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Effect of Agricultural Transformation on the Working Poverty in Developing Countries

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Abstract

The present analysis has investigated empirically the effect of agricultural transformation on the working poverty rate in developing countries. It argues that agricultural transformation affects the working poverty rate by inducing employment shifts (within the agricultural sector) from the primary agriculture to the agrifood system, and from the agricultural sector to other sectors in the economy. The empirical analysis utilizes a panel dataset of 100 developing countries of which 35 poorest countries, i.e., Least developed countries (LDCs), over the annual period from 2000 to 2021. It uses the error component two-stage least squares to address endogeneity concerns, and accounts for the larger between-country variation of variables than their within-country variations. The findings lend support for the hypothesis that agricultural transformation induces the employment shifts highlighted above, but to a lower extent in LDCs than in NonLDCs among developing countries. However, while agricultural transformation has resulted in a lower working poverty rate in NonLDCs, it has raised the working poverty rate in LDCs. This can suggest that for LDCs, the agricultural sector has not been sufficiently transformed to trigger the requisite employment shifts that would effectively reduce the working poverty rate. Similar findings are obtained for Sub-Saharan African (SSA) countries (41 SSA countries) – the bulk of which being LDCs - versus NonSSA countries in the full sample.

Keywords: Agricultural transformation; Working poverty; Developing countries; Least developed countries; Sub-Saharan African countries.

JEL Classification: E24; Q18.

1. Introduction

Historically, the agricultural sector plays a major role in the economic development process (e.g., Johnston and Mellor, 1961; Mellor, 1976). Thanks to the employment opportunities and economic multipliers that it generates, notably at the early stages of development, the agricultural sector is the largest provider of employment in many poor countries² (e.g., World Bank, 2008). However, in many developing countries (especially the poorest ones), this sector is characterized by a subsistence production, a low labor productivity, low wages and underemployed workers (e.g., Christiaensen and Maertens, 2022; Fox et al. 2016; Gaddis et al., 2023; McCullough, 2017). For that reason, many scholars and researchers have advised for the transformation of the agricultural sector, that goes beyond agricultural productivity and covers the development and expansion of agricultural value chain activities, upstream and downstream from the farm³ (e.g., ACET, 2017; Akuriba et al., 2021; Amankwah et al., 2023; Barrett et al., 2017; Christiaensen et al., 2021; Jayne et al., 2022; Townsend et al., 2017).

At the core of the present analysis is the relationship between agricultural transformation and the working poverty rate (a proxy for the quality of employment). According to the International Labor Organization⁴ (ILO), the working poverty rate is the percentage of men and women youth adults (age 15+) that are in employment, and living below US\$2.15 PPP. The topic is particularly relevant because policymakers in developing economies face a huge job creation challenge, with more than 1 billion young people expected to enter the labor market between 2025 and 2050 (e.g., World Bank, 2025). The job creation challenge is particularly acute in poor countries, many of which being located in Sub-Saharan Africa (SSA) where wage jobs and productive employment are scant (World Bank, 2025). For example, SSA is projected to reach more than 2 billion people by 2050 (accounting for 90 percent of global population growth) and its working-age population is expected to increase fivefold by 2050 from the level in 1990, compared to 24 percent in the rest of the world over the same period (World Bank, 2025).

² In the poorest countries, the agricultural sector represents approximately 40 percent of the GDP, and employs three-quarters of the population (Davis et al., 2024).

³ Beyond agricultural productivity, agricultural transformation entails “*the logistics of providing inputs and services to farms and of storing and transporting agricultural produce to processors and consumers. And it covers the manufacturing of agricultural inputs and the processing of farm produce*” (ACET, page 143).

⁴ See information online at: <https://ilostat.ilo.org/data/snapshots/working-poverty-rate/>

On another note, recent evidence has shown that agricultural transformation has the potential of generating significant jobs opportunities⁵ in developing countries, notably in poor countries (e.g., Townsend et al., 2017; Yeboah and Jayne, 2018; Vos and Cattaneo, 2021).

To the best of our knowledge, the present study is the first empirical paper that links agricultural transformation to the working poverty rate in developing countries. The existing literature relates agriculture to poverty reduction (not the working poverty), including through structural transformation (e.g., Chang et al. 2015; Christiaensen and Martin, 2018; Christiaensen et al., 2011; Christiaensen and Martin, 2018; Christiaensen et al., 2011; Gollin et al., 2002; Vos and Cattaneo, 2021). For example, Christiaensen and Todo (2014) have uncovered for developing countries that migration out of agriculture into the missing middle (rural nonfarm economy and secondary towns) results in greater inclusive growth patterns and faster poverty reduction than agglomeration in mega cities. Van den Broeck et al. (2017) have reported empirical evidence that the expansion of the horticultural sector (as part of the food export chains) has exerted a strong poverty reduction effect in Senegal, including through employment generation and the creation of substantial income gains for the poorest half of the rural population.

Our paper relates to these studies, but differs from them in two ways. First, it focuses on the working poverty (and not the poverty) effect of agricultural transformation in developing countries, especially in poorest ones. Second, in contrast with previous studies, the current empirical exercise uses a novel indicator of agricultural transformation developed by Diao et al. (2024, 2025) to investigate the effect of agricultural transformation on the reduction of the working poverty rate in developing countries. We hypothesize that agricultural transformation affects the working poverty in developing countries, especially the poorest countries because it leads to a shift in employment within the agricultural sector, notably away from the primary agricultural sector to the agrifood system sub-sector - and the shift of employment away from the agriculture sector to the other sectors in the economy. In particular, we expect that agricultural transformation would lead to a lower working poverty rate because of the implied employment shifts, insofar as structural change contributes to reducing poverty in developing countries, especially in Asia and sub-Saharan Africa (Erumban and de Vries, 2024).

The analysis is carried out by means of the error component two-stage least squares (EC2SLS) technique (Baltagi, 1981, 2008), over an unbalanced panel dataset of 100 developing countries, of

⁵ See the literature survey by Berdegué et al. (2025).

which 35 poor countries (Least developed countries⁶ - LDCs), with data spanning the annual period from 2000 to 2021. The findings indicate that while agricultural transformation has led to the reduction in the working poverty rate in NonLDCs, it has induced an increase in the working poverty rate in LDCs. This positive working poverty effect of agricultural transformation in LDCs reflects the fact the transformation of the agricultural sector has not reached the requisite level to generate the extent of employment shifts within the agricultural sector, and out of that sector that would ultimately result in the fall in the working poverty rate.

The rest of the paper is structured as follows. Section 2 discusses, theoretically, how agricultural transformation can affect the working poverty rate in developing countries. Section 3 presents the empirical strategy (including the model specification, data analysis, and the econometric approach) to be used to test empirically the question under analysis. Section 4 discusses the empirical outcomes, and Section 5 concludes.

2. Conceptual framework

This section presents a theoretical discussion on the effect of agricultural transformation on the working poverty in developing countries. It first presents the concept of agricultural transformation (sub-section 2.1) and then discusses how it can affect the working poverty in developing countries (sub-section 2.2).

2.1. The concept of “Agricultural transformation”

According to Laborde et al. (2019: p2, footnote2), agricultural transformation can be considered as “*the process by which an agri-food system transforms over time from being subsistence-oriented and farm-centred into one that is more commercialized, productive and off-farm centred*” (see also Jayne et al. 2018). This process is characterized by agricultural growth through extensification (the expansion of agricultural lands) or intensification (the enhanced application of inputs and use of various technologies in agricultural production), as well as by a higher productivity growth in the form of a higher labor productivity and the exit of labor out of the agricultural sector (Wineman, 2025). This is in line with the four phases of agricultural transformation identified by Timmer (1988, 2007): the first stage

⁶ The group of Least developed countries (LDCs) contains countries qualified by the United Nations as the poorest and most vulnerable countries in the world to environmental shocks, as well as external economic and financial shocks. Information of the inclusion and graduation of countries from the LDC category is available online at: <https://www.un.org/ohrrls/content/about-least-developed-countries>

involves “getting agriculture moving”; the second stage is labelled “agriculture as a contributor to growth”; the third stage is called “integrating agriculture into the macroeconomy”; and the final (fourth) called “agriculture in industrial economies” involves the complete transformation of the agricultural sector, which becomes fully integrated into the economy like any other modern nonagricultural sectors. In a similar spirit, De Janvry and Sadoulet (2019) have defined “agricultural transformation” as the third stage of a five-stage framework of agriculture modernization. It is preceded by the stage of “asset building” (first stage) and “Green Revolution” (second stage); and followed by “rural transformation” (fourth stage) and finally “structural transformation”, which entails an acceleration of the rural-urban migration, and the take-off of urban-based industries and services sectors.

The genuine transformation of the agrifood value chains takes place alongside both agricultural and industrial revolutions (Barett et al. 2022). This means that agricultural transformation should be analyzed in a broader sense, that is, by adopting a holistic agrifood system (AFS) approach that embeds the on-farm and off-farm components of agrifood value chains (Diao et al. 2024; Diao et al. 2025). According to FAO (2021, page xii), the AFS comprises both agricultural and food systems⁷ and encompasses the entire range⁸ of actors and their interlinked value-adding activities.

In a nutshell, agricultural transformation is shaped by three inter-related processes, which are improvement in agricultural productivity itself achieved through intensification, mechanization and the change in farm structure from small-scale, subsistence production towards larger-scale, market-oriented operations (e.g., Berdegué et al., 2025; Divanbeigi et al., 2016; Barrett et al., 2017; Jayne et al., 2022; Wineman, 2025).

2.2. How can agricultural transformation affect the working poverty rate?

The potential for agricultural transformation to reduce poverty, and foster employment growth in urban, non-agricultural sectors (e.g., Timmer 1988) depends largely on the inclusiveness and dynamics of the entire AFS, including through both agricultural productivity and the extent to which the rest of the AFS (especially the “hidden middle”) is developed (e.g., Barrett et al. 2019; Reardon and Timmer, 2014; Timmer, 1988; Vos, 2019; Vos and Cattaneo, 2021). Diao et al. (2025) have argued that the

⁷ Food systems comprise all food products that originate from crop and livestock production, forestry, fisheries and aquaculture, and from other sources such as synthetic biology that are meant for human consumption (FAO, 2021).

⁸ These include the primary production of food and non-food agricultural products, as well as in storage, aggregation, post-harvest handling, transportation, processing, distribution, marketing, disposal and consumption of all food products including those of non-agricultural origin.

expansion of the agro-processing (a sub-sector of manufacturing) can be a reliable alternative pro-poor growth strategy in poor countries where the benefits from adopting export-oriented manufacturing-led growth strategies are now limited than in the past. In the same vein, Akuriba et al. (2021: Chapter 9) have put forth that the development of an integrated agribusiness model would provide a new opportunity for poverty reduction across developing nation states. This is because adding value to products through various activities (e.g., sorting, grading, processing, and packaging) provides actors along the value chain with significant opportunities for income generation. This is particularly the case for poor countries (and SSA countries) where alternative employment opportunities are non-existent in rural areas characterized by endemic poverty. On the other hand, structural transformation⁹ has the potential of reducing poverty (e.g., Christiaensen and Kaminski, 2015; Christiaensen and Martin, 2018; Erumban and de Vries, 2024; Timmer and Akkus, 2008). For example, a recent study by Erumban and de Vries (2024) has reported empirical evidence that structural transformation contributed to reducing poverty in Asia and sub-Saharan Africa developing countries, and productivity growth in manufacturing (as part of the structural transformation process) plays a major role in poverty reduction in developing Asian countries but less so in SSA countries.

Our theoretical premise is that agricultural transformation will lead to the decline in the working poverty rate in developing countries (especially the poorest countries) because it provides an impetus for structural transformation by inducing a shift on employment within the agricultural sector, away from the primary agricultural sector to the agrifood system sub-sector, and the shift of employment away from the agricultural sector (including primary agriculture and agri-food systems sub-sectors) to the other sectors in the economy.

As a matter of fact, agricultural transformation paves the way for structural transformation (De Janvry and Sadoulet, 2019; Diao et al. 2024) through *inter alia*, the improvement in agricultural productivity (e.g., Bustos et al. 2016; Chu et al., 2022; Dorinet et al. 2021; James, 2015; Restuccia et al. 2008). The agricultural productivity improvement and the resulting exit of labor out of that sector - which is central to a successful agricultural transformation process (e.g., Diao et al., 2021; Huang, 2016; Charlton et al. 2019) - improves the income of both farmers that remain in the agricultural sector, and those that migrate to other sectors. As a consequence, it contributes to reducing the working poverty rate in whole country.

⁹ Traditionally, “structural transformation” or “structural change” is defined as the process of change in the production structure of an economy, including through the reallocation of labor from the agricultural sector toward manufacturing and services sectors (e.g., Gollin et al. 2014; Herrendorf et al. 2014; Lewis, 1954).

Likewise, the expansion of the AFS can lead to the working poverty reduction through its spillover effects to other economic sectors thanks to its backward (or ‘upstream’) and forward (or ‘downstream’) linkages with those sectors. The backward linkage identifies how a sector is dependent on other sectors in the economy for their input supplies. As far as the AFS is concerned, the backward linkage refers to the collaboration of the agro-industries with the input sector (raw materials), and the forward linkage refers to the connection of the agro-industries to buyers (the output market) (e.g., Akuriba et al. 2021: p 78-79). For example, the backward linkage of agro-industries in developing countries takes the form of contract farming that agro-industries develop with farmers as means of engaging their suppliers. This type of backward linkage generally increases farm employment and facilitates the expansion of small-scale farmers (Allen et al., 2018). Another form of backward linkage of the AFS is the supply by other sectors of tools and machines needed in the agro-industries. The forward linkage indicates how a sector distributes its outputs to the remaining economy. Specifically, the forward linkage of the AFS occurs through the link of the AFS with other sectors such as transport, retail and wholesale trade, and financial services. The forward linkages of the AFS can arise from the improvement in agricultural productivity that generates greater surplus production, and an extra income for farm-households that can, in turn, induce a higher demand for labor-intensive goods and services - and hence, create employment - in their communities (Wineman, 2015). The increased demand for nonfarm jobs encourages the movement of workers toward higher-return nonfarm activities (Barrett et al., 2017).

Another example of the relevance of the backward linkages to the AFS is provided by Savona and Bontadini (2019). The authors have combined the concept of backward linkages à la Hirschman (1958) with that of ‘representative domestic demand’¹⁰ à la Linder (1961: 87) to provide evidence that a revealed comparative advantage in agriculture is associated with an increase in the domestic intermediate demand that promotes diversification into backward-linked sectors, including Knowledge Intensive Business Services (KIBS¹¹), and eventually into high-tech manufacturing. As agricultural transformation supports the expansion of KIBS through the development of modern agricultural supply chains (e.g., Atosina et al., 2021; Barrett et al., 2022), it can spur the process of

¹⁰ The concept of ‘representative domestic demand’ developed by Linder (1961) arises from the fact when trade comparative advantage can generate a domestic demand - qualified as “representative domestic demand” - that is substantial enough to trigger the development of capabilities. According to Linder (1961), the domestic demand is related to manufactured products, insofar as once it has reached a critical level to become a “domestic representative demand”, domestic producers become competitive enough to operate in the international market.

¹¹ KIBS include transport, storage, communications, research and development, financial intermediation, insurance, real estate and business activities (e.g., Baker, 2007; Ciriaci et al. 2015; Gala et al. 2018).

structural transformation, including through the shift of the labor force to more productive activities (Gala et al., 2018) - in view of the potential synergistic and symbiotic relationship between the manufacturing sector and the expansion of KIBS (e.g., Baker, 2007; Ciriaci et al. 2015; Gala et al. 2018).

Existing statistics on how agricultural transformation affects employment provide an illustration of the extent to which agricultural transformation can contribute to the reduction in the working poverty through employment shifts-based structural transformation. Agricultural transformation generates significant jobs opportunities¹² in developing countries, notably in poor countries (e.g., Townsend et al., 2017; Yeboah and Jayne, 2018; Vos and Cattaneo, 2021) featured by large and young populations (e.g., Berdegué et al. 2025; Townsend et al., 2017; Yeboah and Jayne, 2018), provided that appropriate accompanied policies are deployed to ensure the quantity and quality of these jobs (e.g., Berdegué et al. 2025; Christiaensen et al., 2021). The AFS is the most important source of employment in the world - representing approximately one-sixth of the global economy - and supports the livelihoods of most poor and vulnerable people (e.g., Abdelaziz et al., 2020; Corong et al., 2024; Davis et al., 2024; Yi et al., 2024). Davis et al. (2024) have estimated that 1.23 billion people are employed in AFS, and 3.83 billion people worldwide live in households linked to AFS-based livelihoods. Concurrently, the increase in non-agricultural AFS employment worldwide goes along with the fall in the share of agricultural employment in total employment (e.g., Vos et al. 2019; Thurlow, 2021). As income grows, the share of AFS employment in total employment falls, and the number of non-agricultural AFS jobs increases relatively to farm-level employment (e.g., Davis et al., 2023; Dolislager et al. (2020).

There may, however, be hindrances to the capacity of the agricultural sector transformation to enhance the structural transformation process, and reduce the working poverty. If workers migrate to other sectors in the economy where productivity is low (e.g., the services sector in poor countries, many of which being located in SSA), then agricultural transformation may not result in the decline in the working poverty as expected, or it may reduce less the working poverty rate. For example, in many developing countries (e.g., poor countries/SSA countries), there may be obstacles to the capacity of agricultural transformation to reduce the working poverty rate through a successful structural transformation. In these countries, the structural transformation process is constrained by the stagnation of the manufacturing sector (e.g., McMillan et al. 2014; Rodrik, 2016), resulting in the

¹² See the literature survey by Berdegué et al. (2025).

migration of workers from the agricultural sector to the services sector, which is also a low productivity sector (e.g., Baccini et al., 2023; McCullough, 2024; Newfarmer et al. 2018; Rodrik, 2018). This limits the potential for agricultural transformation to generate significant decent job opportunities out of the agricultural sector, and hence to reduce the working poverty rate in the whole country. Incidentally, the constraints to a successful structural transformation can take the form of barriers to poor people's migration to modern sectors (e.g., labor market rigidity, firms' demand for industry-specific skills), and the low interregional worker mobility to geographical regions that are home to the expanding sectors (e.g., Pavcnik, 2017). These obstacles limit the capacity of agricultural transformation to reduce the working poverty rate in poor countries through structural transformation. In support of these arguments, Christiaensen et al. (2021) have argued that in poor countries (like in the majority of SSA countries), the fall in the share of employment in agriculture is still accompanied by an increase in agricultural employment in absolute terms. In these countries, the transition out of agriculture in the short run does not necessarily imply a smaller agricultural workforce overall. This may indicate, for these countries, that as they develop, the shares of employment and value added in the off-farm components of AFS increase relatively to the share of on-farm components. In this context, one may expect for poor countries (relatively to other developing countries) that the income growth may not necessarily be accompanied by the fall in the share of the AFS employment in total employment, and the increase in the non-agricultural AFS jobs relatively to farm-level employment.

Overall, building on the whole discussion under section 2, we expect that agricultural transformation could contribute to reducing the working poverty rate in developing countries, but to a lesser extent in poorest countries (LDCs) than in other countries (NonLDCs). This is thanks to the employment shifts from the primary agricultural sector to the AFS sub-sector, and additionally, from the primary agricultural and AFS sub-sectors to other sectors in the economy.

Against this backdrop, we postulate the following hypotheses.

Hypothesis 1: Agricultural transformation reduces the working poverty rate in developing countries.

Hypothesis 2: Agricultural transformation exerts a lower working poverty reduction effect in poorest countries (LDCs) than in other developing countries (NonLDCs).

Hypothesis 3: Agricultural transformation will induce the shift of the labor force from the primary agricultural sector to the AFS sub-sector in developing countries (*hypothesis 3a*), but to a lesser extent in LDCs than in NonLDCs (*hypothesis 3b*).

Hypothesis 4: Agricultural transformation will induce the shift of the labor force from the sub-sectors of primary agricultural and AFS to other sectors in the economy in developing countries (*hypothesis 4a*), but to a lesser extent in LDCs than in NonLDCs (*hypothesis 4b*).

Hypotheses 3 and 4 help test empirically the employment-shifts channels through which agricultural transformation can affect the working poverty in developing countries.

3. Empirical strategy

This section starts by laying down the baseline model specification that helps test the hypotheses described above (sub-section 3.1). Then, it presents a brief analysis of data concerning our main variables of interest in the analysis (sub-section 3.2). Finally, it discusses the appropriate econometric approach(es) to test empirically the theoretical hypotheses (sub-section 3.3).

3.1. Model specification

Our model specification is constructed by drawing essentially from the limited literature on the macroeconomic determinants of the working poverty (e.g., Combes et al., 2014) as well as from the literature on the macroeconomic determinants of employment in developing countries (e.g., Crivelli et al. 2012; Chami et al., 2018; Hollweg et al., 2016; Rovo et al., 2024). We use a set of control variables, drawing from these two strands of the literature. One of these controls is the development level, which is proxied here by the index¹³ of human development (“HDI”). The latter embeds three dimensions, including having a long and healthy life, being knowledgeable and having a decent standard of living. We expect that an improvement in the development level will be associated with a lower working poverty rate because an improvement in the standard of living is likely associated with greater employment opportunities. In addition, improvement in human capital (education and health) can affect positively labour-market outcomes (e.g., Rovo et al. 2024) as it plays a major role in the labor

¹³ Information on the human development index is available online at: <https://hdr.undp.org/data-center/human-development-index#/indicies/HDI>

movement from agricultural to non-agricultural activities (e.g., Porzio et al., 2022). In a nutshell, we expect that a higher human development will be associated with a lower working poverty rate, including through shifts in employment within the agricultural sector (from the primary agriculture to the AFS), and from the agricultural sector toward other sectors.

The other control variables are the structural reforms; and countries' demographic characteristics. Structural reforms are positively associated with labour-market outcomes (e.g., Crivelli et al. 2012; Hollweg et al., 2016), and can therefore be instrumental in reducing the working poverty. Likewise, we can expect that structural reforms can be associated with shifts in employment within the agricultural sector, and from the agricultural sector toward other sectors. We proxy structural reforms by the Fraser Institute's economic freedom index, which reflects the extent of market liberalizing reforms (e.g., Grier and Grier, 2021; Rutar and Rutar, 2025). Demographic factors (labour force participation rate; working-age population and share of urban population) can also help explain the level of the working poverty rate (e.g., Chami et al. 2018; Hollweg et al. 2016), including through workers' migration from the primary agricultural sector to the AFS (within the agricultural sector), and from the agricultural sector toward other sectors.

Against this backdrop, we consider the following model specification:

$$DEP_{it} = \alpha_0 + \alpha_1 ATI_{it} + \alpha_2 HDI_{it-1} + \alpha_3 EFI_{it-1} + \alpha_4 LFPR_{it} + \alpha_5 Log(WPOP)_{it} + \alpha_6 SHURB_{it} + \gamma_t + \mu_i + \varepsilon_{it} \quad (1)$$

i and t are respectively a country, and a year in the panel dataset. The latter contains 100 developing countries, of which 35 LDCs over the annual period from 2000 to 2021. The panel dataset was built on the basis of data available. The lists of countries in the full sample, and in the sub-sample of LDCs are presented in Appendix 1.

The dependent variable "DEP" is measured by the working poverty rate (denoted "WPOV") - to test hypotheses 1 and 2 - as well as by the ratio of non-agricultural AFS employment to the employment in agricultural sector (denoted "RATIO") - to test hypothesis 3. Finally, the variable "DEP" is measured by share of employment in the other sectors than the AFS to the total employment (denoted "ShNAFT") - to test hypothesis 4. To recall, the working poverty rate is the percentage of men and women youth adults (age 15+) that are in employment and living below US\$2.15 PPP. Data used to compute the indicators "RATIO" and "ShNAFT" were extracted from the FAOSTAT

database (<https://www.fao.org/faostat/en/#home>). Overall, model (1) is estimated with each of the three dependent variables, and based on hypotheses 1 to 4, we expect that agricultural transformation will negatively affect the indicator “WPOV”, and positively affect the indicators “RATIO” and “ShNAFT”, although to a lesser extent in LDCs than in NonLDCs. For the sake of the analysis, the values of the variables “WPOV” and “ShNAFT” range from 0 to 1 (instead of between 0 and 100). Both indicators “RATIO” and “ShNAFT” represent respectively the employment shift within the agricultural sector, that is away from the primary agriculture sector to the AFS – and the employment shift from the agricultural sector to the other sectors in the economy. Given that the variables “WPOV” and “ShNAFT” are proportional indicators (their values range between 0 and 1), we have applied the “logit” transformation to each of these two variables (e.g., Baum, 2008).

The variable “ATT” is the main regressor in the analysis. This is the index of agricultural transformation developed by Diao¹⁴ et al. (2024) building on the frameworks of agricultural transformation proposed by Timmer (1988) and De Janvry and Sadoulet (2019). The indicator “ATT” has four components. The first three components relate to the on-farm component of the agrifood system, and include the staples productivity; crop diversification, and agricultural labor productivity. The fourth and last component is the “food system expansion”, which measures the share of total value added generated “off the farm” in the agrifood system. The staples¹⁵ productivity sub-component is the output value per hectare for staple crops in a country. The second sub-component, crop diversification, reflects the extent to which countries diversify away from low-value crops into higher-value crops, specifically those in which a country is (potentially) competitive in global markets. The third sub-component (agricultural labor productivity) is the agricultural GDP per worker (used in logarithm). The last sub-component of the ATI, that is, the food system expansion, reflects the structural change that takes place within the agri-food system. This is the share of off-farm agrifood¹⁶ system GDP in total agrifood (see Diao et al., 2024 for details on the computation of the indicator ATI). Data on the ATI are available from 2000 to 2021. According to Diao et al. (2025), the proposed ATI can provide useful information about a country’s level of agricultural transformation in relation to other countries and its progress over time. It is worth noting here that in addition to estimating

¹⁴ We would like to express our gratitude to the Diao Xinshen, Jones Eleanor, Pauw Karl, Thurlow James and Xu Wenqian for having accepted to share the dataset they have developed on the agricultural transformation index.

¹⁵ Staples include cereals, such as rice, wheat, maize, barley, sorghum, and millet, and root crops, such as cassava, potatoes, and sweet potatoes (see Diao et al., 2024).

¹⁶ The off-farm components include elements such as agro-processing, food trade and transport, and food services (Diao et al. 2024).

model (1) with “ATT”, we also estimate several other variants of this model, including with each of the four components of “ATT” introduced once in the model specification. These are agricultural labour productivity (“AGRIPR”); crop diversification (“CROPDIV”); staples productivity (“STAPLEPR”); and food system expansion (“FOODSYS”).

The regressor “EFI” is measured by the Fraser Institute’s economic freedom index. It embeds five areas of reforms, which are: (1) size of government; (2) legal system and property rights; (3) sound money; (4) freedom to trade internationally; and (5) regulation (including regulations on credit markets, labour markets, and businesses). Higher values of “EFI” reflect the improvement of market-liberalizing reforms. “HDI” is the indicator of human development. Both variables “EFI” and “HDI” are introduced in model (1) with a one-year lag to mitigate the endogeneity (reverse causality) problem.

The variables “LFPR”, “WPOP” and “SHURB” represent respectively the labour force participation rate, the working population (that is, the population ages 15-64) and the share of urban population. They represent countries’ demographic characteristics, the first two indicators (“LFPR” and “WPOP”) aiming to capture the effect of labour-market supply on labour-market outcomes. We apply the natural logarithm to the regressor “WPOP” in order to limit its skewed distribution. All variables used in the analysis are briefly described in Appendix 2, and the related standard descriptive statistics are presented in Appendix 3.

α_0 to α_6 are parameters to be estimated, and α_1 is our main parameter of interest in the study. γ_t are year dummies that capture common macroeconomic shocks that might have affected employment indicators in countries in the panel dataset. μ_i represent unobserved time-invariant countries' specific effects, and ε_{it} is a random error term with zero conditional means.

3.2. Data analysis

We present in Figure 1 the average (over the period 2000-2021) of the main variables of interest in the analysis, over several samples, including the full sample, and the sub-samples of LDCs and NonLDCs. These indicators are the working poverty rate (“WPOV”); the agricultural transformation index (“ATT”); the ratio of non-agricultural AFS (agriculture and agri-food systems) employment to the employment in agricultural sector (denoted “RATIO”); and the share of employment in the other sectors than the AFS in the total employment (denoted “ShNAFS”). For the sake of graph analysis, all indicators are expressed here in percentage. Figure 2 presents the correlation patterns between each

of the indicators "WPOV", "ShNAFS" and "RATIO", and "ATP" over developing countries. Figure 3 provides the same correlation patterns, but over the sub-samples of LDCs and NonLDCs.

[Insert Figure 1, here]

It appears from Figure 1 that on average, the working poverty rate reached 19.4 percentage in developing countries, while the level of agricultural transformation slightly exceeded 50, as it reached 55.8. The average values of RATIO and ShNAFS over developing countries were respectively 59.6 and 45.6, and indicate that developing countries experienced greater employment shifts within the agricultural sector (i.e., away from the primary agricultural sector to AFS) than away from the agricultural sector to other sectors in the economy. Turning to the sub-samples, we observe that the level of agricultural transformation in NonLDCs almost doubled that of LDCs, and both the employment shifts within the agricultural sector, and from the agricultural sectors to other sectors in the economy are far greater in NonLDCs than in LDCs. As a result, it does not come as a surprise that the working poverty rate in LDCs (40.1 percentage) is five times higher than that in NonLDCs (8.3 percentage).

[Insert Figure 2, here]

Figure 2 indicates that agricultural transformation is negatively correlated with the working poverty rate in developing countries. However, in these countries, the level of agricultural transformation is positively correlated with both the extent of employment shifts within the agricultural sector ("RATIO"), and the extent of workers' movement out of the agricultural sectors to other sectors in the economy ("ShNAFS").

[Insert Figure 3, here]

Figure 3 shows similar correlation patterns for both LDCs and NonLDCs, albeit with steeper slopes for NonLDCs than for LDCs.

3.3. Econometric approach

We note from Appendix 3 that for all variables utilized in the analysis, the value of the between-country variation is far larger than the value of the within-country variation. Thus, to estimate model (1), we need an estimator that allows capturing both the within-country variation and the between-country variation of variables, as the within fixed effects estimator disregards the between-country variation of variables, and result in a loss of efficiency of estimates. For that reason, a good candidate estimator can be the Zellner (1962)'s Feasible generalized least squares (FGLS) estimator (e.g., Cameron and Trivedi, 2010). In addition to permitting to handle heteroskedasticity, serial and cross-

sectional correlations in the residuals (e.g., Bai et al., 2021; Zellner, 1962), the FGLS is particularly useful when the variance-covariance matrix of errors is unknown (Zellner, 1962). Therefore, we start our empirical analysis by using the FGLS estimator to estimate model (1), including with each of the three dependent variables¹⁷.

For the sake of comparison, we also report the regressions' outcomes based on the Driscoll and Kraay (1998)'s within fixed effects estimator (referred to as "FEDK" estimator). The FGLS-based outcomes and FEDK-based estimates are presented in Table 1.

A major limit of these two estimators is that they do not address the potential endogeneity concern (especially in the form of reverse causality) that can plague model (1). In fact, we suspect the variables capturing agricultural transformation, human development and economic freedom to be potentially endogenous. While we submitted in Section 2 that agricultural transformation could affect the working poverty rate, it is possible that developing countries with high working poverty rates will be more eager (than those with relatively lower working poverty rates) to spur the transformation of the agricultural sector, with a view to generating significant employment opportunities, and hence reducing the working poverty rate. This can particularly be the case in countries that face huge job challenges. Similarly, countries with higher working poverty rates can be willing to implement structural reforms, and improve their citizen living standards, thereby making the economic freedom and human development variables subject to the reverse causality problems. The same reasonings can apply to the feedback effect between the indicators "RATIO" and "ShNAFT" and each of the variables 'ATT', HDI' and 'EFF'.

To address this endogeneity concern, we utilize an instrumental variables approach, in particular here, the error component two-stage least squares (EC2SLS) estimator proposed by Baltagi (1981, 2001) and expounded in Baltagi (2008). The EC2SLS estimator is a random effects two-stage least squares (2SLS) estimator whose estimates are obtained as a weighted average of the "Within-2SLS" and the "Between-2SLS" estimates, where weights depend on the respective variance-covariance matrices of both estimates (Baltagi, 1981, 2001). In other words, this estimator allows not only to account for both the within-country variation and between-country variation of variables, but also to handle the reverse causality problem associated with the variables "ATT", "HDI" and "EFF" by means

¹⁷ It is important to note that in all regressions in the analysis where the dependent variable is the extent of employment shift within the agricultural sector, we introduce a dummy variable that captures the outliers observed in Figures 2 and 3 regarding the correlation patterns between the index of agricultural transformation and the variable "RATIO". The outlier-dummy variable took the value of 1 when the value of the indicator "RATIO" is higher than 2, and the value of 0, otherwise. While that dummy variable was included in those regressions, we do not report the estimates associated with it, to save space.

of instrumental variables. To meet the exclusion restriction requirement for the instruments, we need to find instrumental variables that affect the dependent variable (either WPOV, RATIO, or ShNAFT) only through the variable suspected to be endogenous (that is, ATI, HDI and EFI).

We instrument the variable capturing the agricultural transformation by three indicators: the agricultural land area, per 1000 hectares – denoted “AGRILAND” - (in natural logarithm); the land area equipped for irrigation per 1000 hectare - denoted “IRRIGLAND” (in natural logarithm) (it acts for the quality of land); and the pesticides used per value of agricultural production (g/Int\$), denoted “PESTICIDE”. The first two indicators capture countries’ agricultural-related resource endowment; and the last variable represents an agricultural-related input indicator. These three variables are critical for agricultural transformation, including for agricultural productivity (e.g., Rajkhowa and Baumüller, 2024) and the expansion of the agrifood system (e.g., Amare et al., 2023; Grilli et al., 2024; Gollin et al., 2014; Kyle et al., 2016; Laurent et al., 2025; Winemann, 2025). Next, we instrument the human development and economic freedom regressors by the legal origin indicators of La Porta et al. (2008). LaPorta et al. (2008) have shown that the historical origin of a country’s laws is highly correlated with its legal rules and regulations, and economic outcomes, and has implications for implementation of economic reforms. In particular, based on countries in our full sample, we utilize three variables that capture the legal origin of the company law or commercial code of a country (see Laporta et al., 2008). The dummy “LEGFR” takes the value of 1 for countries whose legal structure is based on the French commercial code, and 0 otherwise. The dummy “LEGUK” takes the value of 1 for countries whose legal structure is based on the English common law, and the value of 0 otherwise. Finally, the dummy “LEGGE” takes the value of 1 for countries whose legal structure is based on the German commercial code, and the value of 0 otherwise. Information on the legal origin variables is extracted from the Rahael Laporta’s Website: <https://faculty.tuck.dartmouth.edu/rafael-laporta/research-publications/>

To assess empirically the relevance of the agricultural transformation-related instruments, we run a regression where the dependent variable is the indicator “ATI”, and the regressors are “AGRILAND” (in natural logarithm); “PESTICIDE” and “IRRIGLAND” (in natural logarithm). The regression is estimated by means of both the FGLS and the FEDK estimators, the outcomes of which are reported in columns [1] and [2] of Table 2. We also assess the relevance of the legal origin dummies as appropriate instruments of the human development and economic freedom indicators by running regressions where the dependent variables are the indicators “HDI” and “EFI”, and the regressors are the dummies “LEGFR”, “LEGUK” and “LEGGE”. The regression is estimated by

means of the FGLS estimator only¹⁸, the outcomes of which are reported in columns [3] and [4] of Table 2, respectively for “HDI” as dependent variable, and “EFF” as dependent variable.

The estimations’ outcomes reported in Tables 3 to 5 are uncovered using the EC2SLS estimator. We first estimate model (1) (with each of the three dependent variables) over the full sample, the results of which are presented in columns [1] to [3] of Table 3. These outcomes help test hypotheses 1, 3a, and 4a. To test the hypotheses 2, 3b and 4b, we estimate variants of model (1) (with each of the three dependent variables), which are nothing else than model (1) in which we introduce a dummy “LDC” that represents LDCs, and the interaction between that dummy variable and the indicator “ATT”. The “LDC” dummy takes the value of 1 for LDCs in the full sample, and 0 otherwise (i.e., for NonLDCs). The outcomes of these estimations - that is, with each of the three dependent variables - are presented in columns [5] to [7] of Table 3.

Next, we examine how each component of the indicator “ATT” affects the working poverty rate in the full sample as well as in LDCs versus NonLDCs within the full sample. To assess the effect of ATT’s components on the working poverty over the full sample, we estimate several variants of model (1) – here the dependent variable is only “WPOV” – in which the indicator “ATT” is replaced with each of its four components, namely agricultural labour productivity (“AGRIPR”); crop diversification (“CROPDIV”); staples productivity (“STAPLEPR”); and food system expansion (“FOODSYS”). It is important to note that each of these indicators is introduced once in the model specification. The outcomes of these estimations are reported in columns [1] to [4] of Table 4. To assess the effect of ATT’s components on the working poverty in LDCs versus NonLDCs, we introduce in these previous models, the “LDC” dummy along with its interaction with the variable “ATT”. The outcomes of these regressions are presented in columns [5] to [8] of Table 4.

Finally, we test the robustness of the findings obtained over LDCs versus NonLDCs, by examining the effect of agricultural transformation on the working poverty rate, and on the extent of employment shifts measured by the variables “RATIO” and “ShNAFS” in SSA countries versus NonSSA countries within the full sample. The related estimates are reported in Table 5. These outcomes are obtained by estimating variants of model (1), including with “ATT” (and the dependent variables “WPOV”, “RATIO” and “ShNAFS”) - in which we introduce the dummy “SSA” and its interaction with the variable “ATT”. The dummy “SSA” takes the value of 1 for SSA countries in the full sample, and the variable of 0, otherwise.

¹⁸ As regressors are only dummies here, the FEDK estimator is not appropriate for running the regression.

Finally, we would like to note that for the sake of brevity, we report in Tables 4 and 5 only the estimations' outcomes related to our main variables of interest. The results concerning control variables could be obtained upon request.

4. Empirical results

Outcomes in Table 1 suggest that FGLS-based estimates and FEDK-based estimates are yet different (columns [1] and [2]; columns [3] and [4]; and columns [5] and [6]), but have similar signs, and almost the same statistical significance. We obtain that agricultural transformation is negatively associated with the working poverty in developing countries (columns [1] and [2]). In the meantime, it is associated with a shift in employment both within the agricultural sector (columns [3] and [4]), and away from the agricultural sector to other sectors in the economy (columns [5] and [6]). The findings in columns [3] to [6] explain how agricultural transformation can help reduce the working poverty in developing countries. Regarding control variables, we find that an improvement in human development is negatively associated with the working poverty, but positively associated with the employment shifts within the agricultural sector, and from the agriculture sector to other sectors. Economic freedom is not significantly associated with the working poverty, but it is positively associated with employment shift within the agricultural sector (FGLS-based regressions). This reveals, however, mixed effects on the employment shift from the agricultural sector to other sectors in the economy (columns [5] and [6]). An increase in the share of urban population is negatively associated with the working poverty (see columns [1] and [2]), and positively associated with employment shifts (see columns [3] and [6]). The labour force participation rate and the working age population reveal mixed effects on the employment shifts, as the FGLS-based outcomes are different from the FEDK-based estimates.

[Insert Table 1, here]

[Insert Table 2, here]

Both FGLS-based estimates and FEDK-based estimates in columns [1] and [2] of Table 2 indicate that all three instruments of agricultural transformation are significantly (at the 1% level) associated with the transformation of the agricultural sector. Likewise, the historical origin of a country's laws is positively associated with human development¹⁹, and with economic freedom (a proxy for structural

¹⁹ We, however, observe no significant effect of the legal structure based on the English common law on human development.

reforms). Based on the findings from Table 2, we infer that the agricultural land area; the land area equipped for irrigation; and the pesticides used are appropriate instruments for agricultural transformation. Moreover, the legal origins are suitable instruments for human development and economic freedom. Overall, we conclude that the EC2SLS estimates based on those instruments are reliable.

[Insert Table 3, here]

We now take up outcomes in Tables 3 to 5. We note from Table 3 that agricultural transformation leads to a lower working poverty rate (at the 1% level) (column [1]), including thanks to its positive effect on the variable “RATIO” and “ShNAFS”, which represent respectively the employment shifts from the primary agricultural sector to the AFS (column [2]), and away from the agricultural sector to other sectors in the economy (column [3]). In economic terms, an increase in the index of agricultural transformation by a one standard deviation (i.e., by 0.212-point) leads to the decline in the working poverty rate by 0.83-point [= $0.212 \times (-3.906)$]; and the almost identical increase in the indicators “RATIO” and “ShNAFS”, respectively by 0.255-point [= 0.212×1.203] and 0.26-point [= 0.212×1.225].

Results relating to control variables in Table 3 suggest that economic freedom (a proxy for structural reforms) affects positively and significantly the working poverty rate in developing countries. These puzzling results push us to deepen the analysis by investigating whether the effect of economic freedom on the working poverty depends on countries’ development level. To that effect, we augment model (1) with the interaction between the variables “EFI” and “HDI”, and consider this interaction variable as endogenous in the regression. The latter is estimated by the EC2SLS approach, the outcomes of which are reported in column [4] of Table 3. We find that the coefficient of the interaction variable is negative and significant at the 1% level, and the coefficient of “HDI” is positive and significant, also at the 1% level. We plot in Figure 4, at the 95 per cent confidence intervals, the marginal impact of economic freedom on the working poverty rate in developing countries, for varying levels of human development.

[Insert Figure 4, here]

It appears that this marginal impact decreases as developing countries improve their development level, and becomes particularly negative for relatively high levels of human development. This marginal impact is positive and significant (although decreasing) for values of HDI lower than

0.61. It is negative and significant for values of HDI²⁰ higher than 0.74, and not statistically significant for values of HDI comprised between 0.26 and 0.85. In other words, economic freedom has not resulted in a lower working poverty rate in poorest countries, while it has reduced it in countries with high human development levels. As for other control variables in columns [1] to [3], we find, as expected, that an improvement in human development reduces the working poverty rate, and induces a shift in employment from the agricultural sector to other sectors in developing countries. However, there is no significant effect (at the conventional significance levels) of human development on the employment shift within the agricultural sector. Incidentally, countries' demographic factors also affect the working poverty rate and the employment shifts within the agricultural sector and away from the agricultural sector to other sectors in the economy. We note, for example, that a higher share of the urban population results in a lower working poverty rate, and in greater employment shifts within the agricultural sector and from the agricultural sector to other sectors in the economy. An increase in the working population age results in a higher working poverty rate, and does not allow for the employment shifts with the agricultural sector and away from the agricultural sector to other sectors in the economy.

Outcomes in column [6] of Table 3 indicate that agricultural transformation induces a lower extent of employment shift from the primary agriculture to the AFS in LDCs than in other developing countries. On the other hand, it affects equally the extent of employment shifts from the agricultural sector to other sectors in the economy in LDCs and other developing countries (see column [7]). There is, however, no significant effect of agricultural transformation on employment shifts within the agricultural sector. The net effect of agricultural transformation on the extent of employment shift within the agricultural sector (i.e., on the variable "RATIO") in LDCs and NonLDCs amount respectively to +0.273 (= 1.335 - 1.062) and +1.335. Thus, an increase in the index of agricultural transformation by a one standard deviation induces an increase in the extent of employment shift within the agricultural sector by 0.058-point (= 0.212*0.273) in LDCs, and by 0.283-point (=0.212*1.335) in NonLDCs (almost six-time higher than that of LDCs). Similarly, a 0.1-point increase in the index of agricultural transformation results in an increase in the extent of employment shift from the agricultural sector to the other economic sectors by 0.26-point (= 0.212*1.233) in both LDCs and NonLDCs. These findings contribute to explaining why agricultural transformation exerts a lower working poverty reduction effect in LDCs than in NonLDCs, and ultimately leads to a net

²⁰ The values of HDI in the full sample range from 0.26 to 0.85.

positive and significant effect on the working poverty rate in LDCs, and a net negative effect on the working poverty rate in NonLDCs. In terms of magnitude, an increase in the index of agricultural transformation by a one standard deviation leads to an increase in the working poverty rate by 0.22-point [= $0.212*(-2.431+3.471)$] in LDCs and a decline in the working poverty rate by -0.515 [= $0.212*(-2.431)$] in NonLDCs. Overall, the outcomes indicate that while agricultural transformation leads to a decline in the working poverty in NonLDCs, this has not been the case for LDCs, as for the latter, it has resulted in a higher poverty rate. This signifies for LDCs that agricultural transformation has not reached the requisite level to reduce the working poverty. This can be explained by the very low extent of employment shift from the primary agriculture to the AFS within the agricultural sector, induced by agricultural transformation in LDCs. This runs in contrast with the stronger positive effect of agricultural transformation on the shift of migration of workers from the agricultural sector to other sectors in the economy. These findings tend to support hypotheses 1 and 2.

[Insert Table 4, here]

Estimates presented in columns [1] to [4] of Table 4 indicate that three of the four components of the index of agricultural transformation appear to exert a significant effect (yet negative) on the working poverty rate in developing countries. These are the agricultural productivity, the expansion of the food system, and crop diversification. Staple productivity does not appear to influence significantly (at the conventional significance levels) the working poverty rate. The expansion of the food system exerts the largest working poverty reduction effect, followed by crop diversification, and finally the improvement in the agricultural productivity. Concurrently, we note from columns [5] to [8] of Table 4, and in line with the findings in column [5] of Table 3, that the improvement in agricultural productivity, the expansion of the food system, crop diversification and the improvement in staple productivity exert a lower working poverty reduction effect in LDCs than in NonLDCs. The net effects of agricultural productivity, the food system expansion, crop diversification and the staple productivity on the working poverty rate in LDCs amount respectively to -3.095 (= $-6.123+3.028$); +0.651 (= $-2.843+3.494$); +0.25 (= $-1.307+1.557$), and +1.192 (= $-1.210+2.402$). For NonLDCs, the net effects of agricultural productivity, the expansion of the food system, crop diversification and the staple productivity on the working poverty rate amount respectively to -6.123; -2.843; -1.307; and -1.210. In other words, the positive effect of agricultural transformation on the working poverty rate in LDCs obtained in column [5] of Table 3 reflects yet a negative working poverty reduction effects of the improvement in agricultural productivity, but positive effects of the other three components of

the index of agricultural transformation – namely, the expansion of the food system, crop diversification and the staple productivity - on the working poverty rate. Staple productivity exerts the largest positive effect on the working poverty in LDCs, followed by the expansion of the food system, and finally, crop diversification. Conversely, for NonLDCs, all components of the index of agricultural transformation are conducive to the decline in the working poverty rate. In particular, for NonLDCs, agricultural productivity improvement exerts the largest negative working poverty reduction effect, followed by the expansion of the food system, crop diversification and the improvement in staple productivity. *Overall, the findings indicate that agricultural transformation has not reached the requisite level to lead to the fall in the working poverty rate in LDCs. Conversely, in the other developing countries, agricultural transformation and all its components have resulted in the decline in the working poverty rate.*

[Insert Table 5, here]

Even though the sub-sample of SSA countries is heterogenous as it includes both LDCs and NonLDCs, the findings concerning this group of countries align with those obtained for LDCs (and NonLDCs). We note from columns [2] and [3] of Table 5 that agricultural transformation has resulted in a lower extent of employment shift within the agricultural sector (see column [2]) and from the agricultural sector to other sectors (see column [3]), in SSA countries than in NonSSA countries. The net effects of agricultural transformation on the indicators “RATIO” and “ShNAFS” in SSA countries amount respectively to 0.244 ($= 0.721 - 0.477$) and 0.754 ($= 1.360 - 0.606$). In NonSSA countries, the net effects of agricultural transformation on the indicators “RATIO” and “ShNAFS” amount respectively to 0.721 and 1.360. The weak magnitudes of employment shifts within the agricultural sector, and from that sector to other sectors in SSA countries contributes to explaining why agricultural transformation exerts an increase in the working poverty rate in SSA countries. In the meantime, a greater agricultural transformation leads to a fall in the working poverty rate in NonSSA countries. In fact, the net effect of agricultural transformation on the working poverty rate is positive in SSA countries and amounts to 0.986 ($= -2.648+3.634$), and negative in NonSSA and is equal in magnitude to -2.648.

5. Further analysis

In this section, we test the eventual existence of a non-linear effect of agricultural transformation on the working poverty rate in developing countries. The rationale for undertaking this additional analysis stems from the observation in Figure 5 that there is a nonlinear correlation pattern between

the index of agricultural transformation and the working poverty rate in developing countries – eventually in the form of a U-curve.

[Insert Figure 5, here]

To examine whether there is a causal (nonlinear) effect of agricultural transformation on the working poverty rate in developing countries, we estimate (by means of the EC2SLS approach) a variant of model (1) where the dependent variable is the indicator of working poverty, in which we introduce the square term of the indicator of agricultural transformation. The estimation's results are reported in Table 6.

[Insert Table 6, here]

We note from that Table that the coefficient of the variable “ATI” is positive and significant at the 1% level, while the estimate related to the variable $[ATI]^2$ is negative and significant at the 1% level. Taken together, these outcomes indicate that there is genuinely a non-linear effect of agricultural transformation on the working poverty rate in developing countries, including in the form of U-curve, as expected. Agricultural transformation leads to a reduction of the working poverty rate only once it reaches a certain threshold, which amounts, on average, to 0.57 [= $27.24/(2*23.72)$]. In other words, on average, for developing countries whose levels of agricultural transformation are lower than 0.57, agricultural transformation leads to a higher poverty rate, while developing countries whose levels of agricultural transformation exceed 0.57 experience the working poverty reduction effect of agricultural transformation. We present in Figure 6, at the 95 per cent confidence intervals, the marginal impact of agricultural transformation on the working poverty rate in developing countries, for varying degrees of agricultural transformation.

[Insert Figure 6, here]

It appears that this marginal impact decreases as countries further transform their agricultural sector. However, it is not always statistically significant: it is positive and significant for values of ATI lower than 0.53, and negative and significant for values of ATI higher than 0.6. Put it differently, for developing countries whose levels of ATI are lower than 0.53, agricultural transformation does not reduce the working poverty rate, but rather increases it, although among these countries the positive working poverty rate effect of agricultural transformation is lower, the higher the degree of agricultural transformation. Conversely, countries whose levels of ATI exceed 0.6 (value that is close to the average value found above, which was 0.57) experience a negative and significant effect of agricultural transformation on the working poverty rate, and the higher the degree of agricultural transformation, the greater is the working poverty rate reduction effect of agricultural transformation. Finally,

developing countries whose values of ATI are comprised between 0.53 and 0.6 experience no significant effect of agricultural transformation on the working poverty rate.

We provide three lists of countries in Appendix 4: those whose values of ATI in 2021 exceed 0.6; those for which the values of ATI in 2021 are lower than 0.53; and those for which the values of ATI in 2021 are comprised between 0.53 and 0.6. There are 49 developing countries whose levels of ATI are higher than 0.6 (countries that had levels of agricultural transformation that allowed reducing the working poverty rate). Of these 49 developing countries, 48 are NonLDCs, and only one (Bangladesh) is an LDC. On the other hand, for 13 developing countries (of which 7 LDCs²¹), agricultural transformation has exerted no significant effect on the working poverty rate. All the other LDCs (i.e., 27 LDCs) are among the 38 developing countries that did not sufficiently transform their agricultural sector so as to reduce the working poverty rate in 2021 (see the last two columns of Appendix 4). These findings confirm those in the previous Tables.

6. Conclusion

The present analysis has investigated empirically the effect of agricultural transformation on the working poverty rate in developing countries through the channel of employment shifts within the agricultural sector (i.e., from the primary agriculture to the agrifood system) and out of the agricultural sector to other sectors. The analysis covers 100 developing countries of which 35 LDCs, over the annual period from 2000 to 2021. The findings indicate that while agricultural transformation has resulted in the fall in the working poverty rate in NonLDCs, this is not the case for LDCs, i.e., poorest countries in the world. For those countries, agricultural transformation has, instead, led to an increase in the working poverty rate, thereby suggesting that agricultural transformation has not reached the requisite level to generate a fall in the working poverty rate in poorest countries. These findings apply as well as to SSA countries, many of them being LDCs.

Policymakers in developing countries – including LDCs and SSA countries - are facing a huge jobs creation challenge, and are therefore, contemplating different means of generating decent jobs for their bulge youth population. This paper shows that one of these avenues is the transformation of the agricultural sector. However, to ensure that this transformation genuinely translates into the decline of the working poverty rate, it is important that developing countries' policymakers, especially

²¹ These LDCs are Senegal; Myanmar; Benin; Cambodia; Malawi; Comoros; and Nepal.

those in LDCs, adopt (in parallel of measures to transform the agricultural sector²²), measures that reduce barriers to workers' movement across sectors, as well as policies that support the expansion of other economic sectors, especially productive ones.

²² See for example, Diao et al. (2025); Liu et al. (2025); Otsuka and Fan (2021); Ragasa et al. (2025).

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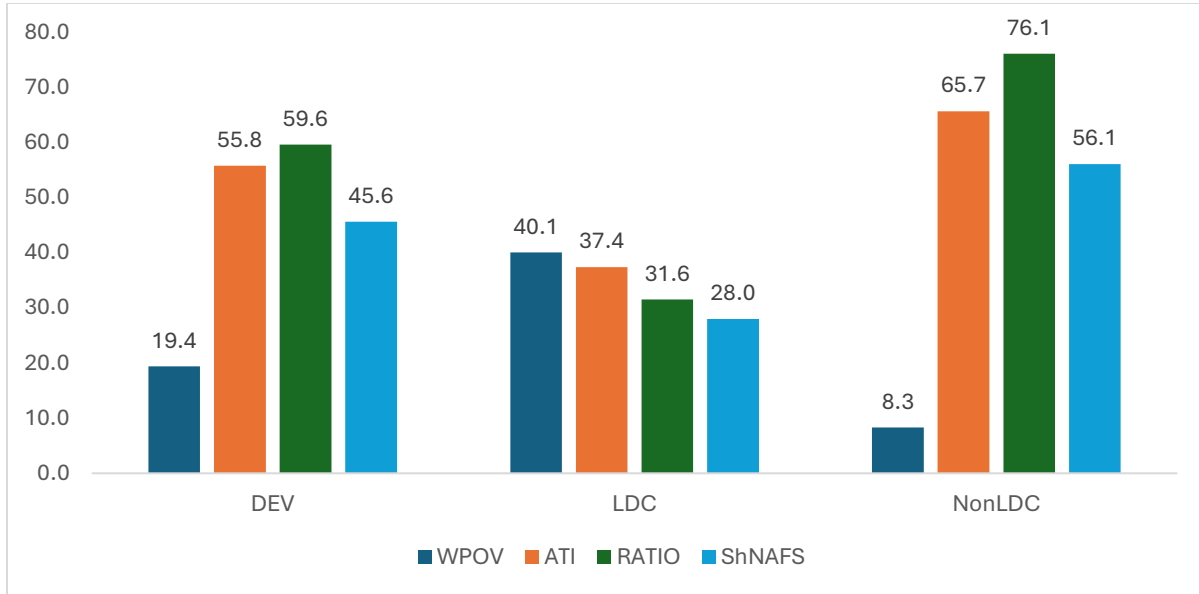
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FIGURES

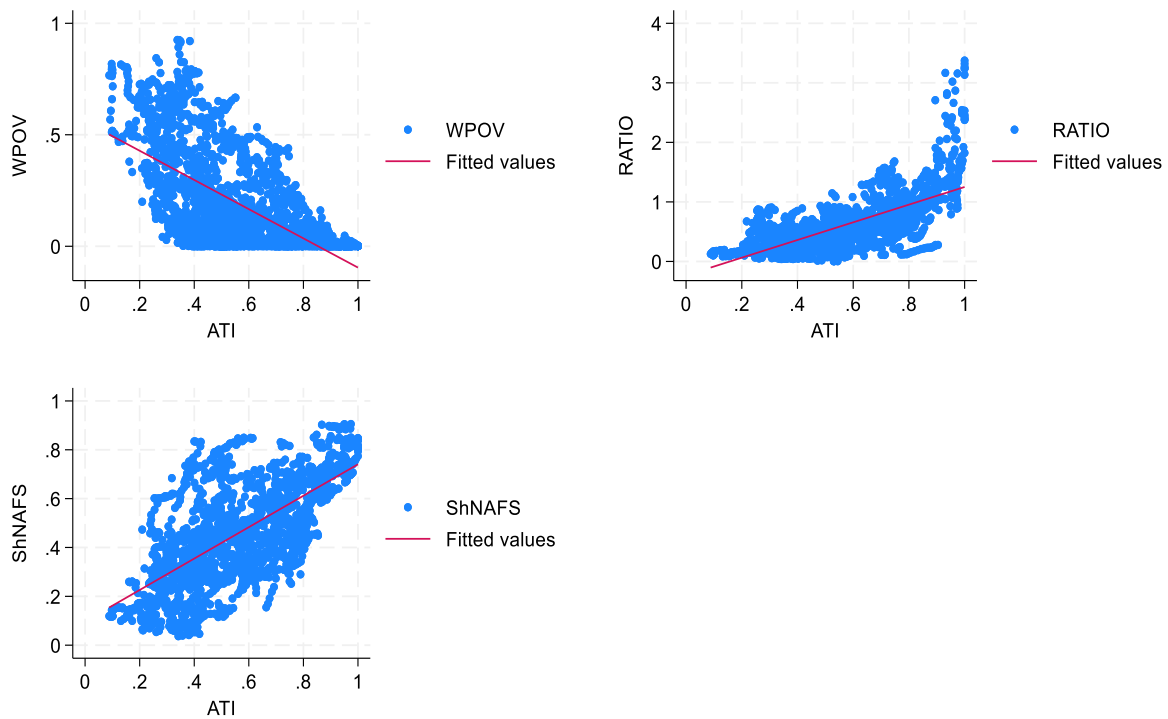
Figure 1: Agricultural transformation, employment in the agri-food system and the working poverty rate in developing countries, including in LDCs and NonLDCs_Average over the period 2000-2021



Source: Author's calculation based on data from the FAOSTAT database.

Note: The indicators "WPOV", "ATI" and "RATIO" are respectively the indicators of working poverty rate; agricultural transformation index, and the ratio of non-agricultural AFS (agriculture and agri-food systems) employment to the employment in agricultural sector. The indicator "ShNAFS" represents the share of employment in the other sectors than the AFS (agri-food system) in the total employment. For the sake of the graph construction, the indicators "WPOV", "RATIO", and "ShNAFS" are expressed in percentage. The values of the indicator "ATI" were initially comprised between 0 and 1. We transformed that indicator (by multiplying it by 100) so that its values range from 0 to 100. The acronym "DEV"; "LDC" and NonLDC" represent respectively the group of developing countries; the sub-sample of Least developed countries; and the sub-sample of developing countries that are not LDCs.

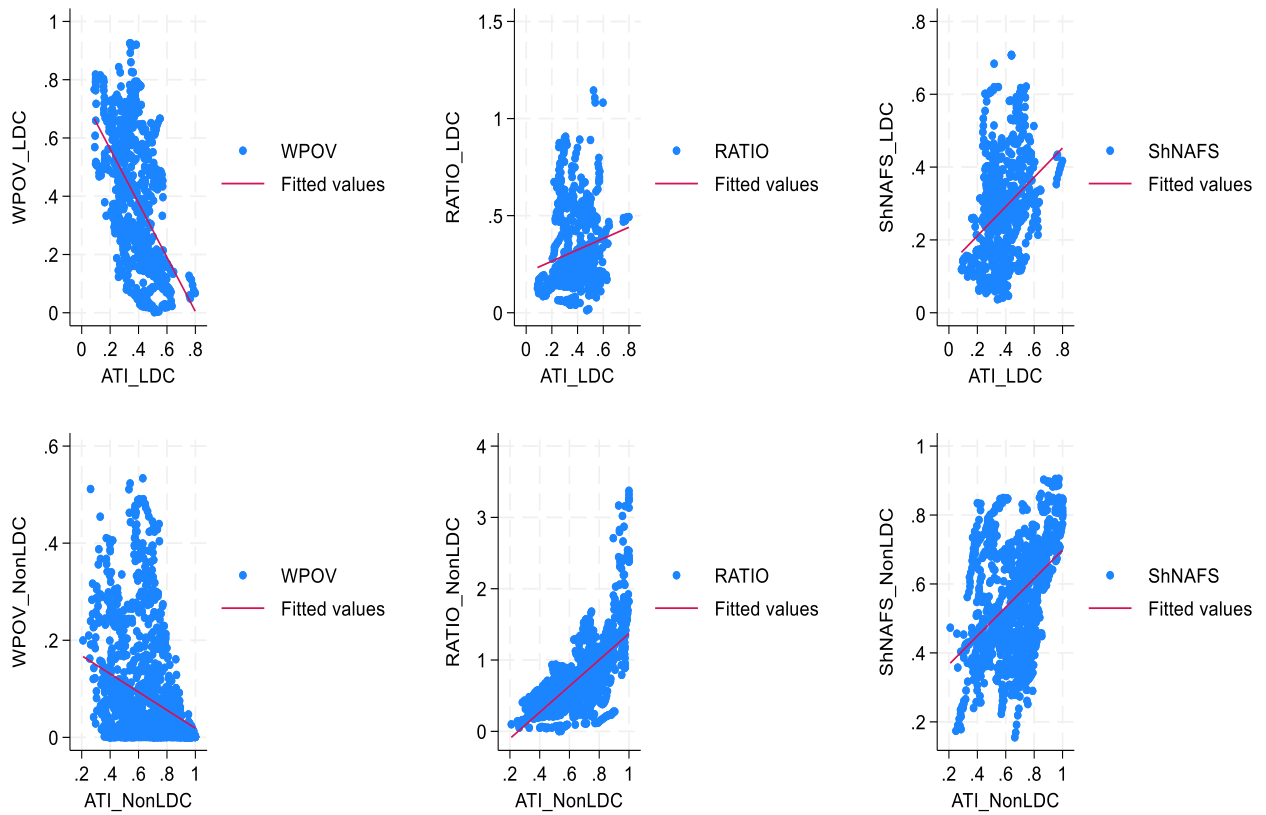
Figure 2: Correlation patterns between “ATI”, “WPOV”, “RATIO” and “ShAFS” in developing countries_Over the period 2000-2021



Source: Author

Note: The indicators "WPOV", "ATI" and "RATIO" are respectively the working poverty rate; agricultural transformation index, and the ratio of non-agricultural AFS (agriculture and agri-food systems) employment to the employment in agricultural sector. The indicator "ShNAFS" represents the share of employment in the other sectors than the AFS (agri-food system) to the total employment. The indicators "WPOV", "RATIO", and "ShNAFS" are not expressed in percentage. The values of the indicator "ATI" are comprised between 0 and 1.

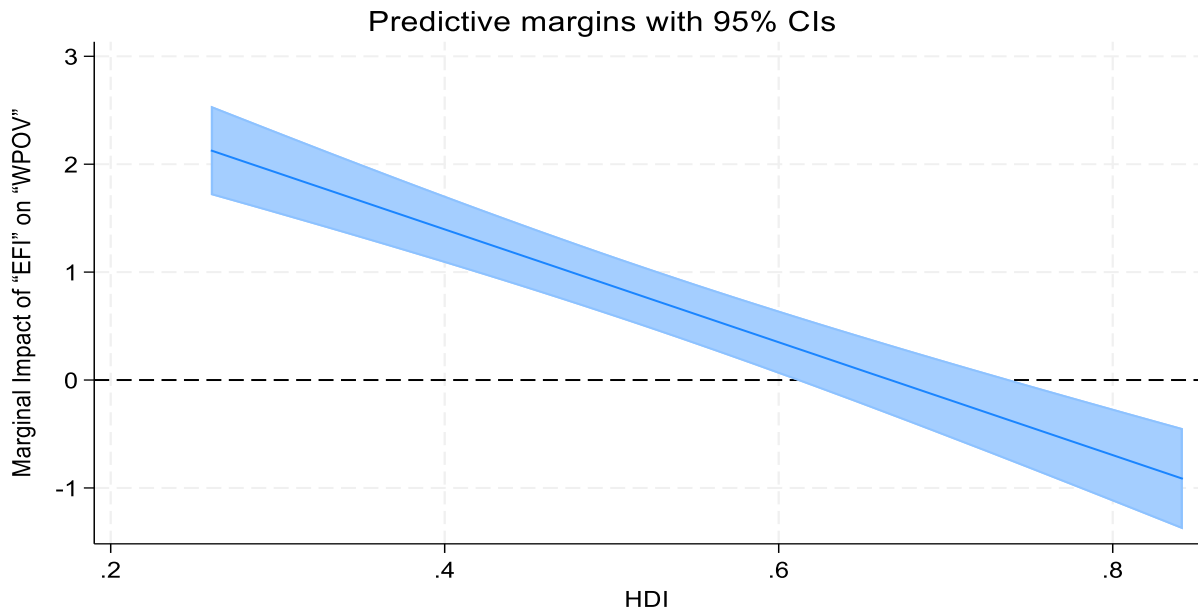
Figure 3: Correlation patterns between “ATI”, and each of the indicators “WPOV”, “RATIO” and “ShNAFS”_ in LDCs and NonLDCs over the period 2000-2021



Source: Author

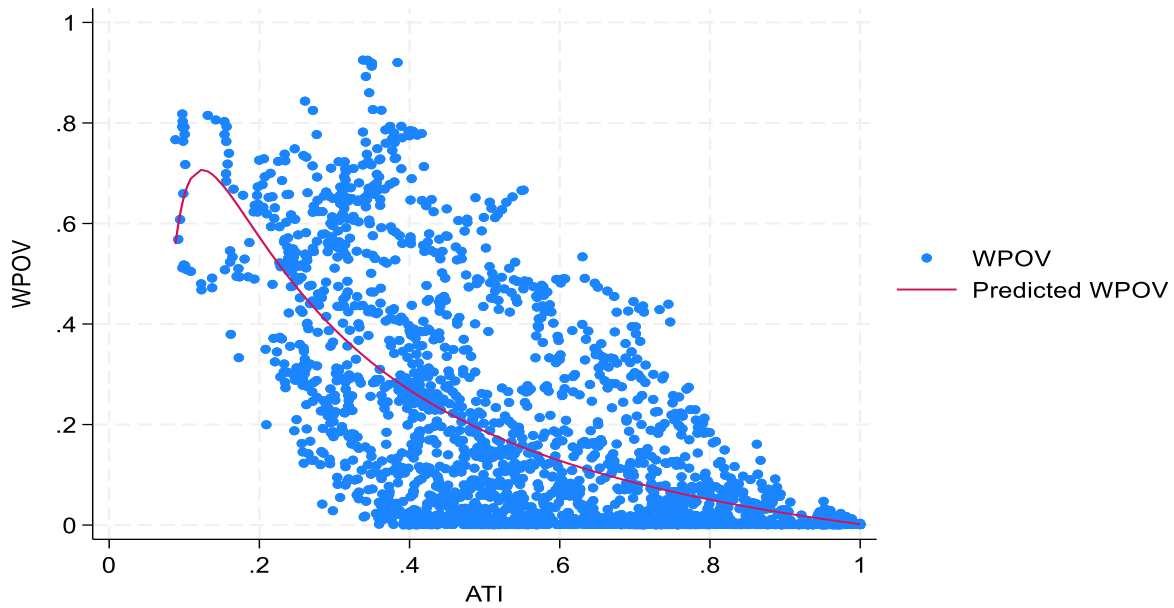
Note: The indicators “WPOV”, “ATI” and “RATIO” are respectively the working poverty rate; agricultural transformation index, and the ratio of non-agricultural AFS (agriculture and agri-food systems) employment to the employment in agricultural sector. The indicator “ShNAFS” represents the share of employment in the other sectors than the AFS (agri-food system) to the total employment. The indicators “WPOV”, “RATIO”, and “ShNAFS” are not expressed in percentage. The values of the indicator “ATI” are comprised between 0 and 1.

Figure 4: Marginal Impact of “EFI” on “WPOV” for varying levels of human development in developing countries



Source: Author

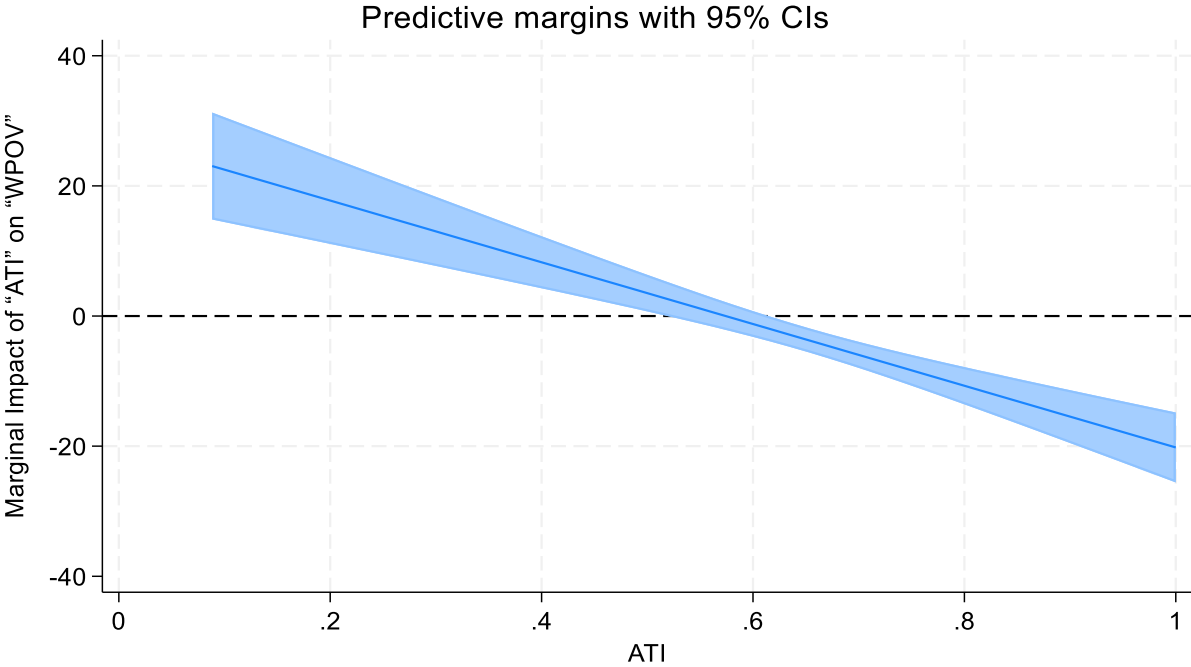
Figure 5: Nonlinear correlation pattern between agricultural transformation and the working poverty rate in developing countries_over the period 2000-2021



Source: Author

Note: The indicators “WPOV” and “ATI” are respectively the working poverty rate, and the index of agricultural transformation. The indicator “WPOV” is not expressed in percentage. The values of the indicator “ATI” range from 0 to 1.

Figure 6: Marginal Impact of “ATI” on “WPOV” for varying levels of “ATI” in developing countries



Source: Author

TABLES and APPENDICES

Table 1: Effect of agricultural transformation on the working poverty rate and the relative AFS employment share in developing countries

Estimators: FGLS (with panel-specific first order autocorrelation) and FEDK

Variables	FGLS	FEDK	FGLS	FEDK	FGLS	FEDK
	WPOV	WPOV	RATIO	RATIO	ShNAFS	ShNAFS
	(1)	(2)	(3)	(4)	(5)	(6)
ATI	-0.320** (0.138)	-2.175*** (0.503)	0.412*** (0.0323)	0.190*** (0.0442)	0.579*** (0.0604)	0.987*** (0.138)
HDI	-10.34*** (0.427)	-14.51*** (0.643)	0.417*** (0.0689)	0.538*** (0.170)	2.849*** (0.173)	1.700*** (0.333)
EFI	0.0101 (0.0156)	0.0269 (0.0261)	0.00530** (0.00253)	-0.00542 (0.00440)	-0.0180*** (0.00626)	0.0638*** (0.0193)
LFPR	0.0151*** (0.00300)	-0.0283*** (0.00443)	-0.000236 (0.000477)	0.00511*** (0.000801)	-0.0165*** (0.00120)	-0.00778*** (0.00227)
Log(WPOP)	0.0377 (0.0363)	1.424*** (0.173)	-0.0406*** (0.00484)	0.156*** (0.0238)	-0.0731*** (0.00997)	0.239*** (0.0325)
SHURB	-0.0195*** (0.00334)	-0.0527*** (0.00600)	0.00673*** (0.000467)	0.00756*** (0.000678)	0.0201*** (0.000874)	0.00309 (0.00247)
Constant	3.153*** (0.594)	-11.23*** (2.342)	0.377*** (0.0838)	-2.983*** (0.342)	-0.774*** (0.154)	-5.641*** (0.398)
Observations	2,149	2,149	1,736	1,736	1,658	1,658
Countries	100	100	82	82	82	82
Pseudo R-squared	0.8333		0.7892		0.8481	
Wald Chi2 Statistic (P-value)	2247.89 (0.0000)		1889.09 (0.0000)		6957.77 (0.0000)	
Within R-squared	0.5000		0.4467		0.4208	
F-Statistic (P- value)	3337.09 (0.0000)		1818.56 (0.0000)		1268.21 (0.0000)	

Note: * p -value <0.1 ; ** p -value <0.05 ; *** p -value <0.01 . Robust standard errors are in parenthesis. The Pseudo R-squared was calculated as the correlation coefficient between the dependent variable and its predicted values. Time dummies were included in the FGLS-based regressions. As all our dependent variables are proportional indicators (their values range between 0 and 100), we have applied the logit to each of these variables (the variables were first divided by 100 to ensure that their values range between 0 and 1) (e.g., Baum, 2008).

Table 2: First-Stage Regressions of the Instrumental Variables Approach
Estimators: FGLS (with panel-specific first order autocorrelation) and FEDK

Variables	FGLS	FEDK	Variables	FGLS	FGLS
	ATI	ATI		HDI	EFI
	(1)	(2)		(3)	(4)
Log(IRRIGLAND)	0.0429*** (0.00130)	0.0545*** (0.00730)	LEGFR	0.0954*** (0.0334)	1.558*** (0.552)
PESTICIDE	0.00923*** (0.00156)	0.0107*** (0.00342)	LEGUK	0.0445 (0.0334)	1.792*** (0.552)
Log(AGRILAND)	-0.0550*** (0.00279)	0.121*** (0.0215)	LEGGE	0.195*** (0.0338)	1.809*** (0.563)
Constant	0.813*** (0.0235)	-0.813*** (0.169)	Constant	0.450*** (0.0333)	4.012*** (0.551)
Observations	2,193	2,193	Observations	2,173	2,173
Countries	100	100	Countries	100	100
Pseudo R-squared	0.4854		Pseudo R-squared	0.3668	0.2998
Wald Chi2 Statistic (P-value)	1770.81 (0.0000)		Wald Chi2 Statistic (P- value)	3749.21 (0.0000)	379.11 (0.0000)
Within R-squared		0.0632			
F-Statistic (P-value)		58.82 (0.0000)			

*Note: *p-value<0.1; **p-value<0.05; ***p-value<0.01. Robust standard errors are in parenthesis. The Pseudo R-squared has been calculated as the correlation coefficient between the dependent variable and its predicted values. Time dummies were included in the FGLS-based regressions.*

Table 3: Effect of agricultural transformation on the working poverty rate and the extent of employment shifts in developing countries
Estimator: EC2SLS

Variables	<i>Effect of “ATI” in developing countries</i>				<i>Effect of “ATI” in LDCs versus NonLDCs</i>		
	WPOV	RATIO	ShNAFS	WPOV	WPOV	RATIO	ShNAFS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ATI	-3.906*** (0.876)	1.203*** (0.162)	1.225*** (0.263)	0.326 (0.815)	-2.431*** (0.611)	1.335*** (0.132)	1.233*** (0.214)
EFI*HDI				-5.229*** (0.599)			
ATI*LDC					3.471*** (0.653)	-1.062*** (0.117)	0.201 (0.237)
LDC					-1.612*** (0.412)	0.344*** (0.0889)	-0.648*** (0.141)
EFI	0.792*** (0.160)	0.0124 (0.0293)	0.0910* (0.0507)	3.488*** (0.343)	0.659*** (0.119)	0.0279 (0.0262)	0.0546 (0.0450)
HDI	-12.57*** (1.789)	-0.566 (0.381)	1.481*** (0.531)	14.47*** (3.580)	-15.95*** (1.283)	-1.052*** (0.374)	-0.511 (0.471)
LFPR	-0.0161*** (0.00544)	0.000770 (0.000952)	-0.0214*** (0.00166)	0.0325*** (0.00636)	0.0163*** (0.00421)	-0.00246*** (0.000878)	-0.0235*** (0.00143)
Log(WPOP)	0.279*** (0.0557)	-0.0367*** (0.0103)	-0.0621*** (0.0140)	0.0417 (0.0472)	0.155*** (0.0323)	-0.0350*** (0.00832)	-0.0749*** (0.0107)
SHURB	-0.0125** (0.00624)	0.00711*** (0.00111)	0.0161*** (0.00167)	-0.00850 (0.00530)	-0.00167 (0.00421)	0.00793*** (0.000928)	0.0186*** (0.00131)
Constant	-0.190 (1.204)	0.328 (0.232)	-0.713** (0.349)	-15.49*** (2.046)	1.166 (0.898)	0.586** (0.243)	0.991*** (0.319)
Observations	2,142	1,729	1,732	2,142	2,142	1,729	1,732
Countries	100	82	82	100	100	82	82
Within R-squared	0.4234	0.3484	0.4104	0.3781	0.4366	0.3804	0.4112
Between R-squared	0.6530	0.7263	0.7338	0.7351	0.7373	0.7697	0.7457
Overall R-squared	0.6228	0.6830	0.7093	0.6905	0.7010	0.7252	0.7213
Wald Chi2 Statistic (P-value)	1705.42 (0.0000)	1401.49 (0.0000)	2071.79 (0.0000)	1926.42 (0.0000)	2569.26 (0.0000)	1733.85 (0.0000)	3373.28 (0.0000)

Note: *p-value<0.1; **p-value<0.05; ***p-value<0.01. Robust standard errors are in parenthesis. The Pseudo R-squared was calculated as the correlation coefficient between the dependent variable and its predicted values. Time dummies have been included in the FGLS-based regressions.

Table 4: Effect of the components of agricultural transformation on the working poverty rate and the extent of employment shifts in developing countries, as well as LDCs versus NonLDCs

Estimator. EC2SLS

Variables	<i>Full sample: Developing countries</i>				<i>LDCs versus NonLDCs among developing countries</i>			
	Dependent variable: "WPOV"				Dependent variable: "WPOV"			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>Components of "ATI"</i>				<i>Components of "ATI"</i>			
	AGRIPR	FOODSYS	CROPDIV	STAPLEPR	AGRIPR	FOODSYS	CROPDIV	STAPLEPR
COMP	-1.155** (0.565)	-5.326*** (0.967)	-1.203*** (0.420)	-0.226 (0.315)	-6.123*** (0.695)	-2.843*** (0.930)	-1.307*** (0.452)	-1.210*** (0.344)
COMP*LDC					3.028*** (0.585)	3.494*** (0.903)	1.557*** (0.483)	2.402*** (0.397)
LDC					-1.922*** (0.390)	-1.838*** (0.639)	-0.433 (0.311)	-1.443*** (0.317)
Observations	2,142	2,142	2,142	2,142	2,142	2,142	2,142	2,142
Countries	100	100	100	100	100	100	100	100
Within R-squared	0.4527	0.3586	0.3962	0.4284	0.5071	0.4238	0.4047	0.4270
Between R-squared	0.7641	0.5424	0.7182	0.7331	0.7264	0.6928	0.7118	0.7449
Overall R-squared	0.7292	0.5209	0.6775	0.6972	0.7005	0.6595	0.6746	0.7076
Wald Chi2 Statistic	4522.07	1369.00	2005.24	2371.35	2680.52	1976.30	2102.84	3122.09
(P-value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Note: *p-value<0.1; **p-value<0.05; ***p-value<0.01. Robust standard errors are in parenthesis. The Pseudo R-squared was calculated as the correlation coefficient between the dependent variable and its predicted values. Time dummies have been included in the FGLS-based regressions. The regressions included all control variables, including "EFI"; "LFPR"; "WPOP" (in log); and "SHURB". Our instrumentation approach applies here as well.

Table 5: Effect of agricultural transformation on the working poverty rate and the extent of employment shifts in SSA countries versus NonSSA countries among developing countries
Estimator. EC2SLS

Variables	Dependent variable: “WPOV”	Dependent variable: “RATIO”	Dependent variable: “ShNAFS”
	(1)	(2)	(3)
ATI	-2.648*** (0.672)	0.721*** (0.146)	1.360*** (0.259)
ATI*SSA	3.634*** (0.750)	-0.477*** (0.150)	-0.606** (0.282)
SSA	-0.380 (0.572)	0.289** (0.139)	0.795*** (0.214)
Observations	2,142	1,729	1,732
Countries	100	82	82
Within R-squared	0.4790	0.4101	0.3824
Between R-squared	0.7266	0.6535	0.7681
Overall R-squared	0.6932	0.6169	0.7380
Wald Chi2 Statistic (P-value)	2465.29 (0.0000)	1480.89 (0.0000)	2268.64 (0.0000)

Note: * p -value <0.1 ; ** p -value <0.05 ; *** p -value <0.01 . Robust standard errors are in parenthesis. The Pseudo R-squared was calculated as the correlation coefficient between the dependent variable and its predicted values. Time dummies have been included in the FGLS-based regressions. The regressions included all control variables, including “EFF”; “LFPR”; “WPOP” (in log); and “SHURB”. Our instrumentation approach applies here as well.

Table 6: Non-linear effect of agricultural transformation on the working poverty rate in developing countries

Estimator. EC2SLS

Variables	WPOV (1)
ATI	27.24*** (4.824)
ATI ²	-23.72*** (3.652)
EFI	0.864*** (0.176)
HDI	-20.70*** (2.189)
LFPR	0.0160** (0.00744)
Log(WPOP)	0.147** (0.0607)
SHURB	0.0120 (0.00759)
Constant	-5.900*** (1.569)
Observations	
	2,142
Countries	
	100
Within R-squared	
	0.3114
Between R-squared	
	0.6842
Overall R-squared	
	0.6334
Wald Chi2 Statistic (P-value)	
	1366.33 (0.0000)

Note: *p-value<0.1; **p-value<0.05; ***p-value<0.01. Robust standard errors are in parenthesis. The Pseudo R-squared was calculated as the correlation coefficient between the dependent variable and its predicted values. Time dummies have been included in the FGLS-based regressions.

Appendix 1a: List of countries in the full sample

Full sample			
Albania	Congo, Dem. Rep.	Jordan	Nigeria
Algeria	Congo, Rep.	Kazakhstan	North Macedonia
Angola	Costa Rica	Kenya	Pakistan
Argentina	Cote d'Ivoire	Kyrgyz Republic	Paraguay
Armenia	Dominican Republic	Lao PDR	Peru
Azerbaijan	Ecuador	Lebanon	Philippines
Bangladesh	Egypt, Arab Rep.	Lesotho	Rwanda
Belarus	El Salvador	Liberia	Senegal
Belize	Eswatini	Libya	Sierra Leone
Benin	Ethiopia	Madagascar	South Africa
Bhutan	Fiji	Malawi	Sri Lanka
Bolivia	Gabon	Malaysia	Suriname
Bosnia and Herzegovina	Gambia, The	Mali	Syrian Arab Republic
Botswana	Georgia	Mauritania	Tajikistan
Brazil	Ghana	Mauritius	Tanzania
Burkina Faso	Guatemala	Mexico	Thailand
Burundi	Guinea	Moldova	Togo
Cabo Verde	Guinea-Bissau	Mongolia	Tunisia
Cambodia	Haiti	Morocco	Turkiye
Cameroon	Honduras	Mozambique	Uganda
Central African Republic	India	Myanmar	Ukraine
Chad	Indonesia	Namibia	Viet Nam
China	Iran, Islamic Rep.	Nepal	Yemen, Rep.
Colombia	Iraq	Nicaragua	Zambia
Comoros	Jamaica	Niger	Zimbabwe

Appendix 1b: List of countries in the sub-samples

35 LDCs	41 SSA countries	
Angola	Angola	South Africa
Bangladesh	Benin	Tanzania
Benin	Botswana	Togo
Bhutan	Burkina Faso	Uganda
Burkina Faso	Burundi	Zambia
Burundi	Cabo Verde	Zimbabwe
Cambodia	Cameroon	
Central African Republic	Central African Republic	
Chad	Chad	
Comoros	Comoros	
Congo, Dem. Rep.	Congo, Dem. Rep.	
Ethiopia	Congo, Rep.	
Gambia, The	Cote d'Ivoire	
Guinea	Eswatini	
Guinea-Bissau	Ethiopia	
Haiti	Gabon	
Lao PDR	Gambia, The	
Lesotho	Ghana	
Liberia	Guinea	
Madagascar	Guinea-Bissau	
Malawi	Kenya	
Mali	Lesotho	
Mauritania	Liberia	
Mozambique	Madagascar	
Myanmar	Malawi	
Nepal	Mali	
Niger	Mauritania	
Rwanda	Mauritius	
Senegal	Mozambique	
Sierra Leone	Namibia	
Tanzania	Niger	
Togo	Nigeria	
Uganda	Rwanda	
Yemen, Rep.	Senegal	
Zambia	Sierra Leone	

Appendix 2: Definition and source of variables

Variables	Definition	Source
WPOV	This is the working poverty rate (share of men and women employed living below US\$2.15 PPP). The indicator was computed for youth adults ages 15+. This variable is a proxy for the employment quality, and is not expressed in percentage, for the sake of the analysis.	Database of the International Labor Organization (ILO), accessible online at: https://rshiny.ilo.org/dataexplorer51/?lang=en
RATIO	Ratio of employment in the non-agricultural agri-food system to the employment in agricultural sector.	FAOSTAT database.
ATI	This is the index of agricultural transformation. It has four components, which are the agricultural labour productivity (“AGRIPR”); the crop diversification (“CROPDIV”); staples productivity (“STAPLEPR”); and the food system expansion (“FOODSYST”). The first three components relate to the on-farm component of the agrifood system, and the last component measures the share of total value added generated “off the farm” in the agrifood system. The values of the indicator “ATI” and of each of its components range between 0 and 1.	Database compiled by Diao et al. (2024).
ShNAFS	This is the share of employment in the other sectors than the AFS (agriculture and agri-food systems) in the total employment. For the sake of the analysis, this indicator is not expressed in percentage.	Author’s calculation based on data from FAOSTAT database.
EFI	This is the economic freedom index. It encompasses five areas of reforms: (1) size of government, which covers government consumption, transfers, subsidies, and the extent of state ownership; (2) legal system and property rights, assessing judicial independence, impartial courts, and property-rights protection; (3) sound money, which reflects inflation variability, freedom to own foreign currency bank accounts, and monetary stability; (4) freedom to trade internationally, incorporating tariffs, regulatory trade barriers, and black-market exchange rates; and (5) regulation, including regulations on credit markets, labour markets, and businesses. Each component of EFI is normalized on a scale from 0 to 10 (the value of 10 represents the highest level of economic freedom), and the overall EFI score for each country is calculated as the average of these five areas. Higher scores of EFI reflect the improvement of market-liberalizing reforms.	Data are collected from the Fraser Institute database accessible online at: https://efotw.org/economic-freedom/dataset?geozone=world&year=2022&page=dataset&min-year=2&max-year=0&filter=0
HDI	This is the human development index, computed by the United Nations Development Programme (UNDP) as an average achievement in key dimensions of human development, including a long and healthy life, being knowledgeable and having a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions.	Data on the human development index are collected from the database developed by the UNDP. Data is available online at:

	Higher values of the index indicate a higher human development level.	https://hdr.undp.org/data-center/human-development-index#/indicies/HDI
LFPR	This is the indicator of the overall labour force participation rate.	World Development Indicators (WDI)
WPOP	This is the working age population, that is, the population ages 15-64.	WDI
SHURB	Share (%) of urban population in total population.	WDI
IRRIGLAND	Land area equipped for irrigation per 1000 hectare.	FAOSAT Database
PESTICIDE	Pesticides used per value of agricultural production (g/Int\$).	FAOSAT Database
AGRILAND	Agricultural land Area, per 1000 hectares.	FAOSAT Database
“LEGFR”; “LEGUK” and “LEGGE”	These are three variables that capture the legal origin of the company law or commercial code of each country in the full sample (see Laporta et al., 2008). The dummy “LEGFR” takes the value of 1 for countries whose legal structure is based on the French commercial code, and 0 otherwise. The dummy “LEGUK” takes the value of 1 for countries whose legal structure is based on the English common law, and the value of 0 otherwise. Finally, the dummy “LEGGE” takes the value of 1 for countries whose legal structure is based on the German commercial code, and the value of 0 otherwise.	Information on the legal origin variables is extracted from the Rahael Laporta’s Website: https://faculty.tuck.dartmouth.edu/rafael-laporta/research-publications/

Appendix 3: Descriptive statistics on variables over the full sample of developing countries

Variable		Mean	Standard deviation	Minimum	Maximum	Observations
WPOV	Overall	0.194	0.223	0.0001	0.925	N = 2142
	Between		0.209	0.0007	0.799	n = 100
	Within		0.079	-0.099	0.585	Tbar = 21.42
ATI	Overall	0.559	0.212	0.088	1.000	N = 2142
	Between		0.204	0.105	0.973	n = 100
	Within		0.059	0.273	0.766	Tbar = 21.42
AGRIPR	Overall	0.568	0.249	0.016	1.000	N = 2142
	Between		0.244	0.073	1.000	n = 100
	Within		0.060	0.373	0.776	Tbar = 21.42
FOODSYS	Overall	0.591	0.267	0.000	1.000	N = 2142
	Between		0.259	0.057	1.000	n = 100
	Within		0.074	0.200	0.871	Tbar = 21.42
CROPDIV	Overall	0.439	0.339	0.002	1.000	N = 2142
	Between		0.312	0.009	1.000	n = 100
	Within		0.135	-0.280	1.149	Tbar = 21.42
STAPLEPR	Overall	0.639	0.304	0.000	1.000	N = 2142
	Between		0.294	0.052	1.000	n = 100
	Within		0.081	0.186	0.909	Tbar = 21.42
RATIO	Overall	0.598	0.465	0.003	3.374	N = 1728
	Between		0.469	0.057	2.962	n = 82
	Within		0.115	-0.017	1.162	Tbar = 21.0732
ShAFS	Overall	0.457	0.208	0.037	0.905	N = 1731
	Between		0.202	0.068	0.894	n = 82
	Within		0.052	0.179	0.706	Tbar = 21.1098
EFI	Overall	6.012	0.957	2.180	8.180	N = 2142
	Between		0.857	3.715	7.780	n = 100
	Within		0.432	3.691	7.579	Tbar = 21.42
HDI	Overall	0.603	0.132	0.260	0.853	N = 2142
	Between		0.126	0.333	0.826	n = 100
	Within		0.039	0.465	0.707	Tbar = 21.42
LFPR	Overall	64.572	11.163	33.066	89.428	N = 2142
	Between		10.965	39.539	87.268	n = 100
	Within		2.485	47.332	76.078	Tbar = 21.42
WPOP	Overall	36200000	126000000	135170	988000000	N = 2142
	Between		125000000	199078.600	956000000	n = 100
	Within		114000000	-128000000	192000000	Tbar = 21.42
SHURB	Overall	0.486	0.193	0.082	0.922	N = 2142
	Between		0.191	0.109	0.908	n = 100
	Within		0.033	0.349	0.615	Tbar = 21.42
IRRIGLAND	Overall	2530.106	9767.439	0.100	75500.000	N = 2142
	Between		9659.293	0.100	67781.520	n = 100
	Within		800.658	-10192.480	10527.920	Tbar = 21.42
PESTICIDE	Overall	0.939	1.100	0.000	7.180	N = 2142
	Between		1.007	0.000	4.460	n = 100
	Within		0.447	-1.709	4.026	Tbar = 21.42
AGRILAND	Overall	30386.070	65051.410	70.000	529038.600	N = 2142
	Between		64638.020	77.409	525245.500	n = 100

LEGUK	Within		1473.130	22158.060	44782.650	Tbar = 21.42
	Overall	0.268	0.443	0	1	N = 2142
	Between		0.446	0	1	n = 100
LEGFR	Within		0.000	0.268	0.268	Tbar = 21.42
	Overall	0.670	0.470	0	1	N = 2142
	Between		0.473	0	1	n = 100
LEGGE	Within		0.000	0.670	0.670	Tbar = 21.42
	Overall	0.051	0.221	0	1	N = 2142
	Between		0.219	0	1	n = 100
	Within		0.000	0.051	0.051	Tbar = 21.42

Appendix 4: List of developing countries whose level of agricultural transformation below and higher than 0.6 in the year “2021”

Country	Value of ATI (ATI >0.6)	Country	Value of ATI (0.53 < ATI ≤ 0.6)	Country	Value of ATI (ATI ≤ 0.53)
Dominican Republic	1	Senegal	0.598	Bhutan	0.529
Costa Rica	0.975	India	0.592	Botswana	0.518
Lebanon	0.974	Myanmar	0.584	Kazakhstan	0.517
Malaysia	0.957	Bolivia	0.574	Morocco	0.515
Argentina	0.951	Benin	0.566	Tunisia	0.508
Brazil	0.946	Moldova	0.554	Rwanda	0.505
Jordan	0.940	Cambodia	0.550	Libya	0.500
Bosnia and Herzegovina	0.929	Nigeria	0.550	Ethiopia	0.493
Paraguay	0.914	Malawi	0.549	Iran, Islamic Rep.	0.489
Colombia	0.907	Comoros	0.544	Pakistan	0.487
China	0.905	Nepal	0.543	Zambia	0.477
Mauritius	0.900	Namibia	0.541	Angola	0.471
Egypt, Arab Rep.	0.878	Georgia	0.531	Kenya	0.441
Jamaica	0.864			Yemen, Rep.	0.441
Ecuador	0.854			Mauritania	0.441
Indonesia	0.852			Uganda	0.426
Peru	0.840			Mongolia	0.420
Ukraine	0.832			Haiti	0.412
Viet Nam	0.827			Guinea	0.410
Sri Lanka	0.820			Syrian Arab Republic	0.403
Belarus	0.799			Cabo Verde	0.400
North Macedonia	0.786			Sierra Leone	0.385
Mexico	0.778			Burundi	0.382
Bangladesh	0.764			Congo, Dem. Rep.	0.380
Albania	0.762			Madagascar	0.368
Thailand	0.760			Tanzania	0.350
Cameroon	0.759			Lesotho	0.348
Turkiye	0.756			Zimbabwe	0.332
Cote d'Ivoire	0.755			Togo	0.319
Gabon	0.750			Central African Republic	0.318

Suriname	0.750
El Salvador	0.748
Nicaragua	0.745
South Africa	0.741
Guatemala	0.736
Congo, Rep.	0.733
Ghana	0.721
Eswatini	0.710
Philippines	0.699
Honduras	0.699
Fiji	0.696
Algeria	0.668
Azerbaijan	0.655
Belize	0.652
Armenia	0.649
Tajikistan	0.639
Lao PDR	0.627
Kyrgyz Republic	0.626
Iraq	0.606

Burkina Faso	0.295
Guinea-Bissau	0.292
Mali	0.291
Gambia, The	0.265
Chad	0.260
Liberia	0.249
Mozambique	0.234
Niger	0.137