Agricultural Inter-Sectoral Linkages and Its Contribution to Economic Growth in the Transition Countries

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Abstract:

This study estimates an econometric model that incorporates the linkages among agriculture, manufacturing, service and trade sectors using a vector error correction model for Poland and Romania. Three cointegrating vectors for Poland and one for Romania confirm that the different sectors in the Poland and Romania moved together over the sample period, and for this reason, their growth rates are interdependent. The long-run relationship of industrial, service and trade sectors to agricultural sector were established, and the results show that the industrial sector in Poland contributes positively to the agricultural sector while the growing service sector shows mixed results. The results of Romania indicate that the industrial sector is detrimental to agriculture however, the service sector contributes positively.

The short-run results show that the service sector is the most significant sector in the Polish economy and it contributes positively to all other sectors. However, growth in the industrial sector affects the other two sectors negatively. A similar effect is observed in the Romanian economy; however, the results are not significant. As expected, the role of agriculture in the short-run is not significant to the other sectors, but it made a positive impact on the industrial sector in Romania.

JEL Classifications: P20; O41; C32

Keywords: transition economy; inter-sectoral growth linkages; cointegration analysis

Agricultural Inter-Sectoral Linkages and Its Contribution to Economic Growth in the Transition Countries

Agriculture plays an important role in contributing to socio-economic development in many countries. It is the primary source for employment, livelihood, and food security for the majority of rural people. The future success of such contributions depends largely on the direct impact agriculture has on the national economy as well as how the agricultural sector stimulates the growth of other sectors. Consequently, understanding the role of agriculture and its linkages to rest of the economy is important.

The linkages between the agricultural sector and economic growth have been widely investigated in the development literature. In the early stages, researchers paid greater attention to studying the relationship between the agricultural and industrial sectors. They argued that agriculture only plays a passive role, which is to be the most important source of resources (food, fiber, and raw material) for the development of industry and other non-agricultural sectors (Rosenstein-Rodan, 1943; Lewis, 1954; Ranis and Fei, 1961). Many of these analysts highlighted agriculture for its abundant resources and its ability to transfer surpluses to the more important industrial sector.

A number of development economists attempted to point out that while agriculture's share fell relative to industry and services, it nevertheless grew in absolute terms, evolving increasingly complex linkages to the non-agricultural sectors. A group of economists (Singer, 1979; Adelman, 1984; Hwa, 1988; Vogel, 1994) highlighted the interdependencies between agricultural and industrial development, and the potential for agriculture to stimulate industrialization. They argue that agriculture's productivity and institutional links with the rest of the economy produce demand incentives (i.e., rural household consumer demand) and supply incentives (i.e., agricultural goods without rising prices) fostering industrial expansion. As a result of such developments, the agricultural inter-sectoral linkages became more complicated.

A factor that has hampered research on the contribution of agriculture to rest of the economy, until recently, has been lack of sufficient time series data. Consequently, cross-sectional regression techniques have dominated the earlier investigations, and the results of such studies should be interpreted with greater care since it might have underestimated the country

specific characteristics. Developments in statistical methodologies and enhancements in software packages allow researchers to undertake more complicated econometric models to quantify the contribution of agriculture to economic growth as well as understanding the inter-sectoral linkages in the economy. Vector autoregressive (VAR) models and cointegration analysis are the most suitable econometric analyses and they are well-developed in most advanced software packages. These analyses solve the endogeneity problems among variables and are able to separate short-run from long-run effects.

Kanwar (2000) studied the cointegration of the different sectors of the Indian economy in a multivariate vector autoregressive framework, and estimated the relations between agriculture and industry using the Johansen procedure. He found that the agriculture, infrastructure, and service sectors significantly affect the process of income generation in the manufacturing and constructions sectors, but the reverse has not been true. Blunch and Verner (2006) found empirical evidence to support a large degree of interdependence in long-run sectoral growth in Cote d'Ivoire, Ghana, and Zimbabwe, and concluded that the sectors grow together or there are externalities or spillovers between sectors.

All these studies have made useful contributions to understanding the links between different sectors in the economy and economic growth. These studies further imply that the contribution of agricultural growth to economic development varies markedly from country to country as well as from one time period to another within the same economy. However, there is a significant gap in the growth literature because most of the inter-sectoral linkage studies were conducted for the developed countries. Furthermore, no research was conducted for the recently liberalized Central and Eastern European Countries. In an attempt to fill the gap in the literature, this study focuses on how the agricultural sector has been inter-related to rest of the economy in Poland and Romania.

Since the reform began in these countries in late 1980s and early 1990s, the agricultural and food systems of these transition economies went through major restructuring processes such as market liberalization, farm restructuring, reform of upstream and downstream operations, and the creation of supporting market infrastructure. These restructuring processes induced major changes in the commodity mix and volume of agricultural production, consumption and trade,

and likely a more complex system of inter-sectoral relationships since the service and trade sectors were allowed to play a greater role in the economy.

The transition processes in the Central and Eastern Countries were not as smooth as some expected. The length and the severity of transition varied among countries because some policies worked well for one country but not for others. Many economists and policymakers wonder why some countries experienced better success in the transition process than others. One-way to solve the mystery is to understand the existence of inter-sectoral linkages among major economic sectors. Once the complex linkages have been identified, the information can be used to determine the impact of various policies adopted by the respective countries. The information could also be used to identify the optimal policy by measuring the impact of various policy alternatives on different sectors in the economy. Therefore, determining the inter-sectoral relationship using appropriate econometric models should play a dominant role in the future growth literature.

This paper is an attempt to identify the pattern of changes in sectoral composition that characterizes the economic dynamics of two transition countries (Poland and Romania) by applying a multi-sectoral endogenous growth framework. This study employs the Johansen procedure of cointegration analysis to identify the existence of long-run and dynamic short-run inter-sectoral linkages among different sectors in the economies. The study will be significant since Poland and Romania are the two largest countries in the Central and Eastern European region, and recently became members of the expanded European Union. After 20 years of the liberalization process, both countries found themselves at different level of transitions. So, understanding the inter-sectoral linkages could shed important insights on the transition process, and such information should assist policymakers to identify the optimal policies to continue further economic growth in these countries. The objectives of this study for each country are (1) to understand the linkages between agriculture and rest of the economy, (2) to investigate the existence of long-run growth relationships among different sectors, and (3) to determine the impacts of the transition on agriculture and other sectors.

Inter-sectoral Linkages

There is significant evidence that dramatic changes occur in sectoral output and employment share during transition processes. The direction of change depends on several factors including the pre-transition conditions, speed of adjustment and available resources. In this study, we focus on how the agricultural sector affects other sectors in the economy and how the other sectors influence the growth of agriculture. According to the traditional economic development view, there are positive links between agricultural productivity and the industrialization process. By raising its productivity, the agricultural sector makes it possible to feed the growing population in the industrial sector with less labor. Consequently, the agricultural sector is able to release more labor for manufacturing employment. The higher incomes generated in the agricultural sector as a result of productivity increases, and the growing number of higher productivity manufacturing workers who were transferred from the agricultural sector, enlarge the domestic market for industrial products. This positive linkage leads to greater productivity in the use of resources, and sustainable economic growth.

The law of comparative advantage, on the other hand, implies a negative link between agricultural productivity and industrialization. According to this view, the manufacturing sector has to compete with the agricultural sector for labor. Low productivity in agriculture implies an abundant supply of 'cheap labor' which the manufacturing sector can exploit.

To understand the differences between these two conflicting views, we need to look at the openness of economies. In an open economy, prices are determined by conditions in the world market. A rich endowment of arable land could be a mixed blessing. For example, high productivity and output in the agricultural sector may, without offsetting the changes in relative prices, squeeze out manufacturing. At the same time, economies which lack arable land and thus have an initial comparative advantage in manufacturing may successfully industrialize by relying heavily on foreign trade through importing agricultural products. Since trade liberalization and privatization became the major policies under the transition process, a negative linkage cannot be overlooked in transition countries. Therefore, the role of agriculture and its linkage to manufacturing cannot be assumed to be unique but should be established.

Similar to the manufacturing sector, the service sector could be detrimental to growth in the agricultural sector (in an open economy) as a result of changes in productivity and differences in income elasticities. Economies in industrialized countries show that there are positive relationships between the price of services and income. Unlike the agricultural and manufacturing jobs, most of the service jobs cannot be substituted by machines, and therefore, the need for quality service personnel will continually increase. Consequently, as the economy grows, the ever increasing demand for service jobs will attract more and more resources from the manufacturing and agricultural sectors, and this could create a negative linkage to the other sectors. Alternatively, the growing service sectors (banking, telecommunication, transport etc.) could allow other sectors to take advantage of the benefits of economies of scale, and make positive linkages to rest of the economy. The linkages between the sectors are, therefore, expected to be complicated and multi-directional. The process could also be easily accelerated in the transition countries if access to capital and technologies, along with the appropriate institutions, are easily available and such inter-sectoral linkages will play an important role in future economic growth.

Conceptual Model and Data

In analyzing the inter-sectoral linkages we focus on the question of whether the agriculture, industrial, service and trade sectors evolve interdependently. In order to identify the inter-sectoral linkages, the following endogenous model was constructed:

(1) $$G_j = g(Agric, Indus, Serv, Trade)$$

where G_j represents log growth of the economic sector j,

Agric = Log of agricultural GDP,

Indus = Log of industrial GDP,

Serv = Log of service GDP, and

Trade = Export share.

Annual time series data from 1989 to 2007 were collected from a World Bank dataset which published at http://data.un.org/. The data on the pre-transition period (prior to 1989) was not used in this study since the command economic system was not comparable and fundamentally different from a market economic system.

The United Nations (UN) publishes the World Bank dataset based on the approach of International Standard of Industrial Classification (ICIC). This approach defines three sectors-- agriculture, industry and service-- as broad aggregates, and is presented in the Table 1.

Table 1: Description of Data

Variable	Definition (constant price, basis=1990)	ISIC[1] categories	Data Description
Agricultural sector	Agriculture, hunting and forestry; and fishing	A,B	Annual data of different sectors in the economy of Poland and Romania was collected from the period of 1989 to 2007 at: http://data.un.org/ Online: May 06, 2009
Industrial sector	Mining and quarrying; manufacturing; electricity, gas and water supply	C, D,E	
Service sector	Wholesale, retail trade, repair of motor vehicles, motor cycles and personal and household goods; hotels and restaurants; transport, storage and communication; financial intermediation; real estate, renting and business activities; public administration and defense, compulsory social security; education; health and social work; other community, social and personal service activities; activities of household.	G, H, I, J, K, L, M. N, O, P	
Trade sector	Export share of total GDP*	--	

* The export share of total GDP is used as a proxy for all other factors that affected the sectoral outputs

[1] International Standard of Industrial Classification of All Economic Activities.

Figure 1: Sectoral outputs of Poland --in millions 1990 dollars

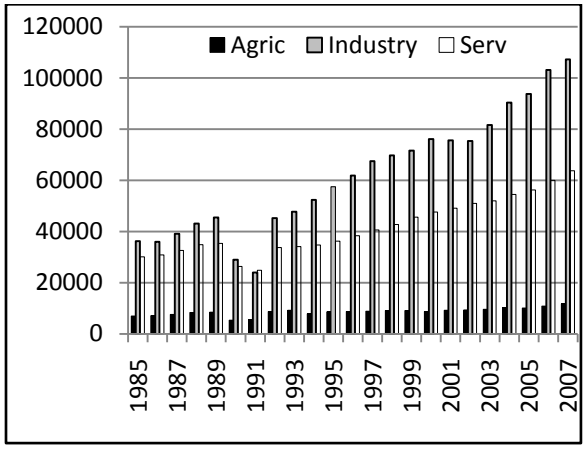
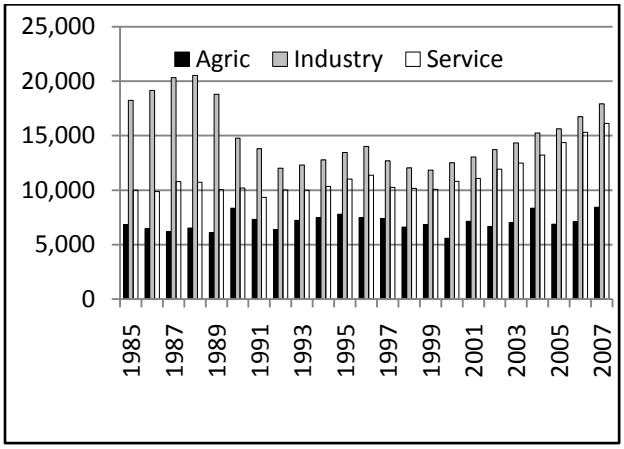


Figure 2: Sectoral outputs of Romania--in millions 1990 dollars



The sectoral outputs of Poland (Figure 1) suggests that the industrial and service sectors play the dominant roles in Poland's economy, and the contribution of the agricultural sector to economic growth seems to be trivial. Conversely, the Romanian economy (Figure 2) failed to recover the dominant industrial sector it had during the pre-transition period, and the agricultural sector seems to play an important role during the transition period. As a result of such contradicting roles of agriculture in these countries, we want to develop an empirical model to understand the actual role of agriculture as well as how the agricultural sector contributes to the economic growth in the respective countries. These results should help policymakers determine the benefits and the costs of particular policy alternatives.

Empirical Analysis

Unit-Root and Order of Integration Analysis

This study uses time series analysis to understand the relationships among the sectors for Poland and Romania. The first step in this analysis is to explore the univariate properties and to test the order of integration of each series. The Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979, 1981) is used to perform unit root tests. The analysis shows that all the four

variables failed to reject the unit root hypothesis at levels and rejected at the first-differences (Table 2).

Table 2: Augmented Dickey Fuller unit root test results for Poland and Romania

	Poland		Romania	
	Level	First differences	Level	First differences
Agriculture	-2.43	--3.29*	-2.26	-4.79*
Industry	-1.66	-7.98**	-1.69	-5.23**
Service	-2.62	-5.00**	-0.90	-4.34*
Trade	-2.79	-4.00*	-0.40	--4.04*

*, ** indicate that the tau-values are significant at 5% and 1%, respectively.

The results show that the series are integrated at the first order, *I(1).* Since all the series are at the same order, the dataset is appropriate for further analysis.

Johansen Methodology

Johansen and Juselius (1992) developed a procedure to estimate a co-integrated system involving two or more variables. This procedure is independent of the choices of the endogenous variables, and it allows researchers to estimate and test for the existence of more than one cointegrating vectors in the multivariate system. The general model can be described as follows:

$$\Delta Y_t = \Pi Y_{t-p} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \mu D_i + \varepsilon_t \quad (2)$$

where Y_t is the column vector of the current values of all the variables in the system (integrated of order one), D_t is a matrix of deterministic variables such as an intercept and time trend, ε_t is the vector of errors are assumed $E(\epsilon_t \epsilon_t') = \Omega$ for all t ; Γ, Π, and μ are the parameters matrices. The p is the number of lag periods included in this model, which is determined by using the Akaike Information Criterion (AIC) and Schwartz Bayesian Criterion (BIC). The first term in equation 2 captures the long-run effects on the regressors and the second term captures the short-run impact.

In the long run parameter matrix Π will be of order n x n, with a maximum possible rank of n. Then, using the Granger representation theorem (Engel and Granger, 1987), the rank of Π is found to be $r < n$, the matrix Π may be factored as $\alpha\beta'$ where α and β are both of order $n \times r$. Matrix β is such that $\beta' Y_t$ is *I(0)* even though Y_t itself is *I(1)*. In other words, it is the cointegrating matrix describing the long-run relationships in the model. The weighted matrix, α, gives us the speed of adjustment of specific variables on account of deviations from the long-run relationship. The cointegration rank is usually tested by using the maximum eigenvalue and trace statistics proposed by Johansen (1988).The long-run information of the series were taken into account in analyzing the short-run sectoral growth and the resulting model is a short-run error correction model.

Evidence for Cointegration

The number of distinct cointegrating vectors can be obtained by checking the significance of the characteristic roots of Π. This means that the rank of matrix is equal to the number of its characteristic roots that differ from zero. The test for the number of characteristics roots that are insignificantly different from unity can be conducted using the following test statistics:

(3) $$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln (1 - \hat{\lambda}_i)$$

(4) $$\lambda_{max}(r, r+1) = -T \sum_{i=r+1}^{n} \ln (1 - \hat{\lambda}_{r+1})$$

where $\hat{\lambda}_i$ is the estimated values of the characteristics roots (called eigenvalues) obtained from the estimated λ matrix and T is the number of usable observations. The first, called the trace test, tests the hypothesis that there are at most r cointegrating vectors. In this test, λ_{trace}equals zero when all λ_i are zero. The further the estimated characteristic roots are from zero, the more negative is $\ln(1 - \hat{\lambda}_i)$ and the larger the λ_{trace} statistic. The second, called the maximum eigenvalue test, tests the hypothesis that there are r cointegrating vectors versus the hypothesis that there are r+1 cointegrating vectors. This means if the value of characteristic root is close to zero, then the λ_{max}will be small. The procedure indicates three cointegrating relationship among the sectors in the Poland (Table 3) and one for Romania (Table 4).

Table 3: Evidence of cointegration using maximal eigenvalue and trace statistical tests for all four sectors in Poland

Hypotheses				Maximum eigenvalue test			Trace statistical test		
Ho	$H1^1$	$H1^2$	Eigen value	λ_{max} values	5% critical value	10% critical value	λ_{trace} values	5% critical value	10% critical value
r = 0	r = 1	r ≤ 1	0.9325	45.82*	27.07	24.73	87.62*	47.21	43.84
r = 1	r = 2	r ≤ 2	0.7257	21.99*	20.97	18.60	41.80*	29.38	26.70
r = 2	r = 3	r ≤ 3	0.6752	19.17*	14.07	12.07	19.80*	15.34	13.31
r = 3	r = 4	r ≤ 4	0.0367	0.64	3.76	2.69	0..64	3.84	2.71

* denotes reject the null hypothesis. [1, 2] denote alternative hypothesis for maximum eigenvalue and trace statistical tests, respectively.

Table 4: Evidence of cointegration using maximal eigenvalue and trace statistical tests for all four sectors in Romania

Hypotheses				Maximum eigenvalue test			Trace statistical test		
Ho	$H1^1$	$H1^2$	Eigen value	λ_{max} values	5% critical value	10% critical value	λ_{trace} values	5% critical value	10% critical value
r = 0	r = 1	r ≤ 1	0.8685	37.74*	27.07	24.73	61.15*	47.21	43.84
r = 1	r = 2	r ≤ 2	0.5735	15.82	20.97	18.60	23.41	29.38	26.70
r = 2	r = 3	r ≤ 3	0.2929	6.71	14.07	12.07	7.59	15.34	13.31
r = 3	r = 4	r ≤ 4	0.0568	0.88	3.76	2.69	0.88	3.84	2.71

* denotes reject the null hypothesis. [1, 2] denote alternative hypothesis for maximum eigenvalue and trace statistical tests, respectively.

Long-run Sectoral Growth model

Using AIC and BIC for optimal lags, Durbin-Watson and ARCH for correlated and heteroscedastic residuals, and Jargue-Bera for normality tests, our sectoral growth models for Poland and Romania were determined. The models included a cointegration space, and a constant (μ_0) and a time trend (μ_t) in the short run. Two lags for each sectoral growth variable were also included (equation 5).

(5) $$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \mu_0 + \mu_t + \varepsilon_t$$

As the models have passed the above statistical tests (data not presented here), and the following long terms relationships, *Π*, are identified:

Table 5: Represents the long-run relationship, *Π* matrix, for economies of Poland

$$\begin{bmatrix} \Delta Agric_t \\ \Delta Indus_t \\ \Delta Serv_t \\ \Delta Trade_t \end{bmatrix} = \begin{bmatrix} -0.5606 & 0.2352 & -2.4279 & -0.6697 \\ 0.1493 & 0.0580 & -3.1876 & -0.0073 \\ 0.0081 & 0.2409 & -1.8315 & -0.2741 \\ -0.7356 & 0.7157 & -0.9775 & -1.0268 \end{bmatrix} \begin{bmatrix} Agric_{t-1} \\ Indus_{t-1} \\ Serv_{t-1} \\ Trade_{t-1} \end{bmatrix}$$

Table 6: Represents the long-run relationship, *Π* matrix, for economies of Romania

$$\begin{bmatrix} \Delta Agric_t \\ \Delta Indus_t \\ \Delta Serv_t \\ \Delta Trade_t \end{bmatrix} = \begin{bmatrix} -0.4516 & -2.3702 & 2.7110 & 0.4520 \\ -0.0926 & -0.4858 & 0.5556 & 0.0926 \\ 0.1824 & 0.9574 & -1.0951 & -0.1826 \\ -0.1279 & -0.6712 & 0.7677 & 0.1280 \end{bmatrix} \begin{bmatrix} Agric_{t-1} \\ Indus_{t-1} \\ Serv_{t-1} \\ Trade_{t-1} \end{bmatrix}$$

The *Π* is a 4x4 matrix as the model contains four endogenous variables. Three cointegration relationships for Poland (Table 4) and one for Romania (Table 5) were imposed to estimate the *Π* matrix.

Since the objective of this study is to understand the contribution of agricultural sectoral and what extent it was influenced by other sectors in the economy, this study focuses on the estimates of first row of the *Π* matrix[2]. In that regard, the following relationships were established for the agricultural sector for Poland and Romania, respectively.

[2] The 2nd, 3rd and 4th rows reflect the impacts on the growth of industrial, service, and trade sectors, respectively.

(6) $$[\Delta Agric_t] = \begin{bmatrix} -0.5606 & 0.2352 & -2.4279 & -0.6697 \\ (0.2039) & (0.2402) & (0.4078) & (0.3794) \end{bmatrix} \begin{bmatrix} Agric_{t-1} \\ Indus_{t-1} \\ Serv_{t-1} \\ Trade_{t-1} \end{bmatrix}$$

(7) $$[\Delta Agric_t] = \begin{bmatrix} -0.4516 & -2.3702 & 2.7110 & 0.4520 \\ (0.1667) & (0.8747) & (1.0005) & (0.1668) \end{bmatrix} \begin{bmatrix} Agric_{t-1} \\ Indus_{t-1} \\ Serv_{t-1} \\ Trade_{t-1} \end{bmatrix}$$

The results show that all the estimates are statistically significant at the 5% level except the variable $Indus_{t-1}$'s of Poland.

As noted earlier, the term Π in the equation 5 can be factorized into speed of adjustment (α) and the long-run estimate (β) such that $\Pi = \alpha\beta'$. Consequently, equation 5 can be written as:

(8) $$\Delta Y_t = \alpha(\beta' Y_{t-1}) + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \mu_0 + \mu_t + \varepsilon_t$$

The dimensions of the matrices of α and β are ($4 \times r$), where r is the rank of Π.The matrix α describes the adjustment speed for each sector after a deviation from the long-run relationship. In other words, the elements in α weight the error correction term in each row of the VECM. Larger values of the coefficients indicate a greater response of the short-run dynamics (i.e., ΔY_{t-i}) to the previous period's deviation from the long-run equilibrium (i.e., $\beta' Y_{t-1}$). Furthermore, the matrix β contains the coefficients of the cointegration relation, i.e., the weights within the linear combination. By imposing the number of cointegration restrictions, three for Poland and one for Romania (normalized to agricultural sector), the long-run estimates and adjustment coefficients are estimated for Poland and Romania, and the results are presented in Tables 7 and 8, respectively.

Table 7: The estimated long-run estimates (β) and speed of adjustment coefficients (α) for Poland

$$\beta \text{ matrix: } \begin{bmatrix} Agric & 1.00 & 1.00 & 1.00 \\ Indus & -0.78 & -2.19 & -0.52 \\ Serv & 2.61 & 3.49 & -0.56 \\ Trad & 1.55 & 3.03 & 1.22 \end{bmatrix}$$

$$\alpha \text{ matrix: } \begin{bmatrix} Agric & -1.14 & 0.21 & 0.37 \\ Indus & -1.10 & 0.09 & 1.16 \\ Serv & -0.49 & -0.06 & 0.57 \\ Trad & -0.23 & -0.16 & -0.34 \end{bmatrix}$$

Table 8: The estimated long-run estimates (β) and speed of adjustment coefficients (α) for Romania

$$\beta \text{ matrix: } \begin{bmatrix} Agric & 1.00 \\ Indus & 5.25 \\ Serv & -6.00 \\ Trad & -1.00 \end{bmatrix}$$

$$\alpha \text{ matrix: } \begin{bmatrix} Agric & -0.45 \\ Indus & -0.09 \\ Serv & 0.18 \\ Trad & -0.13 \end{bmatrix}$$

The stable long-run equilibrium equations for Poland, presented in the Table 7, can be written as:

(9) $$Agric = 0.78\ Indus - 2.61\ Serv - 1.55\ Trade$$

(10) $$Agric = 2.19\ Indus - 3.49\ Serv - 3.03\ Trade$$

(11) $$Agric = 0.52\ Indus + 0.56\ Serv - 1.22\ Trade.$$

The results show that during the transition process the agricultural sector in Poland has established three long-run relationships to the industrial and service sectors. The positive sign of the industrial sector in all three relationships suggests that there exists a strong positive relationship to the agricultural sector. This implies that an increase in the industrial sector will affect the agricultural sector positively, holding all other variables that affect the agricultural sector constant. During the transition period the labor movements from industry to agriculture and agriculture to other sectors are well documented. For example, Boeri and Terrel (2002) noted that during the period of 1989-1998, the agricultural labor in Poland and Romania increased by 0.6 and 12.1 percent, while the industrial labor contracted by 7.9 and 14.2 percent, respectively.

It is important to note that labor adjustment should be the net-effect of two opposing directions: industry to agriculture and agriculture to industry. In the movement from industry to agriculture, the agricultural sector served as a buffer, and absorbed the labor laid off in other sectors, as a source of income and social security during difficult transition times. Labor is

absorbed into the agricultural sector, diminishing the marginal productivity of labor and capital, so output increases at a slower rate. This leads to a negative relationship between output growth in the agricultural and industrial sectors.

In the movement of agriculture to industry, under the communist system, overemployment was stronger in the agricultural sector, and the elimination of input and output subsidies resulted in an outflow of labor from the agricultural sector. According to this view, the employment in the agricultural sector decreases without any significant loss in agricultural output, and the sector enjoys greater productivity in labor and capital. The higher employment and increased output in the industrial sector establishes a positive linkage between industry and agriculture.

The positive signs of industrial sector in equations 9-11 reiterate that Poland has overcome the negative trend (industry to agriculture) of the early transition. Its speedy transition process and initial conditions, like existence of private land rights along with greater trade oriented economy, created better economic environments to overcome the initial shocks. It is a well-known fact that as country's economy grows people will adjust their consumption patterns accordingly. The people want to spend less time on cooking traditional food and are willing to spend more of their food expenditures on processed or ready-made foods. Consequently, a positive relationship will be established between economic growth and food processing industries.

The higher demand for processed food will stimulate the economy a number of ways. First, the higher demand will attract more local and international food processing firms. Second, foreign direct investments and many service sectors like marketing, transportation, and finance will be established, and these sectors will have spillover effects into the agricultural sector as well. Third, farmers will face greater demand for their products, and increase their productivities. Ultimately, the agricultural sector reaches positive backward relationships and establishes fundamentals for sustainable growth in the agricultural sector.

Unlike the Polish economy, the long-run relationship between the industrial and agricultural sectors was negative for the Romanian economy (equation 12).

(12) $$Agric = -5.25\ Indus + 6.00\ Serv + 1.00\ Trade$$

This means that as the industrial sector grows, the growth of agricultural sector will diminish, holding all other variables that affect the agricultural sector constant. This contradiction might be explained by a number of factors. First, in 1990, both Poland and Romania had their first free elections. The anti-communist solidarity party in Poland won the elections, and the new government adopted a shock therapy to make a speedy transition. However, Romania chose the successor of the communist party leader, Ion Iliescu, and he stayed in power together with his party until 1996.

During this period, Romania followed a gradual transition path, and such a transition process failed to provide the appropriate environment for the small scale private sector to take-off. For instance, Boeri and Terrel (2002) found that, in 1996, the employment share in firms fewer than 100 employees was 16% in Romania compared to 50.3% in Poland. Furthermore, hyper inflation, higher black market premiums for foreign exchange, and limited trade dependencies hindered entrepreneurs in Romania. Second, the agricultural sector in Poland was practically private from the beginning and it was never collectivized as in Romania. Consequently, the detrimental effects of liberalization and privatization policies were much greater in Romania. Third, the newly elected former communist government was much more powerful, and spent resources to maintain its power base through the large loss-making state-owned enterprises in Romania. All these factors have contributed to the negative relationship between the agricultural and the industrial sectors.

These effects substantiate the fact that during the first eight years of liberalization, the agricultural employment in Romania increased by 10% (Swinnen et al., 2005). Therefore, we may conclude that the Romanian transition process failed to overcome the early labor movements (industry to agriculture) because the second part of labor movements (agriculture to industrial sector) could not dominate the former, resulting in a negative relationship between the industrial and agricultural sectors.

As noted in the Figures 1 and 2, the service sectors expand as the economy grows, however its relationship to other sectors depend on the level of development. At early stages of development, the service sector is able to stimulate growth of the agriculture and manufacturing sectors and, therefore, a positive relationship is expected. However, in the more matured economies, resources such land, labor and capital will be transferred to the service sector as a

result of higher income elasticities for service compared to the manufacturing and agricultural products.

Our empirical analysis shows that the service sector in the Romanian economy is positively contributed to the agricultural sector. This means that the Romanian economy is at a progressing stage, and the demand for the service sectors is not high enough to transfer significant amounts of resources from the other sectors. Conversely, the service sectors in the Polish economy suggest that it has reached a higher level of economic progress than Romania. Two of three stable long-run relationships show that the service sector is detrimental to the agricultural sector (equations 9 and 10) in Poland. This suggests that either agricultural resources are transferred to service sectors as a result of higher demand for service sectors, or the demand for local agricultural production decreased as the result of greater demand for imported food from rest of the Europe. The latter could be significant because of Poland's proximity to the Western Europe and its openness to rest of the world. Imported food (both fresh and processed) could easily dominate the local market, and therefore, reduce the importance of local production.

The positive relationship (equation 11) between the service and agricultural sectors is consistent with the results for Romania. The finding of weaker service sector growth in Romania compared to Poland is consistent with the finding of Boeri and Terrel (2002). They found that during the first ten years of transition, service employment in Romania increased only by 2.1 percent while Poland had a 7.4 percent increase.

Short-Run Sectoral Growth

By incorporating the result of cointegration analysis of the previous section, we can isolate the short-run effects from the long-run. Therefore, the long-run relationship information was included as explanatory components of the model to understand the short-run relationship. The resulting model is a short-run error correction model, and the results are presented in Table 9.

Table 9: Short-run inter-sectoral linkages among agricultural, industrial and service sectors in Poland and Romania

Explanatory variable	$\Delta Agric_t$		$\Delta Indus_t$		$\Delta Serv_t$	
	Poland	Romania	Poland	Romania	Poland	Romania
$Agric_{t-1}$	-0.56 **	-0.45 **	0.15	-0.09	0.01	0.18 **
	(0.20)	(0.17)	(0.40)	(0.06)	(0.15)	(0.07)
$Indus_{t-1}$	0.24	-2.37 **	0.06	-0.49	0.24	0.96 **
	(0.24)	(0.87)	(0.24)	(0.30)	(0.17)	(0.40)
$Serv_{t-1}$	-2.43 **	2.71 **	-3.19 **	0.56	-1.83 **	-1.10 **
	(0.41)	(1.00)	(0.79)	(0.34)	(0.29)	(0.45)
$Trad_{t-1}$	-0.67	0.45 **	-0.01	0.09	-0.27	-0.18 *
	(0.38)	(0.17)	(0.74)	(0.06)	(0.27)	(0.08)
$\Delta Agric_{t-1}$	-0.20	-0.34 *	-0.13	0.18 **	0.04	0.07
	(0.22)	(0.16)	(0.42)	(0.05)	(0.16)	(0.07)
$\Delta Indus_{t-1}$	-0.37 *	-0.71	-0.53	-0.07	-0.54 **	-0.16
	(0.16)	(0.46)	(0.31)	(0.16)	(0.12)	(0.21)
$\Delta Serv_{t-1}$	2.09 **	-0.64	2.05 **	0.30	1.40 **	0.62
	(0.40)	(0.81)	(0.78)	(0.28)	(0.29)	(0.37)
$\Delta Trad_{t-1}$	0.50 **	-0.72 *	-0.57	0.14	-0.05	0.48 **
	(0.16)	(0.36)	(0.31)	(0.13)	(0.11)	(0.17)
Constant	67.46 **	1.99 **	71.97**	0.35	38.91**	-0.82 **
	(8.16)	(0.74)	(16.82)	(0.26)	(5.85)	(0.34)
Trend	0.15 **	-0.07 **	0.14 **	-0.01	0.08 **	0.03 **
	(0.03)	(0.03)	(0.05)	(0.01)	(0.02)	(0.01)

* and ** denote the estimates are significant at 5% and 1%, respectively. Standard errors are in parenthesis.

The table shows the estimates and the standard errors of variables that affect the growth of agricultural, industrial and service sectors in the short-run for Poland and Romania. The importance of the service sector is proved again in Poland. The results suggest that a one percent increase in growth of the service sector leads to a more than two percent growth in agricultural or industrial sectors, holding all other variables constant. The positive effects of the service sector reiterate the fact that its expansion increases the demand and supply for agricultural and industrial sector output in the short run. However, as noted earlier, in the long-run the service sector could produce negative effects on the other sectors as more and more resources are transferred from the agricultural and industrial sectors as the economy grows.

Growth in the industrial sector affects the other two sectors negatively in Poland. A similar effect is observed in the Romanian economy; however, the results are not significant. As expected, the role of agriculture in the short-run is not significant to the other sectors, but it made a positive impact on the industrial sector in Romania. That may be due to the demand for machinery and equipment for modernizing the agricultural sector and development of new food-processing industries in Romania.

Conclusion

This study estimates an econometric model that incorporates the linkages among the sectors (agriculture, manufacturing, and service) using a Vector Error Correction Model (VECM). This procedure is employed to identify the existence of long-run and short-run relationships among different sectors in the economies of Poland and Romania. The empirical findings from the analysis confirm that the different sectors in the Romanian and Poland economies moved together over the sample period, and for this reason their growth was interdependent. This implies that once the sectors deviate from the stable, long-run path the sectors have the tendency to return to the long-run equilibrium.

Our analysis shows three long-run cointegrating relationships for Poland and one for Romania. The long-run relationship of the agricultural sector to other sectors in the Poland shows that the industrial sector plays a positive role on the agricultural sector. However, the growing service sectors seem to be detrimental to the growth of the agricultural sector. This is an

indication for that Poland's economy is progressing at a higher level of economic development and facing resource constraints. On the other hand the Romanian agriculture is negatively affected by the rising industries, and it is induced positively by the growing service sectors. The short-run analysis shows that the service sector plays an important role in overall economic growth in Poland. The results were not significant for Romania. In contrast to the long-run relationship, the industrial sector in Poland has a negative impact on the other sectors.

The three cointegrating relationships for Poland show that its economy is sturdier than the Romanian economy since the cointegrating vectors can be thought of as constraints that an economic system imposes on the movement of the variables in the long-run. For instance, the three cointegrating vectors (long-run relationships) allow the service sector in Poland to have both positive and negative relationships to the agricultural sector. This leads the Polish economy to grow and reach equilibrium at different directions, i.e., any (negative or positive) shock to the service sector will not affect the agricultural sector significantly. On the other hand, the sole cointegrating relationship in Romania permits the economy to reach equilibrium in a particular direction. For instance, a decrease in the service sector will impact the agricultural sector negatively. An economic system with more cointegrating vectors has more dynamic properties that allow more complex interplay among the endogenous variables.

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