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Spatial heterogeneity in price (dis)incentives: evidence from the Ugandan maize value chain

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Abstract

Impact assessments of policy interventions on agricultural commodity prices are carried out by international organizations using nationwide measures which overlook the effects of spatial heterogeneity in incomplete markets. We introduce a multi-step methodology to build spatially-disaggregated nominal rates of protection in a data-scarce environment and test it along the maize value chain in Uganda. Results confirm that the spatial dispersion of farmers plays a key role in determining heterogeneity in nominal rates of protection. This finding has far-reaching policy implications: i) the assumption of a nationally-representative market pathway is unrealistic; ii) pan-national interventions may exacerbate, rather than reduce, price distortions.

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1. Introduction

The international community regularly monitors the pattern of agricultural (dis)incentives to track changes in domestic policies, anticipate their effects on world prices and support evidence-based policymaking at national and global level[1]. These measures – such as the nominal rate of protection (NRP) – are derived from price comparisons and frequently used to assess the impact of policy interventions on outcomes such as market structure, productivity, welfare and agricultural output composition as well as food security (Magrini et al., 2017; Laroche-Dupraz & Huchet-Bourdon 2016). However, mainly due to data scarcity in developing countries, current measures overlook spatial heterogeneity by relying on the non-trivial assumption that there is a nationally representative market pathway. In competitive systems, spatial arbitrage should lower these price differences across markets to the level of transaction costs. Yet, the literature provides substantive evidence of imperfect spatial price transmission in developing countries due to factors such as market power, marketing costs, government interventions and asymmetric information (Abdulai, 2000; Fafchamps and Hill 2005; Renkow et al., 2004; Osborne, 2005).

Our aim is to reconcile the evidence of spatial heterogeneity with the policymakers' need for synthetic indicators on agricultural price incentives. We thus i) propose a multi-step procedure to build regionally-disaggregated NRPs in a data-scarce environment; and ii) test it along the maize value chain in Uganda. This is a pilot study that can be easily extended to other crops and countries. Uganda is an ideal case study since it is a primarily agriculture-based country and a completely liberalized market. The choice of maize is motivated by its dichotomous role as a food security crop for the country and as an export commodity to the East Africa Community.

Results confirm that the spatial dispersion of farmers plays a key role in determining heterogeneity in NRPs for maize farmers in Uganda. This finding has far-reaching policy implications because it shows that: i) the implicit assumption of a nationally-representative market pathway is unrealistic; ii) pan-national policy interventions may exacerbate, rather than reduce, price distortions along the chain.

2. Methodology and data

This analysis extends the approach developed by the FAO Monitoring and Analysing Food and Agricultural Policies (MAFAP) programme (Barreiro-Hurle and Witwer, 2013). Unlike other methodologies, MAFAP indicators account for vertical heterogeneity, i.e. price differentials at two points along the value chain. MAFAP computes NRPs by comparing observed domestic prices with reference prices for a set of agricultural commodities and countries. Reference prices are proxied using international prices, considered free of influence from domestic

[1]As of today, four major international organizations (IOs) monitor agricultural policy incentives at country level on a continuing basis: OECD with the Producer and Consumer Support Estimates database; the World Bank with the Distortions to Agricultural Incentives database; the FAO with the MAFAP database; the Inter-American Development Bank with the Producer Support Estimate database. Recently, under the coordination of the International Food Policy Research Institute, these IOs created the International Consortium for Measuring the Policy Environment for Agriculture, with the aim of harmonizing and increasing the quality and coverage of the available measures (http://www.ag-incentives.org/).

policies and markets and adjusted by access costs (transportation, handling and processing, profit margins and taxes) incurred along a pre-defined market corridor. Observed domestic prices are compared to reference prices at two points along the value chain, the farm gate (where farmers sell the commodity) and the point of competition (where domestic products compete with identical products at world prices). Exploiting gaps between reference and observed prices, MAFAP calculates two different measures of NRPs: one at the wholesale market and one at the farm gate. However, due to their construction and data constraints, these NRPs are homogeneous within-country, i.e. only a single NRP is provided for each country-year, and this measure is assumed to be nationally representative. In short, MAFAP accounts for vertical heterogeneity, but still overlooks spatial heterogeneity.

To overcome these limitations, we compute within-country disaggregated measures of household NRPs, by extending this methodology through a multi-step procedure. First, we exploit the spatial dispersion of farmers provided by household-level data to obtain differentiated measures of access costs from the farm gate to the main wholesale market. Second, we compute access costs between these regional wholesale markets and their respective border. Third, both access costs are subtracted from Free on Board (FOB) prices to compute household-specific reference prices at the farm-gate level (RFGPs) for the exported commodity:

$$RFGP_{ht} = P_{bt} - ACPoC_{mt} - ACFG_{ht} \tag{1}$$

where the subscripts *h, b, m* and *t* stand, respectively, for households, borders, wholesale markets and years; P_{bt} stands for the benchmark FOB price; $ACPoC_{mt}$ are the observed access costs from each point of competition to the border; $ACFG_{ht}$ are the observed access costs, separately calculated for *each* household, from their farm gate to the respective point of competition. In the final step, we obtain household-level measures of price gaps (PG) by subtracting RFGPs from the observed farm-gate prices (FGPs):

$$PG_{ht} = FGP_{ht} - RFGP_{ht} \tag{2}$$

Household-specific NRPs are then estimated as:

$$NRP_{ht} = \frac{PG_{ht}}{RFGP_{ht}} \tag{3}$$

Lastly, we aggregate the indicator at the desired administrative level taking the average. In this way, we get rid of the bias due to household heterogeneity and provide a useful policy measure at a meaningful unit of aggregation.

Data for this study come from five sources. Household and agricultural data are taken from the World Bank LSMS-ISA surveys (2009-2010; 2010-2011; 2011-2012), Free-on-Board prices are from UN Comtrade, Points of Competition are selected using *FEWSNET Production and Trade flow maps* (see Figure A.1), information on marketing costs excluding transport are from the MAFAP *AgIncentives* database and lastly, estimates of unit transport costs are derived from the World Bank (2009). Table A.1 in the Appendix reports detailed information on the core variables employed.

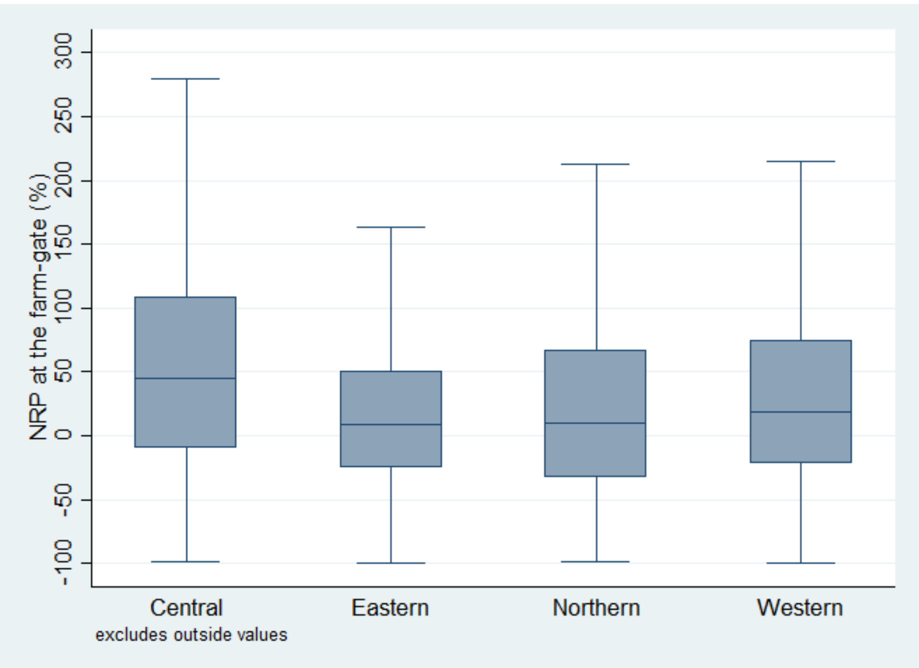
3. Results and conclusions

Table A.2 in the Appendix presents measures of the regionally-disaggregated indicators for each year in our sample. Figure 1 below reports the box plots of average household NRPs for the entire period under investigation (2009-2012) disaggregated by Ugandan regions: Central, Western, Eastern and Northern. The main feature is the evidence of strong heterogeneity both between- and within-region. Remarkably, in some cases, there is also heterogeneity in *sign*. These results contradict the single pathway assumption and emphasize the role of farmers' geographic dispersion in determining price distortions and imperfect within-country price transmission.

Our study provides a workable solution to account for spatial, other than vertical, price heterogeneity, thus overcoming the assumption of a nationally-representative and unique NRP which not only neglects the deep causes of imperfect price transmission but, by applying the same policy tool to heterogeneous market areas, may further increase price distortions leading to inefficient allocation of resources. The analysis can be replicated for other crops included in the *AgIncentives* database as well as for any other country for which detailed household surveys are available.

This exercise provides useful insights for policymakers dealing with the design of nationwide and/or regional specific interventions in support of the agricultural sector in developing countries. The first one is that some national policies usually put in place to support strategic crops such as, for example, import restrictions and government purchases through parastatal agencies do not guarantee the same benefits across the entire territory. Without a further investigation on the spatial distribution of those benefits, the government risks to misallocate the already scarce public resources devoted to the agricultural sector. The second insight relates to the decentralization process that is characterizing many developing countries in Asia and Africa over the last two decades and the consequent devolution of the agricultural policy to sub-national authorities: local policymakers need disaggregated information on the impact of national and regional policies (and their interaction) on agricultural price incentives in order to design effective and tailor-made interventions. Indeed, the analysis of a nationally-representative market pathway is not enough to inform agricultural policy reform processes. In this respect, the implementation of our methodology would represent a more granular evidence-based source of information for local policymakers.

Figure 1 – NRPs at the farm gate by region (2009-2012)



Source: Authors' calculations

We ought to emphasize the limitations of our work. First, this is a descriptive exercise, not a causal analysis. Second, the selected points of competition may not include all the possible pathways for cross-border trade. Third, our reference price relies on official trade statistics, whereas informal trade plays an important role in cross-country maize flows in the area.

Despite these *caveats*, we consider the methodological contribution to be relevant and it should be further refined by future research to fully unleash its substantial policy potential. The preliminary empirical evidence provided here points to the inadequacy of current assumptions underlying policy interventions, and to the need for a spatially-disaggregated approach which better suits the actual functioning of commodity value chains in Sub-Saharan Africa.

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Appendix

Table A.1 – Information on key variables

Variable	Notes	Source
Farm-gate prices (FGPs)[2]	Total value of maize sold in the two rainy seasons before the interview divided by total quantity.	World Bank LSMS-ISA
Free-on-board (FOB) prices	Average FOB price – partner border countries. Computed by dividing the values of annual trade volumes by their respective quantities.	UN Comtrade
Points of Competition	Arua and Mpondwe (for DRC), Gulu (for Sudan) Busia, Moroto, and Suam (for Kenya); Kabale (for Rwanda)	FEWSNET
Road distances	Road distances from each household location[3] to the selected points of competition[4]; and from each point of competition to their respective border.	Google Maps *via R* (*gmapsdistance* package)[5]
Transport costs	Computed by multiplying distance in km for the corresponding estimate of unit transport cost per ton/km of three sub-segments[6].	Estimates of TCs per ton/km for selected pathways[7] from World Bank (2009), adjusted by CPI and assumed as representative
Profit margins in the PoC – border segment	5 % of wholesale prices from selected cities.	Wholesale prices from RATIN
Profit margins in the FG - PoC segment	Only available for the Busia pathway, assumed as representative for all.	MAFAP
Handling and processing costs (both segments)	Same as above.	MAFAP
Taxes and fees (both segments)	Including Council CESS.	MAFAP

[2] Although these should be considered as unit prices, since they do not account for production inputs and household heterogeneity, aggregation at the regional level averages away these differences. As for potential seasonal bias, the fact that waves overlap across calendar years makes the issue unlikely to meaningfully affect the results.
[3] Household coordinates have a random offset of 5 kilometres. Our spatial analysis is based on a medium resolution, so differences are negligible.
[4] The underlying assumption is that the pathway is the one that minimizes distance to reach the PoCs.
[5] *Google Maps* distances are computed according to *current* road infrastructures. This may cause measurement error if new roads have been built since the time surveys were implemented. Still, such an approach is an improvement over Euclidean distances.
[6] Namely: from the farm gate to the primary market, from primary to secondary markets, and from secondary to wholesale markets. As for transport costs from the PoC to the border, we consider only the primary-to secondary and secondary-to-wholesale segments. The assumed mode of transportation is trucks, except for the FG-primary market segment for which bicycles are assumed.
[7] Busoga region (Iganga and Bugiri, producing zones supplying Kampala) and Sironko, Mbale and Kapchorwa districts (from which maize is exported to Kenya through the Busia pathway).

Table A.2 – Regionally-aggregated indicators

Region	NRP_h (%) Mean	sd	Obs
2009			
Central	-27.277	40.776	59
Eastern	-17.621	37.82	82
Northern	-17.371	52.173	37
Western	-15.734	54.651	44
Country	-19.772	44.790	222
2010			
Central	40.555	85.250	154
Eastern	22.336	113.491	195
Northern	27.466	76.74	147
Western	22.495	84.861	114
Country	28.202	93.449	610
2011			
Central	134.853	189.182	133
Eastern	45.002	150.28	142
Northern	24.233	105.107	122
Western	63.265	133.144	122
Country	67.438	154.070	519
2012			
Central	146.646	268.125	90
Eastern	91.801	133.586	95
Northern	66.504	185.366	125
Western	58.451	83.036	105
Country	87.638	180.671	415

Figure A.1 – FEWSNET Production and market flow maps