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# **Relativity Meets Gravity: A Better Measurement of Market Size to Explain Agricultural Trade**

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# Relativity Meets Gravity: A Better Measurement of Market Size to Explain Agricultural Trade

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## Background

Newton’s law of universal gravitation elegantly states that the gravitational force between any two objects is proportional to the product of their masses and inversely proportional to the squared distance between them.

Since Tinbегure (1962), economists have found that the gravity equation model adequately characterizes trade flows between two nations as well, if one translates physical masses into gross domestic products (GDPs). In particular, the GDP of the importing nation measures the size of the importing market. That is, a larger economy imports more.

## Problem

In the context of agricultural trade, however, the empirical performance of importer’s GDP, as an measurement of the size of the importing market, is poor.

For example, Haq et al. (2013) report that agricultural trade can be inversely related to GDPs. In a case study of peanut export from Africa to Europe, Xiong and Beghin (2012) also find negative GDP effects when certain estimation methods are used.

One plausible explanation for the ambiguous GDP effect is that food expenditure accounts for a modest or even small share in households’ overall expenditures. Therefore, the statistical linkage between a country’s GDP and its import of disaggregated agri-food products is relatively weak.

## Remedy

We argue that national expenditure on food items is a better metric of market size when modeling agricultural trade. The reason is that it directly measures the food-purchasing power of the importing country.

We use an analogy in physics to illustrate the new measurement. The equation of special relativity states that energy (E) equals mass (M) multiplied by  $C^2$  (i.e.,  $E=MC^2$ ), where C is the speed of light. If we see energy as GDP and  $1/C^2$  as food share (of course, food share would never go that low...), then our new measurement is the mass (i.e.,  $M=E/C^2$ ), which is the variable suitable for the gravity equation.

## Data

Although food expenditure data are generally unavailable across nations, we approximate it with the product of the GDP and the share of food in overall household consumption as reported by FAO surveys.

With the new measurement of market size, we revisit Xiong and Beghin (2012) to evaluate the impact of EU’s harmonization in aflatoxin policies on peanut export from sub-Saharan Africa.

We expect that (a) the replacement of the measurement re-affirms the main conclusion that EU’s aflatoxin control has not significantly impeded Africa’s peanut exports; and (b) the estimated effect of the market size bears a positive sign when the new measurement is used.

## Results

We present the results from the Helpman-Melitz-Rubinstein model.

	Edible peanut			Shelled peanut			Peanut oil		
	Extensive margin	Existing firms’ margin	New firms’ margin	Extensive margin	Existing firms’ margin	New firms’ margin	Extensive margin	Existing firms’ margin	New firms’ margin
<i>GDP as the measurement of market size</i>									
MRL <sup>a</sup>	-0.165	-0.408	-0.123	-0.030	0.031	-0.013	0.759	1.006	0.287
GDP	1.156***	-7.15***	0.825***	0.820	0.089	0.398	1.602***	-4.007	0.645***
<i>Food expenditure as the measurement of market size</i>									
MRL <sup>a</sup>	-0.413***	0.375	-0.329***	-0.050	0.181	-0.029	0.794	0.833	0.434
GDP	0.786***	-2.33**	0.626***	-0.022	-0.686	-0.013	1.647***	-0.793	0.899***
Note: a. MRL refers to Maximum Residue Limit on aflatoxin B1 in peanut products. ** and *** denote statistical significance levels of 5% and 1% respectively.									

We find that the new measurement of market size alleviates (not solves) the problem of identifying a negative and statistically significant impact of market size.

## Conclusion

Agricultural trade economists utilizing the gravity equation models should consider a better measurement of market size. Our case study of the peanut trade from Africa to Europe suggests that multiplying the conventional measurement (i.e., importer’s GDP) by the share of food in overall household consumption is a first step toward addressing the negative effects of market sizes.

## Reference

Haq, Z. U., Meilke, K., & Cranfield, J. (2013). Selection bias in a gravity model of agrifood trade. *European Review of Agricultural Economics*, 40(2), 331-360.

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