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UNDERSTANDING STRUCTURAL TRANSFORMATION FROM A REGIONAL LINKAGE PERSPECTIVE: EVIDENCE FROM VIETNAM

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ABSTRACT

Structural transformation is one of the most crucial issues in the literature on economic development. This study aims to analyze the structural transformation of localities from the perspective of regional linkages by examining both inside and outside determinants in the case of a typical country undergoing a significant structural change, Vietnam. By employing the data of all 63 provinces from 2015 to 2018 extracted from the annual statistical yearbook, this study performs a mediation analysis with provincial productivity and income as the mediators. The research results show that outside factors that are based on metropolises' characteristics are the origins of structural transformation in provinces rather than inside factors as per previous research. In addition to attracting labor and providing capital for neighboring areas, metropolises are also markets for the consumption of products and centers of information and knowledge in the provinces. These functions of metropolises have promoted the structural transformation of neighboring provinces.

Contribution/Originality: The paper offers insights into the structural change of geographical areas more comprehensively with the existence of regional linkages that are not mentioned in previous studies.

1. INTRODUCTION

Structural transformation is one of the earliest and most essential issues in the literature on development economics. According to several definitions found in the literature, structural transformation refers to the reallocation of economic activity across the broad sectors of agriculture, manufacturing, and services (Kuznets, 1973). This process plays an essential role in the development of any economy, particularly developing countries that depend on agriculture with low productivity. It is a well-known observation that countries have experienced remarkable growth and have seen significant change in economic structure in the past five decades (Rodrik, 2016). Structural transformation not only helps to allocate resources efficiently and increase productivity sustainably (McMillan & Headey, 2014), it also creates opportunities for workers to access better technologies and improve their skills and capabilities. Regarding the policy aspect, structural transformation is an important instrument that enhances an economy's resilience after disturbances and shocks across various disciplines (Aswegen & Retief, 2021).

The determinants of structural transformation have been investigated for a long time, and the policymakers in countries have affected them to develop their economy. However, these determinants are examined for the whole

economy of a country, while a country that has different regions with different characteristics and development levels raises the question of whether the determinants of structural transformation for a whole country's economy are similar to those of smaller regions. The answer to this question is an essential contribution to both existing literature and future implications. Analyzing the structural transformation in smaller areas helps identify the natural origins in which this process is motivated. Furthermore, based on this investigation, policymakers will have a comprehensive view of the determinants of structural transformation and launch more appropriate policies in certain regions.

The main goals of this study are to compare the determinants of structural transformation in the provinces and in the whole country and to identify the natural origins of determinants in local structural transformation. Based on the previous literature on structural transformation and regional linkages, this study establishes the hypotheses of determinants in the change of the economic structure in the provinces. Then, a mediation analysis is employed to examine whether factors which used to explain the structural transformation at the country level are also suitable at the prefecture level. The remainder of this study is organized as follows: The second section provides the theoretical background and develops several hypotheses that inform the research question, the third section describes the data and methods, followed by a section presenting the results, and the final section presents the conclusion.

2. THEORETICAL BACKGROUNDS AND HYPOTHESIS DEVELOPMENT

2.1. Structural Transformation

For a long time, the determinants of structural transformation have been studied in two contexts—closed economy and open economy. Among a large body of literature on structural transformation in a closed economy, two mechanisms through which the process of structural change can occur are changes in income and changes in productivity. The first mechanism is derived from the non-homothetic preferences, which are cross-sector differences in the elasticity of income. The income elasticity of the demand for agricultural products is lower than that of non-agricultural products (Kongsamut, Rebelo, & Xie, 2001); therefore, the increase in income raises the need for non-agricultural products and then leads the movement of labor to non-agricultural sectors (Foellmi & Zweimüller, 2008). By using panel data for 39 countries during the postwar period, Comin, Lashkari, and Mestieri (2021) show that income effects account for the bulk of the within-country evolution of sectoral reallocation. The second mechanism is associated with unbalanced technological progress across sectors and capital deepening. In an economy with two sectors that have different productivity, if the ratio of the outputs of the two sectors is held constant, more of the total labor force must be transferred to the non-progressive sector (Baumol, 1967). Gollin, Parente, and Rogerson (2002) argue that improvements in agricultural productivity can hasten the start of industrialization. Ngai and Pissarides (2007) point to implications of different sectoral total factor productivity (TFP) growth rates for structural change and believe that there is a shift of employment away from sectors with a high rate of technological progress toward sectors with low growth. Bustos, Vincenzi, Monras, and Ponticelli (2019) also confirm that increases in agricultural productivity can lead to a reallocation of labor towards the industrial sector. However, improvements in agricultural productivity have positive effects in the short run because of the generation of specialization in less innovative industries. In the long run, this has adverse effects on manufacturing productivity. Herrendorf, Rogerson, and Valentinyi (2014) developed a multi-sector model that encompasses the main existing theories to account for many salient features of structural transformation. This model shows that both mechanisms are essential. With the open economy, along with income and productivity effects, the role of external factors, which come from outside the country, are investigated. McMillan, Rodrik, and Verduzco-Gallo (2014) discuss the role of globalization through which countries gain opportunities to attract investment and achieve structural change. Święcki (2017) and Teignier (2018) argue that international trade significantly accelerated the transition out of agriculture and contributed to the structural transformation in some countries. Besides globalization and trade, Van (2019) found strong support for the role of outsourcing in contributing to structural change, and particularly deindustrialization, in both developed and developing countries.

2.2. Regional Linkages

Another theoretical field involves regional linkage theories dealing with aspects of the relationship between areas. Basically, these theories attempt to explain regional linkages through the regional growth and shrinkage processes. Perroux (1955) introduced the growth poles theory, which indicates the development is unbalanced; it first appears in points or development poles and spreads along diverse channels and with varying terminal effects to the whole of the economy. Supporting the growth poles theory, Friedman (1966) developed the core-periphery model, which spatially shows how economic, political, and cultural authority is dispersed in core or dominant regions and the surrounding peripheral and semi-peripheral regions. The core regions refer to centers, which are usually metropolitan. These centers typically dominate power in the economy and have a high potential for innovation (improvement) and growth, while the periphery with a lower level of development is dependent. Hirschman (1958) and Myrdal (1957) show two effects in which the growth pole influences the development of surrounding areas. Hirschman's trickling down effects (or spread effects in Myrdal's terms) include the role of the core in the diffusion of investment, innovation, and absorption capacity for disguised unemployment in periphery areas. Hirschman's polarization effects (or backwash effects respectively in Myrdal's terms) refer to the unfavorable effect of core economic growth on periphery economic development through selective migration of the young, skilled, educated people and the capital movement from nearby areas to the center. In addition, in Myrdal's opinion also, spread effects are weaker than backwash effects, whereas Hirschman considers that, in the end, the spread effects would gain the upper hand over the polarization effects if the core had to rely on periphery products for its own expansion. Douglass (1998) and Tacoli (2003) analyzed the regional connection from a spatial perspective between urban areas and rural areas. The linkages between them include a set of flows that are people, production, commodities, capital, information, waste and pollution, and these flows have different directions.

2.3. Hypothesis Development

Following the theoretical background above, it is clear that the determinants of structural transformation comprise inside and outside effects. The inside effects include changes in income and productivity, while the outside effects associate the connection with other areas. However, these determinants are explained for the economy of the country if each country contains smaller regions. Theories of regional linkages in the previous section support the existence of different development between areas, and the relationship between them leads to the change in each area. This study's primary goal is to investigate the natural origin of structural transformation in Vietnam's provinces and examine whether determinants in the structural transformation at the country level fit into the prefecture level; therefore, this section develops the hypotheses of structural transformation in provinces with a combination of structural change and regional linkage theories.

2.4. Inside Factors of Structural Transformation in Provinces

Base on two mechanisms of structural transformation in a closed economy, some scholars show evidence of the relationship between structural change and the agricultural productivity improvement (Balisacan, Mapa, Fuwa, Abad-Santos, & Piza, 2011; Gollin, 2018; Hazell, Haggblade, & Reardon, 2007) and the increase of income (Barrett, Reardon, & Webb, 2001; Haggblade, Hazell, & Reardon, 2010; Hossain, 2004). Therefore, two first hypotheses are proposed as follows:

H1: Agricultural productivity in provinces have a positive and significant influence on the structural transformation in provinces.

H2: The monthly average income per capita in provinces has a positive and significant influence on the structural transformation in provinces.

2.5. Outside Factors of Structural Transformation in Provinces and Mediator Variables

Regarding prefecture-level areas, the international connections have some limitations, and these connections

occur at the few metropolises, which are the economic, cultural, and social centers. Therefore, the outside factors of structural transformation in provinces are the connections to metropolises, and these factors include effects on migration, remittances, land expansion, information, and market.

2.5.1. Migration and Remittances

Migration and remittances always exist together; however, the directions of them are opposite. The out-migration from provinces to metropolises will lead the remittances to move from metropolises to provinces where migrants' households live (Gray, 2009; Mobrand, 2012). Additionally, labor migration between provinces and metropolises has become the core impetus for provincial change, especially agricultural transformation in traditional farming areas (Caulfield, Bouniol, Fonte, & Kessler, 2019; Ge et al., 2020). On the one hand, migration affects structural transformation in provinces due to losing labor in agricultural activities, which leads to agricultural productivity declines (Hussain, Rasul, Mahapatra, Wahid, & Tuladhar, 2018; Shi, 2018; Taylor & Castelhano, 2016). On the other hand, remittances of migrants increase households' income in provinces (Nguyen, Grote, & Nguyen, 2017; Samaratunge, Kumara, & Abeysekera, 2020), which supports agricultural productivity increase by using more chemical fertilizers, pesticides, applying new technologies (Caulfield et al., 2019), and leading reductions of the value of labor, thus removing labor from agriculture (Bhandari & Ghimire, 2016). Although remittance expenditure depends on household characteristics (Adams & Cuecuecha, 2013; Garip, 2014), almost all remittances to provinces are used for food, clothing, health care, and education, with inelastic demand for food and elastic of demand for the rest of the expenditure. Along with the increase of non-agricultural product demand, the opportunity for local industries and services is expanded (Nguyen et al., 2017). In practice, the factors shaping migration also shape remittance distribution and potential impacts. This leads to the study of separated remittance or migration impacts (Taylor & Castelhano, 2016). Therefore, this study estimates the overall effects of migration and remittance instead of separating each effect using hypotheses based on migration reasons, because there can be no migrant remittances without migration. Regarding the overall impacts of migration and remittances, previous studies show that labor loss in agriculture is compensated by increased access to money (McCarthy, Carletto, Davis, & Maltsoglou, 2006; Taylor & Castelhano, 2016), thus any factor which promotes migration is proposed to have a positive effect on structural transformation in provinces. Regarding the cause of province–metropolis migration, the motivation for this has often been analyzed under the push–pull theory (Ge et al., 2020; Nguyen, Raabe, & Grote, 2015), and the social and economic opportunities in metropolises, which include job opportunities with high income, and better education and living conditions, are the main factors (Cho, Kyaw, & Khaing, 2019; Hoffmann, Konerding, Nautiyal, & Buerkert, 2019; Mamgain & Reddy, 2017; Nguyen et al., 2015). Based on the above arguments, the following hypotheses are proposed:

Hypotheses of direct effects from migration and remittance roles:

H3; H4; H5: Metropolises' monthly average income, the qualified teacher ratio, and the postgraduate health staff ratio have a positive and significant influence on the structural transformation in provinces.

H3a; H4a; H5a: Metropolises' monthly average income, the qualified teacher ratio, and the postgraduate health staff ratio have a positive and significant influence on the agricultural productivity in provinces.

H3b; H4b; H5b: Metropolises' average income, the qualified teacher ratio, and the postgraduate health staff ratio have a positive and significant influence on the monthly average income in provinces.

Hypotheses of indirect effects from migration and remittance roles:

H3c; H4c; H5c: Agricultural productivity in provinces mediates the positive effect of metropolises' monthly average income, the qualified teacher ratio, and the postgraduate health staff ratio on structural transformation in provinces.

H3d; H4d; H5d: The monthly average income in provinces mediates the positive effect of metropolises' average income, the qualified teacher ratio, and the postgraduate health staff ratio on structural transformation in provinces.

2.5.2. Land Use Expansion

As a metropolises expand, their demand for surrounding provincial land grows, creating pressure on land prices (Diao, Magalhaes, & Silver, 2019), which leads to increase the opportunity costs of engaging in agriculture (Cali & Menon, 2013), thus motivating households to enter the rural non-farming sector (Cobbinah, Gaisie, & Owusu-Amponsah, 2015). The demand of metropolises' land usage include housing and manufacturing, among other various purposes (Aguilar, Ward, & Smith Sr, 2003); however, research has shown that province–metropolis migration affects farmland usage in provinces (Caulfield et al., 2019; Ge et al., 2020; Qin & Liao, 2016), so using the factors related to housing could lead to endogeneity with migration.

Thus, the hypotheses of the effects of land use expansion are proposed as the following:

H6a; H6b; H6: The land used for manufacturing purposes in metropolises has a positive and significant influence on the agricultural productivity, monthly average income, and structural transformation in provinces.

H6c; H6d: Agricultural productivity and monthly average income in provinces mediate the positive effect of the land used for manufacturing purposes in metropolises on structural transformation in provinces.

2.5.3. Information

Metropolises are information centers (Wattenbach, Bishop-Sambrook, & Dixon, 2005) that supply weather updates, price fluctuations, consumer preferences, knowledge, and technology information. This information helps farmers improve their productivity, yields, and profitability by managing risk from the market and restricting harm from natural hazards (Ajani, 2014; Ajani & Agwu, 2012). Increased access to information has an important role in moving out of farming in favor of more modern types of employment in services and manufacturing (Tacoli, 2003). Hence, the hypotheses regarding information effects are proposed as the following:

H7a; H7b; H7: The internet subscribers to total population ratio in metropolises has a positive and significant influence on the agricultural productivity, monthly average income, and structural transformation in provinces.

H7c; H7d: Agricultural productivity and monthly average income in provinces mediate the positive effect of the internet subscribers to total population ratio in metropolises on structural transformation in provinces.

2.5.4. Market for Goods and Services

Metropolises, which are characterized by a large population, play the role as the market for goods and services from neighboring provinces (Otsuka, 2007). The demand for provincial production raises the incomes of the provincial households, which leads to the development of the provincial non-farm economy (Haggblade, Hazell, & Brown, 1989), and it also creates more opportunities for the processed foods industry (Reardon, Bereuter, & Glickman, 2016). The hypotheses of market effects are proposed as the following:

H8a; H8b; H8: Metropolises' population without migration has a positive and significant influence on the agricultural productivity, monthly average income, and structural transformation in provinces.

H8c; H8d: Agricultural productivity and monthly average income in provinces mediate the positive effect of metropolises' population without migration on structural transformation in provinces.

Based on existing literature and empirical evidence, the research framework in this study assumes that the roles of the metropolises on structural transformation in provinces are determined through direct and indirect effects. Figure 1.

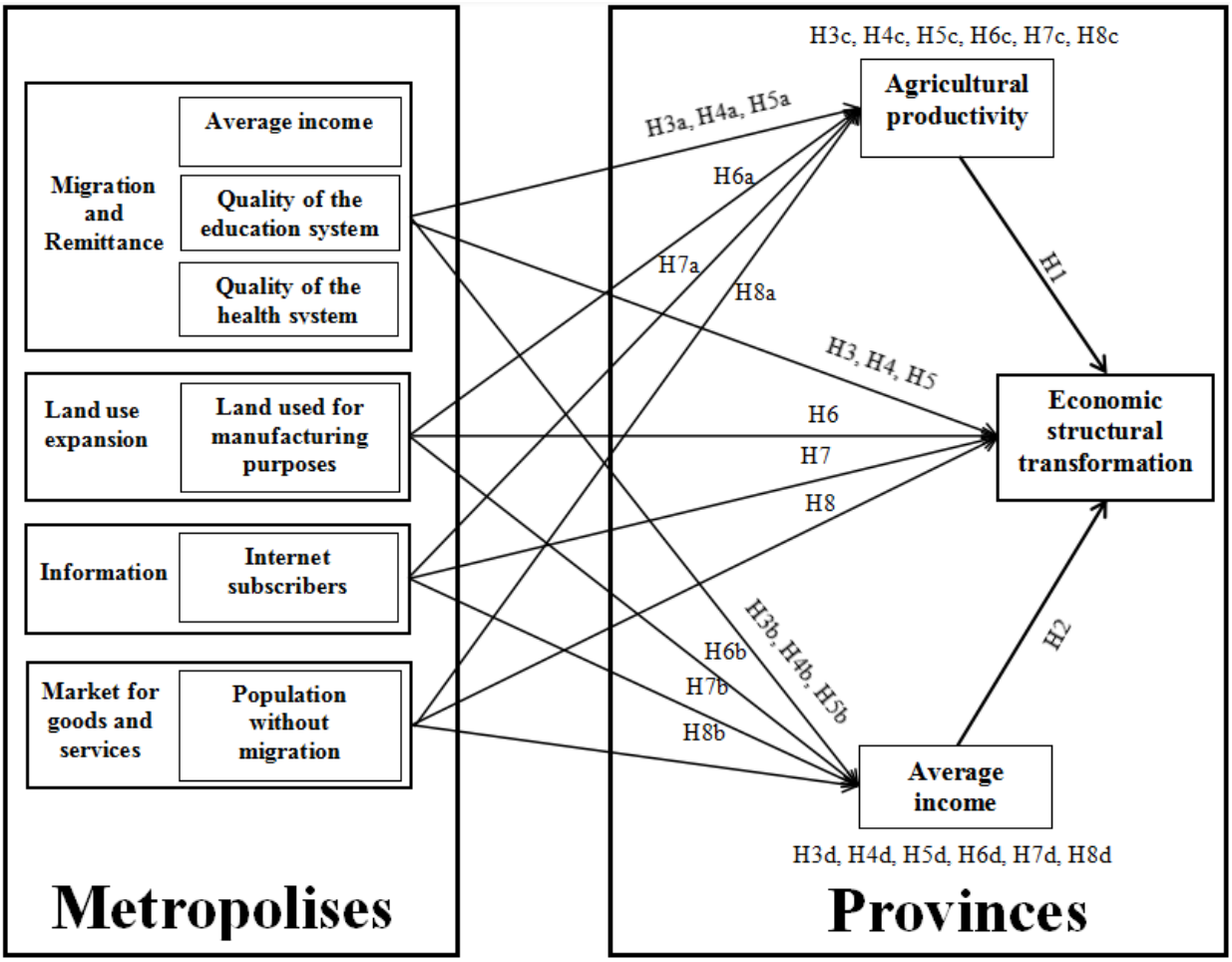

Figure 1. Research framework and hypotheses.

3. METHODOLOGIES AND DATA

3.1. Methodology

To analyze both direct and indirect effects, this study applies mediation analysis, and this helps to understand an observed relationship by exploring the underlying mechanism or process by which independent variables (X) affect the dependent variable (Y) through one or more mediator variables (M). Baron and Kenny (1986) suggest that a mediation analysis is comprised of three sets of regression: The first step helps to confirm that X is a significant predictor of Y (X → Y); in other words, this step finds out the direct effect from the independent variables to the dependent variable. The second step helps to confirm that X is a significant predictor of M (X → M), and the third step helps to confirm that M is a significant predictor of Y with the combination of the effect from X (X + M → Y). In the mediation analysis, this study employs a linear regression for the panel data, which is given in the simplest form (pooled panel data model) in Equation 1:

$$Y_{it} = X_{it}\beta + \mu_{it} \quad (1)$$

Where: Y_{it} is the response variable of province i in year t. The matrix of explanatory variables is denoted by X, β is a vector of regression coefficients to be estimated, and the random disturbance term with a mean of 0 is μ. If evidence of differences across provinces appear, the models which treat the individual effect will have to be specified: the random effects or fixed effects model (Croissant & Millo, 2008; Hausman, 1978). The common form of model which accounts for characteristics of individual provinces is in Equation 2:

$$Y_{it} = X_{it}\beta + \mu_i + \varepsilon_{it} \quad (2)$$

Where: μ denotes the individual error component specific to each province, and ε denotes the idiosyncratic error. To choose a suitable model, the F-test and Lagrange multiplier test were employed to identify the existence of individual effects (Breusch & Pagan, 1980), while the Hausman test was used to choose between fixed or random effects (Hausman, 1978).

3.2. Data

Only 35 years since the Doi Moi reforms, Vietnam has undergone one of the most rapid structural transformations of any low-income country. From 38.06% in 1986, the share of GDP in agriculture fell to 13.96% in 2019, while the share of employment in agriculture fell from 70.88% in 1991 to 37.22% in 2019. This contributes significantly to the enormous progress of Vietnamese economic development. Starting as one of the poorest nations, with the GNI at less than US $500/year in 1990, Vietnam becomes a lower middle-income country with a GNI of around US $1900/year in 2019 (in constant 2010 dollars)[1]. This structural transformation is continuous, especially at the prefecture level when each area has different characteristics. With the similarities of developing countries, the investigation of Vietnam provides a valuable case study for understanding the structural transformation of other low-income countries. Data used in this study were extracted from the 2015 to 2018 statistical yearbooks by the General Statistics Office of Vietnam. The reason for choosing this format is because it contains more information, more variability, and more efficiency that considers the different characteristics of provinces, achieving the most accurate estimates possible.

4. RESULTS AND DISCUSSION

4.1. The Descriptive Statistics

Table 1 indicates the descriptive statistics for the variables used in this study. These variables are separated into two areas: metropolises and provinces. The variables in metropolises are independent variables: Metropolises' monthly average income per capita (MeInc), the qualified teacher ratio (Teach), the qualified health staff ratio (Health), the land used for manufacturing purposes ratio (Land), the internet subscriber ratio (Internet) and the population without migration (Pop). The variables in provinces include the dependent variable, which is the share of non-agriculture (SnA), and mediator variables that are agricultural productivity (Pro) and provincial monthly average income per capita (ProInc).

Table 1. Descriptive statistics of variables.

Variables	Mean	Std. Dev.	Min.	Max.
Independent variables				
MeInc	4.718	0.984	2.843	6.177
Teach	99.365	0.676	97.234	100.000
Health	29.173	2.711	25.271	35.391
Land	3.200	1.220	0.878	5.262
Internet	36.319	22.054	9.055	67.813
Pop	4.452	2.493	0.569	7.650
Mediator Variables				
Prod	22.824	16.520	6.908	175.537
ProInc	2.887	0.98	1.091	6.177
Dependent Variable				
SnA	71.650	10.177	45.020	93.140

[1] Data were extracted from https://data.worldbank.org/.

4.2. Inside Factors Analysis

Based on the previous literature, the change of inside factors that contribute to the structural transformation and the regression results in Table 2 confirm this relationship. However, only the change in income (ProInc) is significant, while the change in agricultural productivity (Prod) is insignificant.

Table 2. Regression of the share of non-agriculture on the inside factors.

Dependent Variable: Share of non-agriculture in provincial economic structure			
	Pooled OLS model	**Fixed effects model**	**Random effects model**
Intercept	58.614*** (35.789)		63.012*** (48.030)
Prod (H1)	-0.205*** (-6.391)	-0.010 (-1.051)	-0.015 (-1.439)
ProInc (H2)	6.136*** (11.353)	2.903*** (10.148)	3.108*** (10.700)
Breusch–Pagan Lagrange Multiplier Test		264.710***	
F-test for individual effects		91.197***	
Hausman Test		16.919***	

Note: T-statistics are in parentheses; *** $p < 0.01$.

4.3. Mediation Analysis

As shown in Table 3, the model which is consistent with the data is the random effects model because the p-value in the Breusch–Pagan Lagrange Multiplier test is significant, and the p-value in the Hausman test is insignificant. In this model, all metropolises' characteristics, excluding the land used for manufacturing purposes (H6), are significantly related to structural transformation in provinces. In other words, the metropolises' monthly average income per capita (H3), the qualified teacher ratio (H4), the qualified health staff ratio (H5), the internet subscriber ratio (H7), and the population without migration (H8) have a positive and significant influence on structural transformation.

Table 3. Regression of the dependent variable on the independent variables.

Model 1	**Pooled OLS model**	**Fixed effects model**	**Random effects model**
Intercept	-4.503 (-0.046)		4.321 (0.281)
MeInc → SnA (H3)	-0.810 (-0.759)	0.785*** (3.689)	0.676*** (3.490)
Teach → SnA (H4)	0.522 (0.512)	0.485*** (2.951)	0.478*** (3.001)
Health → SnA (H5)	0.432 (1.080)	0.300*** (3.440)	0.260*** (3.568)
Land → SnA (H6)	3.002*** (3.404)	0.766 (0.263)	1.108 (1.186)
Internet → SnA (H7)	0.310*** (5.226)	0.039 (0.578)	0.089** (2.247)
Pop → SnA (H8)	-1.2120*** (-2.600)	0.485* (1.898)	0.508** (2.491)
Breusch–Pagan Lagrange Multiplier Test		347.060***	
F-test for individual effects		162.870***	
Hausman Test		9.804	

Note: T-statistics are in parentheses; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

According to the test results for model 2 (see Table 4), the random effects model is more appropriate, and this model indicates that some metropolises' characteristics have significant influences on agricultural productivity in provinces (H3a; H4a; H7a; H8a), and some characteristics do not (H5a; H6a). In addition, these influences are contrasting between factors. The metropolises' monthly average income per capita (H3a) and the population without

migration (H8a) have positive effects, while the qualified teacher ratio (H4a) and the internet subscriber ratio (H7a) have negative effects. The test results for model 3 (see Table 4) show that the consistent model is the fixed effects model (the p-values of both the F-test and the Hausman test are significant). This model likewise reveals that metropolises' characteristics have positive effects on income in provinces when H3b, H6b, H7b, and H8b are supported.

Table 4. Regression of the mediator on the independent variables.

Model 2	**Pooled OLS model**	**Fixed effects model**	**Random effects model**
Intercept	276.519* (-1.728)		274.617** (2.045)
MeInc → Prod (H3a)	4.051** (2.329)	3.636* (1.941)	3.654** (2.402)
Teach → Prod (H4a)	-2.638 (-1.588)	-2.332 (-1.612)	-2.616* (-1.878)
Health → Prod (H5a)	0.109 (0.168)	0.594 (0.773)	0.120 (0.212)
Land → Prod (H6a)	-2.108 (-1.467)	-5.881 (-0.229)	-1.530 (-0.970)
Internet → Prod (H7a)	-0.494*** (-5.106)	-0.804 (-1.352)	-0.424*** (-3.841)
Pop → Prod (H8a)	2.428*** (3.196)	-2.950 (-1.312)	1.727* (1.876)
Breusch–Pagan Lagrange Multiplier Test		29.804***	
F-test for individual effects		2.7291***	
Hausman Test		6.7363	
Model 3	Pooled OLS model	Fixed effects model	Random effects model
Intercept	-3.876 (-0.412)		-3.015 (-1.285)
MeInc → ProInc (H3b)	0.214* (2.096)	0.201*** (6.823)	0.289*** (9.997)
Teach → ProInc (H4b)	0.018 (0.1870)	-0.016 (-0.720)	0.022 (0.9026)
Health → ProInc (H5b)	0.121*** (3.162)	0.003 (0.228)	0.056*** (5.236)
Land → ProInc (H6b)	0.089 (1.050)	2.319*** (5.750)	0.173* (1.736)
Internet → ProInc (H7b)	-0.009 (-1.537)	0.037*** (3.995)	0.004 (0.854)
Pop → ProInc (H8b)	0.097** (2.166)	0.060* (1.698)	0.004 (0.144)
Breusch–Pagan Lagrange Multiplier Test		318.510***	
F-test for individual effects		76.828***	
Hausman Test		57.941***	

Note: T-statistics are in parentheses; *** p < 0.01, ** p < 0.05, * p < 0.1.

Table 5 indicates the regression of the structural transformation in provinces for both the inside and outside factors. Model 4 with random effects shows that, although combining the inside factor (agricultural productivity), the regression results are similar to the regression of the structural transformation in provinces for the outside factors (model 1) in which all metropolises' characteristics (H3c, H4c, H5c, H7c, H8c), excluding the land used for manufacturing purposes (H6c), have significant and positive influences. In other words, there are no mediation effects of agricultural productivity on structural transformation in provinces. Similarly, model 5 with fixed effects gives the same results as model 2 when the inside factor (income in provinces) is included in the regression. This means the impacts of metropolises' characteristics (H3d, H4d, H5d, and H8d) on structural transformation in provinces still exists, but the effect of income in provinces disappears. To put it simply, there are no mediation effects of income in provinces on the structural transformation in provinces.

Table 5. Regression of the dependent variable on the mediator and independent variables.

Model 4	Pooled OLS model	Fixed effects model	Random effects model
Intercept	6.917 (0.07)		7.256 (0.469)
MeInc → Prod → SnA (H3c)	-0.643 (-0.596)	0.823*** (3.833)	0.707*** (3.635)
Teach → Prod → SnA (H4c)	0.413 (0.403)	0.461*** (2.788)	0.452*** (2.819)
Health → Prod → SnA (H5c)	0.437 (1.092)	0.306*** (3.510)	0.262*** (3.602)
Land → Prod → SnA (H6c)	2.915*** (3.292)	0.705 (0.242)	1.103 (1.176)
Internet → Prod → SnA (H7c)	0.290*** (4.643)	0.031 (0.453)	0.085** (2.1349)
Pop → Prod → SnA (H8c)	-1.112** (-2.600)	0.454* (1.773)	0.492** (2.409)
Prod → SnA	-0.041 (-1.054)	-0.010 (-1.237)	-0.011 (-1.282)
Breusch–Pagan Lagrange Multiplier Test		347.35***	
F-test for individual effects		162.62***	
Hausman Test		8.2149	
Model 5	Pooled OLS model	Fixed effects model	Random effects model
Intercept	21.738 (0.290)		6.333 (0.374)
MeInc → ProInc → SnA (H3d)	-2.262*** (-2.755)	0.895*** (3.753)	0.432* (1.738)
Teach → ProInc → SnA (H4d)	0.398 (0.512)	0.476*** (2.893)	0.464*** (2.648)
Health → ProInc → SnA (H5d)	-0.389 (-1.249)	0.302*** (3.457)	0.213*** (2.612)
Land → ProInc → SnA (H6d)	2.401*** (3.563)	2.029 (0.640)	1.035 (1.307)
Internet → ProInc → SnA (H7d)	0.370*** (8.1232)	0.059 (0.843)	0.098* (2.670)
Pop → ProInc → SnA (H8d)	-1.867** (-5.204)	0.518** (1.773)	0.457** (2.146)
ProInc → SnA	6.770 (13.323)	-0.545 (-1.019)	0.714 (1.520)
Breusch–Pagan Lagrange Multiplier Test		275.810***	
F-test for individual effects		93.079***	
Hausman Test		675.290***	

Note: T-statistics are in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. CONCLUSION

This study provides a comprehensive view of structural transformation at the prefecture level when combining the geographical area's internal and external factors. The in-depth analysis results show that outside factors are the origins of structural transformation in provinces instead of inside factors, as per previous research. Their influences are direct without mediator effects. In some cases, the inside factors are agricultural productivity and income, indicating a statistically significant correlation to structural transformation; however, this relationship exists because they correlate to outside factors, and these outside factors are the roles of metropolises, such as the destination of migration, market for goods and services, and information hubs. In addition, it is clear that any country with many regions with different characteristics requires a more specific analysis, and any discussions on the development of a region need to consider regional linkages, which will offer a comprehensive view of any problems.

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REFERENCES

Adams, J. R. H., & Cuecuecha, A. (2013). The impact of remittances on investment and poverty in Ghana. *World Development*, *50*, 24-40.Available at: https://doi.org/10.1016/j.worlddev.2013.04.009.

Aguilar, A. G., Ward, P. M., & Smith Sr, C. (2003). Globalization, regional development, and mega-city expansion in Latin America: Analyzing Mexico City's peri-urban hinterland. *Cities*, *20*(1), 3-21.Available at: https://doi.org/10.1016/s0264-2751(02)00092-6.

Ajani, E. (2014). Promoting the use of information and communication technologies (ICTs) for agricultural transformation in Sub-Saharan Africa: Implications for policy. *Journal of Agricultural & Food Information*, *15*(1), 42-53.Available at: https://doi.org/10.1080/10496505.2013.858049.

Ajani, E., & Agwu, A. (2012). Information communication technology needs of small-scale farmers in Anambra State, Nigeria. *Journal of Agricultural & Food Information*, *13*(2), 144-156.Available at: https://doi.org/10.1080/10496505.2012.663694.

Aswegen, V. M., & Retief, F. P. (2021). The role of economic sectoral structure as a policy mechanism towards more resilient peripheral regions: The case of South Africa. *GeoJournal*, *86*(6), 2823-2843.Available at: https://doi.org/10.1007/s10708-020-10233-0.

Balisacan, A., Mapa, D., Fuwa, N., Abad-Santos, C., & Piza, S. (2011). Addressing infrastructure constraints to the development of the rural non-farm sector: Implications for poverty and rural development. World Bank Report.

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173-1182.Available at: https://doi.org/10.1037/0022-3514.51.6.1173.

Barrett, C. B., Reardon, T., & Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: Concepts, dynamics, and policy implications. *Food Policy*, *26*(4), 315-331.Available at: https://doi.org/10.1016/s0306-9192(01)00014-8.

Baumol, W. J. (1967). Macroeconomics of unbalanced growth: The anatomy of urban crisis. *The American Economic Review*, *57*(3), 415-426.

Bhandari, P., & Ghimire, D. (2016). Rural agricultural change and individual out-migration. *Rural Sociology*, *81*(4), 572-600.Available at: https://doi.org/10.1111/ruso.12106.

Breusch, T. S., & Pagan, A. R. (1980). The Lagrange multiplier test and its applications to model specification in econometrics. *The Review of Economic Studies*, *47*(1), 239-253.Available at: https://doi.org/10.2307/2297111.

Bustos, P., Vincenzi, J. M. C., Monras, J., & Ponticelli, J. (2019). *Structural transformation, industrial specialization, and endogenous growth (NBER Working Paper No. 25871)*. National Bureau of Economic Research.

Cali, M., & Menon, C. (2013). Does urbanization affect rural poverty? Evidence from Indian districts. *The World Bank Economic Review*, *27*(2), 171-201.Available at: https://doi.org/10.1093/wber/lhs019.

Caulfield, M., Bouniol, J., Fonte, S. J., & Kessler, A. (2019). How rural out-migrations drive changes to farm and land management: A case study from the rural Andes. *Land use Policy*, *81*, 594-603.Available at: https://doi.org/10.1016/j.landusepol.2018.11.030.

Cho, K. M., Kyaw, K., & Khaing, P. P. (2019). Effects of rural-urban migration on agricultural production in Taungdwingyi Township, Magway Region, Myanmar. In Population, Development, and the Environment (pp. 317-330). Singapore: Palgrave Macmillan.

Cobbinah, P. B., Gaisie, E., & Owusu-Amponsah, L. (2015). Peri-urban morphology and indigenous livelihoods in Ghana. *Habitat International*, *50*, 120-129.Available at: https://doi.org/10.1016/j.habitatint.2015.08.002.

Comin, D., Lashkari, D., & Mestieri, M. (2021). Structural change with long-run income and price effects. *Econometrica*, *89*(1), 311-374.Available at: https://doi.org/10.3982/ecta16317.

Croissant, Y., & Millo, G. (2008). Panel data econometrics in R: The plm package. *Journal of Statistical Software*, *27*(2), 1-43.Available at: https://doi.org/10.18637/jss.v027.i02.

Diao, X., Magalhaes, E., & Silver, J. (2019). Cities and rural transformation: A spatial analysis of rural livelihoods in Ghana. *World Development*, *121*, 141-157.Available at: https://doi.org/10.1016/j.worlddev.2019.05.001.

Douglass, M. (1998). A regional network strategy for reciprocal rural-urban linkages: An agenda for policy research with reference to Indonesia. *Third World Planning Review*, *20*(1), 1-33.Available at: https://doi.org/10.3828/twpr.20.1.f2827602h503k5j6.

Foellmi, R., & Zweimüller, J. (2008). Structural change, Engel's consumption cycles and Kaldor's facts of economic growth. *Journal of Monetary Economics*, *55*(7), 1317-1328.Available at: https://doi.org/10.1016/j.jmoneco.2008.09.001.

Friedman, J. (1966). *Regional development policy: A case study of Venezuela*. Cambridge: The MIT Press.

Garip, F. (2014). The impact of migration and remittances on wealth accumulation and distribution in rural Thailand. *Demography*, *51*(2), 673-698.Available at: https://doi.org/10.1007/s13524-013-0260-y.

Ge, D., Long, H., Qiao, W., Wang, Z., Sun, D., & Yang, R. (2020). Effects of rural–urban migration on agricultural transformation: A case of Yucheng City, China. *Journal of Rural Studies*, *76*, 85-95.Available at: https://doi.org/10.1016/j.jrurstud.2020.04.010.

Gollin, D. (2018). *Rural-urban linkages and frictions*. Paper presented at the Oxford University. World Bank Urbanization Conference.

Gollin, D., Parente, S., & Rogerson, R. (2002). The role of agriculture in development. *American Economic Review*, *92*(2), 160-164.

Gray, C. L. (2009). Rural out-migration and smallholder agriculture in the Southern Ecuadorian Andes. *Population and Environment*, *30*(4-5), 193-217.Available at: https://doi.org/10.1007/s11111-009-0081-5.

Haggblade, S., Hazell, P., & Brown, J. (1989). Farm-nonfarm linkages in rural Sub-Saharan Africa. *World Development*, *17*(8), 1173-1201.Available at: https://doi.org/10.1016/0305-750x(89)90232-5.

Haggblade, S., Hazell, P., & Reardon, T. (2010). The rural non-farm economy: Prospects for growth and poverty reduction. *World Development*, *38*(10), 1429-1441.Available at: https://doi.org/10.1016/j.worlddev.2009.06.008.

Hausman, J. (1978). Specification tests in econometrics. *Econometrica*, *46*(6), 1251-1271.Available at: https://doi.org/10.2307/1913827.

Hazell, P., Haggblade, S., & Reardon, T. (2007). *Structural transformation of the rural nonfarm economy. In S. Haggblade, P. Hazell, & T. Reardon (Eds.), Transforming the rural nonfarm economy – Opportunities and Threats in the Developing World*. Baltimore: John Hopkins University Press.

Herrendorf, B., Rogerson, R., & Valentinyi, A. (2014). Growth and structural transformation. In Handbook of economic growth (Vol. 2, pp. 855-941). North Holland: Elsevier.

Hirschman, A. O. (1958). *The strategy of development*. NewHaven, CN: Yale University Press.

Hoffmann, E. M., Konerding, V., Nautiyal, S., & Buerkert, A. (2019). Is the push-pull paradigm useful to explain rural-urban migration? A case study in Uttarakhand, India. *PloS One*, *14*(4), e0214511.Available at: https://doi.org/10.1371/journal.pone.0214511.

Hossain, M. (2004). Rural non-farm economy in Bangladesh: A view from household surveys (Working Paper No. 40). Centre for Policy Dialogue (CPD).

Hussain, A., Rasul, G., Mahapatra, B., Wahid, S., & Tuladhar, S. (2018). Climate change-induced hazards and local adaptations in agriculture: A study from Koshi River Basin, Nepal. *Natural Hazards*, *91*(3), 1365-1383.Available at: https://doi.org/10.1007/s11069-018-3187-1.

Kongsamut, P., Rebelo, S., & Xie, D. (2001). Beyond balanced growth. *The Review of Economic Studies*, *68*(4), 869-882.Available at: https://doi.org/10.1111/1467-937x.00193.

Kuznets, S. (1973). Modern economic growth: Findings and reflections. *The American Economic Review*, *63*(3), 247-258.

Mamgain, R. P., & Reddy, D. N. (2017). Out-migration from the hill region of Uttarakhand: magnitude, challenges, and policy options. In Rural labour mobility in times of structural transformation (pp. 209-235). Singapore: Palgrave Macmillan.

McCarthy, N., Carletto, C., Davis, B., & Maltsoglou, I. (2006). Assessing the impact of massive out-migration on agriculture. Working Paper No. 06-14. Food and Agriculture Organization of the United Nations.

McMillan, M., & Headey, D. (2014). Introduction–understanding structural transformation in Africa. *World Development, 63*(11), 1-10.Available at: https://doi.org/10.1016/j.worlddev.2014.02.007.

McMillan, M., Rodrik, D., & Verduzco-Gallo, Í. (2014). Globalization, structural change, and productivity growth, with an update on Africa. *World Development, 63*(11), 11–32.

Mobrand, E. (2012). Reverse remittances: Internal migration and rural-to-urban remittances in industrialising South Korea. *Journal of Ethnic and Migration Studies, 38*(3), 389-411.Available at: https://doi.org/10.1080/1369183x.2012.658544.

Myrdal, G. (1957). *Economic theory and underdeveloped regions*. London: Duckworth.

Ngai, L. R., & Pissarides, C. A. (2007). Structural change in a multisector model of growth. *American Economic Review, 97*(1), 429-443.Available at: https://doi.org/10.1257/000282807780323460.

Nguyen, D. L., Grote, U., & Nguyen, T. T. (2017). Migration and rural household expenditures: A case study from Vietnam. *Economic Analysis and Policy, 56*, 163-175.Available at: https://doi.org/10.1016/j.eap.2017.09.001.

Nguyen, L. D., Raabe, K., & Grote, U. (2015). Rural–urban migration, household vulnerability, and welfare in Vietnam. *World Development, 71*, 79-93.Available at: https://doi.org/10.1016/j.worlddev.2013.11.002.

Otsuka, K. (2007). *The rural industrial transition in East Asia: Influences and implications. In S. Haggblade, P. Hazell, & T. Reardon (Eds.), Transforming the rural nonfarm economy – Opportunities and Threats in the Developing World*. Baltimore: John Hopkins University Press.

Perroux, F. (1955). A note on the notion of growth pole. *Applied Economy, 1*(2), 307-320.

Qin, H., & Liao, T. F. (2016). Labor out-migration and agricultural change in rural China: A systematic review and meta-analysis. *Journal of Rural Studies, 47*, 533-541.Available at: https://doi.org/10.1016/j.jrurstud.2016.06.020.

Reardon, T., Bereuter, D., & Glickman, D. (2016). Growing food for growing cities: Transforming food systems in an urbanizing world (Report No. 3). The Chicago Council on Global Affairs.

Rodrik, D. (2016). Premature deindustrialization. *Journal of Economic Growth, 21*(1), 1-33.

Samaratunge, R., Kumara, A. S., & Abeysekera, L. (2020). Where do remittances go in household consumption? Empirical evidence from Sri Lanka-wide micro-data. *International Migration, 58*(5), 194-219.Available at: https://doi.org/10.1111/imig.12697.

Shi, X. (2018). Heterogeneous effects of rural-urban migration on agricultural productivity: Evidence from China. *China Agricultural Economic Review, 10*(3), 482-497.Available at: https://doi.org/10.1108/caer-10-2017-0193.

Swięcki, T. (2017). Determinants of structural change. *Review of Economic Dynamics, 24*(2), 95-131.

Tacoli, C. (2003). The links between urban and rural development (Vol. 15, pp. 3-12). Thousand Oaks, CA: Sage Publications Sage CA.

Taylor, J. E., & Castelhano, M. (2016). Economic impacts of migrant remittances. *International Handbook of Migration and Population Distribution*, 525-541.Available at: https://doi.org/10.1007/978-94-017-7282-2_24.

Teignier, M. (2018). The role of trade in structural transformation. *Journal of Development Economics, 130*, 45-65.Available at: https://doi.org/10.1016/j.jdeveco.2017.09.002.

Van, N. L. (2019). The drivers of structural change. *Journal of Economic Surveys, 33*(1), 309-349.Available at: https://doi.org/10.1111/joes.12266.

Wattenbach, H., Bishop-Sambrook, C., & Dixon, J. (2005). *Improving information flows to the rural community*. Rome: Agricultural Management, Marketing and Finance Service (FAO).