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Agricultural Productivity as a Prerequisite of Industrialization: Some New Evidence on Trade Openness and Premature Deindustrialization

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Abstract

Most studies of structural transformation assume a closed economy when modeling. Is this assumption justified in a globalized world? I test the relevance of closed versus open economy models of structural transformation using data on the sectoral productivity levels of developed and developing countries over the 1950-2013 period. The empirical findings suggest that trade openness does affect the mechanics of structural transformation in the way predicted by the theory, but that the practical effect of trade is small. Nonetheless, the difficult creation of manufacturing jobs in Latin America and Africa—a trait commonly referred to as "premature deindustrialization"—suggests that trade might have a significant role on the mechanics of manufacturing employment, a role that it does not play on agriculture and services. As an alternative to the role of trade, I also emphasize that large fixed costs in the formal manufacturing sector might explain the difficult industrialization of Latin America and Africa.

JEL classification: O11, O13, O14, O41, F41

Keywords: structural transformation, industrialization, agricultural productivity, international trade

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1 Introduction

In the literature of structural transformation, one of the key research questions is the relevance of closed economy models to explain and describe the dynamics of sectoral employment. A majority of theoretical papers have chosen to develop a closed economy model as an approximation of the situation faced at a country level (e.g. Echevarria (1997), Kongsamut et al. (2001), Ngai and Pissarides (2007), Duarte and Restuccia (2010)). This assumption means that domestic prices are entirely determined by domestic productivity levels, and that any interaction with the world economy is irrelevant. How good is really this approximation? This question is the focus of the present paper.

Directly related to this question is the role of agriculture in the industrialization process. It is widely recognized by economists and historians that the slowromancapxviii@th century's Agricultural Revolution was a prerequisite of the slowromancapxix@th century's Industrial Revolution in Europe. Earlier development economists such as Schultz (1953), Johnston and Mellor (1961) or Timmer (1988) made the point that no progress of the industrial sector could occur without a significant drop in food prices that would allow income to be spent on manufacturing goods. But today, now that roughly half of the world production is made by countries that went through industrialization and beyond, what would be the best policy for countries that still have to achieve this step? If economies essentially behave as closed worlds, then giving priority to agriculture is still probably best practice. But the interdependence of the world economy created new paths of industrialization whereby agricultural development might be squeezed in favor of policies directly aimed at the industrial sector. Indeed, in the context of international trade, patterns of domestic consumption can widely differ from patterns of domestic production, and a country can industrialize by relying on export markets.

In fact, relying too much on agriculture might in some circumstances turn out to be counter-productive. Economic historians (Mokyr (1977), Field (1978), Wright (1979)) analyzing early and late industrializers had already observed that highly productive agriculture can lead to high wages that prevent light manufacturing industries from hiring labor. In the context of a small open economy model, many economists have noted that the growth of agricultural productivity might slow down the process of industrialization through an increased comparative advantage in primary products (e.g. Matsuyama (1992), (2009), Echevarria (1995)). Developing countries would then run the risk of being stuck in specializations with a low potential for productivity growth.

For this reason, trade openness has been seen as a key element of the industrialization strategy, modifying the orientation of public policy toward the agricultural sector. In a closed economy, a strategy of industrialization should prioritize the growth of agricultural productivity as a means to release labor from the traditional economy to more modern economic activities. In an open economy, the growth of agricultural productivity risks strengthening a comparative advantage in agriculture and might prevent a large industrial or service sector to emerge.

This idea however derives from the resolution of theoretical models and has not been confirmed by empirical studies so far. There is no practical knowledge of whether structural change follows the pattern of a closed or an open economy in the typical developed or developing country, and what options should be followed for the agricultural sector. Calibrations usually rely on a closed economy model without questioning if an open economy model or a world economy model might be more relevant (Matsuyama (2009)).

In this paper, I test empirically the main assumptions of structural change theory with regard to trade and agriculture. I first study a simple model of structural change that summarizes the theory and serves as a guide for empirical work. The model relies on the premises that a) the economy is closed or b) agriculture and manufacturing are tradable goods while services are non-tradables. The model is then tested using econometric methods. The objective is twofold: first, assessing if the qualitative predictions of the model are correct. That is, trade openness should weaken and potentially reverse the link between agricultural productivity and industrialization. Second, assessing the quantitative relevance of openness to trade. That is, does the relationship between agricultural productivity and industrialization changes dramatically over a reasonable range of trade openness? Along the way, another theme of structural change emerges in the regression results: the difficulty of African and Latin American countries to create manufacturing jobs, in the context of the relocation of labour-intensive activities in Asia.

Results are unambiguous for Europe, North America and the Asian continent: trade weakens the link between agricultural productivity and sectoral employment, but its effect is small within the range of trade openness that most countries deal with. However, the direct effect of trade on sectoral employment (without the mediation of agricultural productivity) is substantial and clearly favors industrialization. This suggests that policies of trade liberalization do contribute to industrialization, but that they do not change substantially the pattern of structural change in the domestic economy: domestic employment still largely depends on domestic productivity levels. In Africa and Latin America, the direct and indirect effects of trade are not as well identified and are subject to caution. Still, the available evidence is in line with the results of other continents. A more striking result in these regions is the dissymetry between manufacturing and services. For example, I estimate that an increase in agricultural productivity in Africa has a positive effect on employment which is roughly three times higher in services than in manufacturing. I discuss the likely reasons for this dissymetry, which are at the center of the debate on ”premature deindustrialization” (Palma (2005), Tregenna (2008), Rodrik (2016b), Felipe et al. (2018)).

The paper thus contributes to a still modest literature on the econometric determinants of structural change, among which Xiaofei et al. (2013), Gollin et al. (2016) and Diao et al. (2017). Like Xiaofei et al. (2013), I study the effect of an increase in agricultural productivity taking into account the degree of trade openness. Xiaofei et al. (2013) however study the consequences of agricultural productivity on urbanization levels while my research focusses on sectoral employment dynamics. This also results in the use of different databases. Like Diao et al. (2017), I use the Groningen Growth and Development Center (GGDC) database of sectoral value added at a country level. Diao et al. (2017) however do not take into account trade openness as a key mechanism of structural change. My results partially align with the results of Diao et al. (2017) in that agricultural productivity is identified as a driver of manufacturing employment in Europe, North America and Asia. Nevertheless, my findings suggest that Africa and Latin America do not follow the same pattern than the rest of the world, as the generation of employment in manufacturing and services is dissymetric.

The remainder of the paper is organized as follows. Section 2 develops a simple model of structural change to clarify the issues at stake. Section 3 designs an empirical strategy to test the model and comments on the regression results. Section 4 discusses the origins of the dissymetry between manufacturing and services as observed in the data for Africa and Latin America. In particular, it reviews the recent literature on premature deindustrialization and proposes a simple modification to the model of Section 2 to take into account these concerns. Section 5 concludes.

2 The model

2.1 Static results

In this section, I describe how different assumptions of tradability translate into different structural change mechanisms, and the implications of these mechanisms for a public policy commited to industrialization. The model is close in specifications to Ngai and Pissarides (2007), in that the nature of structural change critically depends on the regime of substitution between final goods. Static results are presented first-these are the results that are going to be empirically tested-, then follows a short discussion on a dynamic version of the model.

The economy has three sectors of activity; agriculture, industry and services. I identify the industrial sector with transformed tradable goods while the service sector is identified with non-tradable goods. In agriculture, both non-tradability and tradability are going to be assessed in turn, so that the effect of opening to trade, which is central in this model, is made clear. Output of agriculture, industry and services are denoted respectively Y^A, Y^M and Y^S. The economy is only endowed with one unit of labor, and each sector compete for the same pool of workers. Additionally, all sectors share the same production function, possibly differing in their level of total factor productivity. Formally,

$$Y^j = j\,(L^j)^\delta, \qquad j = A, M, S, \quad \delta \in [0, 1)\,, \tag{1}$$

$$L^A + L^M + L^S = 1. \tag{2}$$

L^A, L^M and L^S stand for labor in agriculture, manufacturing and services respectively and the scale factor j denotes total factor productivity. Competition for labor ensures that the marginal product of labor is equalized across sectors:

$$p_A A\,(L^A)^{\delta-1} = M\,(L^M)^{\delta-1} = p_S S\,(L^S)^{\delta-1}, \tag{3}$$

where p_A and p_S denote output prices of agriculture and services and the price of industrial goods has been normalized to one. Turning to consumers, I assume the existence of a representative household with CES preferences over final goods. Denoting C^A, C^M and C^S these final goods, this gives:

$$U = \left[\alpha_A \left(C^A\right)^{\frac{\sigma-1}{\sigma}} + \alpha_M \left(C^M\right)^{\frac{\sigma-1}{\sigma}} + \alpha_S \left(C^S\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \qquad 0 < \sigma < 1, \tag{4}$$

where I have assumed that the final goods are gross complements; this is natural since the final goods are meant to represent broad categories of human needs. In a closed economy, this assumption means that when the productivity of a sector increases, the demand is not elastic enough to absorb the extra supply at constant employment. As a result, employment must diminish in that sector. The budget constraint of the representative consumer writes:

$$p_A C^A + C^M + p_S C^S = w + \pi \tag{5}$$

where w is the wage rate and π is the sum of profits from the three sectors.

The model is now solved using market clearing conditions that reflects either non-tradability or tradability of agriculture. In either case, I assume for simplicity that the representative household cannot borrow nor lend abroad so that trade must be balanced.

In a closed economy

If agriculture produces non-tradable goods and trade is balanced, the economy becomes *de facto* a closed economy[1] and the market clearing condition is simply

$$C^j = Y^j, \qquad j = A, M, S. \tag{6}$$

The equilibrium allocations of labor are symmetrical and can be solved in closed form:

$$L^j = \frac{\left(\alpha_j (j)^{-\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{1+\delta\frac{1-\sigma}{\sigma}}}}{\sum_j \left(\alpha_j (j)^{-\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{1+\delta\frac{1-\sigma}{\sigma}}}}, \qquad j = A, M, S. \tag{7}$$

In a semi-open economy

If agriculture produces tradable goods, the trade balance writes:

$$p_A C^A + C^M = p_A Y^A + Y^M. \tag{8}$$

[1]Manufacturing goods are the only tradable goods and cannot be exchanged for something else, and there can be no trade surplus nor deficit, so supply must equal demand for manufacturing goods as well.

And the domestic consumption of services must equal its production, or,

$$C^S = Y^S. \tag{9}$$

Now, the solution is symmetrical for the two tradable goods only:

$$L^A = \frac{(p_A A)^{\frac{1}{1-\delta}}}{(p_A A)^{\frac{1}{1-\delta}} + M^{\frac{1}{1-\delta}} + X}, \tag{10}$$

$$L^M = \frac{M^{\frac{1}{1-\delta}}}{(p_A A)^{\frac{1}{1-\delta}} + M^{\frac{1}{1-\delta}} + X}, \tag{11}$$

$$L^S = \frac{X}{(p_A A)^{\frac{1}{1-\delta}} + M^{\frac{1}{1-\delta}} + X}, \tag{12}$$

$$X = \left\{ \frac{(p_A A)^{\frac{1}{1-\delta}} + M^{\frac{1}{1-\delta}}}{\left[\left(\frac{\alpha_A}{\alpha_S}\right)^{\sigma} p_A{}^{1-\sigma} + \left(\frac{\alpha_M}{\alpha_S}\right)^{\sigma}\right] S^{1-\sigma}} \right\}^{\frac{1}{1-(1-\delta)(1-\sigma)}}. \tag{13}$$

I now state the main results of this subsection under Proposition 1 below. Appendix A gives additional results for this proposition as well as the proof for Proposition 2 in the next subsection.

Proposition 1 *Consider a competitive market economy whose technology is characterized by* (1) *and labor market by* (2) *and whose representative consumer has preferences* (4).

In a closed economy

$$\frac{\partial L^A}{\partial A} < 0, \qquad \frac{\partial L^M}{\partial A} > 0, \qquad \frac{\partial L^S}{\partial A} > 0. \tag{14}$$

In a semi-open economy

$$\frac{\partial L^A}{\partial A} \gtreqless 0 \Leftrightarrow \frac{L^M}{L^A} \gtreqless \epsilon L^S, \qquad \frac{\partial L^M}{\partial A} < 0, \qquad \frac{\partial L^S}{\partial A} > 0, \tag{15}$$

where $\epsilon = \frac{(1-\delta)(1-\sigma)}{1-(1-\delta)(1-\sigma)} > 0$ *and* L^A *is increasing then decreasing in* A.

When agriculture is non-tradable, a rise in agricultural productivity releases labor from agriculture to both industry and services. As stated before, this is because while the price of agricultural goods diminishes, the demand is not elastic enough to absorb the extra supply at constant employment. When agriculture is tradable, the mechanism of structural change is more sophisticated. The first noticeable result is that a rise in agricultural productivity increases employment in the service sector but decreases employment in the industrial sector. Simply put, the industrial sector is tradable and a rise in agricultural productivity decreases its comparative advantage. The service sector is non-tradable and benefits from the expansion of the domestic market through an increase in the consumer's budget. Now what about employment in agriculture?

The surprising result of the semi-open economy model, which I believe has not been discussed in the recent literature, is that agricultural employment does not necessarily increase with agricultural productivity. In fact, if agriculture has a strong initial comparative advantage, agricultural employment decreases with a rise in agricultural productivity. To see this, let us rewrite the sign condition of $\frac{\partial L^A}{\partial A}$ in (15) in terms of exogenous parameters:

$$\frac{\partial L^A}{\partial A} \gtreqless 0 \Leftrightarrow \left(\frac{M}{p_A A}\right)^{\frac{1}{1-\delta}} \gtreqless \epsilon L^S, \tag{16}$$

Assuming that world prices are set by a world economy with the same characteristics as the closed economy presented in this paper, one can write $\frac{1}{p_A} = f\left(\frac{A^*}{M^*}\right)$ with $f'() > 0$ and a star over a variable denoting the world economy[2]. Then equation (16) writes:

$$\frac{\partial L^A}{\partial A} \gtreqless 0 \Leftrightarrow \left[f\left(\frac{A^*}{M^*}\right)\frac{M}{A}\right]^{\frac{1}{1-\delta}} \gtreqless \epsilon L^S, \tag{18}$$

If the home economy has a strong comparative advantage in agriculture compared to the world economy, the term $\left[f\left(\frac{A^*}{M^*}\right)\frac{M}{A}\right]^{\frac{1}{1-\delta}}$ is small and agricultural employment may decrease with agricultural productivity. Another interesting feature of (18) is that a large service sector will also increase the likeliness of this situation[3]. This is despite the fact that agriculture is fully open to trade. Thus, in an economy with a specialization in primary products and a large nontradable sector, a positive productivity shock in primary products may lead to a transfer of labor out of agriculture and in the nontradable sector.

[2]The equation for world prices is

$$\frac{1}{p_A} = \left(\frac{A^*}{M^*}\right)^{\frac{1}{\delta+(1-\delta)\sigma}} \left(\frac{\alpha_A^*}{\alpha_M^*}\right)^{-\frac{(1-\delta)\sigma}{\delta+(1-\delta)\sigma}}. \tag{17}$$

[3]Note that the service sector is itself an increasing function of A and M, a decreasing function of S.

2.2 Dynamic results

Imagine now that all sectors face a positive productivity growth. Which dynamic conditions are compatible with industrialization? Proposition 2 below summarizes the answer.

Proposition 2 *Consider the economy of Proposition 1.*

Let us assume that

$$\begin{aligned} &\frac{\dot{A}}{A} = \gamma_A, \quad \frac{\dot{M}}{M} = \gamma_M, \quad \frac{\dot{S}}{S} = \gamma_S, \\ &\gamma_A, \gamma_M > \gamma_S. \end{aligned} \tag{19}$$

Then:

(a) L^S *is monotonically increasing over time and* $\lim_{t\to\infty} L^S = 1$.

(b) L^M *and* L^A *are either hump-shaped or monotonically decreasing.*

(c) In a closed economy,

L^M *is hump-shaped* $\Rightarrow \gamma_M < \gamma_A$.

(d) In a semi-open economy,

L^M *is hump-shaped* $\Rightarrow \gamma_M > \gamma_A$.

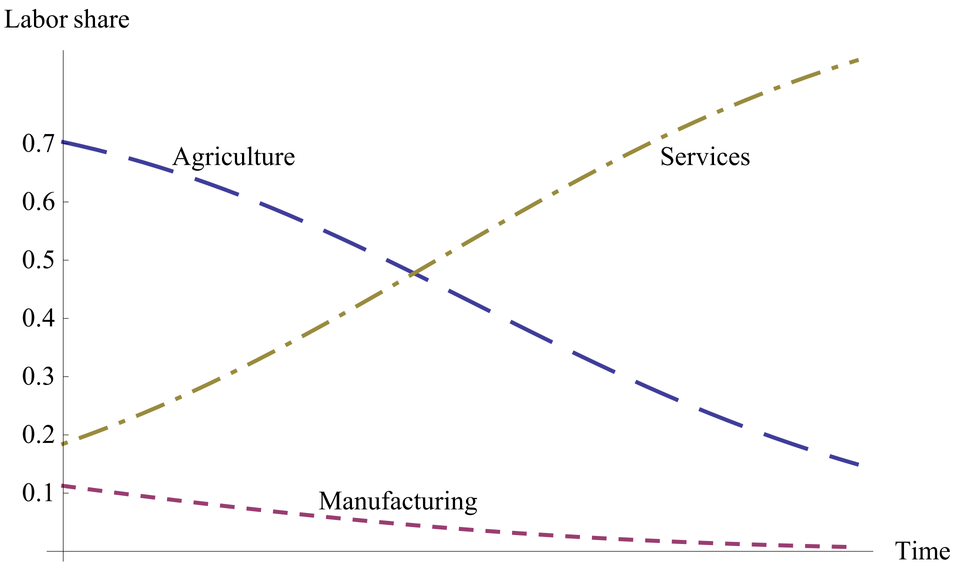
In this dynamic setting, let us assume that the service sector has the lowest rate of total factor productivity. Accordingly, this sector will absorb all the workforce over the long run, whether agriculture is tradable or not. It is also possible to conjecture that L^M and L^A are either hump-shaped or decreasing. Part (c) of Proposition 2 states that if agriculture is non-tradable, a necessary condition for the path of industrial employment to be hump-shaped is that agriculture has a higher rate of productivity. Now, this condition turns out to be reversed when agriculture is tradable.

Let us say for the sake of example that agriculture is a tradable sector and that policy makers can influence the growth of total factor productivity in agriculture and industry. If policy makers choose a path of equal or higher productivity growth in agriculture, this will lead to a steadily decreasing share of industrial employment. As the service sector gradually absorbs all the workforce, the economy will exhibit tertiarization without industrialization. This situation is depicted in panel (a) of Figure 1.

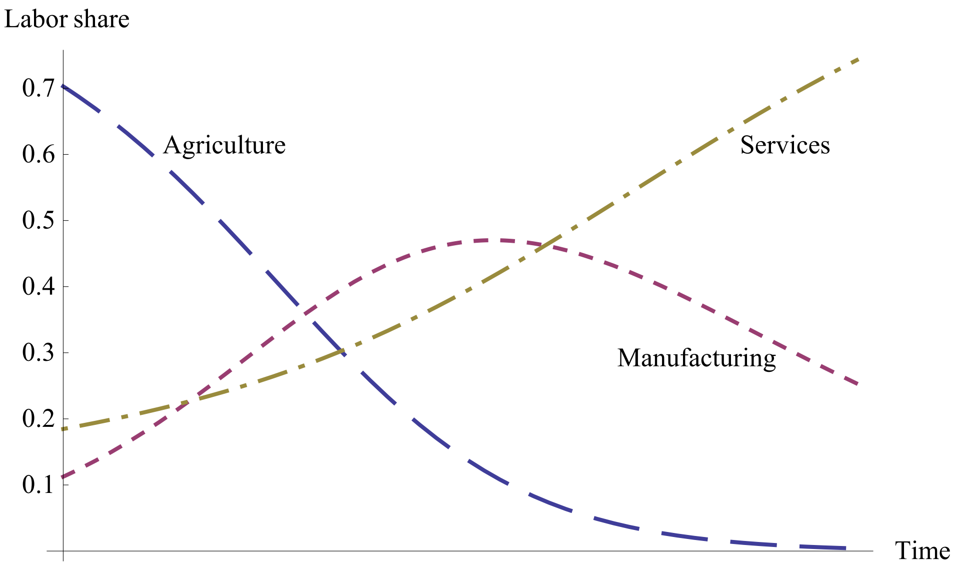
If instead policy makers choose a path of higher productivity growth in industry, this may generate a hump-shaped pattern of industrial employment as is observed today in developed countries. This case is pictured in panel (b) of Figure 1. Though not sufficient to achieve this hump-shaped pattern, this policy is a necessary condition. As described in Appendix A, a sufficient condition to achieve a hump-shaped pattern of industrial employment is that the ratio $\frac{\gamma_M - \gamma_S}{\gamma_M - \gamma_A}$ be high enough.

This conclusion is critical for present-day developing countries, most of which have agricultural sectors that sell their product on international markets. If the semi-open economy model turns out to be appropriate, a policy aimed at industrializing must put greater emphasis on the productivity of the industrial sector. This insight however contradicts the conclusion of classical closed-economy frameworks of structural change, where a relative emphasis on agricultural productivity is the best policy.

Having described the consequences of assumptions of tradability on structural change mechanisms, I now proceed to evaluate the empirical relevance of these mechanisms using a panel data econometric model. The dataset is an unbalanced panel of countries observed over a sixty-year period. The key empirical relationship to test is whether an increase in agricultural productivity results in an increase in industrial employment, as in the closed economy model, or results in a decrease in industrial employment, as in the semi-open economy model (Proposition 4). In my empirical estimates, the effect of agricultural productivity will be made to depend on the degree of trade openness. Thus the key empirical question is to know at which level of trade openness the behavior of an economy switches from closed to open, and if this level of trade openness is reached by a typical medium-sized country. Needless to say, the object of interest here is the nature of structural change mechanisms, and an economy behaving as a closed economy with respect to sectoral employment need not behave as a closed economy in other aspects. Finally, another key prediction of the semi-open economy model is that agricultural productivity should have opposite effects on industry and services, given the non-tradability of services. This will concretize in the fact that tertiary employment changes its behavior at a higher level of trade openness than industrial employment does.



(a) $\gamma_A > \gamma_M$



(b) $\gamma_M > \gamma_A$

Figure 1: *The pattern of labor allocation when agriculture is a tradable sector*

3 Empirical evidence using panel data

This section is devoted to an empirical assessment of the validity of Proposition 1 in Section 2. In a closed economy, agricultural productivity is presumably negatively correlated with the share of agricultural employment, and positively correlated with the share of employment in industry and services. In a semi-open economy, agricultural productivity is negatively correlated with the share of employment in industry but positively correlated with the share of employment in services. These statements are tested at a country level using a panel data regression.

3.1 Data & empirical strategy

I use the Groningen Growth and Development Center (GGDC) 10-Sector Database (Timmer et al. (2015)) to assemble data on sectoral employment and sectoral value added at the country level[4]. In this database, data on sectoral value added originates from the National Accounts, while data on sectoral employment comes from both population censuses and labor force surveys. The GGDC database contains series from 1950 up to 2013 for 13 countries in Africa, 11 countries in Asia, 9 in Latin America and 8 in Europe[5]. The singularity of the database is that it allows comparison between the trajectory of developed and developing countries.

I divide the ten sectors included in the GGDC database into three broad sectors. Agriculture is defined as the sum of agriculture, forestry and fishing and industry is defined as the sum of mining and manufacturing. Services are a residual sector including construction, public utilities, trade, transportation, business services, government services and personal services. Note that the construction sector is conventionally included in industry, but I choose not to define it this way because of its nature as a non-tradable sector. This is for the purpose of sticking with the hypotheses of the model of Section 2, where the industrial sector is assumed to be tradable. In line with this reasoning, mining and manufacturing generally produce the highest share of tradable output at a country level (Bykova and Stöllinger (2017)).

Once the three broad sectors have been set, I define sectoral productivity as sectoral value

[4]https://www.rug.nl/ggdc/productivity/10-sector/
Database last updated in January 2015.

[5]Hong-Kong data ranges from 1974 to 2011. I have not included data points prior to 1985 as there seems to have been an error in data collection on government employment before this date (the database displays zero civil servants for the period 1981-1984, and a unusually high growth rate for 1974-1980).

added per worker in constant 2005 prices, a proxy for total factor productivity[6][7]. Finally, sectoral employment follows the definition of employment of the GGDC database, including employees, self-employed and family workers. For each broad sector $j = A, M, S$, the following equation is estimated:

$$
\begin{aligned}
SE_{it}^{j} &= \beta_0^j + \beta_1^j ln(Prodagri_{it}) + \beta_2^j Open_{it} + \beta_3^j Open_{it} \cdot ln(Prodagri_{it}) \\
&+ \mathbf{Z_{it}} \boldsymbol{\gamma}^{\boldsymbol{j}} + \mu_i^j + \lambda_t^j + \epsilon_{it}^j,
\end{aligned} \tag{20}
$$

where SE_{it}^j is the share of employment in sector j, country i and year t, $Prodagri_{it}$ is agricultural value added per worker in country i and year t, $Open_{it}$ is the sum of exports and imports over GDP in country i year t (World Bank (World Development Indicators) and various other sources[8]) and $\mathbf{Z_{it}}$ is a vector of additional controls including log of value added per worker in industry, log of value added per worker in services, and an index of agricultural prices deflated by manufacturing prices (FAO Food Price Index, Food and Agriculture Organization). The index of agricultural prices is computed by weighting world agricultural prices with world exports, and then deflated using the World Bank's manufactures unit value (MUV) index. Finally, μ_i^j and λ_t^j are the usual country and time fixed-effects.

Because employment in the three sectors must sum to one, i.e. $SE_{it}^A + SE_{it}^M + SE_{it}^S = 1$, the parameters of equation (20) are subject to cross equation restrictions. The constants must sum to one across sectors, i.e. $\beta_0^A + \beta_0^M + \beta_0^S = 1$, and all other parameters must sum to zero across sectors, for example $\beta_1^A + \beta_1^M + \beta_1^S = 0$. The error terms must also sum to zero, i.e. $\epsilon_{it}^A + \epsilon_{it}^M + \epsilon_{it}^S = 0$. This linear dependence means that the estimation of system of equations (20) would involve dropping one of the equation and estimating only two of them. However, each equation in (20) has exactly the same regressors and as a consequence the standard methods for estimating systems of equations (ordinary and generalized least squares) are both equivalent to OLS equation by equation. The latter is the method used in this paper. In any of the regression tables that follow, one can check that the cross equation restrictions hold (the sum is not exact

[6]In the vocabulary of Section 2, value added per worker in constant 2005 prices is equal to $p_{j,2005}\, j_t\, (L_t^j)^{\delta-1}$, where t denotes time and $p_{j,2005}$ is the price of good j in 2005 local currency units.

[7]West Germany (the Federal Republic of Germany), whose value added is expressed in constant 1991 prices, has been excluded from the regressions.

[8]Taiwan: National Statistics of the Republic of China (Taiwan).
Ethiopia: International Monetary Fund (International Financial Statistics).
Mauritius, Tanzania, Zambia: United Nations Statistics Division (National Accounts Main Aggregates Database).

due to rounding) by summing the estimated parameters in row.

With specification (20), β_1^j is to be interpreted as the marginal effect of an increase in agricultural productivity in a closed economy (i.e. with $Open_{it} = 0$), while β_3^j reports how this marginal effect is modified by trade openness. Also, it should be mentioned that value added per worker is measured in local currency units. The log specification in (20) means that this country-specific scale factor is confounded with the country fixed effect μ_i^j.

Endogeneity tests for $ln(Prodagri_{it})$ using lagged values of the agricultural share of employment as instruments strongly reject the hypothesis that $ln(Prodagri_{it})$ is exogenous. Endogeneity is likely to arise because of a simultaneity problem: a decreasing agricultural employment share might cause labor productivity to rise as labor becomes scarce. To reduce the influence of this problem, I choose a two-stage least square estimation strategy whereby lagged values of agricultural employment are used as instrumental variables for $ln(Prodagri_{it})$. That is, the first-stage regression is the following:

$$\begin{aligned} ln(Prodagri_{it}) &= \alpha_0 + \alpha_1 SE^A_{it-1} + \alpha_2 SE^A_{it-2} + \alpha_3 Open_{it} + \alpha_4 Open_{it} \cdot ln(Prodagri_{it}) \\ &+ \mathbf{Z_{it}}\boldsymbol{\delta} + \nu_i + \xi_t + \eta_{it}\,, \end{aligned} \tag{21}$$

And the fitted values of $ln(Prodagri_{it})$ are then used in equation (20).

Equation (20) is estimated dividing the sample into four regions: Europe & North America, Asia, North Africa & Sub-Saharan Africa, Latin America. The countries included in each region are shown in Figure 2 and Table 1 below. I also estimate (20) for two income groups: high income, middle & low income. The sample division is meant to keep a large number of observations (critical for a 2SLS regression) while at the same time grouping countries with similar historical contexts. The regression results of equation (20) are presented both with and without instrumental variables. Lastly, the standard errors are made robust to heteroskedasticity and serial correlation.

Table 1: *Groupings by region and income*

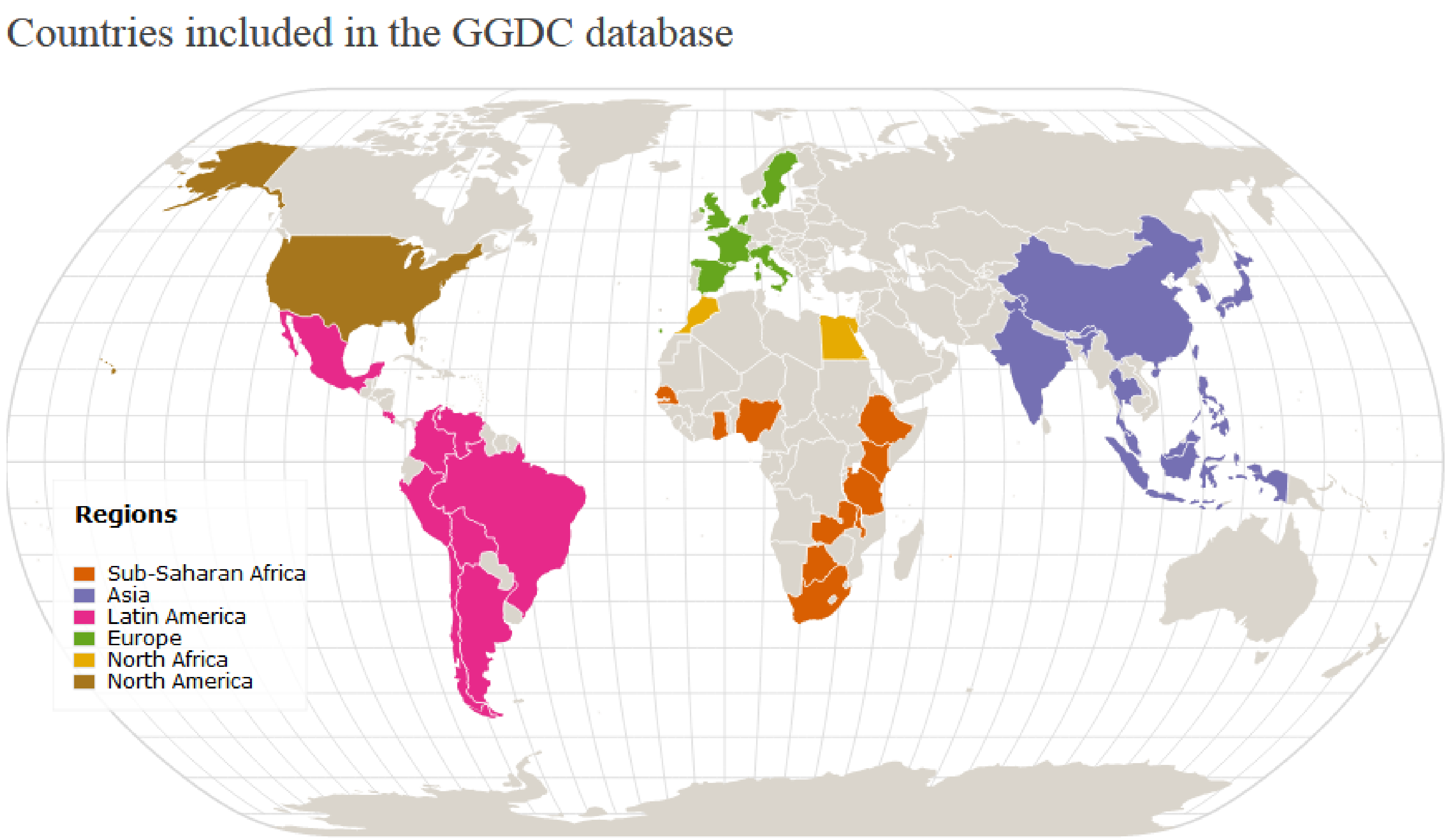
North Africa	Sub-Saharan Africa	Asia	Latin America	Europe	North America
Morocco	Botswana	China	Argentina	Denmark	United States
Egypt	Ethiopia	Hong Kong	Bolivia	Spain	
	Ghana	India	Brazil	France	
	Kenya	Indonesia	Chile	United Kingdom	
	Mauritius	Japan	Colombia	Italia	
	Malawi	South Korea	Costa Rica	Netherlands	
	Nigeria	Malaysia	Mexico	Sweden	
	Senegal	Philippines	Peru		
	Tanzania	Singapore	Venezuela		
	South Africa	Taiwan			
	Zambia	Thailand			

Low income	Lower middle income	Upper middle income	High income
Ethiopia	Bolivia	Brazil	Argentina
Malawi	Egypt	Botswana	Chile
Senegal	Ghana	China	Denmark
Tanzania	Indonesia	Colombia	Spain
	India	Costa Rica	France
	Kenya	Malaysia	United Kingdom
	Morocco	Mauritius	Hong Kong
	Nigeria	Mexico	Italy
	Philippines	Peru	Japan
	Zambia	Thailand	South Korea
		Venezuela	Netherlands
		South Africa	Singapore
			Sweden
			Taiwan
			United States

Source: https://www.rug.nl/ggdc/productivity/10-sector/

Income group classification: World Bank, June 2018

Figure 2



basemap from Natural Earth (CC0) - NB: West Germany is included in the GGDC 10-Sector Database but is not shown here as it was excluded from the regressions.

3.2 Results

The first-stage results of the 2SLS regressions are shown in Appendix B, both for regions and income groups. As expected, the first lag and sometimes the second lag of agricultural employment are significantly correlated with agricultural productivity, with the only exception being the group of high income countries. In this subsection, I only discuss the OLS and second-stage IV regressions. The discussion begins with the results on regions, which are presented in Tables 2 to 9.

In Europe and North America (Table 2 and 3), the results are similar for OLS and IV and essentially confirm Proposition 1. First, agricultural productivity is significantly correlated with a decrease in the share of agricultural labor and significantly correlated with an increase in the share of industry and services as predicted by the closed economy model. Practically in Table 3, an increase of 10% in agricultural productivity decreases agricultural employment by roughly 2 percentage points and increases industrial and tertiary employment by roughly 1 percentage point. Second, the sign of the interaction term between trade and agricultural productivity is positive for agriculture, and negative for industry and services. As trade openness increases, the link between agricultural productivity and sectoral employment gradually reverses. Moreover, the coefficient of this interaction term is lower in absolute value for services, reflecting the lower tradability of services. This means that there is a range of trade openness such that the marginal effect of agricultural productivity on employment ($\beta_1^j + \beta_2^j Open_{it}$) is negative for industry and positive for services, as predicted by the semi-open economy model. If trade openness is sufficiently high though, even the marginal effect on services will become negative. This was precluded by Proposition 1.

One question that can be answered immediately is the following: what is the threshold of trade openness such that the marginal effect of agricultural productivity on employment is zero? Using the coefficients of Table 3, this threshold is 273%, 239% and 316% for agriculture, industry and services respectively[9]. Thus, even so trade openness dampens the effect of agricultural productivity on labor, the predicted amount of trade openness required so as to reverse the relationship (e.g. a negative correlation between agricultural productivity and agricultural labor)

[9]In equation (20), the marginal effect of agricultural productivity growth on employment is $\beta_1^j + \beta_3^j Open_{it}$. Setting this marginal effect to zero means that $Open_{it} = -\frac{\beta_1^j}{\beta_3^j}$. In Table 3 for example, the threshold for agriculture is found by dividing the coefficient of ln(Prodagriculture) by the coefficient of Openness x ln(Prodagri) and taking the opposite.

is very high, and few countries in the sample have reached this threshold[10]. If the indirect effect of trade on employment (β_3^j) is arguably small, its direct effect on employment (β_2^j) however can be viewed as substantial. In Table 3, an increase of one point in trade openness translates into an increase of roughly a third of point in industrial employment and a decrease of nearly half a point in agricultural employment.

Finally, an interesting feature of Europe and North America is that agricultural prices are predicted to increase agricultural employment and are predicted to decrease industrial and tertiary employment. This is in line with intuition, even so an increase in p_A in the semi-open economy model of Section 2 does not necessarily bring such results.

In Table 4 and 5, Asia shows a similar picture as Europe and North America. The coefficients on $ln(Prodagri_{it})$ are consistents with Proposition 1, while the coefficients on the interaction term $Open_{it} \cdot ln(Prodagri_{it})$ predicts that trade openness dampens the effect of agricultural productivity on sectoral employment, at least in the IV regression. Once again, trade openness has a smaller effect on services, both directly and indirectly through agricultural productivity. Also, the level of trade openness that cancels any effect of agricultural productivity on labor is very high: 651%, 587% and 779% for agriculture, industry and services respectively in Table 5. No country in the sample has ever reached these levels.

A distinctive feature of Asia is that the productivity of each sector has a significant negative impact on the share of labor in that sector, a feature that creates a diagonal of negative coefficients in the first three lines of Table 4 and 5. This diagonal of negative coefficients is consistent with the predictions of the closed economy model of Section 2 (see Appendix A.1 Table A1 for a summary of all the predictions).

Turning to Latin America in Table 6 and 7, a salient result is that there is a weak statistical link between agricultural productivity and industrial labor, although the significance and sign of the coefficient is preserved for agriculture and services. This is equally true of the interaction term between trade openness and agricultural productivity, at least in the IV regression. Another striking difference is that the coefficients on the direct effect of trade openness are no longer significant in both OLS and IV, while it was strongly significant for Asia and Europe. It seems difficult to assert the role of trade in this region with confidence.

[10]Only three countries in the sample reach levels of trade openness higher than 200%: Hong Kong, Singapore and Malaysia. Openness does not exceed 220% in Malaysia while Singapore and Hong Kong reach levels above 400%.

Closing the discussion on regions, Table 8 and 9 present the results regarding North Africa and Sub-Saharan Africa. Strikingly, the results differ widely between OLS and IV, suggesting a better fit for the IV model. In the OLS regression in Table 8, results are similar to what was found for Latin America: there is no statistically significant relationship of agricultural productivity with industrial labor, but this significance is preserved for agricultural and tertiary labor. The coefficients of $ln(Prodagri_{it})$ have a significance of 14.3% and 11.6% for agriculture and services respectively, close to the 10% threshold, but a significance of 92.9% for industry. On the other hand, the IV regression in Table 9 shows strong statistical significance between agricultural productivity and sectoral labor, notably a 5% significance level for industrial labor, and a diagonal of negative coefficients comparable with Asia. Note however that in Table 9 the magnitude of the coefficient of $ln(Prodagri_{it})$ with respect to industrial labor is less than one third of what it is for services. This confirms that there is a dissymetry between industrial labor on one side and tertiary labor on the other. This feature stands out since by contrast the regressions on Europe, North America and Asia find similar magnitudes between industry and services for this coefficient (see Tables 3 and 5). In fact, in Asia (Table 5) this coefficient is roughly 50% *higher* in industry than in services.

Finally, in Africa much like in Latin America, nothing strong emerges from the trade variables. Note however that in the IV regression (Table 9) the signs of the trade variables are consistent with what was found for other regions of the world. Besides, one possibility is that trade openness plays a role indirectly through agricultural prices. In Latin America and Africa the effect of agricultural prices on employment, though not statistically significant, is predicted to be substantial: a 1% increase in prices translates into an increase in agricultural employment of 2.8 and 1.4 points in Latin America and Africa respectively (Tables 7 and 9).

Will these results change if the sample is now divided by income group? Table 1 shows the World Bank income classification applied to the sample. Lower income classes have fewer countries, which makes it difficult to obtain clear results when regressed separately. In Tables (10) to (13) I have chosen to display the regression results of high income countries first, then middle and low income countries grouped together. Appendix C shows four additional regressions where upper middle income countries have been regressed separately from low and lower middle income countries. In Tables (10) and (11), high income countries do not provide clear results. I surmise that this is caused by too disparate historical contexts within the high income group, with countries located in Asia, Latin America, North America and Europe. On the other hand, regressions on middle and low income countries (Tables (12) and (13)) provide interesting results that confirm what was found for Africa and Latin America. Agricultural productivity has a substantially smaller effect on industrial labor than on services, and is not significant in the OLS regression. Evidence on the role of trade is weak, but consistent with the idea that trade dampens the effect of agricultural productivity on labor. Another noticeable result is that IV—much like in the regressions on regions—gives more quantitative importance to labor productivity in comparison with OLS. Comparing Table (12) to Table (13), OLS predicts that a 10% increase in agricultural productivity will decrease agricultural labor by approximately 1 point while this number rises to 7 points in the IV regression.

On the whole, the empirical results suggest that the relationships to be expected from the closed economy model are validated by the data. In developed regions, openness to trade is dampening the effect of agricultural productivity on labor, but its impact is small and within a reasonable range it does not reverse the correlation as would be the case in a small open economy. In middle and low income countries, identifying the role of trade openness is more difficult and there is something puzzling: the effect of agricultural productivity on industry is distinct from its effect on services. As the next section will tell, this trait is likely related to trade itself but it is not the only cause.

4 Back to theory : why is the relationship between agricultural productivity and industrialization dysfunctional in Africa and Latin America?

The empirical results of Section 3 raise a simple question: why is there a weaker link between agricultural productivity and industrialization in some parts of the world, namely Latin America and Africa? Among the most plausible explanations, the recent literature has emphasized that the effects of premature deindustrialization (Palma (2005), Tregenna (2008), Rodrik (2016a), (2016b), Felipe et al. (2018)) are particularly severe in Latin America and Africa. That is, they deindustrialize earlier than what the trajectory of developed countries would suggest, reaching their peak employment in industry at lower levels of income per capita. In this section, I start by summarizing the different causes that have been attributed to this stylized fact, then I sketch how some of these observations can be integrated into a theoretical framework by modifying the model of Section 2 in a simple manner.

4.1 The causes of premature deindustrialization

1. Rodrik (2016b) sees this phenomenon as the result of unfavorable terms of trade for manufacturing goods. Developing countries of Africa and Latin America have been exposed to a strong decline in the relative price of manufacturing goods due to rapid technical change in the advanced countries. If developing countries act as price takers with respect to world prices, this should cause deindustrialization even though technical change is slow within the country's boundaries. Asia would have been preserved from this trend due to its strong comparative advantage in manufacturing. In the semi-open economy framework of Section 2, this reasoning translates readily into an increase of p_A, the relative price of agricultural goods in terms of manufacturing goods. Unfortunately, the derivatives of L^A, L^M and L^S with respect to p_A are tedious and do not provide clear results that would confirm the reasoning of Rodrik. The regression results of Section 3 nonetheless give credits to the idea that a rise in agricultural prices increases employment in agriculture and decreases employment in services, although in most regressions there is no significant correlation with employment in the manufacturing sector.

2. Palma (2005) argues that the premature deindustrialization of Latin American countries was driven by a new type of Dutch disease. The trade and financial liberalization reforms of the 1980s and 1990s have led to a reversal of their strategy of import substitution industrialization (ISI) toward a position of primary exporters consistent with their high endowment in natural resources. The Dutch disease therefore was not caused by the discovery of natural resources but by the elimination of trade barriers and of interventionist industrial policies. In terms of the semi-open economy model of Section 2, the elimination of trade barriers that favor industrial employment amounts to an increase in the ratio $\frac{A}{M}$, which indeed causes deindustrialization.

3. The difficulty in creating manufacturing jobs is also related to a difficulty in growing out of informality. Rodrik (2016b) observes that ”In Latin America, as manufacturing has shrunk informality has grown and economy-wide productivity has suffered. In Africa, urban migrants are crowding into petty services instead of manufacturing, and despite growing Chinese investment there are as yet few signs of a significant resurgence in industry.” In Africa, informal

employment largely dominates the manufacturing sector, reaching more than 90% of industrial employment in countries like Ethiopia, Senegal and Ghana (Rodrik (2016a)). In Latin America, the majority of jobs are concentrated in small informal firms, including in the manufacturing sector (Remes et al. (2019)).

4. Another closely related explanation is the lack of an attractive business environment for entrepreneurs. In Africa, Gelb et al. (2014) have listed some of the biggest impediments to entrepreneurship. Among these, firms are constrained by costly transportation services and power outages, they routinely pay bribes on top of labor costs due to poor contract enforcement and they face a small market size due to low population density. Additionally, the creation of new businesses is hindered by monopoly rents that operate under the government's blessing. These obstacles seem to weigh disproportionately on large manufacturing firms which require a large number of transactions to operate (*ibid.*).
In Latin America, Álvarez et al. (2019), Remes et al. (2019) and Bolio et al. (2014) have identified a similar but different list of obstacles. First, a strong concern exists that complex or stringent tax systems and labor laws encourage informality and discourage firm growth. In Mexico for example, informal businesses purchase electricity as residential users, therefore benefiting from lower nominal energy prices as well as government subsidies. Their effective energy price is thus reduced to 25 percent of what registered companies pay (Bolio et al. (2014)). Second, small and medium-sized firms face high interest rates on the market of loanable funds and the lack of competition creates high barriers to entry. Third, some countries in the region face high business costs related to criminal activities.

Explanations 1 and 2 link premature deindustrialization with trade openness and international competition with Asian manufacturing exporters. Despite the uncertain role of trade in Latin America and Africa, the absence of dissymetry between industry and services in Europe and North America and the dissymetry in favor of industry in Asia is consistent with these explanations. The likely reason why Europe and North America have been unaffected by this symptom is that they have industrialized prior to the context of heightened international competition in the 1980s. As to explanations 3 and 4, can they reliably account for difficulties in manufacturing employment? That is the subject of the next subsection.

4.2 Fixed costs in the manufacturing sector

Explanations 1 and 2 can be framed into the semi-open economy model of Section 2 but what about explanations 3 and 4 ? In this subsection, I propose to integrate explanations 3 and 4 into the model of Section 2 in the simplest way possible. This will help ascertain their validity in explaining the patterns of structural change observed in the regressions.

Let us assume that the manufacturing sector now operates under fixed costs, while the production functions of other sectors stay unchanged. I interpret the fixed costs as representative of the large number of market transactions required by formal manufacturing firms before they can operate. Formally, equation (1) is replaced by the following:

$$Y^j = j\,(L^j)^\delta, \qquad j = A, S, \tag{22}$$

$$Y^M = \begin{cases} 0 & \text{if} \quad L^M < K \\ M(L^M - K)^\delta & \text{if} \quad L^M \geq K \end{cases} \qquad \delta \in [0, 1). \tag{23}$$

K is the amount of fixed costs evaluated in labor units that the representative manufacturing firm must pay before starting operations. This fixed cost is not sunk and the firm can always choose to shut down. Because the firm has an area of increasing returns, it is subject to an efficient scale. This efficient scale in terms of labor input is simply $\bar{L} = \frac{K}{1-\delta}$.

In addition, I modify the representative consumer's preferences to include a positive endowment of manufacturing goods:

$$U = \left[\alpha_A\,(C^A)^{\frac{\sigma-1}{\sigma}} + \alpha_M\,(C^M + \mu)^{\frac{\sigma-1}{\sigma}} + \alpha_S\,(C^S)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \qquad 0 < \sigma < 1. \tag{24}$$

I interpret this positive endowment as a free gift of manufacturing goods coming from the informal sector (e.g. from within the household). The role of this hypothesis is to introduce an alternative technology for the production of manufacturing goods that will serve households' needs in the absence of the formal manufacturing sector.

Finally, I assume that the economy is closed:

$$C^j = Y^j, \qquad j = A, M, S. \tag{25}$$

Two types of equilibria arise, depending on whether the formal manufacturing sector chooses to pay the fixed cost or not. Its decision depends on whether the price of manufacturing goods exceeds the minimum of the average cost. Denoting $\bar{Y^M}$ as the efficient scale in terms of output and w as the competitive wage rate, this condition writes out as

$$p_M \geq AC(\bar{Y^M}) \tag{26}$$

$$\Leftrightarrow \quad p_M \geq \frac{w}{\delta M}\left(\frac{\delta}{1-\delta}K\right)^{1-\delta} \tag{27}$$

I now give the labor allocations of both equilibrium types.

No production in the formal manufacturing sector

The firms' profit maximization conditions are

$$p_A A\,(L^A)^{\delta-1} = p_S S\,(L^S)^{\delta-1} \quad \text{and} \tag{28}$$

$$p_M \leq \frac{w}{\delta M}\left(\frac{\delta}{1-\delta}K\right)^{1-\delta}. \tag{29}$$

In equilibrium, this results in the following allocation of labor:

$$L^j = \frac{\left(\alpha_j(j)^{-\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{1+\delta\frac{1-\sigma}{\sigma}}}}{\left(\alpha_A(A)^{-\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{1+\delta\frac{1-\sigma}{\sigma}}} + \left(\alpha_S(S)^{-\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{1+\delta\frac{1-\sigma}{\sigma}}}}, \qquad j = A, S, \tag{30}$$

$$L^M = 0. \tag{31}$$

Equation (29) is turned at equilibrium into the following relation:

$$M \leq \frac{\mu^{\frac{1}{\sigma}}}{\alpha_M}\left(\frac{\delta}{1-\delta}K\right)^{1-\delta}\left[\left(\alpha_A A^{-\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{\lambda}} + \left(\alpha_S S^{-\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{\lambda}}\right]^{\lambda}, \quad \text{with} \quad \lambda = 1 + \delta\frac{1-\sigma}{\sigma} > 0. \tag{32}$$

Production in the formal manufacturing sector

The firms' profit maximization conditions are

$$p_A A\,(L^A)^{\delta-1} = p_M M\,(L^M)^{\delta-1} = p_S S\,(L^S)^{\delta-1} \quad \text{and} \tag{33}$$

$$p_M \geq \frac{w}{\delta M}\left(\frac{\delta}{1-\delta}K\right)^{1-\delta}. \tag{34}$$

This results in the following implicit allocation of labor:

$$L^j = \left[\frac{\alpha_j}{\alpha_M}\left(\frac{j}{M}\right)^{-\frac{1-\sigma}{\sigma}}\right]^{\frac{\sigma}{\delta+\sigma(1-\delta)}} f(L^M, M), \qquad j = A, S, \tag{35}$$

$$\begin{aligned} & f(L^M, M)\sum_{j=A,S}\left[\frac{\alpha_j}{\alpha_M}\left(\frac{j}{M}\right)^{-\frac{1-\sigma}{\sigma}}\right]^{\frac{\sigma}{\delta+\sigma(1-\delta)}} + L^M = 1, \\ \text{where} \quad & f(L^M, M) = \left[(L^M - K)^{\sigma(1-\delta)}\left(\frac{\mu}{M} + (L^M - K)^{\delta}\right)\right]^{\frac{1}{\delta+\sigma(1-\delta)}}. \end{aligned} \tag{36}$$

Given that L^M is only implicitly defined it is not possible to express condition (34) in terms of exogenous parameters like equation (32) above. However it can be expressed in terms of labor input as

$$L^M \geq \frac{K}{1-\delta} \tag{37}$$

Proposition 3 below studies how sectoral employment reacts to an exogenous increase in agricultural productivity under the two types of equilibria. For the no production equilibrium, the results are obtained by direct differentiation. For the production equilibrium, the results are obtained by implicit differentiation.

Proposition 3 *Consider a competitive market economy whose technology is characterized by* (22) *and* (23)*, whose representative consumer has preferences* (24) *and which is closed to trade. In an equilibrium with* <u>*no production*</u> *in the formal manufacturing sector, the inequality*

$$\begin{aligned} & M \leq \frac{\mu^{\frac{1}{\sigma}}}{\alpha_M}\left(\frac{\delta}{1-\delta}K\right)^{1-\delta}\left[\left(\alpha_A A^{-\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{\lambda}} + \left(\alpha_S S^{-\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{\lambda}}\right]^{\lambda} \equiv M_0 \\ & \textit{with} \quad \lambda = 1 + \delta\frac{1-\sigma}{\sigma} > 0 \end{aligned} \tag{38}$$

must hold, and

$$\frac{\partial L^A}{\partial A} < 0, \qquad \frac{\partial L^M}{\partial A} = 0, \qquad \frac{\partial L^S}{\partial A} > 0, \tag{39}$$

provided inequality (38) *is preserved by a marginal change in A.*

In an equilibrium with <u>*production*</u> *in the formal manufacturing sector, the inequality*

$$L^M \geq \frac{K}{1-\delta} \tag{40}$$

must hold, and

$$\frac{\partial L^A}{\partial A} < 0, \qquad \frac{\partial L^M}{\partial A} > 0, \qquad \frac{\partial L^S}{\partial A} > 0, \tag{41}$$

provided inequality (40) *is preserved by a marginal change in A.*

In an equilibrium with no formal manufacturing production, an increase in agricultural productivity leads to a transfer of labor from agriculture to services, without increasing industrial employment. The key equation from Proposition 3 is inequality (38), a necessary condition for an equilibrium with no formal manufacturing sector to emerge. As long as manufacturing productivity is below the threshold M_0 in (38), it is not profitable for the formal manufacturing firm to pay the fixed cost K and to start producing. Equation (38) shows that M_0 is increasing in μ and K, respectively the output from the informal manufacturing sector and the fixed cost; and decreasing in A and S, the total factor productivity in agriculture and services. This is an important point: even so a marginal increase in agricultural productivity may not transfer labor to the manufacturing sector (depending on the type of equilibrium involved) at the very least one can say that a low agricultural productivity decreases the profitability of the formal manufacturing sector, enabling a no-production equilibrium to emerge.

If agricultural productivity is subject to a large change, how much is enough til the manufacturing sector starts to operate? Equation (38) does not say that once the inequality is reversed the manufacturing sector will start to operate, merely that *at the no production equilibrium prices* it is not willing to operate. Solving in closed form for the level of agricultural productivity that enables the manufacturing sector to operate is not possible here. From (40), the only thing known is that A must be such that the optimal level of L^M exceeds $\frac{K}{1-\delta}$.

Also, since the Second Welfare Theorem fails because of increasing returns, there are combinations of exogenous parameters for which utility maximization of the representative household cannot be achieved through a market equilibrium. In particular, if maximizing the utility of the representative household implies choosing L^M in $\left]K; \frac{K}{1-\delta}\right[$ then the formal manufacturing sector is making losses and cannot be profit-maximizing. However, this allocation is achievable through a *marginal cost pricing equilibrium*, where the formal manufacturing sector maximizes profits only locally. In practice, it means that the formal manufacturing firm would have to be owned by the government, or at the very least that a regulation would forbid the managers to shut it down (see Quinzii (1992)).

To sum up, the model has established that the presence of fixed costs can prevent a formal manufacturing sector to emerge, and as a result labor is transferred from agriculture directly into services. Additionally, the model provides information on the highest level of manufacturing productivity M_0 compatible with a no production equilibrium. This highest level is increasing with the production of the informal sector and the size of the fixed cost, and is decreasing with productivity in agriculture and services. Thus, the combination of a large informal sector and of barriers to formalization are likely candidates for the weak creation of industrial employment in Africa and Latin America. A low total factor productivity in agriculture and services can further worsen this problem.

5 Conclusion

In Section 2 of this paper, I presented the main line of reasoning of structural change theory and showed that different assumptions of tradability have drastic consequences on designing an effective industrialization policy. Testing the main line of reasoning of structural change theory has brought many results: the first is that the insights of the closed economy model are validated by the data. The second is that, at least in developed countries, there is evidence that openness to trade modify the mechanisms of structural change in the way predicted by the model. However, the practical importance of openness to trade seems modest and arguably is a real concern for economies that are essentially big towns like Singapore or Hong Kong. In Latin America and Africa, the available evidence on the role of trade is weaker, and one might doubt that the relationship is the same as in advanced countries.

Another stylized fact emerges from the analysis of developing regions: agricultural productivity has asymmetrical effect on employment in industry and services. The creation of jobs in industry requires a larger increase in agricultural productivity than the creation of jobs in services. This trait appears to be related to the phenomenon of ”premature deindustrialization”, the low peak of industrial employment observed in today’s Latin American and African countries. A common explanation of this phenomenon is that Latin American and African countries lack a strong comparative advantage in manufacturing, in a context of decreasing world manufacturing prices and trade liberalization. This point suggests that trade openness might have a specific role to play in the creation of manufacturing jobs, although this mechanism is not well identified in the empirical results.

Additionally, I examine briefly the argument that this phenomenon could be linked to an unfavorable environment for large businesses, which weights more heavily on manufacturing firms. I find that the presence of large fixed costs in the formal manufacturing sector, the existence of a large informal manufacturing sector and the low productivity of agriculture and services can account collectively or individually for a difficulty to create formal manufacturing employment.

All these comments point to a clear direction for future research: taking more explicitly into account the specificity of the manufacturing sector in empirical and theoretical models of structural transformation. This means not only taking into account its higher degree of tradability, but also its higher dependence on formal employment, its physical and human capital intensity, its reliance on imported inputs and many others traits.

A Proofs and additional theoretical results

A.1 Additional results to Proposition 1

In this subsection, I give the full set of derivatives for the closed and semi-open economy model of Section 2. This is useful especially for comparison with the econometric results obtained in Tables (2) to (13). All these results are obtained by direct differentiation.

Table A1: *Derivative signs in the closed economy model*

TFP \ Labor	L^A	L^M	L^S
A	-	+	+
M	+	-	+
S	+	+	-

Table A2: *Derivative signs in the open economy model*

TFP \ Labor	L^A	L^M	L^S
A	+ or -	-	+
M	-	+ or -	+
S	+	+	-

A.2 Proofs of Proposition 2

In the closed economy model

Equation (7) can be rewritten as follows:

$$L^A = \frac{1}{1 + \left(\frac{\alpha_S}{\alpha_A}\left(\frac{A}{S}\right)^{\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{1+\delta\frac{1-\sigma}{\sigma}}} + \left(\frac{\alpha_M}{\alpha_A}\left(\frac{A}{M}\right)^{\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{1+\delta\frac{1-\sigma}{\sigma}}}} \tag{42}$$

$$L^M = \frac{1}{1 + \left(\frac{\alpha_S}{\alpha_M}\left(\frac{M}{S}\right)^{\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{1+\delta\frac{1-\sigma}{\sigma}}} + \left(\frac{\alpha_A}{\alpha_M}\left(\frac{M}{A}\right)^{\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{1+\delta\frac{1-\sigma}{\sigma}}}} \tag{43}$$

$$L^S = \frac{1}{1 + \left(\frac{\alpha_A}{\alpha_S}\left(\frac{S}{A}\right)^{\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{1+\delta\frac{1-\sigma}{\sigma}}} + \left(\frac{\alpha_M}{\alpha_S}\left(\frac{S}{M}\right)^{\frac{1-\sigma}{\sigma}}\right)^{\frac{1}{1+\delta\frac{1-\sigma}{\sigma}}}} \tag{44}$$

Then using the assumption $\gamma_A, \gamma_M > \gamma_S$ it is immediate that L^S is monotonically increasing and that $\lim_{t\to\infty} L^S = 1$. I prove now that L^M can be decreasing or hump-shaped. The proof for L^A is entirely analogous.

If $\gamma_M \geq \gamma_A$, it is immediate that L^M is decreasing.

If $\gamma_M < \gamma_A$, I simplify equation (43) as follows:

$$L^M(t) = \frac{1}{1 + a\,e^{xt} + b\,e^{-yt}}, \qquad x, y, a, b > 0, \qquad j = A, M, \tag{45}$$

where t is the time variable and

$$a = \left[\frac{\alpha_S}{\alpha_M} \left(\frac{M_0}{S_0} \right)^{\frac{1-\sigma}{\sigma}} \right]^{\frac{1}{1+\delta \frac{1-\sigma}{\sigma}}}, \qquad b = \left[\frac{\alpha_A}{\alpha_M} \left(\frac{M_0}{A_0} \right)^{\frac{1-\sigma}{\sigma}} \right]^{\frac{1}{1+\delta \frac{1-\sigma}{\sigma}}},$$
$$x = \frac{\gamma_M - \gamma_S}{\frac{\sigma}{1-\sigma} + \delta}, \qquad y = \frac{\gamma_M - \gamma_A}{\frac{\sigma}{1-\sigma} + \delta}. \tag{46}$$

Then differentiating (45) with respect to time,

$$\frac{dL^M(t)}{dt} = b\,y\,e^{-yt} \, \frac{1 - \frac{a\,x}{b\,y}\, e^{(x+y)t}}{(1 + a\,e^{xt} + b\,e^{-yt})^2} \tag{47}$$

From (47) it is clear that L^M is decreasing or hump-shaped depending on how $\frac{a\,x}{b\,y}$ compares to 1 at $t = 0$. A sufficient condition for L^M to exhibit a hump-shaped pattern is that the ratio $\frac{x}{y} = \frac{\gamma_M - \gamma_S}{\gamma_M - \gamma_A}$ be low enough.

In the open economy model

Rearranging equation (12):

$$L^S = \frac{1}{1 + \left\{ B \left[\left(\frac{p_A A}{S} \right)^{\frac{1}{1-\delta}} + \left(\frac{M}{S} \right)^{\frac{1}{1-\delta}} \right]^{-(1-\delta)(1-\sigma)} \right\}^{\lambda}}$$
$$\text{where} \quad B = \left(\frac{\alpha_A}{\alpha_S} \right)^{\sigma} {p_A}^{1-\sigma} + \left(\frac{\alpha_M}{\alpha_S} \right)^{\sigma} \quad \text{and} \quad \lambda = \frac{1}{1 - (1-\delta)(1-\sigma)} > 0 \tag{48}$$

Once again, using the assumption $\gamma_A, \gamma_M > \gamma_S$ it is immediate that L^S is monotonically increasing and that $\lim_{t\to\infty} L^S = 1$.
Now, rearranging equation (11),

$$L^M = \frac{1}{1 + \left(\frac{p_A A}{M} \right)^{\frac{1}{1-\delta}} + \left[1 + \left(\frac{p_A A}{M} \right)^{\frac{1}{1-\delta}} \right]^{\lambda} \left(\frac{M}{S} \right)^{\lambda(1-\sigma)} B^{-\lambda}} \tag{49}$$

If $\gamma_M \leq \gamma_A$ then L^M is decreasing.

If $\gamma_M > \gamma_A$, consider the following simpler formulation:

$$L^M(t) = \frac{1}{1 + a\, e^{-xt} + (1 + a\, e^{-xt})^{\lambda}\, b\, e^{yt}}, \qquad x, y, a, b > 0, \tag{50}$$

where t is the time variable and

$$\begin{aligned} a &= \left(\frac{p_A\, A_0}{M_0}\right)^{\frac{1}{1-\delta}}, \qquad & x &= \frac{\gamma_M - \gamma_A}{1-\delta} \\ b &= \left(\frac{M_0}{S_0}\right)^{\lambda(1-\sigma)} B^{-\lambda}, \qquad & y &= (\gamma_M - \gamma_S)\lambda(1-\sigma). \end{aligned} \tag{51}$$

Now consider $f(t)$, the denominator of $L^M(t)$:

$$f(t) = 1 + a\, e^{-xt} + (1 + a\, e^{-xt})^{\lambda}\, b\, e^{yt}. \tag{52}$$

Its first order derivative can change sign and converges to positive values:

$$f'(t) = (1 + a\, e^{-xt})^{\lambda}\, b\, e^{yt} \left(y - \lambda \frac{a\, x\, e^{-xt}}{1 + a\, e^{-xt}}\right) - a\, x\, e^{-xt} \lesseqgtr 0. \tag{53}$$

$$\lim_{t \to \infty} f'(t) = \infty \tag{54}$$

And its second order derivative is positive:

$$f''(t) = (1 + a\, e^{-xt})^{\lambda}\, b\, e^{yt} \left[\lambda \frac{a\, x^2\, e^{-xt}}{(1 + a\, e^{-xt})^2} + \left(y - \lambda \frac{a\, x\, e^{-xt}}{1 + a\, e^{-xt}}\right)^2\right] + a\, x^2\, e^{-xt} > 0. \tag{55}$$

Consequently, L^M is either decreasing or hump-shaped. Moreover, by examining $f'(0)$ one can easily show that a sufficient condition for L^M to be hump-shaped is that the ratio $\frac{\gamma_M - \gamma_S}{\gamma_M - \gamma_A}$ be high enough. The proof for L^A is analogous.

B First-stage regression results

Table B1: *First-stage regression results: regions*

Region	Europe & N. Am.	Asia	Latin Am.	N. Africa & Sub. Africa
Dependent variable		ln(Prodagriculture)		
Employment in agriculture$_{t-1}$	-4.472**	-2.244**	-2.040***	-3.753***
	(1.595)	(0.904)	(0.487)	(1.158)
Employment in agriculture$_{t-2}$	0.338	0.290	0.926	3.273**
	(1.291)	(0.497)	(0.613)	(1.440)
ln(Prodindustry)	-0.0345	0.172*	-0.0285	0.0788
	(0.152)	(0.0868)	(0.165)	(0.0703)
ln(Prodservices)	-0.166	0.177	0.732**	0.307**
	(0.184)	(0.106)	(0.261)	(0.115)
ln(Agrealprices)	13.66***	0.703	3.864***	2.833**
	(1.549)	(1.022)	(1.017)	(1.191)
Openness	-1.992***	-0.733**	-0.749	-0.507
	(0.418)	(0.236)	(0.413)	(0.366)
Openness x ln(Prodagri)	0.364***	0.148***	0.219**	0.170**
	(0.0541)	(0.0304)	(0.0791)	(0.0682)
Constant	-62.78***	-0.146	-18.75**	-12.29*
	(7.229)	(4.729)	(5.831)	(5.803)
Country & year fixed effects	Yes	Yes	Yes	Yes
Observations	392	474	456	592
Number of countries	8	11	9	13
Smallest group	48	25	50	39
Average group	49	43.1	50.7	45.5
Largest group	50	51	51	51
R-squared within	0.811	0.910	0.898	0.590
R-squared between	0.100	0.965	0.967	0.948
R-squared overall	0.130	0.951	0.964	0.933

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table B2: *First-stage regression results: income levels*

Income level	High	Middle & low	Upper middle	Low & lower middle
Dependent variable		ln(Prodagriculture)		
Employment in agriculture$_{t-1}$	-0.472	-2.329***	-2.346***	-2.846***
	(1.580)	(0.528)	(0.746)	(0.689)
Employment in agriculture$_{t-2}$	-0.596	1.098	1.602*	1.530*
	(1.671)	(0.773)	(0.877)	(0.805)
ln(Prodindustry)	-0.00361	0.0555	-0.0224	0.115
	(0.171)	(0.0695)	(0.0917)	(0.0916)
ln(Prodservices)	-0.379	0.208**	0.204*	0.254*
	(0.235)	(0.0839)	(0.107)	(0.130)
ln(Agrealprices)	11.01***	3.312**	3.588***	3.047*
	(2.727)	(1.190)	(0.836)	(1.447)
Openness	-0.977**	-0.422*	-0.220	-0.416
	(0.407)	(0.244)	(0.316)	(0.340)
Openness x ln(Prodagri)	0.183**	0.138**	0.120	0.0914
	(0.0725)	(0.0532)	(0.0830)	(0.0673)
Constant	-48.25***	-13.73**	-15.30***	-12.60
	(12.25)	(5.915)	(4.325)	(7.451)
Country & year fixed effects	Yes	Yes	Yes	Yes
Observations	704	1,210	574	636
Number of countries	15	26	12	14
Smallest group	25	35	35	39
Average group	46.9	46.5	47.8	45.4
Largest group	51	51	51	51
R-squared within	0.920	0.720	0.837	0.619
R-squared between	0.626	0.918	0.940	0.983
R-squared overall	0.198	0.883	0.819	0.970

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

C Additional regression results

Table C1: *Upper middle income countries OLS*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.0422	-0.00211	0.0443
	(0.0392)	(0.0143)	(0.0288)
ln(Prodindustry)	-0.0528**	0.000368	0.0524**
	(0.0212)	(0.00671)	(0.0195)
ln(Prodservices)	0.00175	0.0480***	-0.0497**
	(0.0210)	(0.00939)	(0.0203)
ln(Agrealprices)	-0.989***	-0.176*	1.165***
	(0.163)	(0.0856)	(0.148)
Openness	0.00690	0.0171	-0.0240
	(0.0948)	(0.0205)	(0.0791)
Openness x ln(Prodagri)	-0.0128	0.0163**	-0.00351
	(0.0185)	(0.00561)	(0.0163)
Constant	5.763***	0.730	-5.493***
	(0.833)	(0.416)	(0.726)
Country & year fixed effects	Yes	Yes	Yes
Observations	583	583	583
Number of countries	12	12	12
Smallest group	37	37	37
Average group	48.58	48.58	48.58
Largest group	51	51	51
R_squared within	0.937	0.667	0.930
R-squared between	0.0882	0.0225	0.164
R_squared overall	0.221	0.0405	0.431

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table C2: *Upper middle income countries IV*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.699	0.161	0.538
	(0.507)	(0.132)	(0.388)
ln(Prodindustry)	-0.0354	-0.00427	0.0397
	(0.0573)	(0.0165)	(0.0424)
ln(Prodservices)	0.135	0.0130	-0.148**
	(0.0917)	(0.0237)	(0.0735)
ln(Agrealprices)	1.894	-0.872	-1.022
	(2.008)	(0.531)	(1.561)
Openness	-0.129	0.0682	0.0604
	(0.242)	(0.0610)	(0.185)
Openness x ln(Prodagri)	0.0716	-0.00870	-0.0629
	(0.0942)	(0.0232)	(0.0723)
Constant	-7.287	3.878*	4.409
	(8.822)	(2.347)	(6.871)
Country & year fixed effects	Yes	Yes	Yes
Observations	574	574	574
Number of countries	12	12	12
Smallest group	35	35	35
Average group	47.83	47.83	47.83
Largest group	51	51	51
R_squared between	0.0884	0.0400	0.0888
R_squared overall	0.0776	0.0308	0.0841

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table C3: *Low & lower middle income countries OLS*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.112***	-0.00315	0.115***
	(0.0319)	(0.00519)	(0.0311)
ln(Prodindustry)	0.00537	-0.0247**	0.0193
	(0.0260)	(0.00910)	(0.0177)
ln(Prodservices)	0.0959*	-0.000351	-0.0956**
	(0.0472)	(0.00969)	(0.0405)
ln(Agrealprices)	-1.503***	0.168	1.336***
	(0.222)	(0.0970)	(0.146)
Openness	-0.0174	-0.0135	0.0308
	(0.0508)	(0.0150)	(0.0419)
Openness x ln(Prodagri)	-0.0161	0.00732*	0.00882
	(0.0146)	(0.00380)	(0.0120)
Constant	8.004***	-0.616	-6.388***
	(0.946)	(0.453)	(0.584)
Country & year fixed effects	Yes	Yes	Yes
Observations	653	653	653
Number of countries	14	14	14
Smallest group	41	41	41
Average group	46.64	46.64	46.64
Largest group	52	52	52
R_squared within	0.770	0.382	0.805
R-squared between	0.349	0.0711	0.136
R_squared overall	0.424	0.0802	0.254

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table C4: *Low & lower middle income countries IV*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.691**	0.110*	0.581***
	(0.275)	(0.0583)	(0.225)
ln(Prodindustry)	0.0792	-0.0400**	-0.0392
	(0.0628)	(0.0163)	(0.0481)
ln(Prodservices)	0.181	-0.0168	-0.164*
	(0.114)	(0.0227)	(0.0930)
ln(Agrealprices)	1.711	-0.435	-1.276
	(1.680)	(0.331)	(1.395)
Openness	-0.285	0.0401	0.245
	(0.267)	(0.0427)	(0.226)
Openness x ln(Prodagri)	0.0607	-0.00791	-0.0528
	(0.0571)	(0.00844)	(0.0492)
Constant	-6.701	2.133	5.568
	(7.796)	(1.540)	(6.476)
Country & year fixed effects	Yes	Yes	Yes
Observations	636	636	636
Number of countries	14	14	14
Smallest group	39	39	39
Average group	45.43	45.43	45.43
Largest group	51	51	51
R_squared between	0.00323	0.00375	0.0126
R_squared overall	0.00697	0.00291	0.0200

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

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Table 2: *Europe & North America OLS*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.142***	0.0684***	0.0735***
	(0.0179)	(0.0177)	(0.0193)
ln(Prodindustry)	-0.0282	0.0248	0.00337
	(0.0355)	(0.0313)	(0.0184)
ln(Prodservices)	0.0163	-0.0555	0.0392
	(0.0544)	(0.0724)	(0.0577)
ln(Agrealprices)	1.746***	-2.454***	0.709
	(0.418)	(0.440)	(0.537)
Openness	-0.404***	0.331***	0.0732
	(0.0863)	(0.0496)	(0.0818)
Openness x ln(Prodagri)	0.0694***	-0.0400**	-0.0294*
	(0.0194)	(0.0125)	(0.0143)
Constant	-7.945***	12.16***	-3.214
	(2.054)	(2.169)	(2.454)
Country & year fixed effects	Yes	Yes	Yes
Observations	393	393	393
Number of countries	8	8	8
Smallest group	49	49	49
Average group	49.13	49.13	49.13
Largest group	50	50	50
R_squared within	0.884	0.919	0.974
R-squared between	0.118	0.0169	0.0649
R_squared overall	0.211	0.248	0.450

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3: *Europe & North America IV*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.232***	0.114***	0.118***
	(0.0196)	(0.0311)	(0.0272)
ln(Prodindustry)	-0.00831	0.0161	-0.00775
	(0.0349)	(0.0248)	(0.0252)
ln(Prodservices)	-0.0385	-0.0309	0.0694
	(0.0400)	(0.0651)	(0.0602)
ln(Agrealprices)	3.171***	-3.153***	-0.0181
	(0.461)	(0.756)	(0.581)
Openness	-0.466***	0.361***	0.105
	(0.0811)	(0.0686)	(0.0708)
Openness x ln(Prodagri)	0.0851***	-0.0477***	-0.0373***
	(0.0136)	(0.0109)	(0.0114)
Constant	-14.58***	15.41***	0.167
	(2.193)	(3.576)	(2.682)
Country & year fixed effects	Yes	Yes	Yes
Observations	392	392	392
Number of countries	8	8	8
Smallest group	48	48	48
Average group	49	49	49
Largest group	50	50	50
R_squared between	0.100	0.0201	0.0683
R_squared overall	0.130	0.117	0.293

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4: *Asia OLS*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.179***	0.143***	0.0367
	(0.0300)	(0.0322)	(0.0443)
ln(Prodindustry)	-0.0116	-0.0644**	0.0760***
	(0.0216)	(0.0212)	(0.0234)
ln(Prodservices)	0.0553	0.0186	-0.0739**
	(0.0360)	(0.0170)	(0.0280)
ln(Agrealprices)	-0.830*	-0.220	1.050***
	(0.425)	(0.227)	(0.313)
Openness	-0.104**	0.111**	-0.00724
	(0.0368)	(0.0384)	(0.0174)
Openness x ln(Prodagri)	0.0151	-0.0206	0.00554
	(0.0128)	(0.0118)	(0.00763)
Constant	5.091**	0.827	-4.919***
	(1.899)	(1.012)	(1.427)
Country & year fixed effects	Yes	Yes	Yes
Observations	490	490	490
Number of countries	11	11	11
Smallest group	27	27	27
Average group	44.55	44.55	44.55
Largest group	51	51	51
R_squared within	0.890	0.584	0.929
R-squared between	0.154	0.103	0.0620
R_squared overall	0.255	0.133	0.240

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5: *Asia IV*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.488***	0.294***	0.194**
	(0.151)	(0.0703)	(0.0962)
ln(Prodindustry)	0.0812	-0.109***	0.0275
	(0.0632)	(0.0274)	(0.0434)
ln(Prodservices)	0.0887**	0.00224	-0.0909***
	(0.0447)	(0.0156)	(0.0349)
ln(Agrealprices)	-0.0353	-0.640	0.675**
	(0.623)	(0.511)	(0.279)
Openness	-0.370***	0.246***	0.124**
	(0.106)	(0.0707)	(0.0509)
Openness x ln(Prodagri)	0.0750***	-0.0501***	-0.0249*
	(0.0191)	(0.0104)	(0.0134)
Constant	1.844	2.559	-3.403***
	(2.702)	(2.329)	(1.246)
Country & year fixed effects	Yes	Yes	Yes
Observations	474	474	474
Number of countries	11	11	11
Smallest group	25	25	25
Average group	43.09	43.09	43.09
Largest group	51	51	51
R_squared between	0.189	0.115	0.141
R_squared overall	0.261	0.141	0.266

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6: *Latin America OLS*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.0816*	-0.0234	0.105***
	(0.0383)	(0.0244)	(0.0211)
ln(Prodindustry)	0.0333	-0.0623*	0.0290*
	(0.0459)	(0.0327)	(0.0155)
ln(Prodservices)	0.0823	0.0300	-0.112**
	(0.0555)	(0.0289)	(0.0405)
ln(Agrealprices)	-0.924***	0.0732	0.851***
	(0.253)	(0.136)	(0.144)
Openness	-0.117	0.0121	0.104
	(0.137)	(0.0787)	(0.0831)
Openness x ln(Prodagri)	0.0187	0.00793	-0.0266*
	(0.0324)	(0.0218)	(0.0123)
Constant	4.636***	0.0548	-3.691***
	(1.291)	(0.670)	(0.756)
Country & year fixed effects	Yes	Yes	Yes
Observations	457	457	457
Number of countries	9	9	9
Smallest group	50	50	50
Average group	50.78	50.78	50.78
Largest group	51	51	51
R_squared within	0.903	0.500	0.967
R-squared between	0.00996	0.0550	0.437
R_squared overall	0.237	0.00794	0.762

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7: *Latin America IV*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.775**	0.309*	0.466***
	(0.352)	(0.187)	(0.167)
ln(Prodindustry)	-0.0177	-0.0377	0.0554
	(0.133)	(0.0741)	(0.0588)
ln(Prodservices)	0.573*	-0.205	-0.368**
	(0.338)	(0.183)	(0.157)
log(Agrealprices)	2.796	-1.696	-1.100
	(1.959)	(1.041)	(0.930)
Openness	-0.589	0.236	0.353
	(0.427)	(0.197)	(0.238)
Openness x ln(Prodagri)	0.170*	-0.0647	-0.106**
	(0.0953)	(0.0468)	(0.0495)
Constant	-13.55	8.704	5.851
	(10.03)	(5.365)	(4.716)
Country & year fixed effects	Yes	Yes	Yes
Observations	456	456	456
Number of countries	9	9	9
Smallest group	50	50	50
Average group	50.67	50.67	50.67
Largest group	51	51	51
R_squared between	0.245	0.137	0.228
R_squared overall	0.212	0.0761	0.245

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8: *North Africa & Sub-Saharan Africa OLS*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.0603	-0.00117	0.0615
	(0.0385)	(0.0128)	(0.0363)
ln(Prodindustry)	-0.0351	-0.0226	0.0577**
	(0.0354)	(0.0154)	(0.0245)
ln(Prodservices)	0.0737	0.00493	-0.0786*
	(0.0422)	(0.0144)	(0.0385)
ln(Agrealprices)	-1.437***	-0.00706	1.444***
	(0.206)	(0.110)	(0.163)
Openness	0.0638	-0.0111	-0.0528
	(0.0728)	(0.0142)	(0.0628)
Openness x ln(Prodagri)	-0.0262	0.0134*	0.0128
	(0.0202)	(0.00626)	(0.0199)
Constant	7.750***	0.188	-6.939***
	(0.870)	(0.477)	(0.716)
Country & year fixed effects	Yes	Yes	Yes
Observations	609	609	609
Number of countries	13	13	13
Smallest group	41	41	41
Average group	46.85	46.85	46.85
Largest group	52	52	52
R_squared within	0.687	0.211	0.736
R-squared between	0.0189	0.210	0.00808
R_squared overall	0.0865	0.183	0.0812

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 9: *North Africa & Sub-Saharan Africa IV*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.867***	0.202**	0.665***
	(0.289)	(0.0931)	(0.215)
ln(Prodindustry)	0.0437	-0.0422**	-0.00152
	(0.0561)	(0.0203)	(0.0408)
ln(Prodservices)	0.283***	-0.0506**	-0.233***
	(0.107)	(0.0240)	(0.0887)
ln(Agrealprices)	1.392	-0.664	-0.728
	(1.241)	(0.407)	(0.899)
Openness	-0.332	0.0956	0.237
	(0.310)	(0.0895)	(0.227)
Openness x ln(Prodagri)	0.115	-0.0255	-0.0900
	(0.0779)	(0.0210)	(0.0601)
Constant	-4.963	3.126*	2.837
	(5.337)	(1.796)	(3.847)
Country & year fixed effects	Yes	Yes	Yes
Observations	592	592	592
Number of countries	13	13	13
Smallest group	39	39	39
Average group	45.54	45.54	45.54
Largest group	51	51	51
R_squared between	1.40e-07	0.00218	5.50e-05
R_squared overall	0.000709	0.000611	0.00319

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10: *High income countries OLS*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.0493	0.0427	0.00666
	(0.0297)	(0.0252)	(0.0207)
ln(Prodindustry)	-0.0832	-0.00818	0.0914**
	(0.0723)	(0.0397)	(0.0395)
ln(Prodservices)	-0.0463	0.0894*	-0.0431
	(0.0812)	(0.0437)	(0.0445)
ln(Agrealprices)	0.488	-1.559***	1.070**
	(0.749)	(0.471)	(0.379)
Openness	0.0497	-0.0413	-0.00843
	(0.0552)	(0.0609)	(0.0392)
Openness x ln(Prodagri)	-0.0163	0.0140	0.00229
	(0.0159)	(0.0127)	(0.00623)
Constant	-1.422	7.331***	-4.908**
	(3.416)	(2.180)	(1.714)
Country & year fixed effects	Yes	Yes	Yes
Observations	713	713	713
Number of countries	15	15	15
Smallest group	27	27	27
Average group	47.53	47.53	47.53
Largest group	51	51	51
R_squared within	0.729	0.656	0.932
R-squared between	0.385	0.0200	0.244
R_squared overall	0.120	0.00137	0.0277

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 11: *High income countries IV*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.888	0.506	0.382
	(0.596)	(0.344)	(0.269)
ln(Prodindustry)	-0.000416	-0.0479	0.0483
	(0.150)	(0.0768)	(0.0764)
ln(Prodservices)	-0.332*	0.240**	0.0921
	(0.187)	(0.103)	(0.0908)
ln(Agrealprices)	9.781	-6.701*	-3.079
	(6.605)	(3.857)	(2.946)
Openness	-0.866	0.471	0.395
	(0.780)	(0.437)	(0.357)
Openness x ln(Prodagri)	0.161	-0.0855	-0.0757
	(0.142)	(0.0806)	(0.0635)
Constant	-42.90	30.30*	13.60
	(29.66)	(17.35)	(13.22)
Country & year fixed effects	Yes	Yes	Yes
Observations	704	704	704
Number of countries	15	15	15
Smallest group	25	25	25
Average group	46.93	46.93	46.93
Largest group	51	51	51
R_squared between	0.323	0.00689	0.196
R_squared overall	0.152	0.000135	0.0586

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 12: *Middle & low income countries OLS*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.0967***	0.00452	0.0921***
	(0.0273)	(0.01000)	(0.0230)
ln(Prodindustry)	-0.0331	-0.0143	0.0475***
	(0.0203)	(0.0103)	(0.0134)
ln(Prodservices)	0.0631**	0.0239**	-0.0870***
	(0.0250)	(0.00922)	(0.0233)
ln(Agrealprices)	-1.360***	-0.0236	1.383***
	(0.169)	(0.1000)	(0.115)
Openness	-0.0113	0.0285	-0.0172
	(0.0693)	(0.0266)	(0.0545)
Openness x ln(Prodagri)	-0.0154	0.00740	0.00802
	(0.0138)	(0.00563)	(0.0120)
Constant	7.486***	0.129	-6.615***
	(0.767)	(0.453)	(0.536)
Country & year fixed effects	Yes	Yes	Yes
Observations	1,236	1,236	1,236
Number of countries	26	26	26
Smallest group	37	37	37
Average group	47.54	47.54	47.54
Largest group	52	52	52
R_squared within	0.830	0.293	0.860
R-squared between	0.0125	8.41e-05	0.0356
R_squared overall	0.0739	0.00316	0.143

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 13: *Middle & low income countries IV*

Dependent variable	Agriculture	Industry	Services
ln(Prodagriculture)	-0.737***	0.178**	0.560***
	(0.277)	(0.0793)	(0.208)
ln(Prodindustry)	0.0378	-0.0330*	-0.00471
	(0.0506)	(0.0181)	(0.0350)
ln(Prodservices)	0.157**	-0.00267	-0.154***
	(0.0719)	(0.0208)	(0.0544)
ln(Agrealprices)	2.179	-0.967**	-1.212
	(1.691)	(0.456)	(1.281)
Openness	-0.310*	0.116*	0.195
	(0.185)	(0.0629)	(0.130)
Openness x ln(Prodagri)	0.0996*	-0.0254	-0.0742*
	(0.0587)	(0.0176)	(0.0436)
Constant	-8.759	4.461**	5.298
	(7.710)	(2.103)	(5.824)
Country & year fixed effects	Yes	Yes	Yes
Observations	1,210	1,210	1,210
Number of countries	26	26	26
Smallest group	35	35	35
Average group	46.54	46.54	46.54
Largest group	51	51	51
R_squared between	0.00346	0.000413	0.00838
R_squared overall	0.0107	2.96e-05	0.0215

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1