Aid to agriculture, trade and structural change

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Abstract

This paper studies the effect on the industrialization process of developing countries of foreign aid given to agriculture to expand its productive capacity. According to our theoretical analysis this effect is conditional on the openness of receiving countries. Our empirical results based on panel data for developing countries confirm this analysis, as we find that the effect of this kind of agricultural aid on the rate of growth of the industrial sector of landlocked countries is indeed positive.

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1 Introduction

Assessing the impact of foreign assistance to developing countries has been a central concern for

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international donors, policy makers and academic researchers for decades. The pressure to test the effectiveness of foreign aid has been increasing since the establishment of the broad anti-poverty agenda with the United Nations Millennium Development Goals (MDGs) in 2000 and the new Sustainable Development Goals (SDGs) which have followed. No consensus has been reached and in fact scholars have tended to partition themselves into "aid optimists" (for all see Sachs, 2005) and "aid skeptics" (for all see Easterly, 2006). Subsequent studies have looked at particular aspects of the huge issue [1].

Our contribution to this literature is guided by the following reasoning. Economic development is not just a process of quantitative expansion but consists in the structural transformation of society, with some parts of the economy experiencing rapid growth while others contract. Indeed structural changes historically have always included a reduction of agriculture and an increase in industry and then in services [2]. Lewis (1954), Ranis and Fei (1961) and Jorgenson (1961) and (1967) proposed seminal models of a dual economy, disaggregated into a backward sector, mainly agricultural, and a small advanced industrial sector. In these models, with development labor moves from agriculture into industry, where its productivity increases thanks to capital accumulation. Indeed the Lewis model has been recently used to explain the Chinese economic miracle [3]. Recent evidence about unconditional

[1] Conditioning factors shown to have a role go from donor fragmentation (Annen and Kosempel, 2009) to the aid absorption mechanisms of the receiving country (Chatterjee and Turnovsky, 2007), its demographic structure (Kourtellos *et al.*, 2007) and its institutions in general (Angeles and Neanidis, 2009) just to mention a few. Clemens *et al.* (2012) add to the discussion the importance of making assumptions about the timing of aid effects, which will depend on the kind of aid considered (e.g. emergency vs. structural).

[2] For a comprehensive overview on structural transformations see Herrendorf *et al.* (2012). Ocampo *et al.* (2009) chap. 1, Thirlwall and Pacheco -López (2017) chap. 3. and McMillan *et al.* (2014) focus on the experience of developing countries. Felipe *et al.* (2018) show that all today rich countries had manufacturing employment shares over 18% but argue that due to increasing competition, today's late-industrializing countries are unlikely to meet that threshold. Still, they stress that there are not yet any countries that have got rich without industrializing. For the role of manufacturing in the Indian economy, whose growth since the early 1990s has been largely led by the services sector, see Basu and Das (2017).

[3] In the Lewis-Fei-Ranis approach the marginal productivity of "surplus" labour in agriculture is less than the subsistence/institutional wage (assumed to correspond to the average product of labor) and can be nil so that the manufacturing sector can rely on this abundant supply of cheap labor. In the neoclassical approach by Jorgenson (1967, 300): "the marginal productivity of labour in agriculture is assumed to be always positive so that labour is never redundant". For a more detailed analysis of the differences between these various models see Dixit (1973). Leeson

convergence of formal manufacturing industries regardless of country- or regional-level factors offered by Rodrik (2013) tends to confirm that Kaldor's view of manufacturing as the engine of growth still holds [4]. Another important structural feature of an economy is its participation to international trade and its pattern of specialization. Slow growing regions tend to have exports dominated by primary commodities and technologically less dynamic sectors.

Given this broad conceptual background, we focus on a particular kind of aid, i.e. aid given to agriculture to promote the expansion in generalised productive capacity of the sector, and look at its effect on the rate of growth of the industrial sector [5]. We examine not only the positive impacts that this kind of aid can have at the sectoral level, but also the possibility that, at least for some economies, it stimulates economy-wide expansion.

To anchor our empirical analysis we first extend the simple dual economy endogenous growth model in Matsuyama (1992) by introducing in it "productive" agricultural aid in the sense specified above. As in many endogenous growth models the emphasis is on increasing returns, with knowledge assumed to accumulate through learning by doing à la Kaldor [6]. The difference between the traditional and the modern sector arises because the income elasticity of demand for the agricultural good is less than unitary and because technical progress is a by-product of manufacturing experience, so that growth feeds upon itself in industry. We show that the effect of foreign agricultural aid on industrialisation depends then critically on the recipients' degree of openness. In a closed economy, more labour flows to industrial production. On the contrary, in an open economy, the labour flow goes in the opposite direction: a subsidy to agriculture means more agricultural employment. These static reallocation

(1979) offers a broad overview of the interpretations and criticisms of the Lewis model.

[4]For whole economies convergence is conditional rather than unconditional. For recent evidence on convergence clubs see Maasoumi *et al.* (2007).

[5]Expenditures for humanitarian assistance or disaster relief are instead excluded. The reason for this exclusion is that these expenditures have an effect on the production possibilities of an economy that is different and more complex to detect statistically than the "productive" ones, as argued by Clemens (2012). A full list of all the categories of aid considered in our empirical analysis is given in note (21) in Appendix B on the data sources. Items in the list go from expenditures for technological development and for policy and administrative management to investments in infrastructure and education/training, in the sectors of agriculture, fishing and forestry.

[6]For an overview on the integration of endogenous growth and dual economy- structural change perspectives, see Capasso and Carillo (2009). On the "old" roots of "new" growth thinkers see Skott and Auerbach (1995).

effects will translate into dynamic ones because of the reinforcement mechanism that learning by doing in industry represents. A closed economy with relatively more productive agriculture will grow faster. The reverse will be true for an open economy.

To provide some intuition on the difference in policy results between the closed and open economy variants of the theoretical model we can reason as follows. Productive agricultural aid will have an unconditionally positive impact on industrialization in a closed economy, because higher agricultural productivity will induce both a higher supply of agricultural goods and a higher demand of industrial goods, through increased agricultural incomes, given the empirically undisputable Engel's law [7]. While in a closed economy there is a strong complementarity between agriculture and industry because the former provides a market for industrial goods as well as supplying food to industrial workers, if a country is already integrated in world markets aid targeting agriculture only could artificially maintain a comparative advantage of the country in that sector. In an open trading system, where prices are mainly determined by the conditions in the world markets, aid leading to relatively higher productivity and output in the agricultural sector may risk creating a crowding out effect on the manufacturing sector. Basically an open economy may successfully industrialize by relying on foreign trade, through importing agricultural products and raw materials and exporting manufacturing products. However we hasten to add that our analysis should not be taken as a suggestion to give up a country's agricultural development for the sake of faster growth. First, whether growth actually accelerates depends on the successful integration of a country in international markets. Second, even if it does, the long run gain from faster growth may not outweigh the short run loss due to lower incomes in

[7] This effect will not obtain in the Lewis model, where the expansion of the industrial sector is limited only by a lack of capital. Lewis (1954, 172-173) states : "anything which raises the productivity of the subsistence sector (average product per person) will raise real wages in the capitalist sector, and will therefore reduce the capitalist surplus and the rate of capital accumulation". In fact, according to Leeson (1979) this policy implication of (at least some versions) of the model that industrialization should be achieved without dedicating extra-resources to agriculture has always been controversial. Matsuyama (1992) contrasts Lewis's view with those of thinkers such as Nurkse and Rostow, who saw in increased agricultural productivity the premise of the industrial revolution in western countries. Matsuyama (1992) goes on to argue that which of the two views is a better portrait of the take-off experience of individual countries may depend on the degree of openness of the countries.

agriculture [8].

In our empirical analysis, we use a panel that covers up to 76 aid-recipient countries for the period 1973 to 2008, averaging data over five year intervals [9]. We preliminarily check that agricultural aid has the potential to increase agricultural productivity, measured as land and labour average productivity. Then we move to consider the prediction that there is a difference in the effect of agricultural aid on the process of industrialization in economies which face specific impediments to trade when compared to economies which do not face such impediments. More specifically we focus on landlocked countries, as lack of access to the sea constitutes a major obstacle to trade, as long recognized in the literature (see Sachs and Warner, 1997 and Frankel and Romer, 1999 among others).

To give a preview of our empirical results we find evidence that aid given to agriculture for productive purposes has a positive impact on industrialization in landlocked countries only. These results are in line with the predictions of our simple theoretical model.

Our results for the landlocked countries suggest that assistance to agriculture can make a contribution to the economic welfare of developing countries not integrated in the global economy not only by raising farmers' income, as already known, but also by accelerating their modernization [10]. This last finding is striking and new. On the other hand, for countries already open to international trade foreign aid disproportionately given to agriculture could run the risk of hindering the structural change of the economy. Our results indicate that the openness of economies should be a factor to be kept in mind when planning development strategies and predicting growth performances. The overall lesson we can draw from our results is that a "one-size fits all" approach is too abstract and that a successful development strategy requires following policies that are tailored to local economic realities.

[8] Matsuyama (1992) provides a welfare evaluation of this trade off when agents have infinite horizon and a constant rate of time discount.

[9] Regressing the rate of growth of the industrial sector on agricultural aid giving as we do by itself helps to reduce the endogeneity/ reverse causality problem that is inherent in measuring the effects of aid. The early econometric works paid little attention to the problem but the availability of better data and the use of more advanced analytical methods has subsequently enhanced the empirics. Our work makes use of panel data techniques and in particular of generalized methods of moments, now routinely used in the literature (e.g. Neanidis and Varvarigos, 2009 and Tchamyou *et al.*, 2019).

[10] For the effectiveness of agricultural aid in alleviating poverty, see Kaya *et al.* (2013).

The remainder of the paper is organized as follows. Section 2 presents our theoretical model and Section 3 our empirical analysis. Section 4 suggests policy implications and sums up.

2 Theoretical Model

Time is continuous. We consider an economy with two sectors, agriculture and industry, with constant population normalized to 1 and full employment. Each sector uses labor as a production factor. Aggregate labor supply coincides with population. Labor can shift freely from agriculture to industry.

2.1 Producers

The production functions for the agricultural and the industrial sector are respectively:

$$Y_t^A = Z_t^A G(1 - n_t), G' > 0, G'' < 0 \tag{1}$$

and

$$Y_t^I = Z_t^I F(n_t), F' > 0, F'' < 0, \tag{2}$$

where n_t is the proportion of workers employed by the industrial sector at time t. The production functions F and G exhibit diminishing returns to labor. Z_t^I is the endogenously accumulated technology in the industrial sector external to the single firm, through a Kaldor-Verdoorn channel:

$$\dot{Z_t^I} = \phi\left(Y_t^I\right) \tag{3}$$

with $\phi' > 0$. Z_t^A is total factor agricultural productivity: it depends on a constant component Z^A and the amount of foreign aid to agriculture A_t. Z^A is treated as an exogenous parameter and may reflect the level of technology, land endowment, institutional settings and climate, among other things. The presence of agricultural aid and its impact on agricultural productivity are our main departures from Matsuyama (1992):

$$Z_t^A = \psi(Z^A, A_t), \tag{4}$$

Assuming for simplicity perfect competition for labor between (and within) sectors and an interior solution in both of them leads to the following equilibrium condition:

$$W_t = Z_t^A G^{'}(1 - n_t) = p_t Z_t^I F^{'}(n_t), \tag{5}$$

where p_t is the relative price of the industrial good in terms of the agricultural good, taken to be the numeraire, and W_t is the wage.

Eq. (1) says that, coeteris paribus, agricultural production is higher the higher is the level of agricultural productivity and therefore through Eq. (4) of agricultural aid. So for given labor supply agricultural aid will increase national income. From Eq. (5) we see that both the wage and the relative price p_t of the industrial good are also increasing in the level of agricultural productivity, for given n_t.

2.2 Consumers

The representative consumer derives his utility U from the consumption of two types of goods, the agricultural commodity A and the industrial commodity I, according to the following Stone-Geary functional form:

$$U(c_t^A, c_t^I) = \beta ln(c_t^A - \gamma) + ln(c_t^I), \tag{6}$$

with the parameter $\beta > 0$ representing the importance of the agricultural commodity over the industrial one. The consumption of A includes c^A and γ representing, respectively, a variable component and a fixed component which is the minimum amount needed for survival. c^I is the consumption of the industrial commodity that does not have a minimum required level. $\gamma > 0$ leads to non homothetic preferences with income elasticity of the demand for food less than one, consistent with Engel's law. It is assumed that agriculture production can provide the food needed for the survival of the entire population. The utility function in Eq. (6) is maximized subject to the budget constraint $c_t^A + c_t^I p_t = W_t + \Pi_t$, where Π_t are profits obtained by firms due to decreasing returns and distributed to families. Profits in agriculture are given by:

$$\Pi_t^A = Z_t^A G(1 - n_t) - W_t(1 - n_t) \tag{7}$$

and in industry by:

$$\Pi_t^I = p_t Z_t^I F(n_t) - W_t n_t, \tag{8}$$

with $\Pi_t = \Pi_t^A + \Pi_t^I$.Aggregating for the whole economy, we obtain the following relationship:

$$C_t^A = \gamma + \beta p_t C_t^I. \tag{9}$$

Other general equilibrium conditions will differ in closed and open economies.

2.3 Closed economy

In a closed economy, the aggregate consumption of the two goods C_t^A and C_t^I has to be equal to the correspondent internal production Y_t^A and Y_t^I. From (9) it is immediately clear that the value of industrial production will then be higher the higher is agricultural production, because higher income in agriculture will push up demand for the industrial goods. This increase in demand will not only lead to an increase of the relative price p_t of the industrial goods, but also of the quantity produced of the goods. This, given the presence of learning by doing in industry, induces a more rapid pace of industrialization. So an increase in agricultural subsidies leading to higher agricultural production will have a beneficial effect on the whole economy.

Formally, combining Eqs. (1), (2), (5) and (9) we arrive to:

$$\mu(n_t) = \frac{\gamma}{Z_t^A}, \tag{10}$$

with $\mu(n_t) \equiv G(1-n_t) - \beta G^{'}(1-n_t)\frac{F(n_t)}{F^{'}(n_t)}$ being a decreasing function of n_t. Since on the right hand side of Eq. (10) we have a decreasing function of Z_t^A in equilibrium n_t turns out to be an increasing function η of Z_t^A and by Eq. (4) of A_t:

$$n_t = \eta(A_t),\ \eta' > 0. \tag{11}$$

To understand this result in more detail, consider the following. Part of the increase in demand for the industrial products brought about by the increased agricultural production induced by the subsidy, see Eqs. (1) and (4), will be absorbed by an increase in their relative price p_t. However it is not possible that the quantity produced of the industrial goods and therefore of labour employed in their production n_t stays the same. To see why, look at Eq. (5). If, when Z_t^A went up, n_t stayed the same then W_t (labour income) and p_t would increase in the same proportion as Z_t^A. As a consequence, profit income would also increase in that same proportion, as is clear by looking at Eqs. (7) and (8), in which all terms are linear in either Z_t^A or W_t or p_t. So national income would increase in that same proportion. But then due to the non homotheticity of preferences ($\gamma > 0$) agricultural consumption cannot increase in that same proportion. Part of the increase in income must necessarily translate into an increase in real terms of the consumption of the industrial goods,which means n_t must increase.[11] Matsuyama (1992) shows that a higher level of A_t corresponds to a higher n_t for a more general specification of preferences over the two goods than the logarithmic one here assumed for simplicity.

Summing up, the share of industrial labor supply n_t is positively affected by the level of agricultural productivity and therefore by agricultural aid. The increase of industrial labor supply n_t, on its turn, raises overtime industrial production, by Eqs. (2) and (3) and contributes to faster economic growth.

2.4 Small Open Economy

Here we assume that the economy trades with a world economy. Both agricultural and manufacturing goods can be traded. The world economy behaves just as the closed economy in previous section but for simplicity we will take its evolution as given. Variables belonging to the world economy are indicated by the index W. No migration, trade barriers or technological spillovers are present. There is perfect competition in the commodities markets. The law of one price therefore applies for these goods ($p_t^W = p_t$).

Perfect competition for labor between the two sectors holds in the world economy, so we get:

$$p_t = \frac{Z^{A,W} G'(1 - n^W)}{Z^{I,W} F'(n^W)}. \tag{12}$$

[11] In fact suppose there were no change in C_t^I (and n_t). From Eq. (1) agricultural production would increase in the same proportion as Z_t^A.From Eq. (9) we would obtain $dC_t^A/C_t^A = \beta C_t^I dp_t/C_t^A$. But we know that, for given n_t, C_t^A and p_t will change in the same proportion (ie the same proportion as Z_t^A) , so that we could write $dp_t/p_t = \beta C_t^I dp_t/C_t^A$ and, finally, $p_t = C_t^A/\ \beta C_t^I$. This is clearly not possible with γ different from zero.

which we combine with Eq. (5) to get:

$$\frac{F^{'}(n_t)}{G^{'}(1-n_t)} = \frac{Z_t^A Z^{I,W}}{Z_t^{I,} Z^{A,W}} \frac{F^{'}(n^W)}{G^{'}(1-n^W)}. \tag{13}$$

The derivative of $\frac{F^{'}(n_t)}{G^{'}(1-n_t)}$ with respect to n_t, given by $[F^{''}(n_t)G^{'}(1-n_t)+G^{''}(1-n_t)F^{'}(n_t)]/[G^{'}(1-n_t)]^2$ is negative, given the assumption of diminishing returns. If

$$\frac{Z^{W,A}}{Z^{W,I}} < \frac{Z_t^A}{Z_t^I} \tag{14}$$

the home economy has a comparative advantage in the agricultural sector, so that the share of labor supply n_t will be lower than n^W, as an immediate consequence of Eq. (13). Moreover n_t is decreasing in Z_t^A and by Eq. (4) on agricultural aid:

$$n_t = \eta(A_t),\ \eta' < 0.12 \tag{15}$$

This is the counterpart for an open economy of Eq. (11), which is valid for a closed economy. Since the increase in industrial productivity depends on the level of industrial production in the country itself as described by Eq. (3), industrial production in the home economy will grow at a slower rate than in the rest of the world, i.e.

$$\frac{\dot{Z}_t^I}{Z_t^I} < \frac{\dot{Z}_t^{I,W}}{Z_t^{I,W}} \tag{16}$$

The immediate consequence is that agricultural aid by increasing the ratio Z_t^A/Z_t^I can lead to less employment and therefore to a lower rate of increase of productivity in manufacturing. This is just the opposite of what happens in the closed economy. In fact in an open economy, demand for domestic goods also comes for abroad. This means that if, for a given level of n_t,the relative cost of producing industrial goods goes up (because of the agricultural subsidy, $\frac{Z_t^A}{Z_t^I}$ goes up and therefore, for given n_t, p_t goes up) relatively less of them will be produced internally. Essentially the increased demand for industrial goods from increased agricultural incomes will translate itself into more imports of these goods from abroad. Moreover the effect of the subsidy on the economic structure, tends, ceteris paribus, to reinforce itself overtime. In fact taking for simplicity n^W as a constant, i.e. abstracting from structural changes in the world economy, we get, just time differentiating Eq. (13):

$$\left[\frac{F''(n_t)}{F'(n_t)} + \frac{G''(1-n_t)}{G'(1-n_t)}\right]\dot{n}_t = \frac{\dot{Z}_t^{I,W}}{Z_t^{I,W}} - \frac{\dot{Z}_t^I}{Z_t^I}$$

Since in the equation above the coefficient of $\dot{n}_t$ is negative, we conclude, by Eq. (16), that n_t will be decreasing overtime.

3 Empirical Analysis

Summing up our results so far, in a closed economy industrial labor supply n_t depends positively on agricultural aid A_t, as shown by Eq. (11), while in an open economy the opposite is true by Eq. (15). Whether the economy is open or closed the rate of increase of productivity in the industrial sector is positively related to industrial labor supply, given our assumption of learning by doing in knowledge accumulation in industry. Given these assumptions, aid directed to the primary sector will have positive effects on structural change in a developing economy facing obstacles to trade. This is the prediction that we will try to test in this section of the paper [12].

3.1 Empirical Specification

Our first step in taking our model to the data is to specify the function in Eq. (2) as follows:

$$Y_t^I = Z_t^I {n_t}^{\alpha}, 0 < \alpha < 1.$$

Moreover we move to discrete time and specify the process for industrial productivity in Eq. (3) as follows:

$$Z_t^I = Z^I Y_{t-1}^I.$$

The industrial production function can thus be written in logs as:

$$\ln Y_t^I = \ln Z^I + \ln Y_{t-1}^I + \alpha \ln n_t.$$

The equation to estimate becomes:

$$g_t^I = \ln Z^I + \ln Z^A + \delta_1 \ln A_t + \delta_2 \ln A_t \cdot D, \qquad (17)$$

[12]We preliminarily test whether agricultural aid does increase agricultural productivity. The evidence consistent with a positive answer we find is described in Appendix (C).

where g_t^I represents the growth rate of industrial GDP per capita and D is a dummy for closed economies. As said in the introduction we consider a country closed if it is landlocked. Landlocked countries face specific impediments to trade. It is not only the distance from the coast per se to be detrimental: the quantity and quality of infrastructures of transit neighbors and the nature of cross-border political relations are also important (Faye *et al.*, 2004). Additionally, the Sub-Saharan landlocked countries have been found to have institutional weaknesses that can translate into further obstacles to trade (Borchert *et al.*, 2012).

As explained above, we expect a positive sign for δ_2, given Eq. (11), and a negative sign for δ_1, given (15).

3.2 Estimation Strategy

Starting from Eq. (17), we run the following regression:

$$g_{it} = \alpha_i + \beta ind_{i0} + \delta_1 aid_{it} + \delta_2 aid_{it} \cdot D + \gamma_k x_{it} + \tau_t + \epsilon_{it}. \tag{18}$$

g_{it} indicates the growth of industrial GDP per capita for country i at time t. ind_{i0} represents the initial value of industrial GDP per capita in the same country, which is added to reflect the possibility that initial conditions matter, for instance because of a convergence effect. aid_{it} represents the amount of aid for agriculture (as % of GDP). x_{it} includes a number of additional control variables as discussed below. Technological fixed factors Z^I and Z^A in Eq. (17) are captured in the unobserved country heterogeneity term α_i while τ_t is a time effect and ϵ_{it} represents the error term. To remove cyclical effects we average variables over four or five-years time intervals: 1973-1976, 1977-1980, 1981-1985, 1986-1990, 1991-1995, 1996-1999, 2000-2004, 2005-2008.

x_{it} is a vector that includes variables that fit our theoretical framework and have been identified in previous studies as in explaining the growth-aid relationship. In an influential paper, Rajan and Subramanian (2008) point out that there is wide variation in the controls in the literature and pare them down using only the variables in the intersection set of four seminal papers. These are: the initial level of per capita income, institutional quality, assassinations, financial depth measured as the ratio of M2 to GDP, ethnic fractionalization and trade, monetary and fiscal policy variables. To these variables Rajan and Subramanian (2008) add a measure of geographical location and a measure for human capital (in particular health proxied by life expectancy) [13]. We here follow Rajan and Subramanian (2008) parsimonious approach with minimal adaptations.

As most of the literature we include as trade policy variable the Sachs-Warner index (SW) using updated values (Wacziarg and Welch, 2008). We add secondary school enrollment and life expectancy to control for human capital (e.g., Lensink and Morrisey, 2000), while our measures for geographical locations are dummies for East Asia and Sub-Saharan Africa (e.g., Neanidis and Varvarigos, 2009). We use a polity score variable to measure the degree of democracy in a country (see Pettersson, 2007) and a conflict dummy measuring the country-year with civil conflict (Kaya *et al.*, 2012). We add a control that is likely to be important to explain the industrialization process, i.e. the percentage of national population living in the cities as a proxy for urban infrastructures and basic public services in place (as described by Cohen, 2006) [14].

Not all the above controls are available at all times and for all countries. For this reason, we start from a benchmark model that allows for a large sample of countries and then add more controls to check the robustness of our results using smaller samples. For the base model, we use only trade policy, percentage of urban population, secondary education enrollment and life expectancy as controls. In other regressions we add the institutional, political and geographical controls described above.

We estimate coefficients in Eq. (18) using Pooled OLS (POLS), Fixed Effects (FE) and Generalized Methods of Moments (GMM) estimators.

Results obtained with POLS may be affected by the presence of unobservable country-specific effects constant over time. By construction the FE estimator allows consistent estimations when the country fixed terms are correlated with the regressors; however, it cannot identify the coefficients of time-invariant regressors. We also use both the first-difference GMM (diff-GMM) estimator of Arellano and Bond (1991) which relies on lagged levels of the endogenous variables as instruments for regressions in first-difference and the System Generalized Method of Moments (sys-GMM) estimator of Blundell and Bond (1998) which supplements the difference-GMM estimator with a system of regression in levels, instrumented with lagged differences [15]. We report results obtained using both estimators [16].

[13] They also replace assassinations with revolutions as a variable.

[14] All continuous variables in our regressions are expressed in logarithms.

[15] Forward orthogonal deviation is employed for GMM estimations.

[16] For both the GMM estimators, we used the two-step procedure with the Windermeijer's correction of standard

3.3 Data Sources

We use data for the 1973-2008 period for a set of 76 aid recipient countries defined as developing and emerging economies by the International Monetary Fund (IMF) World Economic Outlook Database (2008), and for which all relevant data were available [17]. In particular, the data set includes countries that received agricultural aid, including 18 landlocked economies. The former Soviet Republics are excluded due to data unavailability prior to 1992 [18].

We use a data set built upon different sources (for details see Appendix B). In particular, data on the development assistance to the agricultural sector are from the Creditor Reporting System (CRS) database of the OECD that provides the amount of aid by sector for each recipient country and detailed information on its use. The data disaggregated by sector are available from 1973 and are expressed in USD committed amount [19]. As anticipated, our data set only includes agricultural aid given to recipient countries for productive activities, so food and emergency aid are excluded [20]. We calculate the agricultural aid as percentage of GDP for each recipient country included in our sample. Table 1 presents the descriptive statistics of the data used. Landlocked economies have lower average values of industrial value added and urban population with respect to the other countries in our sample. They appear thus to be more focused on agricultural activities; the agricultural aid inflows and the agricultural value added are also higher than they are in the whole sample.

—Table 1 about here—

errors using unrestricted lags due to limited number of time-observations in our data set; this avoids the possibility of over-fitting the model. Two specification tests are used to check the validity of the instruments. The first is the Arellano-Bond test which detects no second-order serial correlation in the residuals and the second is the Hansen's J test for over-identifying restrictions.

[17] See Appendix A for a complete list of the countries included.

[18] Moreover, they were centrally controlled by the Soviet Union and they would have followed a different path than the dual economy mechanism proposed here.

[19] Committed amounts are the only data at the sector level available from 1973.

[20] See Appendix B for a complete list of the different categories of foreign aid included. These are classified with the codes 311, 312, 313 in the Creditor Reporting System (CRS) database, OECD.

3.4 Estimation Results

This section discusses our econometric findings. We first test the hypothesis that a country's agricultural productivity positively depends on agricultural aid. We find some favorable evidence whose details are described in Appendix C. We then move to consider Eq. (18). Results obtained by estimating Eq. (18) in various specifications and by various methods are summarised in Table 2, 3 and 4. Table 2 reports on our benchmark model, i.e. the one where we use a shorter list of controls.

Column (1) reports results obtained using POLS, column (2) using results (FE), columns (3) and (4) results diff-GMM and sys-GMM respectively. As already said, the coefficients of the variable of interest always have the expected sign. In particular the coefficients of the interaction term agricultural aid times the landlocked dummy are always positive as well as statistically significant (at the 1%, and 10% levels) as Table 2 shows. The coefficients of other regressors tend to have the expected signs but are, in most cases, not statistically significant. The coefficient of life expectancy is significant at the 10% level in column (1) only. The coefficients of the agricultural aid variables are significant: the sign is negative for the whole sample and positive for aid interacted with the landlocked dummy. Indeed the sum of the two coefficient is always positive for the landlocked countries.

When looking at columns (1) and (2), we see that the signs of the coefficients of the variables of interest obtained with FE are not different from those obtained with POLS but the level of their significance is lower with FE, as is often the case.

Results from GMM estimations are also not markedly different. The coefficient of aid for agriculture in landlocked countries remains positively and statistically significant for growth of industrial GDP per capita in diff-GMM and sys-GMM estimations at the 10% level. Summing up, across all the different estimators considered, empirical results so far do not contradict the surprising prediction of our theoretical analysis that aid given for productive purposes to agriculture can boost industrialization in countries which face more obstacles to trade.

—Table 2 about here—

To address the concern that the IMF definition of developing and emerging economies may lead to include in our analysis countries too advanced for our theoretical framework to fit them well we repeat the exercise using a sample composed only of economies classified as low- and lower-middle income by the World Bank Atlas method. This classification is available from 1987. The countries so excluded are Argentina, Botswana, Brazil, Chile, Gabon, Mexico, Panama, Trinidad and Tobago, Uruguay and Venezuela[21]. Table 3 reports on our benchmark model using the reduced sample. When looking at columns (1) to (4), we see that not only the results still hold for diff-GMM and sys-GMM estimations but the level of significance of the coefficient for the variable aid for agriculture in landlocked countries increases at the 5% level. This seems to suggest that our model works on the whole even better when we consider only countries at an early stage of development.

—Table 3 about here—

We then further test the robustness of our empirical analysis using the original sample by adding more controls to our benchmark model while still trying to preserve a large enough number of observations. Table 4 reports the results of these alternative specifications. The additional regressors we consider are the institutional and geographical variables described in the previous subsection. In the first group of variables we consider a proxy for the degree of democracy, the ratio between M2 and GDP, ethnic fractionalization and a conflict dummy. In the second group we consider East Asia and Sub-Saharan Africa (SSA) dummies. We also include some interaction terms between the regressors. We include agricultural aid multiplied by the SSA dummy as a regressor to address the concern that the differential effect of agricultural aid we find for landlocked countries could be mainly due to a Sub-Saharan location, as most of the landlocked countries are indeed in this geographical region. We also interact the democracy and conflict variables with the Sub-Saharan Africa and landlocked countries dummies, respectively, to explore whether the political environment and country instability have a different effect on industrial development in different geographical contexts.

—Table 4 about here—

Table 4 shows results for different combinations of the new controls using both diff-GMM and sys-GMM. In no regression the full set of controls were used to avoid losing too many observations

[21] All these countries were classified as upper-middle income economies in most years during the period 1987-2008.

and/or degrees of freedom. As one can see results from these new set of regressions are not markedly different from those obtained when adopting the benchmark model. In particular the main prediction of our theoretical analysis is again confirmed: we find evidence that aid to agriculture in developing countries appears to affect the process of industrialization in a way which differs markedly in landlocked economies.

When we interact agricultural aid with both the SSA dummy and the landlocked dummy the latter attracts a positive and significant coefficient. This dispels the concern that the effects we find for landlocked countries are in fact limited to Sub-Saharan countries. Other variables attracting significant (and with the expected sign) coefficients are the conflicts (negative) and East Asia dummy (positive).

4 Conclusions

The effect of foreign aid on developing countries has been extensively debated by academic scholars, development practitioners and policy makers for decades with controversial outcomes. The literature has then started to disentangle aid flows' effects by their specific nature and purpose, and to examine their contributions considering the different socio-economic structures of recipient countries, the different reasons for which aid is given by donors, etc. The aim of our paper is to investigate empirically a particular aspect of the general issue, i.e. whether the impact of aid given to agriculture for productive purposes,i.e. excluding food and emergency aid, may be useful for the industrialization of developing countries.

To this purpose, we start from a simple dual-economy model along the lines of Matsuyama (1992), which shows that the effects of agricultural aid can be different depending on a country's openness to trade. We find evidence in line with the model's predictions. On the one hand for countries already integrated in the global economy aid given only to agriculture to the preference of more dynamic sectors runs the risk of slowing down the industrialization process. On the other hand we uncover the interesting possibility that an increase in agricultural productivity brought by aid does have a positive impact on the industrialization of landlocked countries.

Table 1: Summary statistics (1973-2008)

Variable	**Mean**	**Std dev**	**Min**	**Max**
Industrial value added (as % of GDP)	29.44	12.12	4.48	77.28
Industrial value added for landlocked only (as % of GDP)	25.89	11.97	4.48	61.20
Annual average industrial value added growth	0.06	0.29	-2.33	2.27
Annual average industrial value added growth for landlocked only	0.05	0.34	-1.20	1.95
Agricultural aid (as % of GDP)	0.76	1.26	0	11.31
Agricultural aid for landlocked only (as % of GDP)	1.23	1.37	0	6.95
Sachs-Warner index	0.58	0.49	0	1
Urban population (as % of total population)	39.82	21.17	3.42	93.32
Urban population for landlocked only (as % of total population)	24.45	15.23	3.42	65.58
Secondary education (as % of population)	41.22	26.52	1.72	106.95
Life expectancy (in years)	58.77	10.48	30.47	78.94
Democracy (Polity IV)	0.48	6.76	-10	10
M2	45.94	288	0.91	6912
Ethnic fractionalization	51.45	28.50	0	93
Conflict (dummy)	0.23	0.42	0	1

Table 2: POLS, FE and GMM estimation results

Dependent variable: Industrial GDP growth pc	(1) POLS	(2) FE	(3) diff-GMM	(4) sys-GMM
Initial ind GDP pc	-0.078***	-0.299***	-0.133	-0.099
	(0.015)	(0.037)	(0.178)	(0.081)
Landlocked (LL)	-0.136***			-0.274**
	(0.047)			(0.117)
Agricultural aid	-0.151***	-0.127*	-0.157*	-0.091
	(0.043)	(0.070)	(0.093)	(0.069)
Agricultural aid*LL	0.174***	0.206*	0.341*	0.223*
	(0.064)	(0.122)	(0.190)	(0.125)
Sachs-Warner index	0.021	0.071	-0.223	-0.124
	(0.026)	(0.122)	(0.227)	(0.167)
Urban population	0.006	-0.0001	0.129	0.048
	(0.027)	(0.122)	(0.252)	(0.196)
Secondary education	0.029	0.083	-0.005	0.010
	(0.025)	(0.080)	(0.117)	(0.079)
Life expectancy	0.226*	0.405	0.255	0.219
	(0.117)	(0.279)	(0.655)	(0.454)
Cons	-0.423	0.005		-0.265
	(0.420)	(0.980)		(1.574)
Observations	480	480	381	480
Number of groups		76	76	76
F	4.84	12.22		
AR(1)			0.006	0.001
AR(2)			0.591	0.523
χ-squared (Hansen over-id test)			0.523	0.844

Robust standard errors clustered at country level in parentheses for FE. Diff-and Sys-GMM are two-step estimators using Windmeijer's finite-robust sample correction. LL is the dummy for landlocked countries. All variables are 4 or 5 years average values and are expressed in natural log (except landlocked). p-value significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Instrumented endogenous variables are in bold type. No lag limits for the endogenous variables used. The exogenous variable used as instrument is landlocked.

Table 3: POLS, FE and GMM estimation results - Sample excluding upper-middle income economies

Dependent variable: Industrial GDP growth pc	(1) POLS	(2) FE	(3) diff-GMM	(4) sys-GMM
Initial ind GDP pc	-0.124***	-0.317***	-0.381**	-0.242**
	(0.018)	(0.035)	(0.168)	(0.107)
Landlocked (LL)	-0.211***			-0.290**
	(0.051)			(0.131)
Agricultural aid	-0.176***	-0.121*	-0.181*	-0.123
	(0.044)	(0.071)	(0.099)	(0.090)
Agricultural aid*LL	0.263***	0.190	0.497***	0.272**
	(0.067)	(0.121)	(0.179)	(0.107)
Sachs-Warner index	0.010	0.110	-0.320	-0.164
	(0.027)	(0.149)	(0.280)	(0.211)
Urban population	0.066**	-0.002	0.223	0.124
	(0.031)	(0.135)	(0.371)	(0.252)
Secondary education	0.011	0.089	0.017	-0.012
	(0.026)	(0.082)	(0.152)	(0.252)
Life expectancy	0.405***	0.520*	0.909	1.018***
	(0.125)	(0.306)	(0.600)	(0.335)
Cons	-0.998	-0.437		-2.790**
	(0.447)	(0.987)		(1.116)
Observations	416	416	328	416
Number of groups		66	66	66
F	7.95	14.64		
AR(1)			0.021	0.006
AR(2)			0.669	0.858
χ-squared (Hansen over-id test)			0.199	0.375

Robust standard errors clustered at country level in parentheses for FE. Diff-and Sys-GMM are two-step estimators using Windmeijer's finite-robust sample correction. LL is the dummy for landlocked countries. All variables are 4 or 5 years average values and are expressed in natural log (except landlocked). p-value significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Instrumented endogenous variables are in bold type. No lag limits for the endogenous variables used. The exogenous variable used as instrument is landlocked.

Table 4: Difference- and system-GMM estimation results with more controls

Dependent variable: Industrial GDP growth pc	(1) diff-GMM	(2) sys-GMM	(3) diff-GMM	(4) sys-GMM	(5) diff-GMM	(6) sys-GMM
Initial ind GDP pc	-0.276	-0.168	-0.305**	-0.178**	-0.259*	-0.241**
	(0.193)	(0.107)	(0.136)	(0.087)	(0.150)	(0.123)
Landlocked (LL)		-0.205*		-0.164		-0.205**
		(0.118)		(0.103)		(0.104)
Agricultural aid	-0.127	-0.046	-0.350*	-0.140	-0.195	-0.172
	(0.093)	(0.084)	(0.188)	(0.104)	(0.156)	(0.100)
Agricultural aid*LL	0.503***	0.158	0.415**	0.123	0.412*	0.153
	(0.188)	(0.138)	(0.185)	(0.136)	(0.229)	(0.124)
Agricultural aid*SSA					0.291	0.110
					(0.182)	(0.133)
Sachs-Warner index	-0.326*	0.004	-0.302	-0.001	-0.212	0.093
	(0.198)	(0.255)	(0.297)	(0.193)	(0.249)	(0.240)
Urban population	0.449	-0.004	0.346	-0.002	0.314	-0.027
	(0.312)	(0.194)	(0.247)	(0.175)	(0.292)	(0.202)
Secondary education	-0.106	0.067	0.070	0.089	0.059	0.113
	(0.127)	(0.113)	(0.143)	(0.125)	(0.151)	(0.081)
Life expectancy	0.506	0.258	-0.256	0.047		
	(0.729)	(0.410)	(0.840)	(0.536)		
Democracy					-0.007	-0.003
					(0.006)	(0.005)
Democracy*SSA					-0.009	-0.008
					(0.008)	(0.007)
M2					0.077	0.091
					(0.075)	(0.057)
Ethnic fractionalization		0.001		0.001		
		(0.001)		(0.001)		
Conflicts	-0.214*	-0.155**	-0.127	-0.086		
	(0.122)	(0.061)	(0.080)	(0.060)		
Conflicts*LL			-0.401*	-0.213		
			(0.226)	(0.191)		
Sub-Saharan Africa		-0.059		-0.175		-0.165
		(0.101)		(0.114)		(0.152)
East Asia		0.089		0.126*		
		(0.707)		(0.760)		
Cons		0.007		0.867		0.881
		(1.648)		(1.932)		(0.743)
Observations	360	449	360	449	363	462
Number of groups	69	69	69	69	74	74
AR(1)	0.007	0.001	0.010	0.000	0.008	0.007
AR(2)	0.890	0.974	0.826	0.964	0.545	0.623
χ-squared (Hansen over-id test)	0.618	0.801	0.458	0.997	0.224	0.389

Robust standard errors clustered at country level in parentheses for FE. Diff-and Sys-GMM are two-step estimators using Windmeijer's finite-robust sample correction. LL is the dummy for landlocked countries. All variables are 4 or 5 years average values and are expressed in natural log (except landlocked, ethnic fractionalization, Sub-Saharan Africa dummy, East Asia dummy, democracy and conflicts). p-value significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Instrumented endogenous variables are in bold type. No lag limits for the endogenous variables used. The exogenous variables used as instruments are landlocked, ethnic fractionalization, Sub-Saharan Africa and East Asia dummies.

Appendix A. List of countries

List of landlocked economies considered	List of non landlocked economies considered	
Bolivia	Albania	Jordan
Botswana	Algeria	Liberia
Burkina Faso	Angola	Madagascar
Burundi	Argentina	Malaysia
Central African Republic	Bangladesh	Kenya
Chad	Benin	Mauritania
Ethiopia	Brazil	Mauritius
Lesotho	Cameroon	Mexico
Malawi	Cape Verde	Morocco
Mali	Chile	Mozambique
Nepal	China	Nicaragua
Niger	Colombia	Pakistan
Paraguay	Congo	Panama
Rwanda	Congo Dem. Rep	Papua New Guinea
Swaziland	Costa Rica	Peru
Uganda	Cote d'Ivoire	Philippines
Zambia	Dominican Republic	Senegal
Zimbabwe	Egypt	Sierra Leone
	El Salvador	South Africa
	Gabon	Sri-Lanka
	Gambia	Syria
	Ghana	Tanzania
	Guatemala	Thailand
	Guinea	Togo
	Guinea-Bissau	Trinidad and Tobago
	Guyana	Tunisia
	India	Turkey
	Indonesia	Uruguay
	Honduras	Venezuela

Appendix B. List of variables

Variable	Definition	Source
Industrial GDP growth per capita	Industrial value added average growth rate where averages were taken from relevant period of time. Industrial value added includes activities related to mining, manufacturing, construction, electricity, water, and gas and corresponds to ISIC divisions 10-45	World Bank, World Development Indicators; Penn World Table 7.0
Agricultural aid	The ratio of aggregate development assistance aid for agriculture purposes that is committed in current US dollars to GDP in current US dollars.	OECD, Creditors Reporting System (CRS)[22] ; World Bank, World Development Indicators
Urban population	The people living in urban areas as defined by national statistical offices as % of total population	World Bank, World Development Indicators
Sachs-Warner index	Sachs-Warner trade policy index and updates by Wacziarg and Welch	Sachs and Warner (1995) ; Wacziarg and Welch (2008)

[22]The Organisation for Economic Co-operation and Development (OECD) Creditor Reporting System (CRS) is a database that provides detailed information on individual aid activities, such as sectors, countries, project descriptions etc. used to derive aggregate data. For this paper, we aggregate aid with the following reporting codes and descriptions: code 311 AGRICULTURE (including aid provided for agriculture policy and administrative management, agriculture development, agriculture land resources, agriculture water resources, agriculture inputs, food crop production, industrial crops/export crops, livestock, agrarian reform, agriculture alternative development, agriculture education/training, agriculture extension, agriculture research, livestock research, agriculture services, plant, post-harvest protection and pest control, agriculture financial service, agriculture co-operatives and livestock/veterinary services), code 312 FORESTRY (including aid provided for forestry policy and administrative management, forestry development, fuelwood/charcoal, forestry education/training, forestry research and forestry services), and code 313 FISHING (including aid provided for fishing policy and administrative management, fisheries development, fishery education/training, fishery research and fishery services)

Variable	Definition	Source
Secondary education	The ratio of total secondary school enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown [23]	World Bank, World Development Indicators
Life expectancy	Number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life	World Bank, World Development Indicators
Democracy	Difference between the democracy index (0-10) and an autocracy index (0- -10)	Marshall and Jaggers (2009)
Ethnic fractionalization	ethnic fractionalization	Global Development Network Growth Databas, NYU Development Research Institute
M2	The ratio of the sum of currency outside banks, demand deposits other than those of the central government, and the savings and foreign currency deposits of resident sectors other than the central government over GDP.	World Bank, World Development Indicators
Conflicts	Presence of a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths.	UCDP, PRIO Armed Conflict Dataset

[23]Gross enrollment includes students of all ages. In other words, it includes students whose age exceeds the official age group (e.g. repeaters). Thus, if there is late enrollment, early enrollment, or repetition, the total enrollment can exceed the population of the age group that officially corresponds to the level of education – leading to ratios greater than 100 percent

Variable	Definition	Source
Cereal yields	Kilograms per hectare of harvested land of wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat, and mixed grains for dry grain only. Cereal crops harvested for hay or harvested green for food, feed, or silage and those used for grazing are excluded.	Food and Agriculture Organization of the UN, FAOSTAT
Agricultural value added per worker	Agricultural value added denotes the net output of the sector after adding up all outputs and subtracting intermediate inputs. Data are in constant 2010 U.S. dollars.	World Bank, World Development Indicators

Appendix C. Aid for agriculture and agricultural productivity

Here we provide some evidence that aid given to agriculture for productive purposes (ie not for emergency or humanitarian reasons) does indeed increase the production possibilities of the sector. Measuring total factor productivity is, as is well known, challenging in general but all the more so for developing countries where the weak statistical infrastructure, lack of appropriate data collection protocols and scarcity of surveys and censuses limit the availability and quality of data, see Ocampo *et al* (2009), chap 1, as well as FAO (2017).

Ideally to check that in $Z_t^A = \psi(Z^A, A_t)$, as specified by Eq. 4, ψ_A is positive we would like to regress multifactor productivity Z_t^Aon A_t. However Z_t^A is not observable and we have to rely instead on the available indicators.

One indicator widely used the literature is average cereal yields (ACY) that is the number of kilograms of cereals produced per hectare of land. Some of the advantages of using this measure are listed in Gollin *et al.*(2013). Grains correspond to a substantial fraction of agriculture output, do not require aggregation through international prices, thus avoiding a source of bias, and, finally, productivity in these grains is accurately measured. ACY is an indicator of average land productivity. In our notation, from Eq. 1, this measure would be $Z_t^A G(1-n_t)/L$, where L is land.

Another possible indicator related to Z_t^A is average labour productivity (ALP) [24]. From Eq. 1 this would be : $Z_t^A G(1-n_t)/(1-n_t)$.

It is clear that even abstracting from the general problems of data collection mentioned above, and just looking at the issue from an analytical standpoint, neither ACY nor APL are beyond criticism as proxies for Z_t^A in our empirical exercise. An obvious problem with CY is that if labour increases when the subsidy goes up, then cereal yield may go up, even if Z_t^A has not changed. Using the APL

[24] As we will see this indicator is availailable for a shorter period of time with respect to ACY. Also using the per worker measure goes against the OECD (2001) recommendation to use the number of hours effectively worked to calculate APL to take into account the wide variability in working regimes typical of developing countries. However, to the best of our knowledge, there are no databases that include comparable statistics on the number of hours worked in agriculture. ILOSTAT only provides aggregate indicators on hours worked and labour productivity per country for selected years, warning against their use for country comparisons or rankings as "imputed observations are not based on national data, [and] are subject to high uncertainty" (ILOSTAT, 2019)

indicator may also be problematic. If the marginal productivity of labour is decreasing, when labor goes up then APL may go down even if Z_t^A has increased.

Summing up, when regressing ACY on the subsidy the estimate of ψ_A could be upward biased, while regressing APL on the subsidy the estimated could be downward biased. To test the hypothesis that TFP in agriculture is increasing in the agricultural aid we then run a separate regression for each indicator.

—Tables 5 and 6 about here—

We use POLS, FE, diff-GMM and sys-GMM estimators. The last two estimators better deal with the dynamics of the process and the problems related to the potential endogeneity of the aid variable, which is particularly serious in the case. We include in the regressions the variables secondary school enrollment and democracy to control respectively for human capital and institutional quality. To control for the global weather shocks, we include a measure of the El Niño-Southern Oscillation (ENSO), called the Southern Oscillation Index (SOI) (as in McMillan *et al.*, 2007) [25]. The ENSO impact, however, differs by crop according to its water requirement, crop season and geographical areas. The Sub-Saharan Africa dummy is included, considering the general poorer yield performance of the region compared to global values (Pingali and Heisey, 1999). We also use a time trend.

[25] The Southern Oscillation Index (SOI) is a standardized index based on the observed sea level pressure between Tahiti and Darwin, measuring the large-scale fluctuation in air pressure between the western and the Eastern tropical Pacific (The National Climate Data Center, NOOA).

Table 5 presents results when ACY is the dependent variable [26]. Results do no lead to reject the hypothesis that agricultural aid has a positive impact on land productivity. Table 6 presents results when using agricultural valued added per worker is the dependent variable (as in Ssozi *et al.*, 2019) [27]. The aid variable still attracts positive coefficients (except in the case of FE) that are however lower and less significant than in the previous set of regressions. Indeed this was expected if we consider the shifts in labour as possible sources of bias in the estimates described above.[28].

[26]The regressions include 76 countries of our sample during the years 1973-2008, according to the availability of the data for cereal yields.

[27]The regressions include 70 countries in our sample during the years 1991-2008, according to the availability of the data on agricultural valued added per worker.

[28]Indeed, a difference of opposite sign between the coefficients could have obtained with a backward bending labour supply, i.e. if aid to agriculture induced lower employment in the sector.

Table 5: Agricultural land productivity estimation results

Dependent variable: Cereal yield	(1) OLS	(2) FE	(3) diff-GMM	(4) sys-GMM
Cereal yield$_{t-1}$	0.912***	0.461***	0.516*	0.455***
	(0.010)	(0.062)	(0.283)	(0.163)
Agriculture aid	0.004	0.018	0.157**	0.141*
	(0.012)	(0.014)	(0.070)	(0.075)
Secondary education	0.026***	-0.030	-0.056	-0.006
	(0.009)	(0.029)	(0.120)	(0.076)
Democracy	0.0008	-0.0002	-0.007**	-0.006**
	(0.0008)	(0.001)	(0.003)	(0.003)
SOI	0.009**	0.008**	0.009*	0.008
	(0.004)	(0.004)	(0.005)	(0.005)
Sub-Saharan Africa	-0.050***			-0.623***
	(0.014)			(0.202)
Trend	0.0001	0.009***	0.011	0.011***
	(0.0006)	(0.001)	(0.008)	(0.003)
Constant	0.579***	3.851***		4.067***
	(0.076)	(0.468)		(1.319)
Observations	1833	1833	1557	1833
Number of groups		76	76	76
F	2249.03	97.88		
AR(1)			0.018	0.002
AR(2)			0.367	0.313
χ-squared (Hansen over-id test)			0.439	0.184

Robust standard errors clustered at country level in parentheses for FE. Diff-and Sys-GMM are two-step estimators using Windmeijer finite-robust sample correction. Cereal yield, agricultural aid and secondary education are expressed in natural log. p-value significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Instrumented endogenous variables are in bold type. Number of lags used is 5. The exogenous variables used as instruments are SOI, Sub-Saharan Africa and time trend.

Table 6: Agricultural labour productivity estimation results

Dependent variable: Agricultural value added per worker	(1) OLS	(2) FE	(3) diff-GMM	(4) sys-GMM
Agricultural value added per worker$_{t-1}$	0.988***	0.782***	0.758***	0.987***
	(0.003)	(0.057)	(0.171)	(0.033)
Agriculture aid	0.001	-0.001	0.028	0.059*
	(0.011)	(0.014)	(0.027)	(0.031)
Democracy	0.0003	-0.001	-0.008	-0.003
	(0.0007)	(0.001)	(0.007)	(0.003)
Secondary education	0.013	0.010	0.010	0.061
	(0.009)	(0.023)	(0.105)	(0.039)
SOI	0.004	0.004	0.004*	0.004**
	(0.002)	(0.002)	(0.003)	(0.002)
Sub-Saharan Africa	-0.016*			-0.014
	(0.010)			(0.033)
Trend	0.0007	0.003**	0.004	0.0004
	(0.0008)	(0.001)	(0.005)	(0.001)
Constant	0.042	1.522***		-0.131
	(0.040)	(0.400)		(0.205)
Observations	778	778	637	778
Number of groups		70	67	70
F	19410	142.94		
AR(1)			0.031	0.023
AR(2)			0.186	0.173
χ-squared (Hansen over-id test)			0.526	0.524

Robust standard errors clustered at country level in parentheses for FE. Diff-and Sys-GMM are two-step estimators using Windmeijer finite-robust sample correction. Agricultural value added per worker and agricultural aid are expressed in natural log. p-value significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Instrumented endogenous variables are in bold type. Number of lags used is 9. The exogenous variables used as instruments are SOI, Sub-Saharan Africa and time trend.

References

[1] Angeles, Luis and Kyriakos C. Neanidis, 2009. Aid Effectiveness: The Role of Local Elite. Journal of Development Economics 90, 120-134.

[2] Annen, Kurt and Stephen Kosempel, 2009. Foreign Aid, Donor Fragmentation, and Economic Growth. The B.E. Journal of Macroeconomics (Contributions) 9(33), 1-30.

[3] Arellano, Manuel and Stephen Bond, 1991. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equation. Review of Economic Studies 58, 277-297.

[4] Basu, Deepankar and Debarshi Das (2017). Profitability and Investsments: Evidence from India's Organized Manufacturing Sector. Metroeconomica 68(1), 47-90.

[5] Blundell, Richard and Stephen Bond, 1998. Initial Conditions and Moment Restrictions in Dynamic Panel Data Models. Journal of Econometrics 87, 11-143.

[6] Borchert, Ingo, Batshur Gootiiz, Arti Grover Goswami and Aaditya Mattoo, 2012. Landlocked or policy-locked? http://www.voxeu.org/article/landlocked-or-policy-locked.

[7] Capasso, Salvatore and M. Rosaria Carrillo, 2009. The legacy of Dualism in New Growth Theory. In Geography and Structural Change in Economic: Theory and Empirics edited by Neri Salvadori, Pasquale Commendatore and Massimo Tamberi, Edward Elgar Publisher, 2009, 203-226.

[8] Chatterjee, Santanu and Stephen J. Turnovsky, 2007. Foreign Aid and Economic Growth: the Role of Flexible Labor Supply. Journal of Development Economics 84, 507-533.

[9] Clemens, Michael A., Steven Radelet, Rikhil R. Bhavnani and Samuel Bazzi, 2012. Counting Chickens when They Hatch: Timing and the Effects of Aid on Growth. The Economic Journal 122(561), 590-617.

[10] Cohen, Barney, 2006. Urbanization in Developing Countries: Current Trends, Future Projections, and Key Challenges for Sustainability. Technology in Society 28, 63-80.

[11] Dixit, Avinash K., 1973. Models of dual economies, in Models of Economic Growth (International Economic Association conference volume), eds. J.A. Mirrlees and N.H. Stern, London: Macmillan, 325-352.

[12] Easterly, William, 2006. The White Man's Burden: How the West's Efforts to Aid the Rest Have Done So Much Ill and So Little Good. New York: Penguin.

[13] Faye, Michael L., John W. McArthur, Jeffrey D. Sachs and Thomas Snow, 2004. The Challenges Facing Landlocked Developing Countries. Journal of Human Development 5(1), 31-68.

[14] Felipe, Jesus, Aashish Mehta and Changyong Rhee (2018). Manufacturing Matters...but It's the Jobs That Count. Cambridge Journal of Economics 43(1), 139-168.

[15] Food and Agriculture Organization of the United Nations (FAO), 2012. The State of Food and Agriculture - Investing in Agriculture for a Better Future. FAO, Rome.

[16] Food and Agriculture Organization of the United Nations (FAO), 2017. Productivity and Efficiency Measurement in Agriculture , Literature Review and Gaps Analysis. Global Strategy to Improve Agricultural and Rural Statistics. Technical Report Series GO-19-2017. FAO, Rome.

[17] Frankel, Jeoffrey A. and David Romer, 1999. Does Trade Cause Growth? American Economic Review 89(3), 379-399.

[18] Gollin, Douglas, David Lagakos and Michael E. Waugh, 2014. Agricultural Productivity Differences Across Countries. American Economic Review 104(5), 165-170.

[19] Herrendorf, Berthold, Richard Rogerson, and Ákos Valentinyi, 2014. Growth and Structural Transformation. In Handbook of Economic Growth (eds. Philippe Aghion and Steven N. Durlauf) vol. 2, chapter 6, 855-941.

[20] Jorgenson, Dale, 1961. The Development of a Dual Economy. The Economic Journal 71(282), 309-334.

[21] Jorgenson, Dale, 1967. Surplus Agricultural Labour and the Development of a Dual Economy. Oxford Economic Papers, New Series, 19(3), 288-312.

[22] Kaya, Ozgur, Ilker Kaya and Lewell Gunter, 2012. Development Aid to Agriculture and Economic Growth. Review of Development Economics 16(2), 230-242.

[23] Kaya, Ozgur, Ilker Kaya and Lewell Gunter, 2013. Foreign Aid and the Quest for Poverty Reduction: is Aid to Agriculture Effective? Journal of Agricultural Economics 64(3), 583-596.

[24] Kourtellos, Andros, Chih Ming Tan and Xiaobo Zhang, 2007. Is the Relationship between Aid and Economic Growth Nonlinear?. Journal of Macroeconomics 29(3), 515-540.

[25] Leeson, P. F., 1979. The Lewis Model and Development Theory. The Manchester School 47, 196-210.

[26] Lensink, Robert and Oliver Morrisey, 2000. Aid Instability as a Measure of Uncertainty and the Positive Impact of Aid on Growth. The Journal of Development Studies 36(3), 31-49.

[27] Lewis, Arthur, 1954. Development with Unlimited Supplies of Labour. The Manchester School 22, 139-92.

[28] Maasoumi, Esfandiar, Jeff Racine and Thanasis Stengos, 2007. Growth and Convergence: A Profile of Distribution Dynamics and Mobility. Journal of Econometrics 136(2), 483-508.

[29] Marshall, Monty and Keith Jaggers, 2009. Polity IV Project. Political Regime Characteristics and Transitions, 1800-2007. Center for Systemic Peace.

[30] Matsuyama, Kiminori, 1992. Agriculture Productivity, Comparative Advantage, and Economic Growth. Journal of Economic Theory 58, 317-334.

[31] McMillan, Margareth, Alix Peterson Zwane and Nava Ashraf, 2007. My Policies or Yours: Does OECD Support for Agriculture Increase Poverty in Developing Countries? In Globalization and Poverty edited by Ann Harrison. Chicago: University of Chicago Press.

[32] McMillan, Margareth, Dani Rodrik and Íñigo Verduzco-Gallo, 2014. Globalization, Structural Change, and Productivity Growth, with an Update on Africa. World Development 63, 11-32.

[33] Neanidis, Kyriakos C. and Dimitrios Varvarigos, 2009. The Allocation of Volatile Aid and Economic Growth: Theory and Evidence. European Journal of Political Economy 25, 447-462.

[34] Ocampo, José Antonio, Codrina Rada and Lance Taylor (2009). Growth and Policy in Developing Countries: a Structuralist Approach. New York: Columbia University Press.

[35] Organization for Economic Cooperation and Development, 2001. Measuring Productivity. OECD Manual: Measurement of Aggregate and Industry-level Productivity Growth. OECD, Paris.

[36] Pettersson, Jan, 2007. Foreign Sectoral Aid Fungibility, Growth and Poverty Reduction. Journal of International Development 19, 1074-1098.

[37] Pingali, Prabu and P.W. Heisey, 1999. Cereal Crop Productivity in Developing Countries. CIMMYT Economics Paper 99-03. Mexico D.F.: CIMMYT.

[38] Ranis, Gustav and John C. H. Fei, 1961. A theory of economic development. American Economic Review 51, 533-556.

[39] Rajan, Raghuram G. and Arvind Subramanian, 2008. Aid and Growth: What Does the Cross-country Evidence Really Show? The Review of Economics and Statistics 90(4), 643-665.

[40] Rodrik, Dani, 2013. Unconditional Convergence in Manufacturing. The Quarterly Journal 128(1), 165-204.

[41] Sachs, Jeffrey D. and Andrew M. Warner, 1995. Economic Reform and the Process of Global Integration. Brookings Papers on Economic Activity 1, 1-95.

[42] Sachs, Jeffrey D. and Andrew M. Warner, 1997. Sources of Slow Growth in African Economies. Journal of African Economies 6(3), 335-376.

[43] Sachs, Jeffrey, 2005. The End of Poverty: Economic Possibilities for Our Time. New York: Penguin.

[44] Skott, Peter and Paul Auerbach (1995). Cumulative Causation and the 'New' Theories of Economic Growth. Journal of Post Keynesian Economics 17(3), 381-402.

[45] Ssozi, J. , S. Asongu, V. H. Amavilah, 2019. The effectiveness of development aid for agriculture in Sub-Saharan Africa, Journal of Economic Studies 46(2), 284-305

[46] Tchamyou, Vanessa S., Guido Erreygers and Danny Cassimon. Inequality, ICT and financial access in Africa. Technological Forecasting and Social Change 139, 169-184.

[47] Thirwall, Anthony P. and Penélope Pacheco-López, 2017. Economics of Development (10th Edition). New York: Palgrave MacMillan.

[48] Wacziarg, Romain and Karen Horn Welch, 2008. Trade Liberalization and Growth: New Evidence. World Bank Economic Review, World Bank Group, vol. 22(2), 187-231.