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Food Supply and the Agricultural Labor Shift

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Several complementary mechanisms have been proposed to explain the economic structural transformation of developing countries in which its labor shifts from the agricultural sector to the non-agricultural sector. This study examines the mechanism that focuses on the role of food, by using panel data econometric methods. Whereas previous empirical studies have mainly examined the influence of agricultural productivity on the labor shift, we examine the influence of food imports, as well as agricultural productivity. We find empirical evidence that both food import and agricultural productivity non-trivially influence the structural transformation.

Keywords Labor shift, Food imports, Agricultural productivity, Structural transformation, Cross-country panel data analysis

1 Introduction

It is well-known that a less developed country undergoes a structural transformation where labor shifts from the agricultural to non-agricultural sector as the country develops (hereafter, structural transformation). Several complementary mechanisms have been proposed to explain the structural transformation. Such structural transformations may reduce domestic food production and, eventually, domestic food consumption. Therefore, to achieve the structural transformation, a less developed economy needs to supplement potential reductions in the domestic food supply. Some theoretical studies suggest that a less developed country can decrease its agricultural labor without facing food shortages when agricultural productivity increases. Empirical studies have also investigated the influence of agricultural productivity on the structural transformation.

Another possibility to supplement potential reductions in the domestic food supply is provided by food imports, an increase of which could also conceivably contribute to a decrease in

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agricultural labor. At this point, a question arises: while it is theoretically possible that food imports influence the structural transformation, in reality, do food imports (as well as agricultural productivity) promote the transformation? This study examines this question econometrically.

The structural transformation from agricultural to non-agricultural economy in less developed countries is commonly known as the Petty-Clark Law, after the study by Clark (1940). Recently, the mechanisms behind structural transformations have received renewed attention from economists.¹⁾ The literature suggests that the labor shift from the agricultural to the non-agricultural sector (hereafter, the agricultural labor shift)²⁾ is caused by various factors. One of the factors is related to the food supply, that is, if a less developed country starts to concentrate its factors of production on the non-agricultural sector, the country can face a food shortage problem. Schultz (1953) refers to this issue as the food problem. Given the food problem, how can a less developed country move its labor from the agricultural sector to the non-agricultural sector without eventually reducing domestic food consumption? A possibility is to improve the productivity of the domestic agricultural sector. Nurkse (1953) points to the key role of the agricultural revolution taking place in the context of the industrial revolution. Rostow (1960) considers increases in agricultural productivity as one of the necessary conditions for economic takeoff. Johnston and Mellor (1961) make similar arguments. More recently, Laitner (2000), Gollin et al. (2002, 2007), Hansen and Prescott (2002), Ngai and Pissarides (2007), Strulik and Weisdorf (2008), Duarte and Restuccia (2010), and Üngör (2013) develop closed economy models where a rise in agricultural productivity enables labor to shift from the agricultural to the non-agricultural sector without reducing domestic food consumption.

Recently, some empirical studies examining the relationship between domestic agricultural productivity and the agricultural labor shift have emerged, for example, Alvarez-Cuadrado and Poschke (2011), Bustos et al. (2016), and McArthur and McCord (2017). As noted above, the labor shift from the agricultural to the non-agricultural sector may have a negative effect on the domestic food supply. However, a rise in the domestic agricultural productivity may supplement the reduction in the domestic food supply. This rise in productivity, in turn, increases the potential for an agricultural labor shift. To aid the analysis, we introduce the term “agricultural labor shift potential.” This term refers to the extent to which the economy can sustain an agricultural labor shift without a reduction in domestic food consumption in case of a shock to the food supply, such as a rise in agricultural productivity.

Regarding factors that increase food supply, the aforementioned argument focuses on the effect of domestic agricultural productivity. In contrast, our study revisits the view that an in-

crease in food supply may be caused not only by an increase in domestic agricultural productivity, but also by food imports. In this case, it would follow that an increase in both food imports and agricultural productivity encourage the agricultural labor shift.

The mechanism by which food imports promote agricultural labor shift may be explained as follows. If a country's food imports increase, the country's food supply increases as well. Given a new source of food supply (i.e., an increase in food imports), the country would now have more agricultural labor shift potential without reducing domestic food consumption. Matsuyama's (1992) model illustrates this point. By using general equilibrium models, Uy et al. (2013), Świącki (2017) and Teignier (2018) examine the role of international trade, which includes food imports, in the structural transformation. Moreover, less developed countries have an incentive for the agricultural labor shift if the productivity of the non-agricultural sector is higher than that of the agricultural sector. In this case, by moving the labor from the agricultural sector to the non-agricultural sector, the country can increase its income. In fact, Caselli (2005), Gollin (2010), Gollin et al. (2014), Herrendorf and Schoellman (2015), and Cai and Pandey (2015) empirically show that in less developed countries, the productivity of the non-agricultural sector is higher than that of the agricultural sector. By contrast, Schultz (1953) argues that poor countries do not import food because the cost of food imports is too high.

At this point, one may wonder whether food imports, as well as agricultural productivity, really influence the structural transformation. Our study econometrically sheds light on this research question.

The originality of this study lies in the following points. Previous empirical studies investigate the relationship between agricultural productivity and the agricultural labor shift. In contrast, we econometrically examine the role of food imports, as well as the agricultural productivity. We econometrically find that both food imports and agricultural productivity non-trivially influence the agricultural labor shift (i.e., the structural transformation).

Our contribution is related to the economic development of less developed countries. According to previous studies, it is expected that the agricultural labor shift in less developed countries would increase per capita income. The improvement in per capita income is one of the most critical economic issues for less developed countries. To deepen our understanding of the environment that supports agricultural labor shift, this study provides an empirical analysis of the food supply factors that promote such a shift.

The remainder of this paper is organized as follows. Section 2 describes the methods employed. Section 3 explains the data used for our analysis. Section 4 provides the estimation re-

sults and Section 5 concludes.

2 Empirical method

In this section, we discuss the methods employed to answer the research questions proposed in the introduction. Subsection 2.1 introduces the regression equation estimated by a fixed effects model. Subsection 2.2 extends this regression equation by including a lagged dependent variable as a regressor. The extended model is estimated using the system generalized method of moments (hereafter, system GMM).

2.1 Fixed effects model

We now introduce the regression equation used to examine the relationship between food imports and the agricultural labor shift. Suppose that an increase in per capita food imports or domestic agricultural food productivity occurs in a less developed country. As explained in the introduction, these changes increase the amount of food per capita available in the country. If per capita food imports and/or domestic agricultural productivity increase, the country can decrease its agricultural labor share without reducing per capita food consumption. Therefore, in the case where a rise in these food factors occurs in a country, it should become easier for the country to shift its labor from the agricultural to the non-agricultural sector. Moreover, a number of empirical papers suggest that less developed countries have an additional motivation for the agricultural labor shift, namely, the productivity of the non-agricultural sector is higher than that of the agricultural sector. In that case, by moving the labor from the agricultural sector to the non-agricultural sector, these countries can increase their income. This argument suggests that an increase in either food imports or agricultural food productivity may in fact promote the agricultural labor shift.

So, does a change in food imports or agricultural food productivity affect the agricultural labor shift in reality? We examine this empirical question by using the following regression equation.

$$\ln s_{it}^A = \alpha_0 + \alpha_1 \ln m_{it}^F + \alpha_2 \ln z_{it}^F + \alpha_3 \ln l_{it}^T + \eta_i + \lambda_t + \varepsilon_{it}, \quad (1)$$

where the subscripts i and t denote country and time period respectively, while the terms η_i and λ_t represent individual effects and time effects, respectively. The term ε_{it} is an error term.

The independent variables m^F and z^F represent per capita food imports and agricultural food productivity, respectively. The dependent variable s^A represents the agricultural labor shift, which is calculated as the share of agricultural labor in total labor. Because s^A is the share of

agricultural labor in total labor, it is affected by total labor. When total labor increases, s^A changes even if agricultural labor is stable. To control for this change, we include the total ratio of the total labor to the population (l^T) as a control variable in Eq. (1). Other changes specific to individual countries and periods are, to some extent, controlled by the terms η_i and λ_t .

To avoid heteroscedasticity, we use the natural logarithms of all variables. Detailed explanations and derivations related to the variables are provided in Section 3.³⁾ We estimate Eq. (1) by employing a fixed effects model.

We are specifically interested in the estimates of α_1 and α_2 . If α_1 is statistically significantly negative, it indicates that food imports and agricultural labor are negatively correlated. In other words, the result is consistent with the hypothesis introduced above that an increase in food imports supports the agricultural labor shift. Similarly, if α_2 is statistically significantly negative, the hypothesis that an increase in agricultural food productivity promotes agricultural labor shift is supported.

2.2 Dynamic panel data model

In this subsection, we extend the estimation setup of Eq. (1). Generally speaking, a dependent variable often has a serial correlation. If the lagged dependent variable can, to some extent, explain behaviors of the dependent variable, inclusion of the lagged dependent variable as an independent variable may reduce the missing variable problem. For this reason, we extend our previous model by considering a regression of the following form:

$$\ln s_{it}^A = \beta_0 + \beta_1 \ln s_{it-1}^A + \beta_2 \ln m_{it}^F + \beta_3 \ln z_{it}^F + \beta_4 \ln l_{it}^T + \tilde{\eta}_i + \tilde{\lambda}_t + \tilde{\varepsilon}_{it}. \quad (2)$$

To estimate consistent parameters for Eq. (2), a method for a dynamic panel data model is needed. This study employs the system GMM.⁴⁾ The terms $\tilde{\eta}_i$, $\tilde{\lambda}_t$, and $\tilde{\varepsilon}_{it}$ represent individual effects, time effects, and an error term respectively. In Eq. (2), we are specifically interested in the estimation results of β_1 and β_2 . If β_1 is statistically significantly negative, the result implies that increases in food imports and the agricultural labor share are negatively correlated. That result is consistent with the hypothesis that an increase in food imports promotes an agricultural labor shift. Similarly, if β_2 is statistically significantly negative, then the hypothesis that an increase in agricultural food productivity promotes an agricultural labor shift is supported.

3 Data

This section describes data construction regarding the variables introduced in Section 2. Subsection 3.1 explains definitions of the variables in detail. To make the data correspond to the

definitions of our variables, we build an appropriate database. Subsection 3.2 describes how this database is constructed.

3.1 Variable definitions

The subscript j denotes the j -th agricultural food good (hereafter, agricultural good), such as wheat, rice, potatoes, and so on. We express output, exports, and imports of the j -th domestic agricultural good by Y_j^F , X_j^F , and M_j^F , respectively. When estimating the data of the j -th food agricultural good, we need to avoid double counting the j -th good. This issue is better explained by an example. Suppose a country produces rice as an agricultural good. Moreover, suppose that part of the produced rice is used as an intermediate good for a rice-based product. We avoid counting that part of the rice twice by only considering the quantity of final rice products. More generally, we avoid double counting the j -th agricultural good due to the inclusion of intermediate goods since we only consider final goods when compiling the data.

Here, we use the calorie as the measurement unit for Y_j^F , X_j^F , and M_j^F . To justify this choice, recall the idea presented in the introduction that food imports and agricultural productivity promote the agricultural labor shift. This mechanism presumes that if a less developed country decreases agricultural labor, the per capita food level would come closer to the subsistence food supply level. Hence, such a country could not easily decrease agricultural labor. Considering this presumption, we are compelled to use a measurement unit that can express the amount of food relative to a minimum level required for subsistence. We therefore employ the calorie as the measurement unit for the food variables.

Next, we define D_j^F as

$$D_j^F = Y_j^F + M_j^F - X_j^F, \quad (3)$$

where D_j^F represents the domestic use of the j -th agricultural good. Note that D_j^F includes disposed parts of the goods and new stocks of the goods as a type of domestic use. By rearranging Eq. (3), we derive Eq. (4):

$$D_j^F + X_j^F = Y_j^F + M_j^F. \quad (4)$$

The right-hand side of Eq. (4) denotes the total supply of the j -th agricultural good in a country. Eq. (4) clearly indicates that the total supply of the j -th agricultural good, which corresponds to the right-hand side of Eq. (4), is either used domestically (D_j^F) or exported (X_j^F).

We aggregate Y_j^F , X_j^F , M_j^F , and D_j^F across j . The aggregate result is given by Eq. (5).

$$D^F + X^F = Y^F + M^F$$

where

$$D^F = \sum_j D_j^F, \quad X^F = \sum_j X_j^F, \quad Y^F = \sum_j Y_j^F, \quad M^F = \sum_j M_j^F. \quad (5)$$

Let N , L^A , and L^T represent the population, agricultural labor, and total employed labor in the country. We define m^F (per capita food imports) and z^F (agricultural food productivity) introduced in Section 2 as follows:

$$m^F = M^F / N. \quad (6)$$

$$z^F = Y^F / L^A \quad (7)$$

We also define s^A (agricultural labor share) and l^T (share of total labor in the population) as follows:

$$s^A = L^A / L^T \quad (8)$$

$$l^T = L^T / N. \quad (9)$$

3.2 Data construction

As mentioned in Subsection 3.1, we employ food factor data measured in calories. We shall also justify the use of the calorie as a measurement unit in this subsection. We then construct a cross-country panel dataset for the calorie-based variables, by using the following procedure.

The data on food factors (Y_j^F , D_j^F , X_j^F , and M_j^F) in weight units (but not in calories) are part of the Food Balance Sheet, a database released by the Food and Agriculture Organization (FAO). If we also have data that specifies the number of calories contained in one kg of the j -th agricultural good, we can then transform weight-based data into calorie-based data. In fact, the Food Balance Sheet includes two types of data regarding the supply of the j -th agricultural good: (1) the food supply in weight terms; (2) the food supply in calorie terms. From these two types of food supply data, we calculate the number of calories per unit weight of the j -th food agricultural good. By using this ratio (kcal/kg), we calculate Y_j^F , D_j^F , X_j^F , and M_j^F measured in calories. More specifically, we compute calorie-based data for 562,520 data points ($= 41$ countries $\times 35$ years $\times 98$ food agricultural goods $\times 4$ variables⁵⁾). We then aggregate the calorie-based data across agricultural goods by type of food factor (Y^F , D^F , X^F , and M^F). Because we are interested in the long-run change in the agricultural labor share, we divide the entire sample years into seven five-year periods and calculate period averages for the variables. To verify that our calorie data estimation is acceptable, we compare our per-capita per-day calorie data with that of Food Balance Sheet and find that the two are basically the same.

Through this process, we have made the calorie-based dataset of the variables Y^F , D^F , X^F , and M^F by period and by country. If all of the data were available, the number of observations for each variable would be 287 ($= 41$ countries $\times 7$ periods). In reality, because of data avail-

ability issues, the number of observations (which varies across the estimation models) is at most 250.

The sample countries are restricted to those whose agricultural labor share (i.e., s^A) in the initial year is higher than 10%. Details of these countries are summarized in Appendix A. Since we choose countries with high agricultural labor shares as our sample countries, they are essentially non-developed economies. Our data also include former non-developed economies that are currently regarded as developed economies such as Japan, which is now recognized as one of the most developed and industrialized countries, whose agricultural labor share in the beginning of the sample year (1976) was still large. In this study, when the agricultural labor shares of these countries becomes less than a certain threshold (we consider two cases: 10% and 15%), we exclude them from the sample. We also exclude the original members of the OECD except Turkey, whose per capita GNI in 1976 was 14% of the U.S. value.⁶⁾

For population data, we employ the data provided by the Food Balance Sheet. Regarding labor data, we refer to two datasets: (i) the GGDC 10-sector database released by the Groningen Growth and Development Centre,⁷⁾ and (ii) the APO Productivity Database released by the Asian Productivity Organization.

4 Estimation results

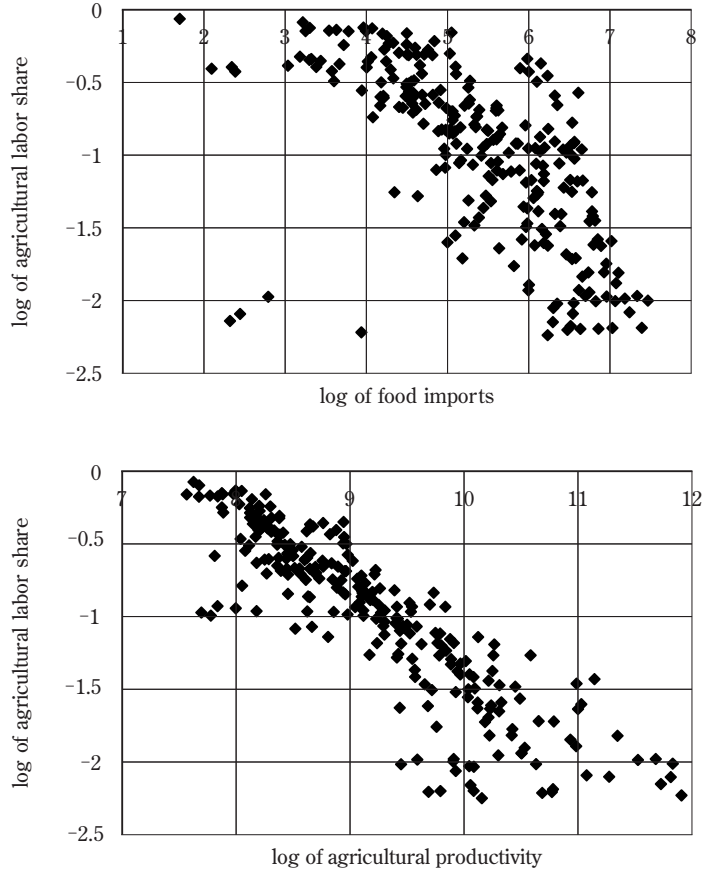
4.1 Scatter diagrams

Before going further into estimation results, we take a brief look at the relationships between the agricultural labor share and both per capita food imports and agricultural food productivity by using scatter diagrams. The diagrams are shown in Figure 1.

The upper panel in Figure 1 presents a scatter diagram of food imports vs. agricultural labor share. The diagram indicates a downward-sloping relationship between these variables, suggesting that food imports may be negatively correlated with agricultural food productivity. The downward-sloping relationship remains across all levels of agricultural labor share. The lower panel in Figure 1 presents a scatter diagram of agricultural food productivity vs. agricultural labor share. This diagram also indicates a downward-sloping relationship, indicating that agricultural food productivity may be negatively correlated with the agricultural labor share.

While the diagrams in Figure 1 tell us the presence of simple relationships between the agricultural labor share and the two food factors, for more detailed relationships between the variables introduced in Section 2, we need more elaborate econometric tools to rule out the possibility that, for example, food imports and the agricultural labor share are influenced by vari-

FIGURE 1. FOOD FACTORS AND AGRICULTURAL LABOR SHARE



ables not included in the figure. For example, there are four outliers in the upper panel corresponding to Argentina. Considering that the Argentinian agricultural labor share is low, one may expect food imports to be larger, based on the downward-sloping relationship depicted in the upper panel. On the other hand, if we check the values of the country's agricultural productivity, they are high and the corresponding dots in the lower panel are located around the right-most area. This fact implies that the country can consume a sufficient amount of food with a relatively small amount of imports because its agricultural productivity is high and it can produce enough food domestically. As the Argentinian case suggests, for a more detailed analysis we need econometric tools that can capture multivariate relationships.

In Subsections 4.2 and 4.3, by removing the influence of the other variables introduced in Section 2, we focus on the relationship between the two food factors and the agricultural labor share. We examine these relationships utilizing the regression equations introduced in Section 2.

4.2 Results of the fixed effects model

In this subsection and the next we econometrically examine the following question: do food imports, as well as agricultural productivity, influence the structural transformation? By employing the method explained in Subsection 2.1, we estimate Eq. (1) for the chosen countries and exclude those whose agricultural labor share is low because, generally speaking, in countries with low agricultural labor share, the agricultural labor share does not substantially change as the agricultural labor share is already close to its lower bound of zero. Therefore, we use countries whose agricultural labor share is higher than the threshold values of 10% and 15% as our sample countries.

We employ a two-stage least squares (2SLS) as our benchmark regression to deal with the endogeneity problem. We adopt one lag of the independent variables as instruments. Table 1 summarizes the estimation results.

Table 1
Fixed effects model estimation of agricultural labor share

	Dependent Variable: Agricultural Labor Share					
			Agricultural Dependence			
	> 10%	> 10%	> 10%	> 10%	> 10%	> 15%
	OLS	2SLS	2SLS	2SLS	2SLS	2SLS
Food Imports	-0.041* (0.022)	-0.160* (0.086)	-0.215* (0.127)			-0.151* (0.090)
Agricultural Productivity	-0.319*** (0.043)	-0.310*** (0.059)		-0.307*** (0.065)		-0.254*** (0.058)
Total Employment	-0.913*** (0.212)	-1.069*** (0.272)			-1.132*** (0.360)	-0.883*** (0.264)
Observations	250	209	209	209	209	188
Num. of Countries	41	41	41	41	41	38
R-squared (Within)	0.829	0.791	0.554	0.740	0.687	0.773
Year Dummies	Y	Y	Y	Y	Y	Y

Notes: a) Robust standard errors are in parenthesis. b) ***, **, and * represent significance at the 1%, 5%, and 10 % level, respectively. c) Agricultural Dependence represents the share of agricultural employment in total employment.

Source: Food Balance Sheet, GGDC 10 Sector Database, and APO Productivity Database 2016. See Section 3 for details.

The term “agricultural dependence” in Table 1 refers to the lower bound of the agricultural labor share. For example, if we set the agricultural dependence to “> 10%,” we choose countries whose agricultural labor shares in the sample periods are larger than 10% as our sample countries. More specifically, if a country’s agricultural labor share is larger than 10% only before, for instance, 1991, we include the country before 1991 in our sample, but exclude the

country after 1991. The second column in the table shows the benchmark results.

Regarding food imports, this variable's estimated coefficient is negatively significant in all cases. This result is consistent with the theoretical mechanism mentioned in the introduction where an expansion of food imports promotes an agricultural labor shift. Furthermore, as we employed 2SLS, these results possibly suggest that the food imports have a causal connection with an agricultural labor shift (i.e., a reduction in the agricultural labor share).

From Table 1, the coefficients of agricultural productivity are also negatively significant in all cases. An analogous argument to that for food imports suggests that an increase in agricultural productivity leads to an agricultural labor shift (i.e., a reduction of the agricultural labor share⁸). This result is consistent with previous empirical studies.

In addition, the coefficient of total labor is also negatively significant. As explained in Subsection 2.1, we include total labor because the variable is important as a control variable. When total labor increases, the agricultural labor share (i.e., the ratio of agricultural labor to total labor) decreases even if the value for agricultural labor does not change.

For a robustness check, we adjust the sample to include countries whose agricultural dependence is higher than 15% as sample countries. The results are summarized in the last column. The results also indicate a significantly negative coefficient of food imports, which is again consistent with the hypothesis that food imports promote an agricultural labor shift even if we consider countries that are more dependent on the agricultural sector than the sample countries considered previously. This result matches that of Figure 1. The downward-sloping relationship between food imports and the agricultural labor share in Figure 1 is also observed for all levels of the agricultural labor share, and not only in a specific level. Consistent with Figure 1, the result in Table 1 also indicates a significantly negative coefficient of agricultural food productivity.

4.3 Results of the dynamic panel data model

In this subsection, we examine Eq. (2) by using the system GMM. As before, we exclude countries whose agricultural dependence is too low. Table 2 summarizes the results.

In all the estimation results in Table 2, the p-values of "AR(2)" are sufficiently large. This implies that the error terms of the original equation are not serially correlated. In addition, the Hansen test indicates that the instruments are exogenous as a group.

In regards to the coefficients of food imports and agricultural productivity, according to Table 2, they are both again negatively significant in all the regressions. Because the system GMM

Table 2
System GMM regressions of agricultural labor share

	Dependent Variable: Agricultural Labor Share				
	Agricultural Dependence				
	> 10%	> 10%	> 10%	> 15%	> 15%
Dependent Variable (-1)	0.890*** (0.051)	0.887*** (0.047)	0.871*** (0.053)	0.873*** (0.050)	0.848*** (0.053)
Food Imports	-0.069*** (0.021)	-0.066*** (0.019)	-0.076*** (0.025)	-0.061** (0.023)	-0.069*** (0.020)
Agricultural Productivity	-0.068** (0.030)	-0.071*** (0.026)	-0.079** (0.034)	-0.083*** (0.026)	-0.085*** (0.023)
Total Employment	-0.087 (0.075)	-0.060 (0.058)		-0.095 (0.068)	-0.086* (0.048)
<i>Tests (p-values)</i>					
AR (1)	0.016	0.015	0.019	0.018	0.019
AR (2)	0.819	0.771	0.883	0.283	0.270
Hansen Test	0.616	0.289	0.618	0.580	0.416
Observations	209	209	209	188	188
Num. of Countries	41	41	41	38	38
Num. of Instruments	41	41	31	41	41
Year Dummies	Y	N	Y	Y	N

Notes: a) Robust standard errors are in parenthesis. b) ***, **, and * represent significance at the 1%, 5%, and 10% level, respectively. c) Agricultural Dependence represents the share of agricultural employment in total employment.

Source: Food Balance Sheet, GGDC 10 Sector Database, and APO Productivity Database 2016. See Section 3 for details.

takes into account the endogeneity problem, these new results suggest that both agricultural productivity and food imports influence the agricultural labor shift (i.e., the agricultural labor share).

We also run regressions without the year dummies as they are not significant when included in the regressions in Table 2. In both cases, food imports and agricultural productivity are negatively significant and similar in terms of coefficient values.

A result worth noting is the difference between Table 2 and Table 1. The coefficients of food imports are not considerably different between the two tables. By contrast, the coefficients of agricultural productivity are considerably different between these tables. The coefficients of agricultural productivity in Table 2 are much closer to zero than those in Table 1. This result suggests that the coefficient of agricultural productivity in Table 1 includes the effect of the one-period lag of the dependent variable (agricultural labor share). In Table 2, by adding the one-period lag of the dependent variable, the effect which should be attributed to the lagged agricultural labor share is removed from the coefficient of agricultural productivity. Consequently, the coefficients of agricultural productivity in Table 2 are much closer to zero.

As explained in the previous subsections, we include total labor as a control variable. Table 2 shows that the coefficients of agricultural productivity and food imports are robust with respect to the exclusion of total labor.

In summary, in Subsections 4.2 and 4.3, we have econometrically examined whether food imports and agricultural productivity affect agricultural labor share by using 2SLS and system GMM estimation. In both cases, our results suggest that food imports and agricultural productivity impact the agricultural labor shift.

5 Conclusions

This study econometrically examines the question of whether food imports, along with agricultural productivity, influence the structural transformation known as the labor shift from the agricultural to non-agricultural sector (i.e., agricultural labor shift). The originality of our study lies in this research question. Previous empirical work has focused only on the relationship between agricultural productivity and the agricultural labor shift. However, considering previous theoretical studies, we suggest that food imports may also influence the agricultural labor shift. In other words, we extend previous empirical work by including a new factor (i.e., food imports). Our extended research question is the original aspect of the study. As a result of our analysis, we empirically find that the food imports have a significant influence on the agricultural labor shift.

The contribution of this study is as follows. In light of recent work suggesting that the labor shift from the agricultural sector to the non-agricultural sector (i.e., agricultural labor shift) in less developed countries increases their income,⁹⁾ and the fact that increase in per capita incomes is one of the most critical policy issues faced by less developed economies, the results of this study suggest that an appropriate food import policy may also be beneficial for per capita income growth in the long run. Apart from analyzing food imports in more detail, future research should aim to deepen our understanding of the factors that affect the agricultural labor shift. Our results, based on experiences of countries that underwent a significant agricultural labor shift, suggest that other factors may be at play, and new policy implications remain to be discovered.

Appendix A. Sample countries

The countries in the sample include those in which the agricultural dependency level is higher than

10% or 15% in the sample periods. Countries with the symbol “*” are not included in the 15%-criterion sample.

Argentina*	Egypt	Mauritius	Rep. of Korea	Zambia
Bangladesh	Ethiopia	Mexico	Senegal	
Bolivia	Ghana	Mongolia	South Africa	
Botswana	India	Morocco	Sri Lanka	
Brazil	Indonesia	Myanmar	Taiwan	
Cambodia	Iran	Nepal	Tanzania	
Chile	Japan*	Nigeria	Thailand	
China	Kenya	Pakistan	Turkey	
Colombia	Malawi	Peru	Venezuela*	
Costa Rica	Malaysia	Philippines	Vietnam	

Notes

- 1) The works by Gollin (2010) and Herrendorf et al. (2014) provide comprehensive literature reviews regarding recent studies on structural transformation.
- 2) Denis and İşcan (2009), assuming a closed economy, compare three factors: (1) the low income elasticity of demand for agricultural goods (Engel's effect), (2) differential sector productivity growth rates (Baumol's effect), and (3) differential capital deepening. Meanwhile, Shultz (1953) points out the importance of agricultural development in the structural transformation process. More recently, Uy et al. (2013), Świącki (2017) and Teignier (2018) shed light on the role of international trade in the structural transformation process.
- 3) We regard labor outflows from the agricultural sector into the non-agricultural sector or unemployment as the agricultural labor shift.
- 4) We have used the xtabond 2 module for Stata developed by Roodman (2009).
- 5) Data for some years are not available.
- 6) By this criterion, we exclude Italy and Spain from our sample. Nevertheless, even if we include them in our sample, the estimation results do not significantly change.
- 7) Details of the GGDC data are summarized in Timmer et al. (2015).
- 8) For details, see Alvarez-Cuadrado and Poschke (2011), Bustos et al. (2016), and McArthur and McCord (2017).
- 9) For example, see Caselli (2005), Gollin et al. (2014), Herrendorf and Schoellman (2015), and Cai and Pandey (2015).

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