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OECD AGRICULTURAL SUBSIDIES AND POVERTY RATES IN LOWER INCOME COUNTRIES

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Abstract

We investigate the implications of the OECD support for agriculture on the headcount poverty rates of developing countries. Following the strategy proposed by McMillan, Peterson Zwane, and Ashraf (2005, 2007), we estimate the cross-country empirical framework building a new OECD policy index and applying different panel data techniques. In addition to the standard parametric model estimators, we also use the finite mixture models to detect heterogeneous effects of the OECD policy index within our sample. We find statistically significant evidence that OECD agricultural policies worsened the poverty rates in some developing countries. Most of the main food exporters appear in fact to be negatively affected by the OECD support for agriculture while the impact detected on food importers is not significant or near to zero.

Keywords: *OECD Countries, Agricultural Distortions, International Trade Markets*

1. Introduction

Agricultural policies continue to be a major concern in global trade negotiations. For decades, the agricultural sector has been in fact highly protected in advanced economies while it has borne a high direct and indirect burden in developing countries, respectively through taxes on agricultural exports and industrial substitution policies (Anderson, 2010a; Krueger, Schiff, & Valdés, 1988; Schiff & Valdés, 2002). All these sets of measures have been responsible for reducing national and global welfare, inhibit growth rates and add poverty to developing countries (Anderson, 2010b).

The creation of the World Trade Organization (WTO) in 1995 encouraged trade liberalization measures to reach economic development targets. Shortly after, in 2001, the multilateral negotiations known as the Doha Round started to put pressure on national governments to comply with long-term objectives of creating a fairer trading system and eliminating distortions in the agricultural world market. The Doha Development Agenda asked, in particular, developed countries to reduce their domestic support and eliminate export subsidies for agricultural commodities (Shaw, 2007). However, after more than a

decade, members countries still seem unable to bring to a successful conclusion the bulk of the negotiations, confirming agricultural issues among the most controversial topics to reach an agreement on (Hebebrand & Josling, 2011; Matthews, 2013).

Large agricultural direct subsidies in OECD countries have been claimed to create an unfair competitive environment and distort world trade dynamics by lowering international market prices of food and agricultural commodities below their production costs (Aksoy & Beghin, 2005; Beghin Roland-Holst, & van der Mensbrugghe, 2002).

Moreover, market access barriers, such as import tariffs, import restrictions on raw and processed agricultural commodities, non-tariff barriers, etc., have contributed to even more welfare losses in global terms (Anderson, Martin, & Valenzuela, 2006; Hertel & Keeney, 2006). The consequent inability of lower income countries to compete on distorted markets may have hampered the development of their primary sector. This may reflect on the whole economic process of poorer economies, considering that the largest part of their population relies on agricultural activities for their living (World Bank, 2007).

The effects of OECD agricultural practices may vary depending on the trade and productive structure of lower income countries . On one hand, the OECD subsidized regime is pointed out to depress the world prices and harm the current and potential exporters of agricultural products. As a consequence, its withdrawal has the effect of expanding the output production in those countries. On the other hand, some scholars suggested the theoretical possibility that the effects of the removal of OECD support are not so straightforward, detecting instead a negative impact for the development process of the net food importers and developing countries involved in preferential trade agreements (Bhagwati, 2005; Panagariya, 2002, 2005). It has been also found that restricted trade regimes amplifies the volatility of world food prices (Tyers & Anderson, 1992). When a country sets a policy isolating the domestic food market from international prices fluctuations, in fact, other countries in turn alter their agricultural trade measures causing the weakening of the original attempt and the increase of the global price volatility (Anderson, 2013). This price instability might have hampered the poorest people, who devote a large proportion of their income on food expenditures, and inequality rates in developing countries (Caracciolo & Santeramo, 2013; Organisation for Economic Co-operation and Development, 2011). The issue is contentiously discussed, also in light of the increasing agricultural protection in Eastern Europe and East Asian countries.

The aim of our paper is to investigate the effects of the OECD trade and agriculture policies on developing countries using panel data models. The likely impact of eliminating the agricultural trade distortions on the global and national welfare has been assessed so far using Computable General Equilibrium (CGE) models. Although developing countries tend to be affected in different ways by the removal of subsidies in the OECD countries, most of the analyses detected a pro-development net effect (Stiglitz & Charlton, 2005). Simulating the removal of the OECD subsidies and trade barriers, Diao, Diaz-Bonilla, Robinson, and Orden (2005) showed results conducive to an increase of the agricultural exports and, consequently, of the value added of the primary sector in developing countries. Their model also predicted that the increasing agricultural production led to multiplicative effects on the overall GDP, boosting the employment rate and the demand for non-agricultural goods and services. Using long term projections, the LINKAGE model of the World Bank calculated the impact of removing all the market distortions on the world economy. Using the database built by Anderson and Valenzuela (2008), the projections suggested that the reforms intervened to correct distortions during the past decades led to an overall gain of 233 billion of USD per year (Valenzuela, van der Mensbrugghe, & Anderson, 2009). Simulating, instead, a global removal of all agricultural subsidies, taxes and import tariffs on the world baseline economy in 2004, the global gain would be around 168 billion of USD per year. Even if negative effects may be tracked for some developing countries, Valenzuela et al.

(2009) calculated a net farm incomes increasing of 5.6 percent in developing countries, confirming the effectiveness of this strategy to alleviate poverty and inequality.

In alternative to the CGE models, a cross-country regression framework was first proposed by McMillan, Peterson Zwane, and Ashraf (2005, 2007). They built an index that weighted own OECD agricultural support on the agricultural production of developing economies for the period 1982-2000. They found no robust evidence that the OECD agricultural subsidies captured by the index worsen poverty rates or income in various samples, i.e. including all developing countries, the Cairns Group and historical food importers . Using the same index, Dewbre, Thompson, and Dewbre (2007) estimated, instead, a negative effect on farm income growth in all the developing economies included in their sample, although with low statistical significance.

Our investigation is new in many respects. Our first innovation is to build a new measure to estimate the impact of the support for OECD agriculture on the poorer economies. We employ the same methodology proposed by McMillan et al. (2005, 2007) using instead a different database that includes a longer time series and the OECD support measure for cotton, an heavily subsidized commodity especially in United States, which was not accounted by the authors. We estimate the impact of our OECD agricultural policy index using the standard parametric models (i.e. OLS, FE and FGLS) considering the pre-assigned samples: all developing countries, the Cairns Groups and the food importers. For the latest, we consider all the countries with a long-term net food importer status. We also employ the finite mixture models estimation approach to deal with possible sources of heterogeneity in our specification. Parameters may in fact vary in cross-country and panel growth regressions (Durlauf, 2001). Moreover, the standard parametric models do not take into account the unobserved heterogeneity due, for example, to institutional, cultural and geographical factors, initial conditions of the countries (Bloom, Canning, & Sevilla, 2003; Desdoigts, 1999), or omitted variables in the specification (Aitkin, 1999). Introducing latent effects to model heterogeneity sources, the finite mixture models allow for an endogenous (i.e. posterior) clustering of the countries. The assumption is that each country has some probability to be assigned to a specific group (or latent class), based on the random parameters associated to some elements of the covariate set. Data then attribute each country to a specific group and draw the number of clusters. For our analysis, we associate a random parameter to the constant and to our OECD agricultural policy index, considering that - as emerged in the debate - the effects of the rich-countries agricultural policies may differ due to some developing countries' trade characteristics. Using both kind of techniques, our econometric results show that the OECD support policies are likely to worsen poverty rates, especially in large net food exporters.

The paper is structured as follows: after this introduction the Section 2 describes the samples and the construction of the OECD policy index. Section 3 presents the empirical strategy and the related methodology. In the Section 4 our results are described and discussed. The Section 5 concludes.

2. Data

Our sample includes 67 countries classified by the World Bank as low-, lower-middle- and upper middle-income countries, for the period 1978-2009[i]. We consider all the developing countries that have at least two observations for the headcount poverty rate. Considering our interest in historical agricultural production, we exclude some countries for which data on agricultural output were not available in the early '60s (mostly ex-Soviet Republics) and small islands with a very limited agricultural sector.

To calculate the OECD support for agriculture, we consider the richest economies that subsidized their agricultural sectors since the '60s.

As anticipated, we estimate the impact of the OECD agricultural policy index on all the developing countries and then on subsamples that group together only the members of the Cairns Group and the food importers, respectively. The Cairns Group is composed by competitive agricultural exporting countries which account for more than 25% of the world's agricultural exports[ii]. For the sub-sample of the net food importers, we consider all the countries with a long-term (i.e. during the whole time period) net food importer status. For the identification of these countries, we rely on the classification proposed by Ng and Aksoy (2008)[iii]. Appendix 1 lists the classification of all the countries included in all our samples and of the OECD countries considered. In Appendix 2 it is reported the food and the general agriculture trade status of the developing countries included in our sample[iv].

2.1. The OECD Agricultural Support Index

We now describe the procedure we have followed to build our country- and time-specific index measuring the implicit production-weighted subsidy faced by each developing country. For its construction, we use the World Bank database "Global Estimates of Distortions to Agricultural Incentives" created by Anderson and Valenzuela (2008) and its updated version by Anderson and Nelgen (2012)[v]. These databases reports on commodity-specific and aggregate agricultural distortions for both developed and developing countries complementing and broadening the existent database built by Krueger *et al.*, OECD and IFPRI (Anderson, 2010a).

To calculate our index we employ the methodology proposed by McMillan *et al.* (2005, 2007) using, as said, a different database and time span. McMillan *et al.* (2005, 2007) used the database from the OECD Trade and Agriculture Directorate (available data from 1987) and US Department of Agriculture (USDA) (for the period 1982-1990). They used three types of indicators that identify the agricultural support: the Producer Support Estimates (PSEs), the Producer Nominal Protection Coefficients (NPCs) and the Nominal Assistance Coefficients (NACs). In their econometric analysis, the authors used the NPCs variable as a measure of OECD agricultural support, although claiming lack of results also when using the other measures. Details on the support measures are in the Appendix 3.

In a perfectly competitive economy with no market failures, a country would maximize the national welfare allowing domestic farm and consumer price of a (homogenous) product to equal the international price multiplied by the country' exchange rate. Any government-imposed intervention that shifts the price from equality is considered welfare reducing (Anderson, 2010b). To track these distortions in the agricultural sector, we use the Nominal Rates of Assistance (NRAs) that combine tariffs on imports of competing commodities, direct subsidies (or taxes) to production and subsidies (or taxes) to the farm use of intermediate inputs (Anderson, Croser, Sandri, & Valenzuela, 2009)[vi]. A positive NRA represents essentially the percentage by which the government policies raise gross returns to farmers of a specific agricultural commodity above what they would be without government's intervention.

Our index includes the following agricultural commodities: barley, oat, maize, wheat, rice, beef, pig meat, poultry, sheep meat, eggs, milk, sugar, cotton, wool, rapeseed, soybeans and sunflowers.

Differently from McMillan *et al.* (2005, 2007), we also include cotton, a commodity heavily subsidized in the United States. The commodities we choose are the most heavily subsidized agricultural goods produced in the OECD for which the data are available for all the OECD countries in our sample.

For each commodity listed above, first we obtain the weighted mean of NRA across OECD countries using as weights each country's share of production.

We then weight the average OECD NRAs, obtained in the previous step for each commodity, with the share of the commodity in each developing country' historical agricultural output in 1961. Moreover, the choice of using historical production structure rather than the current one avoids a problem of endogeneity, i.e. that the current agricultural output may be determined by the OECD support level, and address the issue of the potential of export of developing countries[vii].

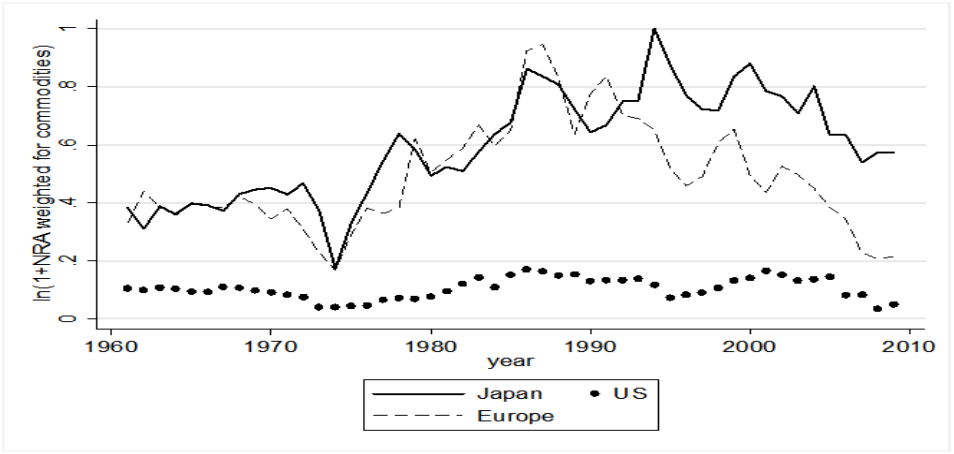

Figure 1. Agricultural Support in Europe, Japan and US

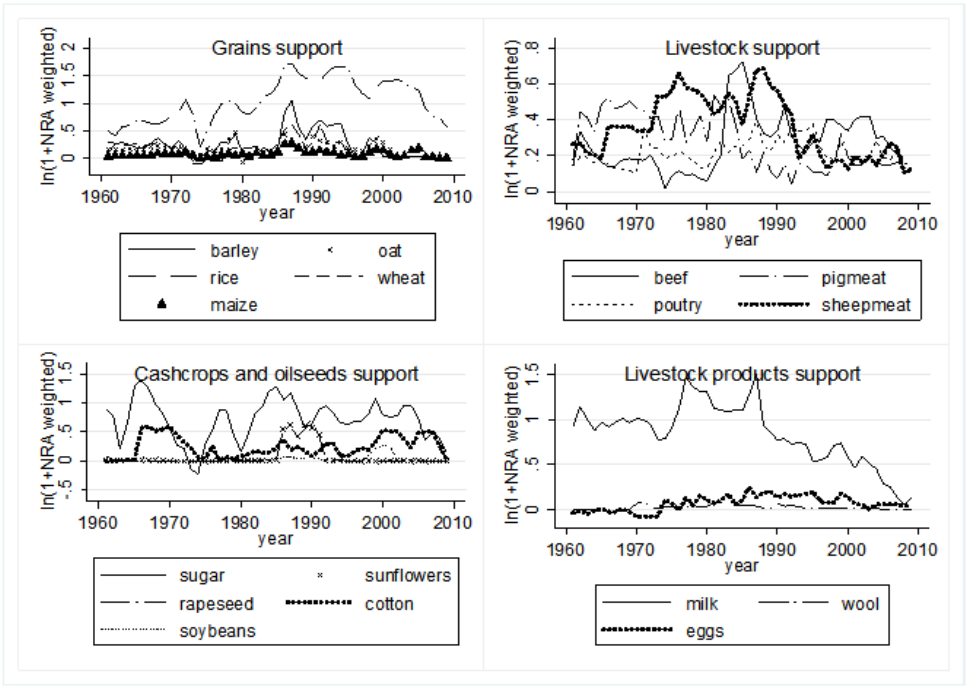

Figure 2. Agricultural Support (Nominal Rate of Assistance) by Commodities in OECD Countries

Countries with a traditional agriculture production oriented to tropical commodities or large food importers would have lower OECD index values, while countries with a primary sector structure that competes directly with agricultural products heavily subsidized by the OECD countries would have instead a higher value of the index.

Details on the trend of general agricultural support for Europe, US and Japan (as the main subsidizers), and commodity specific support are illustrated in Figures 1 and Figure 2. In particular, Figure 1 shows that the overall support in high-income countries increases steadily until the end of the '80s, apart from a fall when the international food prices rose in 1973-1974. During the '90s, the aggregate OECD NRA started to decline, probably influenced by decoupled programs[viii] (Anderson, 2010b), remaining however higher in Japan. Figure 2 illustrates instead the trend for each commodity.

Among the grains, rice is the most subsidized commodity, especially in Japan. Livestock and its by-products are mostly subsidized in the United States, as well as cotton. In Europe, the commodity that receives larger support is sugar.

3. Empirical Strategy

3.1. Standard Parametric Models

We estimate the following equation

$$HP_{it}=\alpha+\beta_1 OECDpolicy_{it}+\sum_{k=2}^{K}\beta_k X_{it}+\tau_t+\varepsilon_{it} \quad (1)$$

where HP is the headcount poverty rate for the country *i* at time *t* (i.e. the percentage of population living below the absolute poverty line of 1.25 USD/day) and the variable *OECDpolicy* is the index that measures OECD support described in the previous section. As both the dependent variable and the *OECDpolicy* index are expressed in log, β_1 represents the elasticity of poverty in lower income countries with respect to the agricultural support in high-income countries. The vector X includes K control variables found relevant by the literature, and especially in McMillan *et al.* (2005, 2007).

In particular, a measure that summarizes the Southern Oscillation Anomaly (SOI) is included for controlling global weather shocks[ix]. The inflation rate and trade variable (as the sum of total import and export over GDP) are added as controls for own-country policies, as well as a polity score that measures the degree of democracy in the country (Lledó, Yackovlev & Gadenne, 2011; Yang, 2008)[x].

The headcount poverty ratio, the inflation rate and the trade variables are from the World Bank's World Development Indicators (WDI), the polity score (democracy) is calculated by the Polity IV Project and the Southern Oscillation weather measure is based on data from the National Oceanic And Atmospheric Administration (NOAA) (see details in Appendix 4). This set of regressors allows to preserve a reasonable number of observations on poverty. τ_t is time specific effect common to all countries, α is the constant and ε_{it} is the error term.

The effects of the OECD support may depend on whether the country is a net importer or a net exporter. To take into account these possible heterogeneous effects of the variable *OECDpolicy* due to the different trade status of developing countries, we first estimate the Eq. (1) for all the developing countries and then we keep in the sample first the members of the Cairns Group and then only the food importers. Details on the countries included are in Appendix 1.

Table 1 reports the summary statistics for all the variables used in the estimations considering the whole sample of developing countries, the Cairns Group and the net food importers. The Cairns Group has a lower average poverty rate than the net food importers,

that gather together the poorest countries mostly located in the Sub-Saharan Africa. As expected, the OECD policy index is higher for the Cairns Group that competes directly in international markets with the agricultural output of the OECD countries. Their inflation rate is also higher than the net food importers, considering that most of the Latin American countries are included in the Cairns Group. The trade openness and the level of democracy for the net food importers is, respectively, higher and (much) lower than the average levels for the Cairns Group.

Table 1. Summary Statistics

Variable	Obs	Mean	Std dev	Min	Max
Summary statistics: All developing countries					
OECD policy index	2912	0.64	0.60	0	3.64
Log consumer price index	2306	0.16	0.33	-0.14	5.50
Trade openness	2607	0.69	0.39	0.003	3.75
Democracy	2582	0.66	6.72	-10	10
Summary statistics: The Cairns Group					
Head count poverty rate	217	12.43	12.82	0	68.16
OECD policy index	512	0.80	0.48	0.047	2.71
Log consumer price index	477	0.25	0.56	-0.011	4.77
Trade openness	512	0.58	0.37	0.11	2.20
Democracy	512	4.49	5.91	-9	10
Summary statistics: The net food importers					
Head count poverty rate	180	26.89	26.78	0	92.55
OECD policy index	1376	0.55	0.59	0	3.42
Log consumer price index	1031	0.12	0.16	-0.10	1.54
Trade openness	1167	0.76	0.41	0.063	3.75
Democracy	1170	-0.11	6.60	-10	10

We carry out our analysis using Pooled Ordinary Least Squares (POLS), Fixed Effects (FE) and Feasible Generalized Least Squares (FGLS) estimations.

Pooled Ordinary Least Squares combines cross-sectional data on N units and T time periods, i.e. a total of N X T observations. FE captures instead the presence of unobservable and time invariant country-specific characteristics α_i that are wiped off from the estimation by subtracting from each time period's observation its country mean value. The inefficiencies related to possible presence of the heteroskedastic-clustered standard errors and/or autocorrelated structure of the errors are corrected using FGLS. Considering our panel structure with N > T, we can compute a regression only with groupwise heteroskedasticity but not the heteroskedastic error structure with cross-sectional correlation (Greene, 2003; Hoechle, 2007). Due to the dispersion of the data, we specify the AR(1) autocorrelation structure of the errors only for the sub-sample including the Cairn Group that presents longer and consecutive observations[xi].

3.2. Finite Mixture Models

To confirm the results obtained by our *a priori* grouping, we use the finite mixture models to detect homogeneous group-structures in the full set of observations. The finite mixture models approach (Alfò, Trovato, & Waldmann, *2008;* Paap, Franses, & van Dijk, 2005) allows the introduction of random components (or latent variables) to gain flexibility in modelling a heterogeneous population that, otherwise, would be represented by a single distribution. The method can be seen as a semiparametric compromise between a full parametric model represented by a single distribution and a nonparametric model represented by as many different distributions as the number of observations (McLachlan & Pell, 2000).

In details, the finite mixture approach proposes that the overall conditional density can be represented by a weighted summation of g different density functions (or groups). The number of *g* clusters is treated as fixed and estimated via penalized likelihood criteria. It is assumed that each observation *i* has some probability to get assigned to these groups. The weights of each density function and its parameters represent the unknown values to estimate and the main interest for using this approach.

The maximum likelihood (ML) estimation with the iterative EM (Expectation-Maximization) algorithm is the method used to estimate the unknown components of the finite mixture model. In particular, the E-step takes the conditional expectation of the log-likelihood function for complete data with respect to the latent variables. The M-step maximizes the expected log-likelihood obtained with the E-step for the parameters of the model. The iteration with the E- and the M-steps continues until the log-likelihood improvement reaches an arbitrarily small amount, i.e. a convergence. For analytical details, see McLachlan and Pell (2000) and Grün and Leisch (2008)[xii]. To choose among the number of mixture components, we use selection criteria penalizing for the number of parameters and observations in the model, such as Bayesian Information Criterion (BIC) and Consistent Akaike Information Criterion (CAIC).

This estimation method fits the purpose of our study particularly well. The OECD policy measures may have in fact a different (or even opposite) impact on different countries. Also the constant term may be heterogeneous among economies reflecting, for example, the income distribution structure and other countries' characteristics not detected by the covariates of our model.

4. Results

Tables 2 to 7 show our empirical results under all the estimation methods and the post-estimation results of country-grouping obtained using FMM[xiii].

Table 2 reports the estimated coefficients of the *OECDpolicy* variable and of the other covariates on the headcount poverty rate for the sample including all developing countries for which poverty data are available.

The *OEC policy* coefficient is always positive and is statistically significant with POLS, FGLS and FMM estimations (0.502, 0.490 and 0.829 respectively). In other words, we detect a positive relationship between the OECD support measure and the poverty rates in developing countries. The FE estimate of the coefficient is positive but not significant. The openness to trade as well as the democracy variable appear to lower poverty rates for POLS, FGLS and FMM.

The results for the sample including the countries of the Cairns Group (Table 3) confirm and reinforce the initial statement that the OECD agriculture support policy may be negatively related to the development process of food exporting countries. The estimated coefficients of the *OECD policy* variable are positive and significant using all estimators (for OLS and FE at the 10% level of significance, for FGLS at the 5% level) and their values are

higher than the ones obtained for the sample including all the countries (1.064, 1.457 and 0.916 respectively for POLS, FE and FGLS). The FE estimate is significant (at the 10% level), which contrasts with the result obtained by McMillan *et al.* (2005, 2007). For this group of countries, the coefficient of openness to trade is negatively related to the poverty rates (even though not significant using FE) and the inflation rate is significant only for the FGLS and positively linked to poverty.

Table 2. Headcount poverty rate and OECD agriculture subsidies: All the countries

Dependent variable	(1)	(2)	(3)	(4)
Poverty	POLS	FE	FGLS	FMM
OECD policy	0.502** (0.254)	0.536 (0.482)	0.490*** (0.175)	0.829*** (0.139)
SOI	0.322 (0.518)	0.001 (0.044)	0.587 (0.377)	0.0003 (0.020)
Inflation	-0.231 (0.197)	0.016 (0.085)	0.051 (0.090)	0.010 (0.081)
Trade openness	-0.379** (0.176)	-0.322 (0.427)	-0.296*** (0.106)	-0.314*** (0.084)
Democracy	-0.070*** (0.011)	0.023 (0.018)	-0.078*** (0.005)	-0.011* (0.006)
constant	4.313*** (1.223)	2.713*** (0.256)	4.293*** (0.998)	2.510*** (0.319)
N	504	504	504	504
R^2	0.105	0.287		
F /Wald^2	2.75		294.15	
Log-likelihood				-508.507
sigma^2				0.306 (0.019)
g				5

Note: p-values significance level: * p < 0.10, ** p < 0.05, *** p < 0.01.
Column (1): Pooled OLS with year dummies (omitted); Column (2): Fixed effect with year dummies (omitted) and robust standard errors; Column (3): Feasible Generalized Least Squares with year dummies (omitted) corrected by heteroskedastic panel; Column (4): Finite Mixture Model with latent effect on constant and OECD policy variables. g is the number of mixture components selected by the BIC criteria

Considering the sample comprising the net food importers (Table 4), using all the estimators the *OECDpolicy* index is not significantly related to the percentage of poor. In fact, by construction, the *OECDpolicy* index tracks the effects of the rich-economies support on the production structure of the developing country, and this affects mainly the direct competitors on food and agricultural output. To track the hypothetical positive impact of the *OECDpolicy*index in poorer countries, it would in fact require an index based the consumption patterns of economies affected by the lowering effect of international food prices. While the sign of the inflation rate is ambiguous, the presence of the democracy is the leading factor in decreasing the poverty rates for net food importers.

Table 3. Headcount Poverty Rate and OECD Agriculture Subsidies: the Cairns Group

Dependent variable	(1)	(2)	(3)
Poverty	POLS	FE	FGLS
OECDpolicy	1.064* (0.558)	1.457* (0.814)	0.916** (0.378)
SOI	0.367 (0.521)	-0.008 (0.134)	0.113 (0.118)
Inflation	0.005 (0.214)	0.089 (0.141)	0.174*** (0.058)
Trade openness	-1.009*** (0.268)	-1.196 (0.702)	-0.415** (0.178)
Democracy	-0.066*** (0.025)	0.026 (0.023)	-0.001 (0.010)
constant	3.131*** (1.074)	2.27*** (0.380)	2.510*** (0.319)
N	202	202	202
R^2	0.102	0.435	
F/ Wald^2	1.70		93.02

Note: p-values significance level: * p < 0.10, ** p < 0.05, *** p < 0.01.
Column (1): Pooled OLS with year dummies (omitted); Column (2): Fixed effect with year dummies (omitted) and robust standard errors; Column (3): Feasible Generalized Least Squares with year dummies (omitted) corrected by heteroskedastic panel and panel-specific AR(1) error structure

Table 4. Headcount Poverty Rate and OECD Agriculture Subsidies: The Net Food Importers

Dependent variable	(1)	(2)	(3)
Poverty	POLS	FE	FGLS
OECD policy	-0.062 (0.417)	0.246 (0.795)	-0.187 (0.308)
SOI	-0.061 (0.196)	0.143 (0.097)	-0.029 (0.156)
Inflation	-2.885*** (0.829)	-0.461 (0.278)	-1.929*** (0.645)
Trade openness	-0.902** (0.345)	0.315 (0.225)	-0.297 (0.217)
Democracy	-0.037* (0.021)	-0.008 (0.024)	-0.078*** (0.013)
constant	4.002*** (0.608)	2.661*** (0.586)	3.619*** (0.481)
N	161	161	161
R^2	0.106	0.449	
F /Wald^2	1.66		95.28

Note: p-values significance level: * p < 0:10, ** p < 0:05, *** p < 0:01.
Column (1): Pooled OLS with year dummies (omitted); Column (2): Fixed effect with year dummies (omitted) and robust standard errors; Column (3): Feasible Generalized Least Squares with year dummies (omitted) corrected by heteroskedastic panel

The finite mixture model enables us to cluster the countries and detect heterogeneous values for the constant and the OECD agricultural policy through all the sample. This

approach seems to better describe the data as shown in the Fig 3 that plots the density of the poverty variable and the ones obtained with the OLS and FMM estimations.

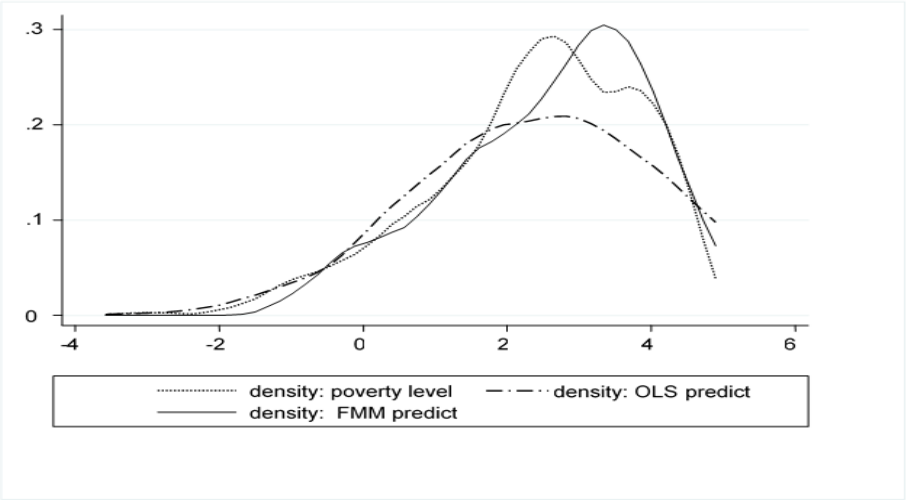

Figure 3. Observed and Fitted Density Distribution

The number of clusters *g* is selected by the Bayesian Information Criterion (BIC) and amounts to five (Table 5). Tables 6 and Table 7 show the list of countries grouped in each cluster, and their latent coefficients and density function probabilities, respectively.

Table 5. Penalized Likelihood Criteria

g	2	3	4	5	6
log likelihood	-658.963	-551.187	-528.737	-508.507	-505.544
AIC	1325.92	1114.37	1073.475	1037.014	1035.088
BIC	1367.707	1177.045	1157.037	1141.465	1160.429
CAIC	1375.707	1189.045	1173.037	1161.465	1184.429

Table 6. Country clusters

Clusters	
1	Albania, Bulgaria, Egypt, Iran, Jamaica, Jordan, Malaysia, Romania, Thailand, Turkey, Uruguay
2	Argentina, Costa Rica, Dominican Republic, Mexico, Morocco, Tunisia
3	Bolivia, Cambodia, Cameroon, China, Cote d'Ivoire, Guatemala, Honduras, Indonesia, Kenya, Lao PDR, Mauritania, Pakistan, Panama, Philippines, South Africa, Vietnam
4	Algeria, Brazil, Colombia, Ecuador, El Salvador, Fiji, Nicaragua, Paraguay, Peru, Sri Lanka, Venezuela
5	Bangladesh, Botswana, Burkina Faso, Burundi, Central African Republic, Gambia, Ghana, Guinea-Bissau, India, Lesotho, Madagascar, Malawi, Mali, Mozambique, Nepal, Niger, Nigeria, Rwanda, Senegal, Swaziland, Tanzania, Uganda, Zambia

Table 7. Location for The Random Effects

Clusters	Constant	OECDpolicy	Probability
1	-2.805	0.935	0.162
2	-1.421	0.584	0.094
3	0.357	0.274	0.264
4	-0.428	0.001	0.154
5	1.717	-0.855	0.326

For each group, the constant and the estimated coefficient of the variable *OECDpolicy* are calculated summing up their respective values (Table 2, Column 4) with the correspondent latent effect obtained with countries' post-estimation grouping. The first two clusters identify the group of countries that have the lower constant term and a higher positive impact of the OECD policy measure on poverty.

Among these two groups, there are five countries of the Cairns Group and other major agricultural exporters, such as Mexico, Turkey and Morocco. The third cluster groups the countries with higher constant and a still positive impact of the OECD policy measure. In this group, we recognize other members of the Cairn Group (Bolivia, Guatemala, Indonesia, Pakistan, Philippines and South Africa), some major exporters also from Sub-Saharan Africa, such as Cameroon and Cote d'Ivoire. The forth group includes the remaining countries of the Cairn Group that have a lower constant term and an additional impact of the OECD policy measure next to zero. Cluster 5 is the most numerous group of countries that accounts for the higher poverty rates. The coefficient for the *OECDpolicy* index offsets the overall coefficient accounting for an approximate zero effect of the agricultural support policy in the high-income countries. Low- and some lower-middle income economies, and most of the Sub-Saharan countries are included in this group.

The results of the FMM estimations confirm then the results obtained by our *a priori* sub-sampling choices. Differencing the countries based on the constant term and the OECD agricultural support measure shows that the poverty in developing countries is affected in opposite ways. All the largest food exporters, that are also lower-middle and upper-middle income countries, are negatively affected by the OECD agricultural support policy. The poorest countries and the food importers have a non-significant or near to zero effect of the *OECDpolicy* index. However, some exceptions to these general conclusions may be driven by the multidimensional differences among the countries that cannot be fully captured by cross-country econometric techniques.

5. Conclusions

For decades, the primary sector of the developing countries has been depressed by their pro-industrial and urban bias, and by the high agricultural protection in advanced economies. Import barriers and subsidies in OECD countries contributed, in fact, to cause an overproduction of farm products in rich countries and bring distortion in the world trade dynamics. For this reason, donor countries have been often criticized for providing aid with one hand and using trade restrictions with the other.

The effects of OECD agricultural practices are, however, widely discussed and may vary depending on the trade status of lower income countries. We test the impact of the OECD agricultural policies on headcount poverty rates, differentiating the developing countries based on their net food trade status.

Building an appropriate index that weights the OECD agricultural support on the agricultural production path of developing countries, econometric results show that the

OECD support policies are likely to worsen poverty rates, especially in large food exporting countries. Consistently with the debate, no evidence or a near to zero impact is instead detected for net food importing countries.

Continuing reforming the agricultural practice of high-income countries can contribute to the poverty alleviation targets of developing countries mostly affected by international distorted competition on agricultural output. Moreover, a more efficient and equitable trade environment could also help poorer countries to gain opportunities through reforming their agricultural sector, mostly neglected in favour of non-farm tradable activities.

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Appendix 1. List of Countries

List of countries included in the sample (67 in total), classified by income level (according to 2011 GNI per capita, the World Bank)

Low-income economies (1,025 USD or less) (18): Bangladesh, Burkina Faso, Burundi, Cambodia, Central African Republic, Gambia, Guinea-Bissau, Kenya, Madagascar, Malawi, Mali, Mauritania, Mozambique, Nepal, Niger, Rwanda, Tanzania, Uganda.

Lower-middle-income economies (1,026 USD to 4,035 USD) (25): Albania, Bolivia, Cameroon, Cote d'Ivoire, Egypt, El Salvador, Fiji, Ghana, Guatemala, Honduras, Indonesia, India, Lao PDR, Lesotho, Morocco, Nicaragua, Nigeria, Pakistan, Paraguay, Philippines, Senegal, Sri Lanka, Swaziland, Vietnam, Zambia.

Upper-middle-income economies (4,036 USD to 12,475 USD) (24): Algeria, Argentina, Botswana, Brazil, Bulgaria, China, Colombia, Costa Rica, Dominican Republic, Ecuador, Iran, Jamaica, Jordan, Malaysia, Mexico, Panama, Peru, Romania, South Africa, Thailand, Tunisia, Turkey, Uruguay, Venezuela.

OECD countries (20): Australia, Austria, Canada, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Netherland, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

Cairns Group[1] (15): Argentina, Bolivia, Brazil, Colombia, Costa Rica, Guatemala, Indonesia, Malaysia, Pakistan, Paraguay, Peru, Philippines, South Africa, Thailand, Uruguay.

[1] OECD countries included in the OECDpolicy index calculation are excluded from this list

Historical net food importers (29): Algeria, Bangladesh, Burundi, Central African Republic, Dominican Republic, Egypt, El Salvador, Fiji, Gambia, Ghana, Guinea-Bissau, Iran, Jamaica, Jordan, Lao PDR, Lesotho, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Panama, Romania, Rwanda, Sri Lanka, Tunisia, Uganda, Venezuela.

Appendix 2. Countries Agricultural Trade Status

Country	Net Food Trade Status	Net Agriculture Trade Status
Albania	Exporter/Importer	Importer
Algeria	Importer	Importer
Argentina	Exporter	Exporter
Bangladesh	Importer	Importer
Bolivia	Importer/Exporter	Exporter
Botswana	Importer/Exporter	Importer
Brazil	Mostly Exporter	Exporter
Bulgaria	Exporter	Exporter
Burkina Faso	Importer/Exporter	Exporter
Burundi	Importer	Exporter
Cambodia	Exporter/Importer	Exporter
Cameroon	Exporter	Exporter
Central African Republic	Importer	Exporter
China	Exporter	Importer
Colombia	Exporter	Exporter
Costa Rica	Exporter	Exporter
Cote d'Ivoire	Importer/Exporter	Exporter
Dominican Republic	Importer	Mostly Importer
Ecuador	Exporter	Exporter
Egypt, Arab Rep.	Importer	Importer
El Salvador	Importer	Mostly Exporter
Fiji	Importer	Exporter
Gambia, The	Importer	Importer
Ghana	Importer	Exporter
Guatemala	Exporter	Exporter
Guinea-Bissau	Importer	Exporter
Honduras	Exporter	Exporter
India	Importer/Exporter	Exporter
Indonesia	Importer	Exporter
Iran, Islamic Rep.	Importer	Importer
Jamaica	Importer	Importer
Jordan	Importer	Importer

Kenya	Importer/Exporter	Exporter
Lao PDR	Importer	Importer/Exporter
Lesotho	Importer	Importer
Madagascar	Exporter	Exporter
Malawi	Importer	Exporter
Malaysia	Importer	Exporter
Mali	Importer	Exporter
Mauritania	Importer	Importer
Mexico	Changing status	Importer
Morocco	Exporter	Importer
Mozambique	Importer	Exporter/Importer
Nepal	Exporter/Importer	Exporter/Importer
Nicaragua	Exporter	Exporter
Niger	Importer	Exporter
Nigeria	Importer	Importer
Pakistan	Importer	Importer
Panama	Importer	Importer
Paraguay	Exporter	Exporter
Peru	Exporter/Importer/Exporter	Exporter
Philippines	Exporter/Importer	Exporter/Importer
Romania	Importer	Importer
Rwanda	Importer	Exporter
Senegal	Exporter/Importer	Exporter/Importer
South Africa	Exporter	Exporter
Sri Lanka	Importer	Exporter
Swaziland	Exporter	Exporter
Tanzania	Mostly Importer	Exporter
Thailand	Exporter	Exporter
Tunisia	Importer	Importer
Turkey	Exporter	Exporter
Uganda	Importer	Exporter
Uruguay	Exporter	Exporter
Venezuela, RB	Importer	Importer
Vietnam	Importer/Exporter	Importer/Exporter
Zambia	Importer	Exporter

Appendix 3. OECD database

To calculate the index that weighted OECD agricultural support, McMillan et al. (2005, 2007) used three types of indicators: the Producer Support Estimates (PSEs), the Producer Nominal Protection Coefficients (NPCs) and the Nominal Assistance Coefficients (NACs). The PSEs calculate the annual monetary value of gross transfers from consumers and taxpayers to the agricultural producers, measured at farm gate level and arising from policies that support agriculture. The NACs are derived by the division of the value of gross farm receipts (including support) by the value of gross farm production at the border price (the international price). The NPCs are instead the ratios of average price received by the producer at the farm gate level (including payments per tonne of current output) and the border price (OECD, 2008). No support (i.e. no agriculture distortion) is implicitly indicated with a NPC equal to 1. OECD agricultural support was reported for selected commodities such as wheat, maize, rice, other grains, oilseed, sugar, milk, beef, sheep meat, wool, pig meat, poultry and eggs. Cotton is not included in their analysis.

Appendix 4. List of variables

Variable	Definition and Source
Head count poverty rate	Percentage of the population living on less than 1,25 USD a day at 2005 international prices, World Development Indicators (WDI), The World Bank
SOI anomaly	Southern Oscillation Index anomaly average measured in January and June. National Oceanic and Atmospheric Administration (NOAA). Spreadsheet available at http://www.cpc.ncep.noaa.gov/data/indices/
OECD policy	See details
Inflation	Inflation, consumer prices (annual %), World Development Indicators (WDI), The World Bank
Trade	Trade openness is the sum of exports and imports of goods and services measured as percentage of GDP, World Development Indicators (WDI), The World Bank
Democracy (polity score)	Difference between a democracy index (0-10) and an autocracy index (0-10), Polity IV Project. Spreadsheet available at http://www.systemicpeace.org/polity/polity4.htm

[i]The sample also includes some economies that recently became members of the OECD.

[ii]We exclude from this sample Australia and New Zealand that are included in the sample of the OECD countries.

[iii]They calculated the total food import and export in monetary terms, including all the commodities present in the categories: Meat and Dairy Products, Grains and Cereals, Vegetables and Fruits (Standard International Trade Classification (SITC) Rev.2). Ng & Aksoy (2008), however, do not consider the data before the '80s, which we calculate by adopting their same methodology using UN COMTRADE data.

[iv]All agricultural commodities include Raw Food (Meat and Dairy Products, Grains and Cereals, Vegetable and Fruits), Cash Crops (Figs and Nuts, Tropical Products, Feeds, Oilseeds and Tobacco), Other Food (Processed and Seafood) and Non-Food (Agricultural Raw Materials) (Ng & Aksoy, 2008; elaboration based on UN COMTRADE Statistics).

[v]This World Bank's research project includes Nominal Rates of Assistance to producers, or NRAs, together with a set of Consumer Tax Equivalents, or CTEs, for farm products and a set of Relative Rates of Assistance to farmers, initially for 75 focus countries and the database expanded to 82 countries.

[vi]The combination of border price and domestic support, and the direct assistance to input for each commodity provides the following rate of assistance:

$$NRA = NRA_{BS} + NRA_{DS} + NRA_i$$

In details, the NRA_{BS} (Nominal Rate of Assistance to farm output conferred by border price - i.e. international price - support) represents the distortion produced by an ad valorem tax (or tariff) on competing import. For a perfect substitute of the domestically produced good, it is equivalent to an export subsidy. The NRA_{DS} (Nominal Rate of Assistance to farm output conferred by domestic price support) measures the production subsidy for farmer conferred by direct government intervention. The NRA_i contains any tax and/or subsidy for intermediate inputs used in the farm production. In principle, all the three rates can be negative (Anderson, 2010b).

[vii]We also build an OECD index weighted with the share of the contemporaneous commodity production for each developing country. The results from the estimations do not change substantially for what concerns the signs and the significance of the OECD policy coefficient with respect to the ones obtained using the historical agricultural output in 1961.

[viii]Decoupled programs or payments are not tied to production, output level and/or market conditions, creating in this way less distortion in the commodity markets.

[ix]The Southern Oscillation Index (SOI) is a standardized index based on the observed sea level pressure between Tahiti and Darwin, measuring the large-scale fluctuations in air pressure between the western and the eastern tropical Pacific (The National Climate Data Center, NOOA). It measures the el Nino Southern Oscillation. For each year, we take the average of the SOI anomaly measured in January and June.

[x]McMillan *et al.* (2005, 2007) also considered the impact of OECD support on average per capita income and included the latter as a covariate in the estimation for the poverty headcount rate. Testing for the presence of unit root, however, we detect the non-stationary of the per capita income variable, using PPP Converted GDP Per Capita (Chain Series) at 2005 constant prices, Penn World Tables 7.1. For this reason, we focus our analysis only on the headcount poverty rates and exclude the per capita income as regressor. The original framework did not take into account the degree of democracy.

[xi]For the other samples, we compute the only groupwise heteroskedasticity.

[xii]We use the GLLAMM package proposed for Stata software (Rabe-Hesketh, Pickles, & Skrondal, 2001).

[xiii]With respect to the other estimations, the FMM does not include year dummies due to the convergence problems of the ML function.