Structural Transformation in Developed and Developing Countries

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Differences in key features of the development process across rich and poor countries can provide clues to the sources of the large variation of cross-country income. Kuznets included structural transformation as one of six stylized facts of economic development, finding that developed countries all followed the same process. In this paper, I compare structural transformation processes in developed and developing countries. I find that developing countries follow distinct structural transformation paths that deviate from that followed by developed countries. A puzzling finding is the presence of substantial sectoral changes during times of economic stagnation or decline.

Key words: Africa, Asia, Latin America, Structural Transformation, Economic Development, Structural Change

JEL Classification: O10, O11, O14, O57

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1. Introduction

Understanding why some countries are so poor relative to others is one of the most important objectives of economics. In this paper, I examine key features of structural change that differ across rich and poor countries. These structural differences can provide important insights about the underlying sources of income differentials. One prominent feature of economic development is the process of structural transformation, i.e., the reallocation of resources across sectors that accompanies development. In fact, Kuznets (1971) included structural transformation as one of six stylized facts of economic development. He found that developed countries all followed the same process of structural transformation. It is therefore of interest to ask whether developing countries are also following a similar process. In this paper, I conduct a detailed analysis that compares structural transformation processes in developed and developing countries. I find that the processes being followed by developing countries are often dramatically different from the path followed by developed countries. This finding implies that it is important to consider the structure of economies for understanding income differences between rich and poor countries.

Kuznets distinguished between two phases of structural transformation. In the beginning of the development process, an economy allocates most of its resources to the agricultural sector. As the economy develops, resources are reallocated from agriculture into industry and services. This is the first phase of structural transformation. In the second phase, resources are reallocated from both agriculture and industry into services.

The analysis conducted here covers nine developed countries with data going back to 1870 and 38 developing countries for the period 1965-2000[1]. Using fixed effects panel data regressions, I confirm Kuznets' claim that developed countries followed the same process of structural transformation.

My analysis of structural transformation in developing countries yields three main

[1]The paper uses sectoral output shares in current prices. I also used limited data in constant prices to verify that my findings are not driven by relative price changes. This data and analysis are available from the author upon request. Kuznets (1966) also argued that for the developed countries for which he had data, the conclusions on structural transformation were robust to unit changes.

findings. First, there is a considerable heterogeneity in the structural transformation processes being followed by developing countries. Although most developing countries are not following the path of the developed countries, a few are. I show that the structural transformation processes in developing countries deviate from the path followed by the developed countries along two key dimensions: the relationship between changes in sectoral output shares and changes in log of GDP per capita, and levels of sectoral output shares for a given per capita GDP. To illustrate these differences, I analyze five patterns of structural transformation being followed by developing countries.

Second, I find that the sub-continents of Africa, Asia and Latin America are following different structural transformation processes. African countries tend to have low agriculture and high service output shares at very low GDP per capita. Compared to developed countries, Latin American countries move from the first to the second phase of structural transformation at lower per capita GDP. Asian countries on the other hand, have relatively higher industry output shares and comparable service shares. On average, Asian countries are closest to the structural transformation path of developed countries.

Third, whereas from the traditional view we expect structural transformation to be associated with economic growth, I find that many developing countries experience substantial structural transformation during periods of economic stagnation and even decline. This was most evident among African and Latin American countries. This finding suggests that structural transformation can occur without or with little changes in GDP. This is a puzzle from Kuznets' view of structural transformation. However, there is no always a systematic link between GDP per capita growth and structural transformation. In a three-sector model developed by Bah (2008), GDP per capita is affected by levels of sectoral total factor productivities (TFP) while structural change is affected by changes in relative sectoral TFPs and the elasticity of substitution between the industrial good and services. In the context of that model, structural transformation can occur with very little growth in GDP per capita.

The importance of structural transformation in economic development was a central theme in the development literature of the 1960s and 1970s. The issue was made promi-

nent by the works of Kuznets (1966, 1971) and Chenery (1960, 1975)[2] and more recently, there has been a great deal of work that allows for structural transformation in the neoclassical growth model in order to explain some facts of economic growth and development[3]. The main contribution of this paper is to provide a systematic characterization of structural transformation processes in developing countries. The findings suggest that there is no systematic link between GDP growth and structural change and it is important to use disaggregated models of growth for understanding the sources of differences in income between rich and poor countries.

The rest of the paper is organized as follows. Section 2 analyzes the structural transformation of developed countries. Section 3 analyzes the main differences in structural transformation between developed and developing countries. Section 4 provides a detailed analysis of structural transformation in Africa, Latin America and Asia. Section 5 shows evidence of structural transformation in times of economic stagnation or decline. Finally, section 6 concludes.

2. Structural Transformation in Developed Countries

In this section, I study the structural transformation process followed by developed countries from 1870 to 2000. The analysis includes nine developed countries: Australia, Canada, France, Germany, Italy, Japan, Sweden, United Kingdom and the United States. The choice of countries is based on data availability.

2.1. Data

The data for sectoral output shares come from three sources. The early series are from Temin (1967), which provides agricultural and industrial shares of national income in current prices for the years 1870, 1890, 1910, 1930 and 1950. I obtained data from the World Bank Tables (1983) for the years 1955, 1960, 1965 and 1970. The World Develop-

[2]Other authors include Chenery et al. (1986); Syrquin (1986, 1994); Beaumol (1967) and Temin (1967).

[3]See Echevarria (1997), Restuccia et al. (2007), Duarte and Restuccia (2006, 2007), Gollin et al. (2002, 2007), Laitner (2000), Murphy et al. (1989), Rogerson (2007), Kongsamut et al. (2001), Ngai and Pissarides (2007) and Buera and Kaboski (2007).

ment Indicators online database has yearly data from 1971 to 2000. I use 5-year interval time series from 1975 to 2000. This gives me a panel data set consisting of 15 cross-sections for nine countries[4]. Data for GDP per capita, expressed in 1990 international Geary-Khamis dollars, is from the "Historical Statistics for the World Economy: 1-2003 AD" by Maddison (2006). I use the same sources for developing countries for the period 1965-2000.

2.2. Paths of Sectoral Output Shares

The movement of sectoral output shares is a key regularity of the data for developed countries during their long development process. Even though the speed of transformation may differ across countries, all present the following similar features. As GDP increases, the agricultural output share declines, the industry output share initially increases and subsequently decreases, while the service output share is always increasing.

To determine whether the developed countries experienced a similar structural transformation process, I use a polynomial function to fit the relationship between sectoral output shares and per capita income for all countries. The degree of the polynomial is determined by the goodness of fit. Starting from a linear polynomial, I increase the degree by one and continue this process until the change in R-squared is less than 0.01[5].

For each sector, I estimate the following equation:

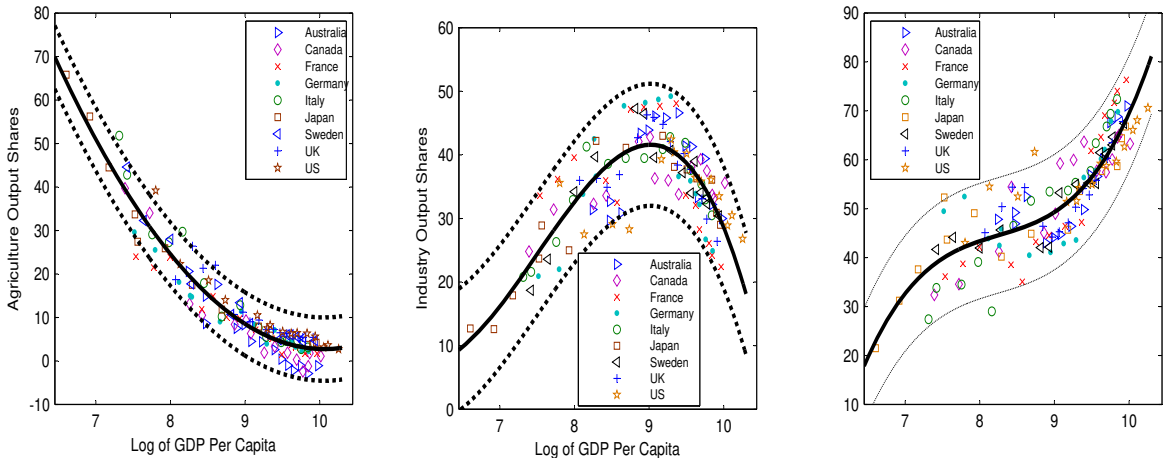
$$va_{it} = \alpha_i + \beta_1 \log(gdp_{it}) + \beta_2 \left(\log(gdp_{it})\right)^2 + \beta_3 \left(\log(gdp_{it})\right)^3 + \ldots + \epsilon_{it} \qquad (1)$$

where va_{it} is the sectoral value added share of GDP for country i in period t and α_i is a country fixed effect.

The regression results are presented in table 1 in the appendix. The relationship between agricultural output share and log of GDP per capita is best fitted by a quadratic

[4]Note that the panel data set has two different time intervals: 20-year until 1950 and 5-year from there. I also used a second panel data set with 20-year intervals for the whole period. The results are essentially the same.

[5]I also experimented with higher order polynomials but there were no improvement in the fitting of the data.



(A) Agriculture (B) Industry (C) Services

Figure 1: Structural Transformation in Developed Countries

polynomial ($\beta_3 = 0$). The R-squared for the fixed effects estimation is 0.92. The average standard error for the prediction is 3.6. For industry, the best fit for the data is a third degree polynomial. The goodness of fit is lower than that of agriculture. The R-squared is 0.63 and the average standard error is 4.8. The relationship between service output shares and log of GDP per capita is also approximated by a third degree polynomial with an R-squared of 0.74. The average standard error is 5.9.

We know that the standard within estimation for panel data does not pin down the fixed effect (α_i) for each country. However, we can use country dummy variables to estimate the Least Square Dummy Variable model (LSDV). Let $\overline{\alpha}$ be the average fixed effects for the 9 countries. For each country i, I calculate $\widetilde{\alpha}_i = \alpha_i - \overline{\alpha}$ and call it the fixed effect deviation from the mean. The distribution of this coefficient helps us understand the extent of heterogeneity between countries. Table 2 shows the fixed effect deviation from the mean for each country. The standard deviations of the distributions are 3.7 for agriculture, 3.1 for industry and 2.5 for services. In agriculture, the big deviations are experienced by Australia, Germany, Italy and the UK. Australia and Italy are above the average of the fixed effects while Germany and the UK are below. In industry, Germany and Japan are well above the average fixed effects while Australia and to some extent the US are below. In services, the noticeable deviations are for Italy that is well

below the average and the US that is well above. Figure 1 shows the scatter plots of the sectoral output shares corrected for the fixed effects deviation from the mean (i.e., $va_{it} - \widetilde{\alpha}_i$ for all i) versus log of GDP per capita. The graphs also show the fitted curves with the lower and upper bounds at two standard deviations of the forecasted values. Most of the data points are very close to the fitted curves and almost all are within the bounds of the estimation. These three graphs along with the regression tables show that developed countries all followed a similar process of structural transformation. This process fits Kuznets' description. In the following sections, I discuss how the structural transformation processes of developing countries compare to the above baseline process.

3. Structural Transformation in Developing Countries

In this section, I analyze the structural transformation in developing countries. I selected 38 countries for the analysis based on a set of criteria. The first criterion is coverage of as many different regions of the world as possible. Thus countries from Sub-Saharan Africa, Southeast & East Asia and Latin America were selected. The second criterion is data availability. Sectoral output shares from 1965 to 2000 are available for 54 developing countries from the regions mentioned above. From this initial sample, I exclude six countries, Botswana, Gambia, Guinea-Bissao, Lesotho, Swaziland, that had less than 1 million inhabitants in 1965. I also exclude countries that experienced major political disruptions like civil war. This criterion excluded Burundi, Nicaragua, Rwanda and South Africa[6]. In addition, major oil and mineral producers are not included. In particular, I exclude countries that had mining and oil production above 30% of GDP for five years. The following five countries fit this criterion: Republic of Congo, Mauritania, Nigeria, Venezuela and Zambia. At the end of the selection process, I have 38 countries distributed as follows: 16 in Africa, 10 in Asia and 12 in Latin America. The list of countries is in table 3 of the appendix[7].

Contrasting the structural transformation of developing and developed countries re-

[6]South Africa had no civil war but I consider the apartheid system as a major political disruption

[7]The selection criteria eliminate the two biggest African economies (South Africa and Nigeria) and also the two most successful (Botswana and Mauritius). In the appendix, I analyze these countries briefly.

veals two main findings. First, developing countries in general are following a different path of structural transformation, although there are a few countries that are following the path of developed countries. Second, there is a lot of variation in the structural transformation paths followed by developing countries. My analysis will show that the structural transformation process in developing countries differs from the path followed by the developed countries along two key dimensions. The first dimension is the relationship between changes in sectoral output shares and changes in log of GDP per capita (slope effect). The second dimension is a level effect that shows the levels of sectoral output shares for a given per capita GDP. I should note that many countries deviate in both dimensions.

The first question is whether the structural transformation process in developing countries is similar to the process followed by developed countries. One way to address this question is to use similar polynomial functions to fit the data for both groups. For developed countries, I used fixed effects panel regressions to estimate equation (1). The agricultural sector are best fitted by a quadratic function while the industry and service sectors are best fitted by third degree polynomials. For developing countries, I also use fixed effects panel regressions to estimate equation (1). Table 4 shows the results of the regressions. Several remarks are in order. First, the R-squared are very low. They are 0.08 for services, 0.27 for industry and 0.35 for agriculture. For the agricultural sector, only the constant term is statistically different from 0. None of the coefficients is statistically different from 0 for services while all of them are statistically different from zero for the industrial sector. These results differ greatly from those of developed countries where the R-squared were high and all coefficients were significantly different from 0 at the 5% level. From this table we can conclude that the structural transformation process for developing countries differs from that of developed countries.

To assess the heterogeneity among developing countries, I calculated the fixed effect deviation from the mean ($\widetilde{\alpha}_i$) for each of the 38 countries. Table 5 shows considerable heterogeneity among countries. The standard deviations for the distributions are 6.8 for agriculture, 5.8 for industry and 7.0 for services. These standard deviations are much

larger than those obtained for developed countries.

Another way to consider the above results is to plot the sectoral output shares versus log of GDP per capita. Figure 11 in the appendix shows the scatter plots along with the fitted curves and prediction bounds for developed countries. It is clear from these figures that many developing countries have their sectoral output shares outside of the prediction bounds for developed countries.

3.1. Patterns of Structural Transformation in developing Countries

Given the heterogeneity of structural transformation processes in developing countries, I selected five countries to highlight some of the differences. These five countries will also show how structural transformation processes in developing countries deviate from the path of developed countries. The process in each of the five countries represents a particular pattern of structural transformation that is followed by other developing countries in my sample. The selected countries are: Korea[8], Brazil, Pakistan, Ghana and Senegal. To keep the analysis simple, I just show, in figure 2, the service output shares versus log of GDP per capita for the example countries.

From the figure we see that Korea's data points can be fitted by a third degree polynomial. Korea's path is similar to the one followed by developed countries, especially after per capita GDP surpasses $4000 (log of GDP per capita higher than 8.3). Other countries that have a similar path include Chile, Indonesia, Malaysia and Thailand. The path followed by Pakistan traces the upper bound curve of the prediction for developed countries. Thus, this pattern differs from that of the developed countries in the level effect dimension. Countries that have this pattern include India, Sri Lanka and Uruguay.

Brazil's path shows a clear change in trend. Before per capita GDP reaches $5000, service output shares were close to the fitted curve. From there, the service output shares increase greatly with only small changes in per capita GDP. The last data points are all above the upper bound curve. Both the slope and the level effects differ from those of developed countries.

[8]Although Korea cannot be counted now as a developing country, it was one for a better part of the period 1965-2000.

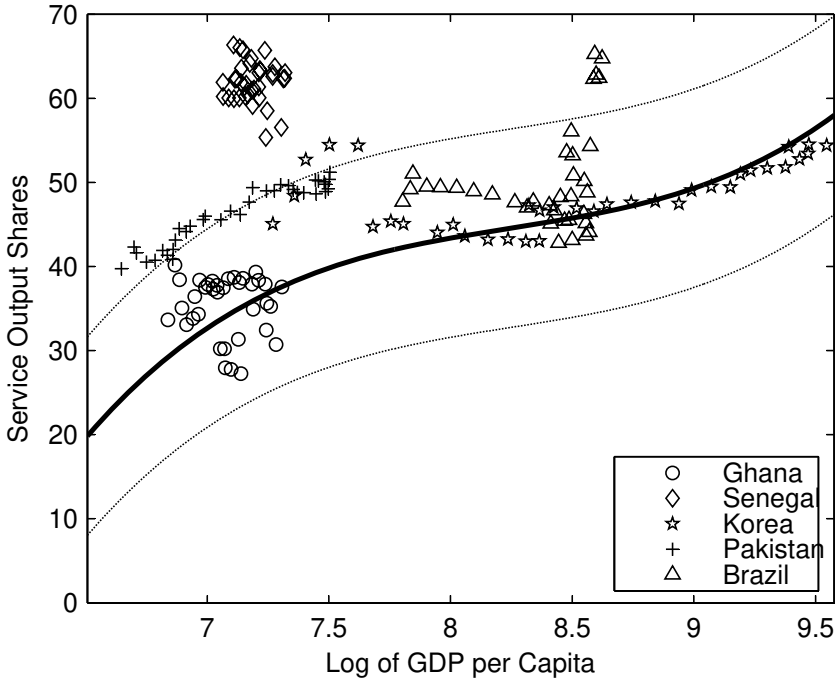
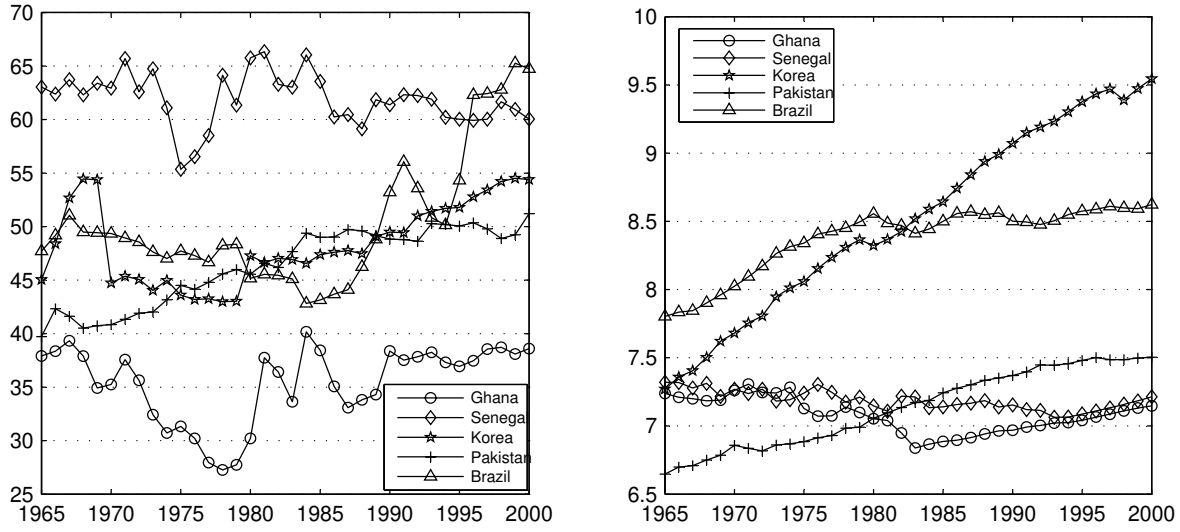


Figure 2: Patterns of Structural Transformation

NOTE: The fitted curves and the confidence interval bounds are obtained from the regression results for developed countries.

The two African countries in the figure have no clear paths. Therefore, we cannot see the relationship between service output shares and GDP per capita from this figure. However, we can see that Ghana's data points are all close to the fitted curve while Senegal has all its points above the predictions' upper bound curve. Therefore, Ghana deviates from the baseline process in the slope dimension while Senegal differ from both the level effect and slope dimensions. Countries with Ghana's pattern include Mali, Cameroon and Uganda while countries like Madagascar and Zimbabwe follow Senegal's pattern. Another way to see the differences between the five patterns is to look at the time series plot of the shares of services in output represented in figure 3. I also plot the time series of log of per capita GDP. This representation helps us see the direction of movement for the countries that stay stagnant in terms of income per capita. The service output shares for Senegal were the highest and they varied a lot around a constant trend. Brazil had the second highest shares followed by Korea and Pakistan. Ghana had the lowest shares and they vary quite a bit especially before 1990.

The analysis above shows that structural transformation in developing countries is



(A) Services Output Shares (B) Log of GDP per Capita

Figure 3: Time Series Plot of the Patterns of Structural Transformation

different from the one followed by developed countries. The analysis also shows some of the heterogeneity that exists among developing countries. In the following section, I will reinforce these points by analyzing the structural transformation processes of Africa, Asia and Latin America.

4. Differences in the Structural Transformation Processes for Africa, Asia and Latin America

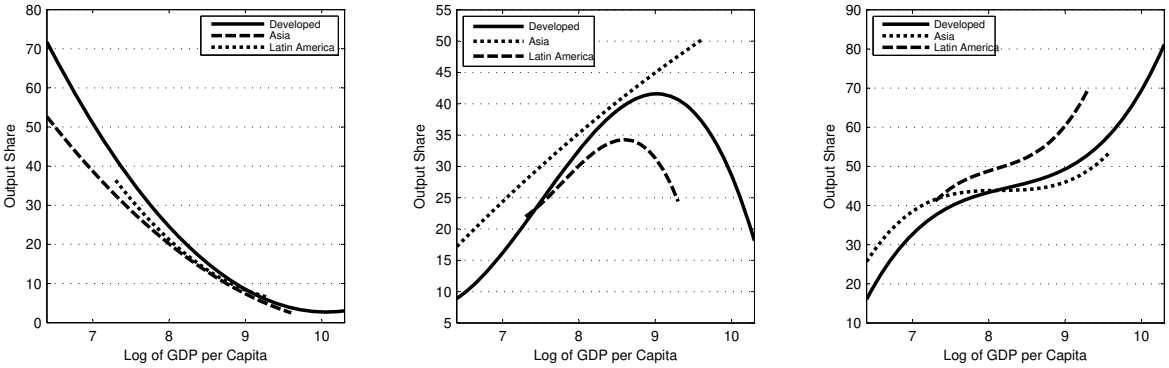
In the previous section, I showed that there is heterogeneity in the structural transformation processes for developing countries. In this section, I push the analysis farther and ask if the heterogeneity is mostly due to continent effects. In other words, how different are the structural transformation processes of countries in Africa, Asia and Latin America. The analysis of this section leads to two findings. First, the structural transformation process of all three regions are distinct. Second, significant heterogeneity remains between structural transformation processes of countries within each geographical group.

4.1. Comparing fitted Curves

The first exercise I conduct is to find the best fit of the data for each continent and compare the fitted curves. Again, I use fixed effects panel regressions to fit the data. For the African countries, table 6 shows that there is not a good fit for the data. The regressions for all three sectors have R-squared close to 0. Therefore, I will not draw a fitted curve for Africa and I conclude that Africa's structural transformation is different from the other processes. For Asia, table 8 shows the results of the regressions. The agriculture and industry sectors are best fitted with quadratic polynomials with R-squared equal 0.76 and 0.63 respectively. The service sector is fitted with a third degree polynomial with an R-squared of 0.44. For Latin America, the output shares of agriculture are fitted by a quadratic polynomial while those of industry and services are fitted by third degree polynomials. The highest R-squared is for the agricultural sector at 0.49. The other two sectors have R-squared at respectively 0.17 and 0.19. The results are shown in table 7.

The fitted curves for Asia, Latin America and the developed countries are shown in figure 4. For the agriculture, the fitted curve for Latin America is very close to the one for all developed countries. For the Asian countries, the fitted curve starts low but moves closer to the other two later. For industry, the previous pattern is reversed. The curve for Asia is above the one for developed countries. However, the two curves are close when log of GDP per capita is between eight and nine. The curve for Asia is increasing during the whole range of log of GDP per capita. This suggests that these countries are in the first phase of their structural transformation process. The curve for Latin America coincides with that for the developed countries in the beginning but it reaches its maximum at a lower per capita GDP. This suggests that Latin American countries transitioned from the first to the second phase of their structural transformation at a lower GDP per capita with a lower maximum industrial output share. For services, the curves for Asia and the developed countries are close while the one for Latin America again starts close to the two but ends up well above them.

To show the heterogeneity between countries in each group, I calculated the fixed effect



(A) Agriculture (B) Industry (C) Services

Figure 4: Comparing Fitted Curves

NOTE: The fitted curves for each group are obtained by regressing sectoral output shares on log of GDP per capita as in equation (1).

deviation from the mean for each country. Table 5 shows the results[9]. For Asia, the standard deviations are 4.6 for agriculture, 6.6 for industry and 5.3 for services. Notice that a big driver of these standard deviations are China. When I exclude China, the standard deviations are respectively 4.2, 3.2 and 3.9. For Latin America, the standard deviations are respectively 4.9, 5.4 and 3.2. Recall that the respective standard deviations for developed countries are 3.7, 3.1 and 2.5.

This brief analysis shows that Africa, Asia and Latin America have very different structural transformation processes. It also shows that the structural transformation of Asia is the closest to that of the developed countries. However, given the poor goodness of fit for Africa and Latin America, I will conduct further analysis to strengthen the above findings. Next, I analyze the averages of sectoral output shares for each continent and I show the scatter plots to highlight the differences between countries.

4.2. Structural Transformation in Africa

The analysis of the sectoral output shares for the 16 African countries reveals some important features. In 1965, the service output share was the highest in nine countries out of the 16 in the sample. After services, the agriculture sector was the second most important. The service output share was 42.81% on average for the 16 countries while

[9]I don't show the results for Africa because there is no good fit of the data.

the agricultural share was 40.62%. Maddison argues that Africa started its structural transformation around 1950. It is then surprising to see high service output shares at such an early stage of the transformation. Next, let's examine the changes of the output shares of the three major sectors in the last four decades.

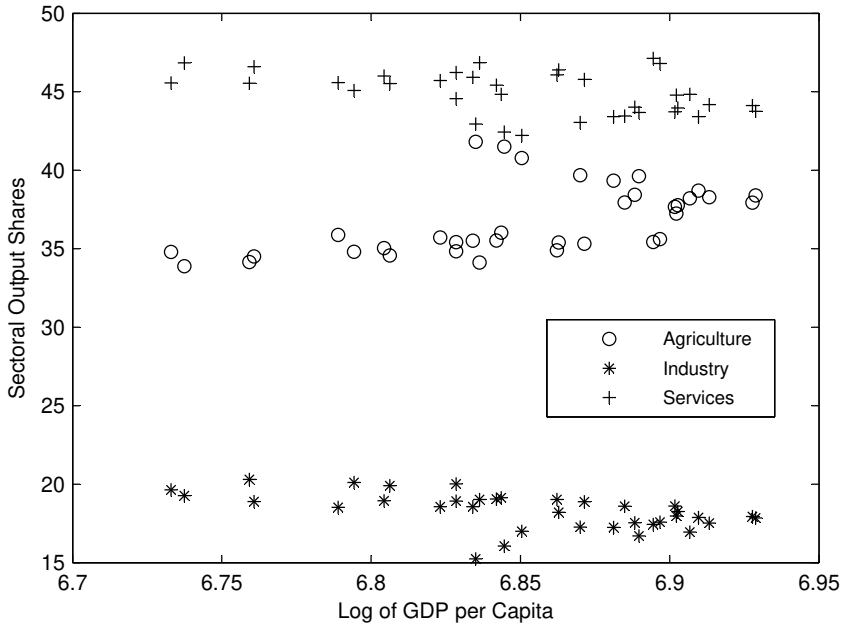
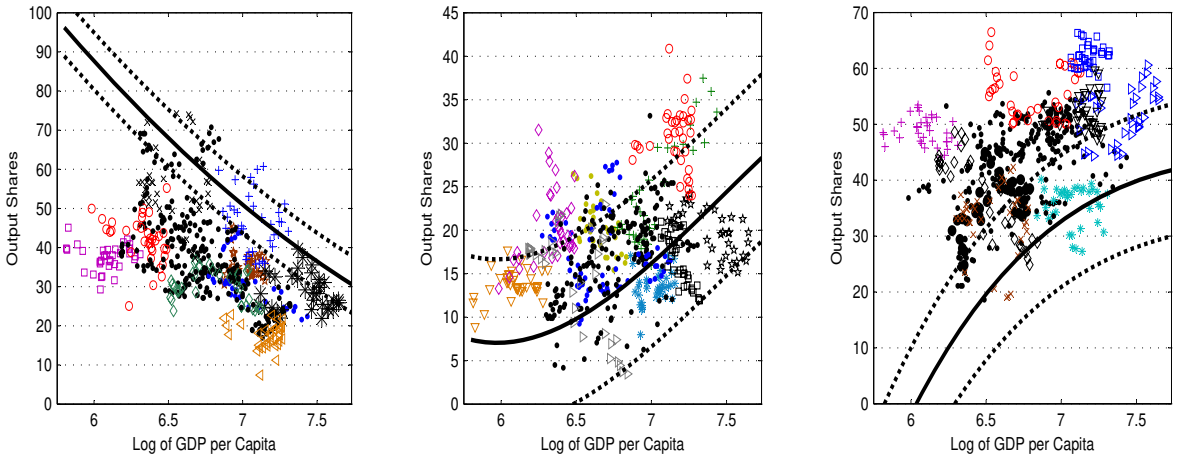


Figure 5: Structural Transformation for Africa

NOTE: The data points represent the cross-country average of sectoral output shares for Sub-Saharan African countries.



(A) Agriculture (B) Industry (C) Services

Figure 6: Structural Transformation in Africa

NOTE: The fitted curves and the confidence interval bounds are obtained from the regression results for developed countries.

Figure 5 shows the yearly averages from 1965 to 2000 of sectoral output shares versus the average log of GDP per capita for the 16 African countries. It is clear from the figure that the changes of sectoral output shares are different from the transformation described by Kuznets. This process deviates from the path of developed countries not only in the relationship between sectoral output shares and GDP per capita but also in the levels of sectoral shares for given per capita GDP. On average, the sectoral output shares change very little. The levels of agriculture and industry output shares are small while those of services are high. From the figure, the relationship between GDP per capita and the sectoral shares is somewhat misleading because average GDP per capita is sometimes decreasing. However, the changes in GDP are small, so we can say roughly that on average sectoral output shares were almost constant between 1965 and 2000.

This graph hides the differences that exist between African countries. In figure 6, I plot the sectoral output shares versus log of GDP per capita for all 16 countries. First, looking at the agricultural sector, we see that African countries have significantly lower output shares. Most of the data points are outside of the prediction bounds for developed countries. This is not the case for industry where most data points are within the bounds and a few are actually above the upper bound. The third panel of the figure shows that most African countries have high service output shares for their level of per capita income. Only a few data points are within the prediction bounds of the developed countries. The graphs also show the differences between African countries. We already saw for example that Ghana had service output shares close to the fitted curve while Senegal has all its data points well above the upper bound curve of the predictions. Many countries with comparable per capita GDP have very different sectoral output shares.

4.3. Structural Transformation in Latin America

In this section, I analyze the structural transformation of the 12 Latin American countries. First, I plot in figure 7, the yearly averages of sectoral output shares versus average log of GDP per capita for the period 1965-2000. When average GDP per capita was below $4000 the speed of transformation was slow. There was a clear change of speed after

that. It looks like on average, the Latin American countries moved from the first to the second phase of structural transformation at GDP per capita around $4000. Looking at only this figure, we may be tempted to conclude that the structural transformation for Latin America looks like the path of developed countries. However, as we will see, this average is misleading since most countries do not resemble this path. In addition, the levels of sectoral output shares deviates from the path of developed countries even for this average.

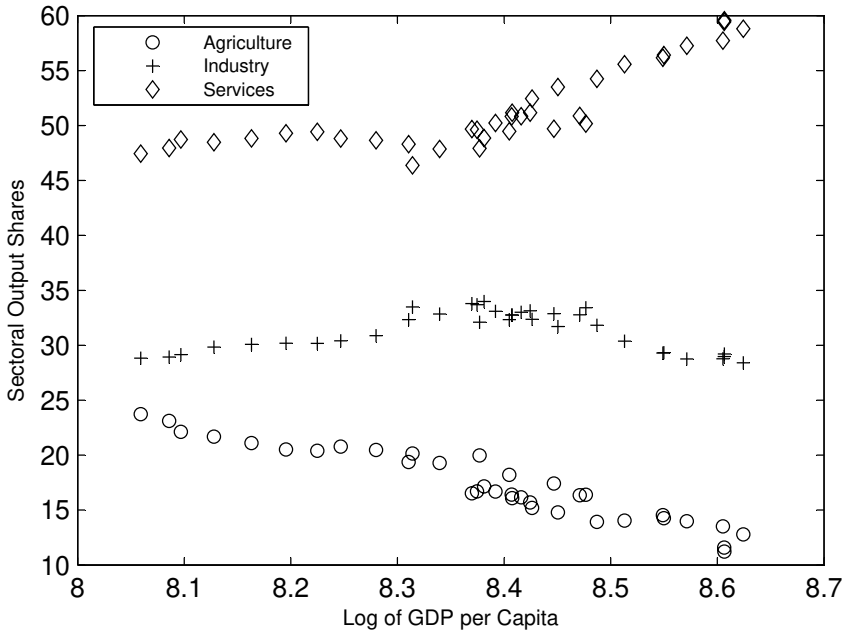
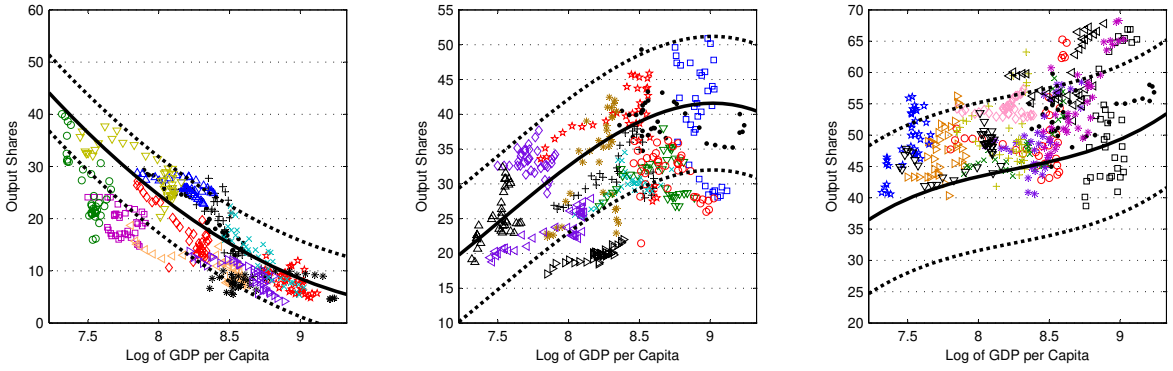


Figure 7: Average Structural Transformation for Latin America

NOTE: The data points represent the cross-country average of sectoral output shares for Latin American countries.



(A) Agriculture (B) Industry (C) Services

Figure 8: Structural Transformation in Latin America

Figure 8 shows the scatter plots for sectoral output shares for all Latin American countries. The first panel shows that most countries had agricultural output shares within the prediction bounds for the developed countries. In fact only Bolivia, Brazil and Honduras have data points below the lower bound curve. This is reflected in the fitted curve graph that I showed previously. The second panel shows that many countries have industrial output shares around the lower bound curve. For the service sector in the third panel, many countries start with shares close to the fitted curve but they end up much higher. In fact there are quite a few data points above the upper bound of the predictions for the developed countries. This confirms again the result obtained from the analysis of the fitted curves conducted in section 4.1. Recall that the fitted curve for the service share of GDP for Latin America starts close to that for developed countries but ends up much higher. The scatter plot graphs also show that there are important differences among countries.

4.4. Structural Transformation in Asia

Next, I analyze the process for the 10 Asian countries of the sample. I start by plotting, in figure 9, the yearly averages of sectoral output shares versus average log of income per capita for the period 1965-2000. There are two points to note about this figure. First, there was a steady decline in the agricultural output shares. Since the service sector shares initially decreased as well, there is a big increase in the share of industry in the beginning. After GDP per capita passes $2000, there were steady increases of the shares of industry and services. The second point is that, on average, the Asian countries are in the first phase of structural transformation as we saw with the fitted curves analysis.

The scatter plots in figure 10 show the sectoral output shares versus log of GDP per capita for all countries. The first panel shows that some countries had low agricultural output shares. Many data points are around the lower bound curve. However for the industry sector in panel two, there are very few points below the fitted curve for developed countries. Most countries had high industrial output shares. In fact, there are a few data points above the upper bound curve. The third panel shows that the service output

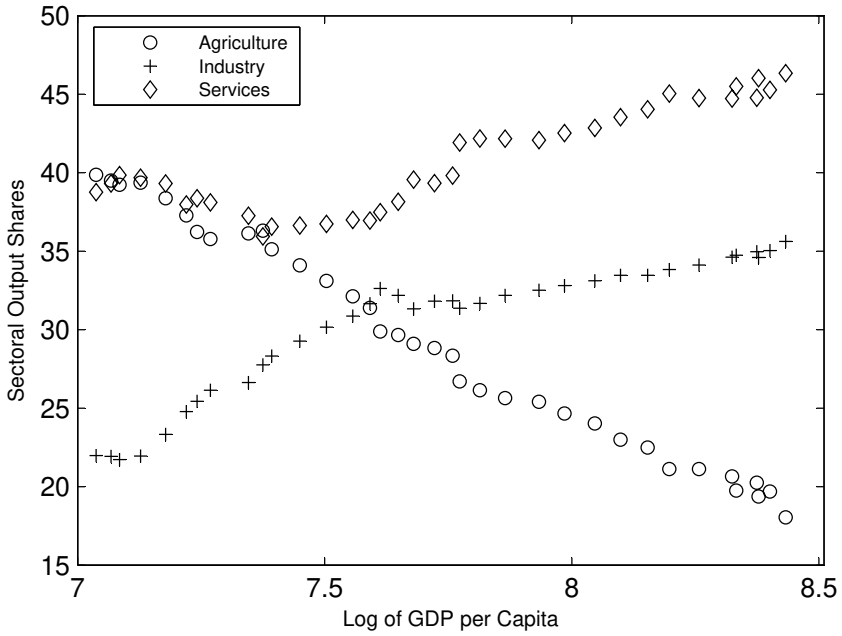
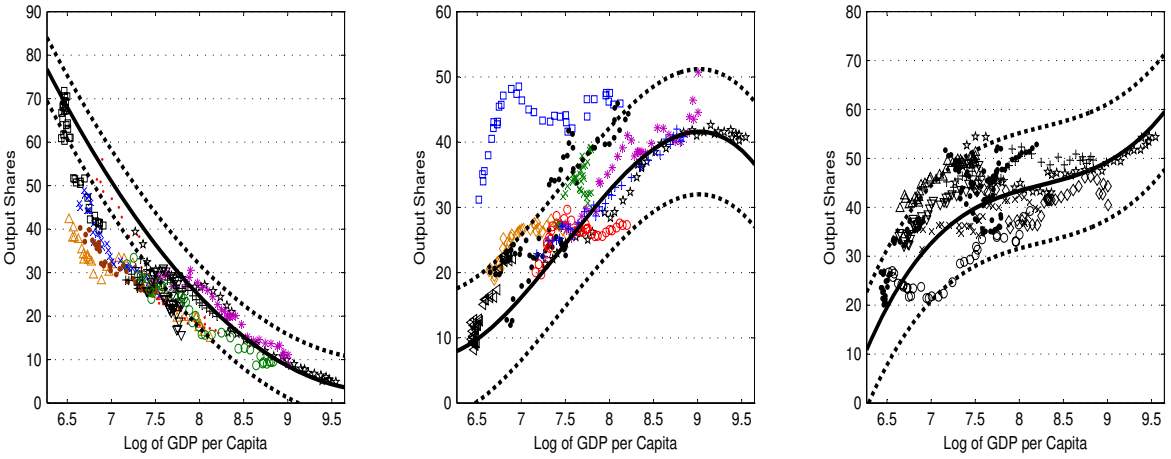


Figure 9: Structural Transformation for Asia

NOTE: The data points represent the cross-country average of sectoral output shares for Asian countries.



(A) Agriculture (B) Industry (C) Services

Figure 10: Structural Transformation in Asia

shares of these countries are distributed around the fitted curve. There are only few data points around the upper bound curve. The heterogeneity between countries is also apparent from these graphs. For example, China has very high industry output shares and low service shares. It is the contrary for Pakistan and India.

5. Structural Transformation and Economic Stagnation

In the literature, structural transformation is commonly linked to development or growth of per capita GDP. As Syrquin (1994) puts it: "There is a strong association of economic structure with the level of development and between growth and structural change." However, structural transformation can also occur during periods of economic stagnation and even economic decline. In fact this was a key feature of structural transformation in Africa and Latin America. For Latin America, this happened when the countries moved from the first to the second phase of structural transformation. We already saw in section 3 that Brazil's service output shares increased greatly when per capita GDP was stagnant around $5000. For African countries, GDP per capita in 2000 was the same or lower than that of 1965; yet they experienced structural transformation during the period. From Kuznets' view of structural transformation this is a puzzle because we would expect the sectoral output shares not to change if GDP is not changing. To illustrate the puzzle, I show the time series plot for Argentina and Niger as examples.

Looking at figure 12, we can divide the period for Argentina into three sub-periods, 1965-1976, 1977-1990 and 1991-2000. For the first and last sub-periods, the changes in sectoral shares seem consistent with the changes of GDP per capita. However, from 1977 to 1990, GDP per capita decreased from $8304 to $ 6436. During the same period, the share of industry decreased from 47.81% to 36.02% while service output share increased from 44.11% to 55.85%. Even though the share of services in output increased by 11 percentage points and that of industry decreased by 12 percentage points; GDP per capita decreased by 23%. It is the reverse of what one might expect. If we consider the period 1965-1990, GDP per capita was constant but there were great changes in sectoral

output shares.

From figure 13, we see that GDP per capita for Niger decreased from $935 in 1965 to $518 in 2003, a 45% decline. During the same period, the agricultural output share decreased from 67.7% to 39.86%, the share of industry increased almost 5-fold, from 3.47 % to 16.76% while the service output share increased from 28.82% to 43.38%. This shows a substantial structural transformation with a big decrease in GDP per capita. Again, it is the reverse of what one might expect. It seems that when countries are growing, the sectoral output shares move in the "right" direction. But when countries are stagnant or declining, the sectoral output shares move in the "wrong" direction. Other examples of structural transformation with economic stagnation are shown in figure 14 in the appendix.

Models of structural transformation use mostly two features to drive labor reallocation across sectors: non-homothetic preferences and productivity growth differential. Consider a three-sector economy with non-homothetic preference with respect to agricultural good and TFP growth differential between industry and services[10]. Assume that TFP growth in services is 1/3 of the growth in industry. In such an economy, labor will move out of agriculture if income elasticity is below 1. Labor will also reallocates from industry to services because of their TFP growth differential. However, if TFP growth rates are low in agriculture and industry, GDP will growth very little. This shows that it is possible for an economy to experience big changes in sectoral employment or output shares with very little change in GDP per capita.

6. Conclusion

The processes of structural transformation across developed countries are similar and they fit the pattern described by Kuznets. However, the analysis of the structural transformation processes of Africa, Latin America and Asia conducted in this paper leads to different conclusions. First, the structural transformation for developing countries in general is different from the path followed by developed countries. Second there is a lot

[10]See Bah (2008)

of heterogeneity in the structural transformation processes followed by developing countries. I show five patterns of structural transformation, and only one resembles to the path followed by developed countries.

The are also differences between the paths followed by the sub-continents of Africa, Asia and Latin America. Asia is following a path that is the closest to that of developed countries. A key feature for Asian countries is high industrial output shares. African countries have low agricultural output shares and high service output shares at very low GDP per capita. Latin American countries on the other hand, have agricultural output shares similar to those of developed countries, but a key feature for these countries is that they move from the first to the second phase of structural transformation at a low GDP per capita and with low maximum industrial output shares. This leads to high service output shares around the end of the period.

The third main finding of the paper is the presence of structural transformation during periods of economic stagnation or decline. Many African and Latin American countries experienced periods of significant sectoral output changes in the "wrong" direction while GDP per capita was stagnant or even declining. This is a puzzle from Kuznets' view of structural transformation.

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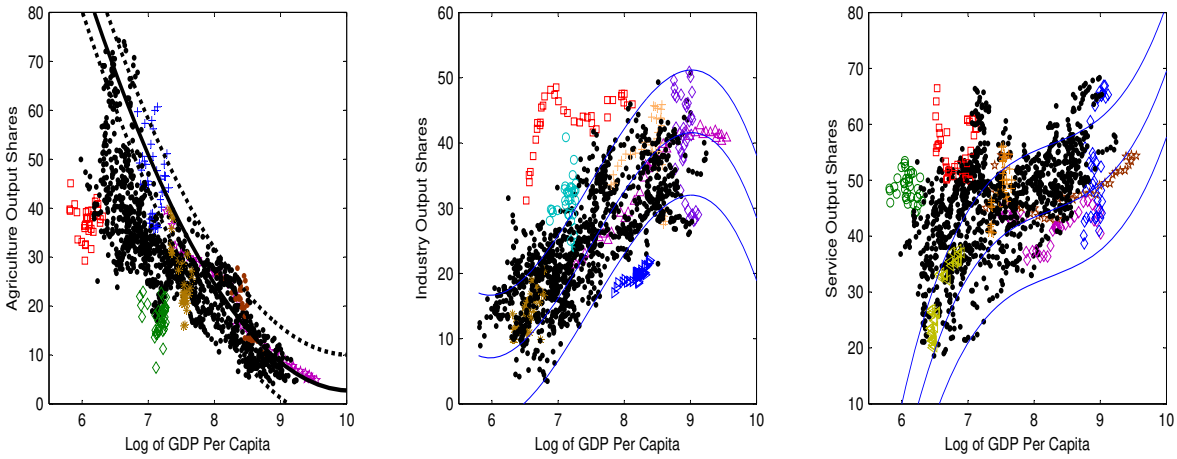
A. Appendix A: Figures and Tables

Table 1: Regression Results for Developed Countries

	Agriculture	Industry	Services
constant	524.32	926.0	-1773.0
	(34.9)***	(366.3)**	(446.0)***
$log(gdp)$	-103.7	-394.9	651.7
	(8.1)***	(129.5)***	(157.6)***
$log(gdp)^2$	5.2	54.9	-78.4
	(0.5)***	(15.2)***	(18.5)***
$log(gdp)^3$	-	-2.4	3.2
		(0.6)***	(0.7)***
R-squared	0.92	0.63	0.74

NOTE: This table report the fixed effects panel regressions of equation (1) for each sector. The data consist of 9 developed countries with 15 observations per country. The standard errors are in parentheses.
*** significant at 1%, ** significant at 5%, * significant at 10%.



(A) Agriculture (B) Industry (C) Services

Figure 11: Structural Transformation in Developed Countries
NOTE: The fitted curves and the confidence interval bounds are obtained from the regression results for developed countries.

Table 2: Fixed Effects Deviation from the Mean

Country	Agriculture	Industry	Services
Australia	4.9	-4.3	-0.4
Canada	1.2	-1.9	0.7
France	1.1	0.5	-2.1
Germany	-4.1	5.4	-1.3
Italy	5.8	-1.5	-4.3
Japan	-2.8	3.3	-0.5
Sweden	-0.3	-1.0	1.2
UK	-4.5	2.1	2.6
US	-1.5	-2.6	4.0
std. dev.	3.7	3.1	2.5

NOTE: This table report the difference of the average fixed effects with each country fixed effect. The average fixed effect is obtained by regressing equation (1) for each sector. The country fixed effect is obtained by LSDV estimation.

Table 3: List of Developing Countries

Africa	Benin, Burkina Faso, Cameroon, Central African Republic (C.A.R), Chad, Côte d'Ivoire, Ghana, Kenya, Madagascar, Malawi, Mali, Niger, Senegal, Togo, Uganda, Zimbabwe
Asia	China, India, Indonesia, Korea, Malaysia, Nepal,Pakistan, Phillippines, Sri Lanka, Thailand
Latin America	Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Mexico, Paraguay, Uruguay

Table 4: Regression Results for all Developing Countries

	Agriculture	Industry	Services
constant	110.1	744.8	-4.5
	(23.3)***	(117.7)***	(146.7)
$log(gdp)$	-7.8	-304.7	14.0
	(6.0)	(46.4)***	(57.8)
$log(gdp)^2$	-0.4	41.4	-1.7
	(0.38)	(6.1)***	(7.5)
$log(gdp)^3$	-	-1.8	0.1
		(0.26)***	(0.3)
R-squared	0.35	0.27	0.08

NOTE: This table report the fixed effects panel regressions of equation (1) for each sector. This regression is similar to the one done for the developed countries. The data consist of 38 developing countries with 36 observations per country (yearly data, 1965-2000). The standard errors are in parentheses.
*** significant at 1%, ** significant at 5%, * significant at 10%.

Table 5: Fixed Effects Deviations from the Means for Developing Countries

	Agriculture			Industry			Services		
	min	max	Std. dev	min	max	Std. dev	min	max	Std. dev
All countries	-15.6	16.2	6.8	-13.5	20.6	5.8	-16.6	17.7	7.0
Asia	-6.4	9.0	4.6	-5.5	16.9	6.6	-10.6	7.1	5.2
Asia w/o China	-5.5	9.0	4.2	-5.5	3.2	3.2	-4.2	7.1	3.9
Latin America	-6.9	8.0	4.9	-12.3	7.6	5.4	-6.7	5.9	3.2

NOTE: This table report the difference of the average fixed effects with each country fixed effect. The average fixed effect is obtained by regressing equation (1) for each sector. The country fixed effect is obtained by LSDV estimation.

Table 6: Regression Results for Africa

	Agriculture	Industry	Services
constant	63.3	-8.6	226.83
	(11.7)***	(6.8)	(93.2)***
$log(gdp)$	-3.9	4.0	-54.1
	(1.7)**	(1.0)***	(27.6)*
$log(gdp)^2$	-	-	4.0
			(2.0)*
$log(gdp)^3$	-	-	-
R-squared	0.001	0.03	0.01

NOTE: This table report the fixed effects panel regressions of equation (1) for the 16 African countries. The standard errors are in parentheses.
*** significant at 1%, ** significant at 5%, * significant at 10%.

Table 7: Regression Results for Latin America

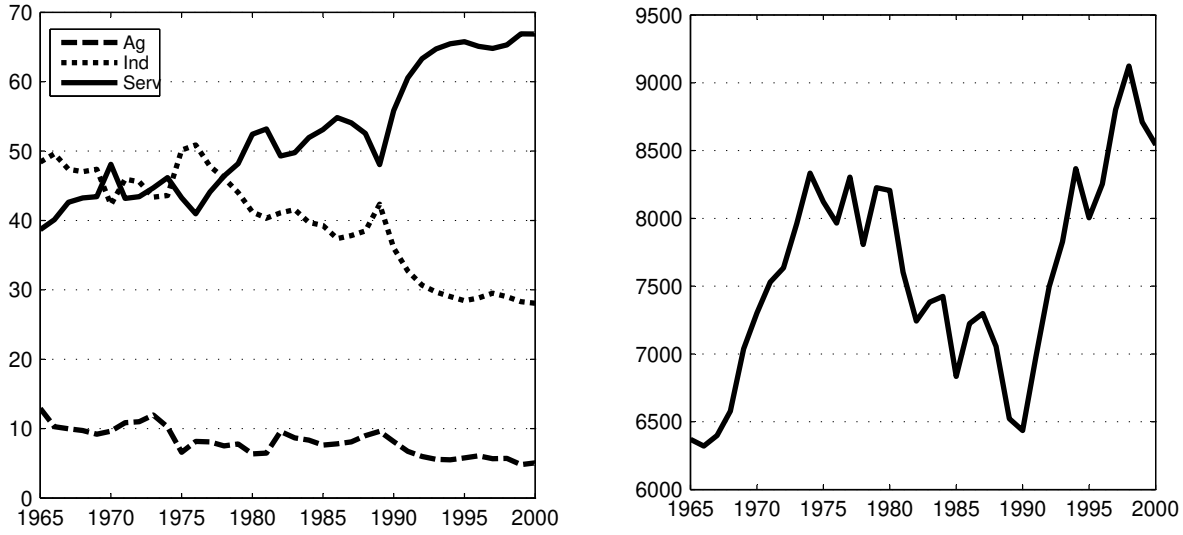
	Agriculture	Industry	Services
constant	499.7	2883.1	-3884.8
	(68.4)***	(1180.7)**	(1441.7)***
$log(gdp)$	-101.0	-1127.3	1447.6
	(16.4)***	(428.1)***	(522.7)***
$log(gdp)^2$	5.2	146.6	-178.3
	(1.0)***	(51.6)***	(63.0)***
$log(gdp)^3$	-	-6.3	7.3
		(2.1)***	(2.5)***
R-saquared	0.49	0.17	0.19

NOTE: This table report the fixed effects panel regressions of equation (1) for the 12 Latin American countries. The standard errors are in parentheses.
*** significant at 1%, ** significant at 5%, * significant at 10%.

Table 8: Regression Results for Asia

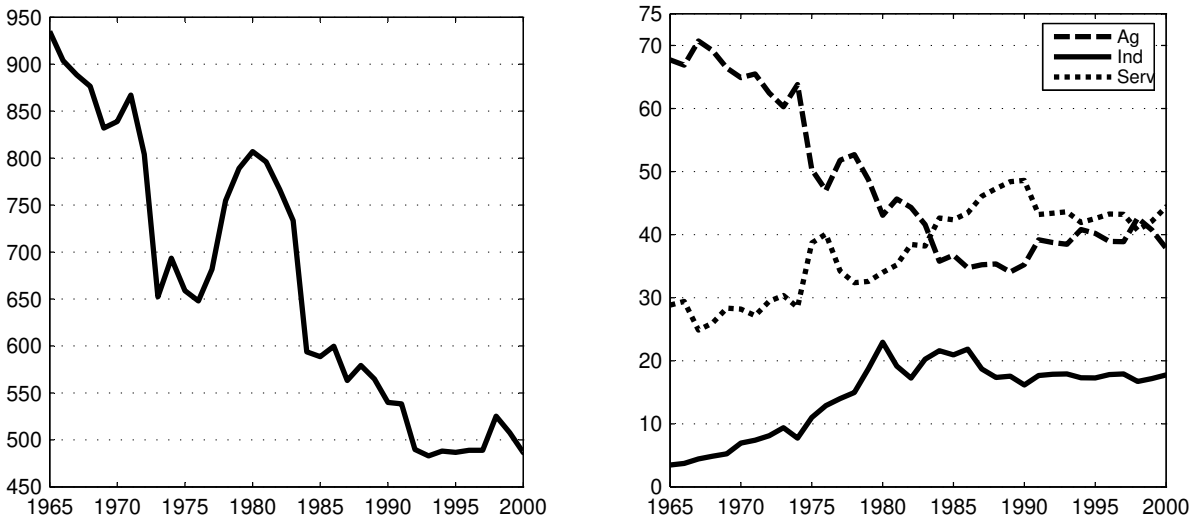
	Agriculture	Industry	Services
constant	331.4	-88.1	-1727.8
	(27.3)***	(23.6)***	(196.5)***
$log(gdp)$	-62.2	20.6	650.7
	(6.9)***	(6.0)***	(75.4)***
$log(gdp)^2$	2.9	-0.6	-79.7
	(0.4)***	(0.4)*	(9.6)***
$log(gdp)^3$	-	-	3.2
			(0.4)***
R-squared	0.76	0.63	0.44

NOTE: This table report the fixed effects panel regressions of equation (1) for the 10 Asian countries. The standard errors are in parentheses.
*** significant at 1%, ** significant at 5%, * significant at 10%.



(A) Services Output Shares (B) Log of GDP per Capita

Figure 12: Structural Transformation for Argentina



(A) Services Output Shares (B) Log of GDP per Capita

Figure 13: Structural Transformation for Niger

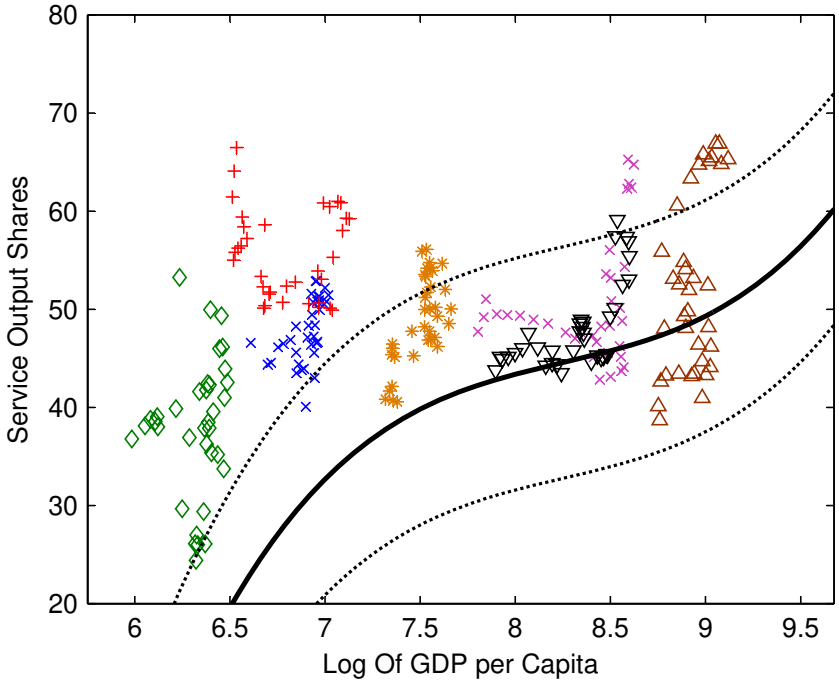
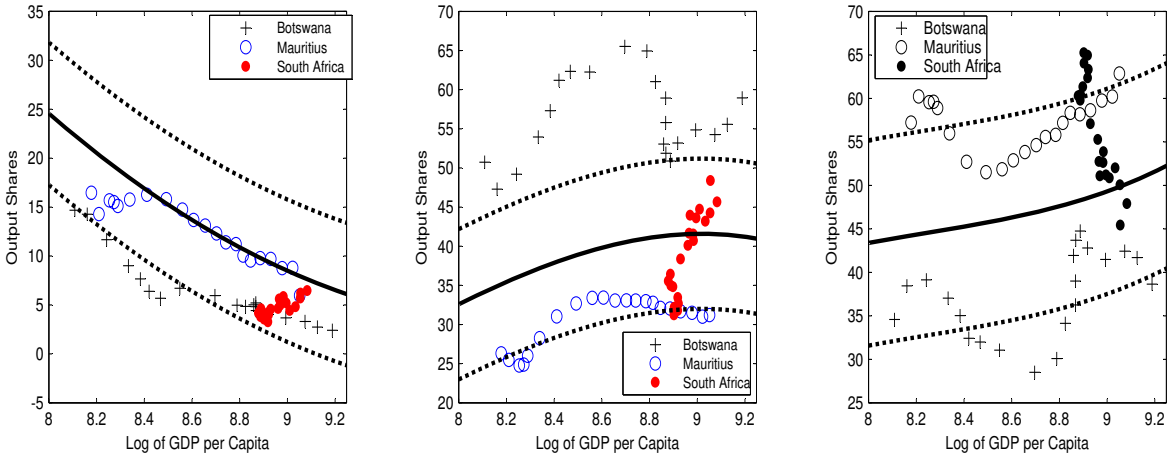


Figure 14: Sectoral Output Shares for Other Stagnant Developing Countries



(A) Agriculture (B) Industry (C) Services

Figure 15: Structural Transformation in Other African Countries

B. Appendix B: Other African Countries

The selection criteria for Africa eliminates the two biggest economies, South Africa and Nigeria, and its two most successful, Botswana and Mauritius. In this appendix, I show the structural transformation of Botswana, Mauritius and South Africa starting in 1980[11]. GDP per capita nearly tripled in Botswana and by 2.4-fold in Mauritius between 1980 and 2000. South Africa's GDP per capita in 2000 was 87% of its level in 1980. Figure 15 show the sectoral output shares for the three countries. Botswana's economy is primarily led by the exploitation of diamonds. We see the industrial share of GDP is above the upper bound curve of the developed countries. Its agricultural and service shares are all near the lower bound curve. For Mauritius, agricultural shares trace nicely the fitted curve for the developed countries while industry and service shares trace respectively the lower and upper bound curves. We can say that Mauritius is mostly following the path of the developed countries. This is not the case for South Africa. The country has been almost stagnant in the last 20 years. While the data points are mostly inside the prediction curve, agricultural shares have not changed much. Industrial shares decreased from a high of 48% in 1980 to 32% in 2000[12]. This was matched by increase in service share which increased from 54% to 65% in this period. Therefore, South Africa has the path of stagnant countries and it is very similar to Argentina.

[11]There is no data available for Nigeria.
[12]South Africa is big producer of minerals which explains the high share of industry