442

Notes: [a]For millet, the price used is that of flour not grain.
Source: Author's calculations based on the Uganda Census of Agriculture 2008/2009.

Figure 1: Relationship between average milk prices and output at district level, 2008/9



Source: Author's calculations based on UCA data.

It is clear that the regions that produce the largest quantities have the lowest average prices for all commodities, with the exception of maize in the central region. This is plausibly the case because the central region includes Kampala, which is the major trading region and sometimes attracts competition, thus lowering the prices of commodities. The relationship between the average prices and the output in the districts is counterintuitive. To illustrate this point, Figure 1 shows that the main milk-producing districts are likely to have lower prices, and the opposite is true. This further justifies the inclusion of the districts' production capacities in the analysis, as their variability significantly determines the initial price difference. The charts in Appendix A illustrate the spatial differences in the prices of individual commodities based on regions, illustrating that regions with higher production levels are likely to have lower prices, and the opposite is true. For example, western Uganda, which is the main producer of bananas, has the lowest price, and the rest of the regions have higher average prices. It is evident that the average regional prices are likely to be

lower when the production and yield levels are higher. This suggests that, in the domestic commodity market, price differentials are exacerbated by production and storage capacities in addition to transport costs and transaction constraints.

4.1.2 Road infrastructure

Although Uganda's internal trade is facilitated by road, rail, inland water, and air transport, much of the movement of agricultural commodities occurs by road. Table 2 gives selected road indicators at the regional level from the sample districts included in this study. The average distance to districts from households is not significantly different among the regions, plausibly explained by the recent proliferation of districts, a policy the Local Government has been pursuing for the last ten years. The total district road length shows that the central region has the highest average, followed by the western region, northern region and then eastern region. This clearly illustrates that the districts in the central region have, on average, more road length compared to the rest, especially the eastern region.

In particular, northeastern Uganda has lagged behind in infrastructural development. It is noted that road density largely favours the central region, with the western and eastern regions having smaller and similar magnitudes. This pattern of infrastructure indicators spells out the regional inequality and the disadvantage that northern Uganda faces, especially after two decades of conflict, which have resulted in its lagging behind in development.

The main challenges facing transportation infrastructure are the low density of roads and the poor quality of the associated infrastructure. Thus, the transportation of commodities tends to be slower due to a host of factors, including potholes in the roads, narrowness of the roads, and inadequacy of transport-related services such as fuel stations and garages, among others. This state of affairs leads to damage and deterioration, especially of perishable commodities. There is, in addition, a very low level of integration and competition among the different modes of transportation in Uganda (Uganda National Roads Authority 2008). The relatively high cost of transportation is clearly, in part, a reflection of the lack of competition among the different modes of transportation, the low density and quality of infrastructure, and the lack of integration of the different modes and networks of transportation in the country.

4.1.3 Production and yield

This section presents the annual production and yields for selected crops (Table 3). The regional averages definitely mask the disparities across districts but still give a fair picture of the differences. There are significant crop production variations for the commodities of interest across regions. Whereas eastern Uganda is the largest producer of maize, sweet potatoes and millet, the western region is the largest producer of bananas. This pattern is closely mirrored by the yields and the percentage distribution of crops among the regions.

Maize: Nationally, Uganda produced 2.4 million metric tons of maize on 1 million hectares. The yield per hectare demonstrates that the eastern region had the highest yield with 2.9 mt/ha, followed by the western region with 2.6 mt/ha, the central region with 2.4 mt/ha, and the northern region performed poorly at 1.2 mt/ha. Furthermore, the eastern region reported the highest production distribution of maize, amounting to 46.9 percent, followed by the western region with 21.1 percent, the central region with 19 percent and the

Table 2: Selected regional road indicators, km

Indicator	Central	Eastern	Northern	Western
Distance to District[a]	24.6	24.3	22.9	23.9
District road length[b]	422.9	212.1	273.9	362.4
Road density	0.6	0.2	0.1	0.2

Source: [a] Author's calculations based on UNHS data; [b] Ministry of Works databases

northern region producing the least (12.9 percent). The districts that emerged as the key producers included Iganga, Mubende and Soroti. These production and yield characteristics suggest that the eastern region is the main maize supply region in the country.

Sweet potatoes: Sweet potato production was 1.8 mt from an estimated area of 440,000 ha, with the largest proportion coming from the eastern region. Similarly, the eastern region had the largest yield of 5.3 mt /ha, followed by the northern region with 4.8 mt/ha. The Iganga district was the leading producer of the crop, followed by Soroti and Kamuli.

Bananas: Bananas (food type) is one of the major staple foods in Uganda. National production was estimated at 4 million mt from an area of 809,000 ha. The western region reported the highest production of the crop (67.9 percent), followed by the central region with 23.1 percent, eastern region (8.3 percent) and northern region (less than one percent) (Figure 2). In terms of yield, bananas have one of the highest potentials, with a national average of 5 mt/ha. The western region had the highest yield of 6 mt /ha, followed by the eastern region (5.6 mt/ha), the northern region (5.1) and finally the central region (3.3 mt/ha). The districts that produced the highest amounts of the crop include Isingiro, Mbarara and Bushenyi.

Finger Millet: Production was 277,000 mt from an estimated area of 250,000, with a national yield of 1.1 mt/ha. The eastern region is the largest producer, with the northern and western regions producing almost the same quantities. Although the central region is the lowest producer, it is the highest-yielding region at 2.4 mt/ha. The Tororo district is the largest producer, followed by Soroti and Amuru.

Milk: The exact amount of milk produced in Uganda has been a subject of debate. This paper adopts milk production in the *past week,* as was captured by the questionnaire during the livestock census. The UCA gathered data related to numbers of milked cows, average milk production in litres per milked cow (in the

Table 3: Crop area, production and yield by regions, 2008/9

Regions	Maize	Bananas	Sweet Potatoes	Millet
Production in tonnes				
Central	449 859	929 534	312 402	13 734
Eastern	1,108 554	333 851	847 140	106 838
Northern	305 798	26 015	292 932	78 572
Western	497 745	2 728 587	366 295	77 784
National	2 361 956	4 017 986	1 818 769	276 928
Yield -tonnes per acre				
Central	2.4	3.3	3.2	2.4
Eastern	2.9	5.6	5.3	1.2
Northern	1.2	5.1	4.8	0.7
Western	2.6	6.0	3.0	1.5
National	2.3	5.0	4.1	1.1
Percentage distribution				
Central	**19.0**	**23.1**	**17.2**	**5.0**
Eastern	46.9	8.3	46.6	38.6
Northern	12.9	0.1	16.1	28.4
Western	21.1	67.9	20.1	28.1
National	100	100	100	100

Notes: Production and Yield is in Metric tons per Hectare

Source: Author's calculations based on the Uganda Census of Agriculture 2008/2009.

past week), percentage of milk sold, and average price per litre of milk, which is summarized in Table 4. The western region produced the largest proportion of milk (31 per cent), followed by the Central (29 per cent), with northern Uganda producing the least amount of milk (6 per cent). Overall, about a third of all the milk produced in Uganda (35 per cent) is sold. The western region leads in terms of the proportion of milk produced that is sold (43 per cent); while the Karamoja sub-region was lowest in terms of the proportion of milk produced that is sold (6 per cent).

4.1.4 Regional distribution of marketed food surplus

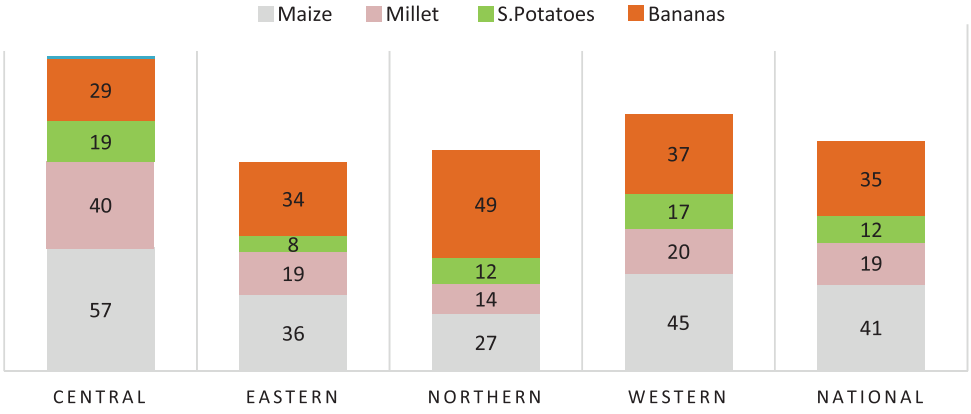
Given that not all produce is sold on the market and that some is partially consumed by households (subsistence), it is important to establish the proportion that is sold out of the total produced. Figure 2 illustrates the proportions sold on the market, giving an indication of the level of market development for each crop. The statistics reveal that maize (41%) is the most-sold commodity, followed by bananas (35 percent), millet (19 percent) and sweet potatoes (12 percent). This suggests that households largely grow crops for subsistence and have not significantly ventured into market-oriented production for various reasons. This echoes the limited commercialization of agriculture in Uganda.

Table 4: Milk production and prices by region in 2008/9

Region	Number of Milk cows	Average milk in past week per cow	Estimated milk produced per week	Share of national production (%)	Milk sold (%)	Mean Price/ litre
Central	376,080	9.8	3,685,584	29	39	428
Eastern	310,480	7.3	2,266,504	18	36	459
Northern	158,540	5.2	824,408	6	42	517
Western	413,300	9.7	4,009,010	31	43	355
Karamoja Sub-region	261,190	7.8	2,037,282	16	6	540
National	1,519,580	8.5	12,916,430	100	35	442

Source: Author's calculations based on the Uganda Census of Agriculture 2008/2009.

Figure 2: Regional contribution of crop production sold immediately after harvest, %



Source: Author's calculations based on the Uganda Census of Agriculture 2008/2009.

4.2 Econometric results

In section 4.1, the descriptive analyses of the determinants of commodity price differentials in the districts were presented, highlighting heterogeneity across several dimensions (production conditions, geography, infrastructure, income per capita, etc.). Below are the results of the estimated model, used to establish the extent to which this heterogeneity can explain price differences across districts. Table 5 presents the results for the five commodities analysed (maize, bananas, millet, milk and sweet potatoes).

Table 5: Determinants of cross-district price differentials for selected crops

Variable	Maize	Bananas	Milk	Potatoes	Millet
Co_{ij}	-102.4***	-109.5***	-43.35***	-42.83***	-95.96***
	(-5)	*(-5.133)*	*(-7.25)*	*(-2.457)*	*(-6.05)*
Re_i	10.83	2.299	51.24***	-17.73***	-56.67***
	(-5.7)	*(-5.89)*	*(-7.47)*	*(-2.86)*	*(-6.94)*
Re_j	5.545	0.55	55.73***	-23.30***	-63.04***
	(-5.835)	*(-6.04)*	*(-7.63)*	*(-2.94)*	*(-7.07)*
$Re_i * inf_i$	-118.7***	-130.8***	-119.2***	112.0***	891.3***
	(-18.96)	*(-19.69)*	*-(25.94)*	*(-9.33)*	*(-22.9)*
$Re_i * inf_j$	-106.5***	-94.31***	-143.1***	116.7***	903.8***
	(-19.23)	*(-19.81)*	*(-26.21)*	*(-9.45)*	*(-23.17)*
Pr_i	-2.718***	-0.75**	-1.335**	-0.32*	4.387***
	(-0.473)	*(-0.262)*	*(-0.469)*	*(-0.13)*	*(-1.216)*
Pr_j	-2.299***	-0.44	-1.395**	-0.84***	4.516***
	(-0.486)	*(-0.27)*	*(-0.472)*	*(-0.132)*	*(-1.247)*
PC_i	-0.23***	-0.03*	-0.034	0.00	-0.36**
	(-0.021)	*(-0.012)*	*(-0.036)*	*(-0.015)*	*(-0.12)*
PC_j	-0.22***	-0.052***	-0.053	0.03**	-0.37**
	(-0.021)	*(-0.01)*	*(-0.04)*	*(-0.01)*	*(-0.126)*
PCIi	-57.03***	-63.97***	13.58	-44.99***	55.85***
	(-4.34)	*(-4.536)*	*(-7.65)*	*(-2.15)*	*(-5.23)*
PCI_j	-69.64***	-58.71***	72.81***	-18.93***	67.35***
	(-5.502)	*(-5.64)*	*(-9.002)*	*(-2.704)*	*(-6.68)*
RC_{ij}	-22.35***	-23.29***	14.52*	-1.03	-27.86***
	(-3.86)	*(-3.65)*	*(-5.72)*	*(-1.87)*	*(-4.71)*
RE_{ij}	-16.59***	.	74.69***	40.82***	14.81*
	(-4.75)	.	*(-6.92)*	*(-2.336)*	*(-5.81)*
RN_{ij}	-13.97***	-2.70	0.35	5.21**	-25.35***
	(-3.83)	*(-4.17)*	*(-5.71)*	*(-1.878)*	*(-4.58)*
RW_{ij}	1580.2***	1513.9***	-784.2***	752.4***	-1195.7***
	(-77.09)	*(-77.46)*	*(-127.2)*	*(-38.13)*	*(-93.56)*
r2	0.129	0.108	0.0617	0.132	0.321

Notes: The figures above are coefficients and below are the standard errors; level of significant * $p<0.05$, ** $p<0.01$, *** $p<0.001$; Prob>F =0.000; Observations: crops=12,324 and milk 6,162.

The results for contiguity (bordering districts) for all the commodities are highly significant, with the correct signs (negative) suggesting that closeness among the given districts reduces the price differentials. The law of one price is thus operational, as closeness of districts reduces transport and distribution costs for the analysed commodities. Remoteness exhibits different patterns for the commodities and does not show significant results for maize and bananas. For potatoes and millet, remoteness is significant and negative, conforming to the *a priori* expectations. Overall, the results suggest that price difference is increased by remoteness. This pattern of behaviour may be explained by the fact that the variable used was distance to the nearest municipality normalized by the population and fuel costs. With the proliferation of districts in Uganda, most production areas (rural) are no longer far away from district headquarters and municipalities, as was the case in the past. The analysis is improved when we interact the impact of remoteness with infrastructure, especially in rural areas, which highlights the deficiencies of rural infrastructure.

The interaction between remoteness and infrastructure further improves the results, and the effect of remoteness is significantly attenuated by good transport infrastructure. This paper adopts road density as a proxy for infrastructural development at the district level, although this should encompass a variety of infrastructure in rural areas, such as valley dams, irrigation, disease control infrastructure, research infrastructure, markets, and agro-processing infrastructure, among others.

All the commodities reveal negative significant coefficients, suggesting that the interaction of remoteness and poor infrastructure is likely to increase the price difference regardless of commodity. This is intuitive because bananas and milk are highly perishable commodities that require an efficient infrastructural system to be moved from points of production to points of marketing and consumption. It thus emerges that remote and infrastructure-deficient districts are likely to pay higher prices than their counterparts for these commodities. Therefore, remoteness is less costly when transport and other infrastructure are better.

Productivity (yield) differences do affect the price differential of the commodities significantly. Regardless of commodity, improving the yield capacity would greatly lower the price difference among the different districts in Uganda. For these commodities, the policy approach should be to increase yield per acre (per cow for cattle) through the use of improved varieties (breeds) and use of better inputs. The Development Strategy and Investment Plan of the Ministry of Agriculture, Animal Industry and Fisheries has correctly identified productivity in the agricultural sector as an area for investment.

The output per capita of the commodity significantly affects the price differences. Districts that produce more of a given commodity relative to their populations face a lower price for the product. This suggests that the price difference for these commodities between producing districts and consuming districts is quite high. Uganda has much unutilized arable land that can help expand commodity production. The limiting factor has been partially inadequate mechanization, in the form of tractors that can enhance the opening of large areas of land. Therefore, high price differentials among districts can be reduced and opportunities for arbitrage can be exploited if commodity production is expanded through opening new areas and increasing yield per hectare/cow.

The effect of differences in quantities consumed – associated with per capita income – is dominated by all the commodities, as the coefficients are negative and significant except for milk which is positive. These results suggest that as households increase their per capita income, the resulting effect is lower price differences among the districts for these commodities. Increase in per capita income increases demand for the commodities, triggering demand in the deficient districts and leading to more- or less-even distribution of the commodities and hence a lower price difference.

5. CONCLUSIONS AND POLICY IMPLICATIONS

This paper has provided insights into the drivers of price differentials across districts in Uganda. The study is particularly relevant for a country that is resource-

endowed but limited by infrastructure and other rigidities. It is important to understand what drives the phenomenon of plenty in some districts and scarcity in others. The uneven distribution of commodity prices across the country is partly explained in this paper. It is anticipated that this will allow the government to take appropriate measures to enable farmers/producers to make optimal production decisions and traders to reach out to the entire country.

The interaction between remoteness and quality of infrastructure clearly influences price differentials. Remote towns pay a higher price, but the effect of remoteness is attenuated by good transport infrastructure. Furthermore, price differences are also significantly explained by per capita output and land productivity. The effect of per capita income on price differentials is relatively uniform across commodities. Furthermore, per capita income captures unobserved quality differences across districts as well as development and local production capacities.

The analysis points towards two important policy implications: first, it confirms the importance of investing in infrastructure, demonstrating that the constraints generated by geography and remoteness can be alleviated by upgrading the infrastructure. This can be achieved through improvements in the investment climate to promote private investment and through investments in public works. Second, findings point towards the importance of strengthening productivity as an important means not only to improve households' livelihoods but also as an instrument to foster more efficient markets with faster supply responses to changes in prices.

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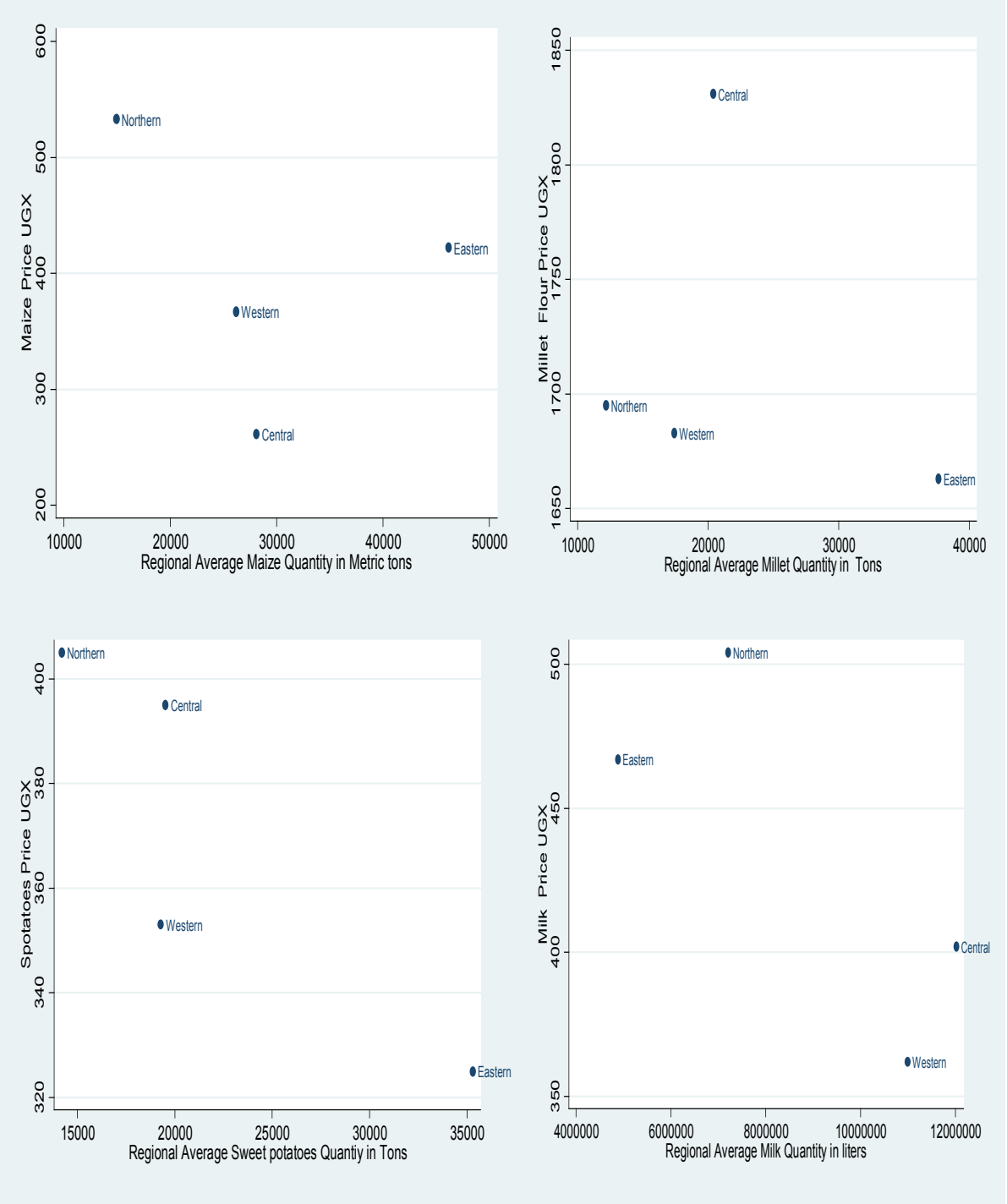
APPENDIX

APPENDIX A: The relationship between prices and output for all the commodities



[1] This study does not primarily aim to examine the degree of market integration in Uganda's internal market but rather the role of key constraints that influence price differentials in the country.

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