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Structural Analysis of Development Patterns

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ABSTRACT

This study provides a sketch on the trends of domestic production and labor productivity in agriculture, industry and services sector of 155 countries from across the globe during the period of 1980 to 2012, while focusing mainly on the impact of income and size of the stated economies on their domestic productions and labor productivity. Findings confirm that the trend of production is decreasing for agricultural sector while increasing for service sector whereas, parabolic trend is found observed for it in industry sector, while the trend of labor allocations is found upward in industry and service sectors in contrast to downward trend in agricultural sector for all of the stated nations as the whole. It was noted that the average labor productivity was found with negative trend for all of the stated sectors. The findings further confirms that the income and size of the economies positively affect the productions in agriculture and industry sector substantially while manage to affect the service sector somehow as well. While the size of economy also effect the labor productivity in all of sectors of selected nations.

Keywords: patterns of development, development, de-industrialization, productivity, labor productivity.

Introduction

The research aims to compare and investigate trends in the variables of production and labor productivity. Firstly, production is a core process which adds intrinsic-value to the inputs by turning them into outputs; it is the process accounting for which leads to the most widely used economic measure of the GDP, as this process drives the economic growth itself. Secondly, both the factors, productivity and production would be aligned had there not been factors interfering with the economy-wide resource mobilization and variation in the market-prices of inputs (esp. labor); Moreover, the rapidly changing technological environment of today and technological shifts in the production process further blur out the rather vivid relation between the two.

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Furthermore, overall trends of rising development and in-turn rising incomes across the globe has led to changes in both the economic and social spheres. Whereby, the study utilized the methodological analysis by the Chenery and Syrquin (1989); Syrquin (1988), who investigated the trends of economic development and the underlying structural changes brought to the value addition (by the production process) and the relative labor utilized; whereby covering three economic sectors of: services, industry, and agriculture. Furthermore, value-addition by the production processes is measured using the GDP, while the allocation of the labor is measured by the means of net workforce under employment. Whereby, the impact of de-industrialization is determined to be more prominent than was by the previous studies; while the relative productivity of labor is determined to have declined.

The studies conducted by Chenery (1975) and Syrquin (1988) have been widely referred in this research, since the inherent patterns of development and the structural changes brought about to the industrialization process have been extensively analyzed by them. However, there also lie differences as to what underlying factors have been focused upon, since Chenery (1975) focused on the primary sectors of value addition: agricultural, and quarry and mining sector along with disaggregated industry sector at a broad level; whereas Syrquin (1988) utilized GNI as a measure of production instead of GNP.

Literature Context

Syrquin and Chenery (1989), Clark (1957), Lewis (1954), and Kuznets (1967) have worked upon the groundwork developed on the subject of economical structural changes. However, this research in-turn adopts the methodologies used by Chenery and Syrquin (1989),in-order to examine the structural changes and the inherent global trends of production and labor-productivity. Syrquin (1989), in his research, regarded size and income as being explanatory variable sand employed them into the semi-log model. Both the terms of income and size have taken the squares, which helps tackle the present non-linearity in the data, once refined through an evolutionary process; the model is as follows:

$$\mathbf{X = \alpha + \beta_1 \ln Y + \beta_2 (\ln Y)^2 + \gamma_1 \ln N + \gamma_2 (\ln N)^2} \qquad \text{(Equation 1)}$$

Where X is the dependent variable, denoting our variables of interest like value added production as a share of GDP (V_A, V_i, V_s) and labor force as a share of the total workforce employed (L_A, L_i, L_s), in three sectors agriculture, industry, and services respectively.

Moreover, Y and N are explanatory variables indicating incomes in GNI per capita (US$ 2005), and the size of an economy in terms of population in millions.
α, β, and γ are the parameters to be estimated.

Equation (1) is used to determine the normal or average values of the variables under study; where N=20,which translates to a population size of 20 million looked at varying stages of the developmental process. At the tails (below 300 and above 20000 GNI per capita),the actual means are calculated rather than the predicted values by the regression model, due to the model becoming inconsistent (Chenery 1975).Moreover, relative labor productivity is obtained by dividing the sectoral values of the value-added production by the share of the same sector's employment-share at that particular income level.

Furthermore, amongst the family of panel regression, pooled regression is perhaps the simplest and the most useful one, especially when groups are relatively homogenous and even without the homogeneity its usage for average patterns remains valid (Chenery, 1975). OLS for the variables of value added production and labor is run on the regression model in-order to estimate the parameters and all the relevant values of individual and overall reliability and robustness (Table A1 in appendix). Moreover, t-values are calculated and shown in parenthesis, below the estimated parameters; whereas for showing the overall

reliability and robustness, both the coefficient of determination (R^2) and the standard error of estimates (SEE) have been used. In addition, R^2 is affected by a number of explanatory variables in the model, and may reflect an erroneous measure of robustness of the model, thereby SEE is used as a check over the R^2 (Gujarati, 1988).

Description of Data and selected variables of the study

For the purpose of this research study, data on the relevant variables covering up to 155 countries across the globe is accessed through the official website of The World Bank, where more than two hundred economies are listed (for data go to www.worldbank.org). The data of dependent variables which include value added production as a share of GDP (V_A, V_i, V_s) and labor force as a share of the total workforce employed (L_A, L_i, L_s), in three sectors (agriculture, industry, and services respectively) were collected for the period from 1980 to 2012. While the explanatory variables include income of an economy in terms of GNI per capita and the size of an economy in terms of population in millions were also collected for the same period.

Results and Discussion

Descriptive statistics

Table (1a &b) summarize the characteristics of the value-added production and labor. The number of observations included in this study for the factor of value-added-production, are relatively more than that of the labor allocation in all the three sectors of the economy (more than 3600 versus 2100). Data-spread in the value-added-production around the mean-income (8000 GNI per capita (US$2005)) is lesser than that of the labor-allocation, where mean income was noted to be above 12600 GNI per capita (US$2005). The country with highest income included in this study is Norway with 67580 GNI per capita (US$ 2005); whereas in terms of the value-added-production the poorest country is that of Liberia, lying even poorer than Ethiopia which is the poorest when it comes to the labor sector. Hong Kong leads in its share of the services-sector in terms of both the value-added and the labor-allocation and productivity. Whereas in Liberia the share of industrial value-addition is the least amongst all the countries, with agricultural value-addition making-up 80 percent of the GDP. Similarly, in Burundi, the majority of the labor force is engaged in the agricultural activities (92 percent), with the smallest segment of the labor force involved in the services sector.

Patterns of development

Relative labor productivity in the industry sector leads to the other two sectors of production. The result shown in table (2b) and depicted in figure 3 reflects a contrasting pattern of productivity in comparison with that of the post war era, where relative labor productivity in the services sector led the productivity patterns. The contagious previous decade of seventies shows similar patterns in productivity as those of this study. Early de-industrialization confines the productivity gap within a small range in the industrial sector. Whereas relative labor productivity in all the sectors has a decreasing trend with an increasing trend in the income per capita throughout the transition.

Trends in production and employment, as shown in the table (2a) and the figures 1 and 2, for value-added production and labor respectively are similar to the previous periods with de-industrialization is noted to have started occurring earlier, as according to this study. This leads to an increase in the value-added production of services, and the labor-engagement in the same sector. Total change (table (2a) last row) in the services sector has been trending up-wards since the post war period, making room for more labor-engagement in this sector

throughout the globe. Moreover, services are noted to generate more employment and more value-addition through the production processes, covering a larger share of the economy than any other sector as from the onset of transition. The study also confirms the intersection of falling value-added by production in agricultural sector and increasing industry share of the said value-added production by 26 percent of the GDP.

Trends in agriculture sector

The agricultural sector comes down with increasing incomes, producing 36 percent of the annual GDP with an engagement of 62 percent of the total workforce at the lowest income ladder of 300 GNI per capita (US$2005) (table 2a). As the income grows, the share of value-added agriculture decreases and comes down to about 3 percent of the GDP, while labor allocations remain at a mere 7 percent (20000 GNI per capita).

Table 1a: Descriptive Statistics: Value-Added Production

	Mean	**Min/Max***	**SD**	**N**
Va	0.16	0.00/0.8	0.14	
GNI per capita(US$2005)	7670	40/67580	11640	3464
Population (in mill.)	48.6	0.6/1350.7	152.8	
Vm	0.15	0.00/0.46	0.08	
GNI per capita(US$2005)	8300	40/67580	12500	2916
Population (in mill.))	52.2	0.6/1350.7	162.7	
Vi	0.31	0.03/0.77	0.11	
GNI per capita(US$2005)	8426	40/67580	12612	3529
Population (in mill.)	48.0	0.6/1350.7	151.5	
Vs	0.53	0.13/0.93	0.13	
GNI per capita(US$2005)	7909	40/67580	12375	3420
Population (in mill.)	48.2	0.6/1350.7	153.7	

(author's calculation),
* Va: Singapore/Liberia, Vm: China/Sweden, Vi: Liberia/Congo, R and Vs: Sierra Leone/Hong Kong, GNI per capita: Liberia/Norway, Population: -/China

Table 1b: Descriptive Statistics: Labor Allocation

	Mean	**Min/Max***	**SD**	**N**
La	0.20	0.00/0.92	0.18	
GNI per capita(US$2005)	12657	121/67580	14178	2135
Population (in mill.)	53.3	0.7/1344.1	158.3	
Ls	0.55	0.06/0.88	0.15	
GNI per capita(US$2005)	12693	121/67580	14190	2139
Population (in mill.)	53.2	0.7/1344.1	158.2	

Li	0.25	0.02/0.46	0.07	
GNI per capita(US$2005)	12693	121/67580	14190	2139
Population (in mill.)	53.2	0.7/1344.1	158.2	

(author's calculation),
*La: Uraguay/Burundi, Li: Syria/Bulghria and Ls: Burundi/Hong Kong, GNI per capita: Ethiopia/Norway and Population: -/China

The agricultural sector shows a declining trend as is noted in the trends of preceding periods by the study. The total difference within the transition from 300 to 20000 GNI per capita (US$2005) is that of 33 percent in value-addition, with the help of 55 percent of the total labor force. The decreasing trend is more pronounced in the income reaching up to 7000 GNI per capita, whereby about 90 percent (or nine-tenth) of the decline occurs at up to 7000. After the achievement of this level of development, the steepness of the curve smoothens and only one-tenth of the decline is recorded in the wider range of 7000 to 20000 GNI per capita (US$2005). At this level of development, middle-to-high income range of the productivity increases due to a comparatively higher-rate of technological change in this sector. Furthermore, the intersection between the agricultural and the industrial value-addition is observed by Chenery (1975) and was later confirmed by Syrquin (1989), the result hereby comes to be re-confirmed in this study, covering at about 26% of GDP at an income level of about 750 GNI per capita (US$2005). The intersection of the labor in agriculture and the labor in industry is at the same level of labor force but at different development levels (in the range 2000-4000 GNI per capita).

Trends in industry sector

In the industrial sector, de-industrialization appears after the achievement of 4000 level of development. The total difference in this sector of production is the least, whereby 11 percent accounts for value-addition and 19 percent for the labor–engaged. Thus perusing Figures 1 and 2 with the table (2a), reveals that after 7000 GNI per capita the value-added production goes down about 3 percent of GDP. Whereas, the labor-engagement remains around at 28 percent of the total workforce. Since from initial to 7000, the level of development in the value-added production goes up by 14 percent (21-35 percent of the GDP); engaging up-to 9-28 percent of the total workforce with differences that turn out to be an overall 19 percent increase in the labor employment of the workers coming from the low-middle-income countries. The phenomenon of de-industrialization as discussed in the economic literature (OECD 1979, Blackaby 1978).

Table 2a: Normal variation at different levels of development in value added production and labor (1980-2012)

GNI Per Capita (Us$2005)	Value Added Production			Labor Allocation		
	Va	Vi	Vs	La	Li	Ls
<300	0.40	0.19	0.42	0.72	0.08	0.17
300	0.36	0.21	0.43	0.62	0.09	0.27
500	0.29	0.26	0.45	0.51	0.14	0.33
1000	0.21	0.31	0.48	0.39	0.19	0.41
4000	0.09	0.35	0.55	0.19	0.27	0.54

GNI Per Capita (Us$2005)	Value Added Production			Labor Allocation		
	Va	Vi	Vs	La	Li	Ls
7000	0.06	0.35	0.58	0.14	0.28	0.58
10000	0.05	0.35	0.60	0.11	0.28	0.61
15000	0.04	0.33	0.63	0.08	0.28	0.64
20000	0.03	0.32	0.65	0.07	0.28	0.65
>20000	0.03	0.30	0.68	0.05	0.27	0.68
Difference 20000-300	-0.33	0.11	0.21	-0.55	0.19	0.39
Total change	-0.37	0.11	0.26	-0.67	0.18	0.51

Trends in services sector

The services sector shows increasing trend with respect to income, the share of workforce producing the same share of GDP in value added is 58 percent at 7000 level of income. Total difference in this sector follows the same pattern as in the other two sectors; it is 21 percent in value added services and just below the double for this in labor force employed in this sector.

Figure 1: Value Added Production by Sector (1980-2012)

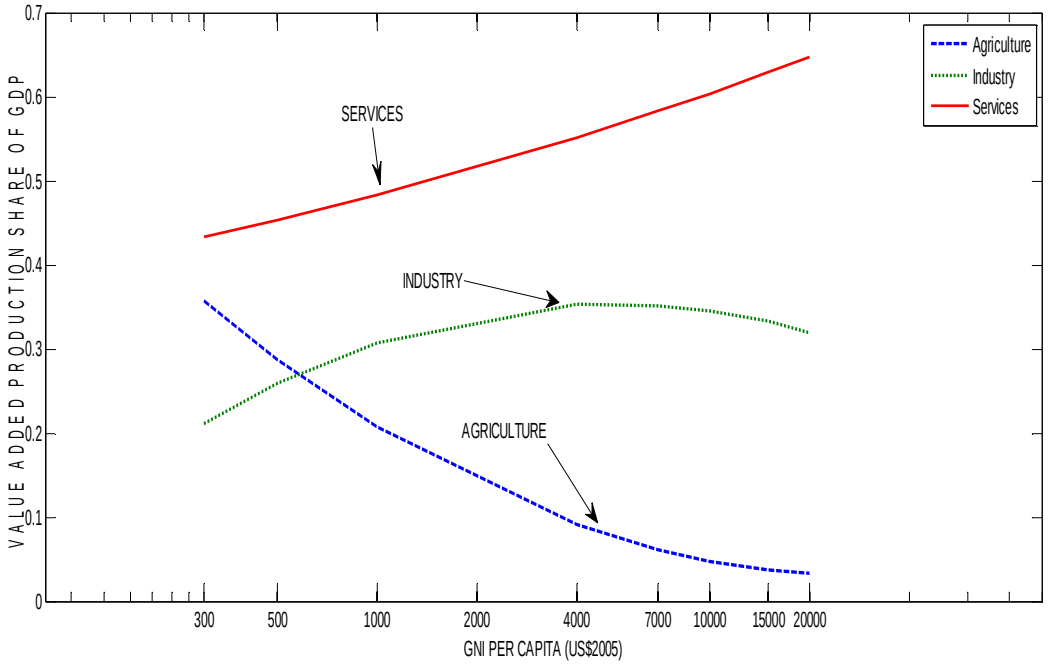
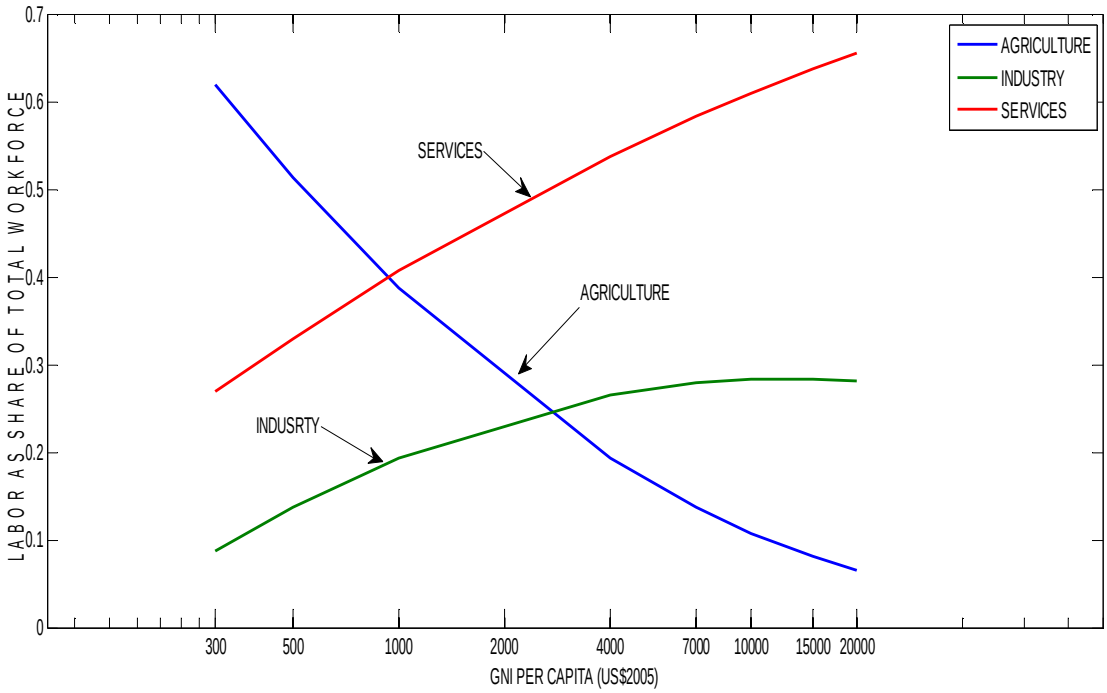


Figure 2: Labor Allocation by Sector (1980-2012)



Value added services in the period 1980- 2012 goes up from 43 percent of GDP at 300 GNI per capita to 65 percent at the final level of income with 27percent to 66 percent of overall workforce employment in this sector. The declining trend of services value added at higher levels of income, as was observed by Chenery (1975), is not present in this study nor is in Syrquin (1989). The divergence of value added services and labor required to produce it at a higher level of income in the period 1950-70, for which Fuchs (1969) concluded that for the advanced countries this phenomenon in the services sector is a sign of comparatively lower rates of technological progress in the sector, and shows a greater difficulty in substituting labor for capital. For the subsequent periods studied, this pattern is not present and both the share in GDP and workforce in services, move in the same direction and have almost the same share of value addition and labor force, hinting towards betterment in the technological progress within the sector, with the ease of substitutability of labor with capital.

Trends in relative labor productivity

Productivity in the industrial sector comes out to be the greatest amongst all. It lies in the range of 2.43-1.14 with a difference of -1.29 between the productivities of the poorest and the richest economies in the transition. But total change, the difference between the normal values of the countries with incomes beyond 20000 and below 300 GNI per capita, is reduced and comes out to be -1.14. Likewise the productivity in the agricultural sector is recorded to be the least in the range of 0.58-0.49. The total difference in the productivity in this sector turns out to be merely -0.08.

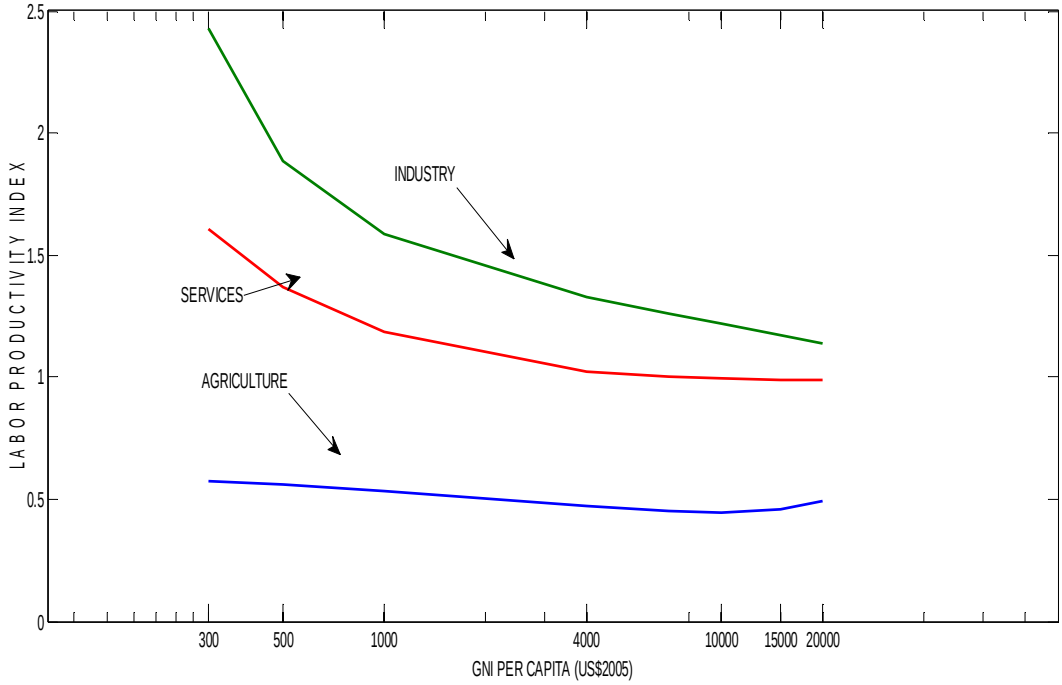
Table 2b: Productivity with productivity differential at different levels of development (1980-2012)

GNI per Capita (US$2005)	Relative Labor Productivity			Productivity Differential		
	Pa	**Pi**	**Ps**	**Pi-Pa**	**Ps-Pa**	**Pi-Ps**
<300	0.56	2.26	2.49	1.70	1.93	-0.23
300	0.58	2.43	1.61	1.85	1.03	0.82
500	0.56	1.88	1.37	1.32	0.81	0.51
1000	0.54	1.59	1.19	1.05	0.65	0.40
4000	0.47	1.33	1.02	0.86	0.55	0.30
7000	0.45	1.26	1.00	0.81	0.55	0.26
10000	0.44	1.22	0.99	0.77	0.55	0.23
15000	0.46	1.17	0.99	0.71	0.53	0.18
20000	0.49	1.14	0.99	0.64	0.50	0.15
>20000	0.59	1.12	1.00	0.53	0.41	0.12
Difference 20000-300	-0.08	-1.29	-0.62	-1.20	-0.54	-0.67
Total change	0.03	-1.14	-1.49	-1.17	-1.52	0.35

Productivity in the agricultural sector shows a peculiar pattern of first a decline from 300 level of development to 10000 GNI per capita (US$2005), and then displaying an increase up to the income level of 20000 and beyond. The previous studies, covering the post war era till 1980s, note productivity in the agricultural sector as going up in the richer economies, showing an induction of technology lately in the transition while coming into play quite early in this study. The value added share of agriculture at a level of 10000 GNI per capita is 5 percent, with only 11 percent of the work-force engaged in agricultural activities. Kuznets (1971) hints that the mere substitution of capital for labor is not the core factor behind productivity increments in the agricultural sector. The low productivity must be attributable to all the factors and not just the induction of capital.

In the services sector, labor productivity moves in the range of 1.6 to 0.99.with a difference of -0.62 from 300 to 20000 GNI per capita. Moreover, Baumol's law (Baumol 1967) puts some light on the slowdown of productivity in the services sector. This is termed as structural-change burden, as many services are labor intensive and productivity cannot be improved with the help of technology. But Szirmai (2009) has hinted towards some of the services activities that are affected by the technological growth. Assessment of labor productivity in the services sector requires deeper and disaggregated analysis of the sector.

Figure 3: Average Labor Productivity (1980-2012)



The general pattern of productivity in all the sectors of production, except agriculture, is of the declining nature throughout the transition. Similar patterns in these sectors are observed in previous period of 1973- 83 (Syrquin 1989).For the post war period (1950-70),the patterns are quite different and the productivities do not incline downwards from the initial income level still the final one. Time has affected the productivity in a sense that it is moving downward with an increasing level of development.

Robustness of model

Table 3

Dependent variable	SEE	No. of observations
Va	0.055	3464
Vi	0.089	3529
Vs	0.055	3420
La	0.10	2135
Li	0.055	2139
Ls	0.10	2139

Table 3 provides a comparison of the SEEs of regression, for all those variables that appear in the study, covering the period 1973-83.whileChenery's (1975) study covers the 1950-70 periods. Furthermore, table 3 shows the values of SEE for the regressions used to estimate the production variables of value added and labor allocation. This shows 3420-3529 observations of the value-added production and over 2100 observations of labor engaged, in the three sectors of production each. As this study covers 33 years since 1980 with 155 countries, the number of observation is much higher for the current study. Comparison of SEEs reveals that the results are more robust in this study then the previous ones. Robustness of individual estimates is shown by t-ratios provided in the table A1 in appendix.

Conclusions

Covering the past three decades starting 1980, this study compares the previous post War studies providing stage for chalking out future policy. Findings of increased productivity in the agricultural sector for the middle income countries, demonstrates an increasing induction of technology in the sector; this result was absent in the other studies on post war patterns where only the rich economies have been reported to have improvements in productivity, in their agricultural sector.

This study provides a sketch of the trends of development patterns of domestic production and labor productivity in agriculture, industry and services sector of 155 countries from across the globe during the period of 1980 to 2012. The scope of this study is limited due to its aggregated nature at sectoral and global level. A deeper and finer disaggregated analyses to ascertain the changes in the subsectors (at a country level), are needed to define the scope of national and regional policies.

Declarations

Competing Interests

The authors declare that they have no competing interests.

Authors' Contribution

Hussain, I. was involved in framing the hypotheses, proposition of this research along with finalizing the variable specification and formulating the research model of the study. Khan, K. U. was mainly involved in reviewing the literature and collecting the required data along with finalizing the write up of this research paper.

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Appendix

Table A1: Regression for Normal values (Model 1)

	const	lnY	lnY2	lnN	lnN2	Rsquare	SEE	No. of observations
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Va	1.684	-0.324	0.016	0.008	-0.002	0.81	0.055	3464
t-ratios	66.32	-50.64	39.50	3.92	-5.61			
Vi	-0.944	0.307	-0.018	-0.012	0.003	0.28	0.089	3529
t-ratios	-24.68	32.03	-30.22	-3.86	6.28			
Vs	0.331	-0.002	0.003	0.005	-0.001	0.45	0.055	3420
t-ratios	8.21	-0.19	5.41	1.51	-2.53			
La	2.535	-0.452	0.021	-0.012	0.003	0.71	0.10	2135
t-ratios	31.63	-23.93	18.58	-2.45	4.39			
Li	-0.966	0.266	-0.014	-0.007	0.002	0.36	0.055	2139
t-ratios	-20.15	23.60	-21.48	-2.35	3.33			
Ls	-0.685	0.209	-0.008	0.014	-0.004	0.60	0.10	2139
t-ratios	-8.59	11.14	-6.85	2.84	-5.26			

(Author's calculation)
Column 1 shows the dependent variable, for which the regression with explanatory variables (column 2 to 6) in model (1) is done. Column 2 shows estimate of α. Column 7 and 8 show coefficient of determination and Standard error of estimate respectively. Last column shows the number of observations used to estimate the regressions.