SECTORAL SHARES AND ECONOMIC GROWTH

Dr. Nisar Ahmad
Department of Border Region Studies
University of Southern Denmark, Alsion 2, Sønderborg
Email: nisar@sam.sdu.dk , Tel: 0045-6550 1773

Amjad Naveed
PhD. Student
Department of Border Region Studies
University of Southern Denmark, Alsion 2, Sønderborg
Email: amjadn@sam.sdu.dk , Tel: 0045-6550 1247

Amber Naz
PhD. Student
Department of Border Region Studies
University of Southern Denmark, Alsion 2, Sønderborg
Email: amber@sam.sdu.dk , Tel: 0045-6550 1774

ABSTRACT

In developed countries, the share of services and industrial sector has increased in the past few decades and at the same time the share of agriculture sector went down considerably. In the literature, there exists a debate about structural change in the developed countries. Neoclassical economists believe that structural change is an unimportant side effect of the economic development. On the contrary, economists associated with the World Bank and some others posit that growth is brought about by the changes in sectoral composition. The objective of this study is to empirically test the relationship between sectoral shares and economic growth by using the panel data for 20 developed countries. The results of the granger causality suggest that both services and agriculture sectors do granger cause economic growth, whereas industrial sector does not granger cause growth. Reverse causality does not hold for any of the three sectors. The results of Barro and Non-Barro regressions along with the set of control variables have suggested that services sector is negatively affecting growth, whereas both industrial and agriculture shares are positively affect economic growth.

Keywords: *Economic growth, Sectoral shares, Panel data, Fixed and Random affects*

INTRODUCTION

There exist a considerable debate that why there are structural changes in the developed countries in the past few decades. The neoclassical approach is based on the view that structural change is an unimportant side effect of the economic development (Cristina (1997)). However economist associated with the World Bank and Baumol et al. (1985) posit that growth is brought about by changes in sectoral composition.

The objective of this study is to see how sectoral shares are related with economic growth. We used the data of 20 developed countries to analyze the relationship in standard barro and non-barro regressions for panel studies. The direction of causality has been tested through well-known Granger test. We used standard set of control variables to capture the cross-country differences. In order to see, whether our results are robust or not we did fixed effect estimation. We compare the results with both 3 and 5 years averaging of the data to see if the results are robust with respect to averaging of the data.

Results for the causality test have suggested that causality runs from sectoral shares to growth rate. Both agricultural and services shares do granger cause growth rate but industrial share does not granger cause growth. Reverse causality does not hold i.e. Growth does not granger cause any of the sectoral shares.

The results have shown that services sector is negatively affecting growth rate whereas industrial and services shares are positively related with economic growth. The magnitude of the effect is very small but it does matter in the long run for growth rate. It has been shown that results heavily depend on set of control variables. The results of fixed effect estimation have suggested that these findings are not robust.

The study is organized as follows: section 2 gives some of the theoretical background. Review of some selected studies is given in section 3. Section 4 gives the casual analysis of data and variables. Methodology is discussed in section 5. Section 6 discuses the results of the study. Conclusion is given in section 7.

SECTORAL SHARES AND ECONOMIC GROWTH

There are basically two approaches to answer the question that why there has been structural changes in the developed countries in the past few decades. The neoclassical approach is based on the view that structural change is an unimportant side effect of the

economic development (Cristina (1997)). However economist associated with the World Bank and Baumol et al. (1985) posit that growth is brought about by changes in sectoral composition.

Typically we can divide a country into three main sectors that is agricultural, industrial, and services sectors[1]. This division leads to the fact that sectoral shares with respect to the GDP will add up to one. Theoretically, there exist some views about how these sectors are related with economic growth.

Industrial Sector

The relation of industrial sector with growth has it roots in Kaldor views about manufacturing sector. Kaldor (1966) argued that an industrial sector is the "engine of growth". Kaldor has explained his ideas by giving three laws. According to Kaldor's first law, "*the faster the rate of growth in manufacturing sector the faster will be the growth of overall gross domestic product"*. He argued that when manufacturing sector develops then other sectors of the economy also develops through spillover effects. The second law, which is also known as Verdoorn's law[2], states that "there is strong relationship between the growth of labor productivity in the manufacturing sector and the growth of output in manufacturing sector". In third law Kaldor states that "productivity growth is positively related with the employment in the manufacturing sector where as it is negatively related with non-manufacturing sectors".

Services Sector

It is widely believed that an expansion of the service sector relative to the rest of the economy leads to a reduction in the long run growth rate of output per capita (see for example, Baumol et al. (1989), Wolff (1985), and Wilber (2002), among others). This could be due to the fact that services are mostly in non physical production[3]. Baumol (1967) argued that scope of productivity growth in the services sector is slower than in the sectors that produce goods. Recently, Cristina (1997) followed Baumol type of model to describe the expansion of service sector of developed countries during the 20th century. Another explanation is actually based on the views of Kaldor discussed above. The growth of engine hypothesis indirectly means that increase in the share of the services sector relative to the other sectors reduces the rate of technological progress and the rate of innovation in an economy. The dramatic rise in the share of the services in total economic activity during the post war periods is often cited as a major factor in the apparent productivity slowdown in the united states and other advanced economies during the late 1960s and early 70s (Wilber (2002)).

Agriculture Sector

There is no direct theory that explains how share of agricultural sector is related with economic growth. Empirically it has been observed that share of agriculture sector goes down as country develops. Indirectly, we can explain the phenomenon with the help of theory given by Lewis (1954). According to this theory when a country develops then the labour move from traditional agriculture sector to modern industrial sector where wages are higher. During this transitional period share of agricultural sector goes down and country develops hence we expect negative relation between share of agriculture sector and growth rate of developing country.

In developed countries the share of agriculture sector goes down very slowly and there growth rate is also have a tendency of going down since they already had high growth rate in their transitional stage. In this case we are expecting zero or positive relationship between share of agriculture sector and growth rate of developed countries.

LITERATURE REVIEW

The empirical research to see the impact of industrial development on economic growth started from Kaldor (1966). The study found strong positive and statistically significant correlation between the rate of growth of manufacturing sector and rate of growth of output.

In order to see the impact of the expansion of services sector on economic growth in cross section of countries Dutt and Lee (1993) have regressed the growth rate of GDP on share of services in employment. They found negative and significant coefficient suggesting that relative increase of the services share in employment in associated with decline in the growth rate.

Necmi (1999) have tested Kaldor's law on "manufacturing as an engine of growth" using the cross country data mainly of developing countries for the period 1960-1994. The result of the study show that manufacturing output growth rate is exogenous as Kaldor envisaged and his `laws' are applicable to most of the developing world.

Wilber (2002) investigated the relationship between service sector expansion and growth rate of output using panel data of 25 OECD countries over the period from 1960 to 1994. The study did the causality analysis and found that causality runs from services to growth. According to the results of the study relative expansion of the service sector as a whole is associated with a reduction in the rate of growth of total output. Moreover, the disaggregated analysis for the service sector found that not all the services are bad for economic growth. Furthermore, producer services are found to have positive impact on growth while consumer and government services have a negative impact.

[1] We have divided the economy in to these three main sectors since the separate data is available on these different sectors.
[2] See Verdoorn (1949).
[3] Since services sector include the services provided by the government, financial professional, education, and health care and real state services.

DATA VARIABLES AND CASUAL ANALYSIS

In this section we will explain how variables, used in the analysis, and are constructed. Then we will give raw analysis of the data with help of tables and graph.

Date And Variables

In order to test the theory that how sectoral shares are related with long run growth rate of output we must first determine the appropriate variables to measure expansion of each sector. There can be two possibilities. First, it could be possible to use expansion in terms of increase in output of each sector. In this case either increase in share or increase in the growth rate of output can be used as expansion variable. Second, it is also possible to use expansion in term of increase in employment in sector. In this study we are going to use increase in sectoral share as an expansion variable.

An economy of a country is divided into three main sectors agriculture, industry and services sectors. Agricultural output includes forestry, hunting fishing, and cultivation of corps and livestock production. Industrial output comprises mining, Manufacturing, construction, electricity, water and gas. Services include transport, government, financial professional, education, health care real estate and whole sale and retail trade[4]. The total share of these sectors in GDP adds up to one.

We used real GDP per capita growth rate as variable to capture economic growth. Following Islam (1995), all the variables are measured as "N" year's averages. This is typical done to control for short-term cyclical effects. The value "N" is normally 3, 4, 5 and different studies have used different average but we would rather like to report the result with different values of "N" in order to see whether the results are robust with respect to these averages.

We have used the panel data of 20 developed countries starting from 1971 to 2000. The list of countries is reported in table 1. We have selected these developed countries since structural changes are quite visible in these countries.

Table 4.1 List of Sample countries

Australia	Luxembourg
Austria	Netherlands
Belgium	Norway
Denmark	Portugal
Finland	South Africa
France	Spain
Greece	Sweden
Ireland	Turkey
Italy	United Kingdom
Japan	United States

Casual and Graphical Analysis of Sample Data

Before going into the details of the modeling variables it is sometimes very helpful to have bird eye view of the raw data in order to make appropriate model. Table 4.2 and 4.3 reports the economic growth in selected sample of countries over the sample period.
Casual observation is supporting the theory since rate of growth for per capita income has fallen for all most of the sample counties and share of industrial sector is decreasing while the share of services sector is increasing. We will test these observations with the help of econometric modeling to see whether these patterns are significant or not.
The graph of the convergence relation is represented in figure 1. For convergence we are expecting negative patter in this figure where as it is not showing any significant pattern of convergence or divergence among the sample countries. Hence we are expecting zero convergence in empirical analysis.

Table 4.2 Economic Growth in Sample countries (Growth Rate of real GDP per capita)

Country Name	1971-80	1981-90	1991-2000	Full Sample period 1971-2000
Australia	1.49	1.54	2.38	1.88
Austria	3.46	2.16	1.82	2.48
Belgium	3.17	1.90	1.92	2.33
Denmark	1.56	1.55	1.93	1.68
Finland	3.27	2.68	1.86	2.61
France	2.71	1.95	1.49	2.05

[4] We have followed division of sectors like this from world development Indicator since we are using its data available on CD-ROM.

Greece	3.74	0.19	1.95	1.96
Ireland	3.27	3.35	6.47	4.36
Italy	3.15	2.22	1.41	2.26
Japan	3.33	3.52	1.15	2.67
Luxembourg	1.93	4.04	4.48	3.48
Netherlands	2.09	1.71	2.26	2.02
Norway	4.18	2.05	2.79	3.01
Portugal	4.08	3.16	2.65	3.30
South Africa	1.28	-1.08	-0.21	0.00
Spain	2.61	2.56	2.23	2.47
Sweden	1.64	1.88	1.44	1.65
Turkey	1.76	2.83	2.14	2.24
United Kingdom	1.84	2.46	2.11	2.14
United States	2.23	2.24	2.00	2.16

Table 4.3 Average Structural Change in Sample countries.

	Agriculture share			**Industrial Share**			**Services Share**			**Over All (1971-2000)**		
Country	**1971-80**	**1981-90**	**1991-2000**	**1971-80**	**1981-90**	**1991-2000**	**1971-80**	**1981-90**	**1991-2000**	**Agri**	**Industry**	**Service**
Australia	7.46	5.28	3.54	36.70	32.99	27.34	55.84	61.72	69.12	**5.43**	**32.35**	**62.23**
Austria	5.81	4.10	2.69	40.13	35.49	32.81	54.06	60.41	64.50	**4.20**	**36.14**	**59.66**
Belgium	3.71	2.59	1.75	40.33	33.40	28.97	55.96	64.01	69.27	**2.68**	**34.23**	**63.08**
Denmark	6.17	5.27	3.40	29.14	27.21	25.99	64.70	67.53	70.61	**4.94**	**27.44**	**67.61**
Finland	10.18	7.60	4.66	38.85	35.85	32.00	50.97	56.55	63.33	**7.48**	**35.57**	**56.95**
France	6.20	4.32	3.23	37.30	32.21	27.00	56.51	63.47	69.77	**4.58**	**32.17**	**63.25**
Greece	14.57	12.79	9.57	34.28	30.26	23.52	51.15	56.95	66.91	**12.31**	**29.36**	**58.34**
Ireland	16.59	11.08	6.62	34.69	35.17	38.02	48.72	53.75	55.36	**11.43**	**35.96**	**52.61**
Italy	7.35	4.72	3.31	41.02	35.91	30.85	51.63	59.37	65.83	**5.13**	**35.93**	**58.94**
Japan	5.02	3.00	1.84	41.91	39.37	34.60	53.07	57.63	63.57	**3.28**	**38.63**	**58.09**
Luxembourg	3.28	2.61	1.12	39.90	34.30	24.92	56.82	63.09	73.96	**2.34**	**33.04**	**64.62**
Netherlands	4.73	4.41	3.48	36.42	32.60	28.22	58.85	62.98	68.30	**4.21**	**32.42**	**63.38**
Norway	5.08	3.76	2.64	34.21	38.45	35.68	60.71	57.79	61.68	**3.83**	**36.11**	**60.06**
Portugal	23.86	13.26	5.31	34.72	32.53	30.80	41.42	54.21	63.90	**14.14**	**32.68**	**53.18**
South Africa	7.14	5.29	3.95	41.27	42.83	33.98	51.59	51.88	62.07	**5.46**	**39.36**	**55.18**
Spain	9.67	6.24	4.63	40.87	36.40	31.19	49.46	57.36	64.17	**6.85**	**36.16**	**57.00**
Sweden	5.29	4.16	2.35	35.90	32.81	29.44	58.82	63.03	68.21	**3.93**	**32.72**	**63.35**
Turkey	32.96	20.25	16.22	21.03	28.52	28.26	46.01	51.23	55.52	**23.14**	**25.94**	**50.92**
United Kingdom	2.68	1.94	1.57	41.77	39.07	30.95	55.56	58.99	67.48	**2.06**	**37.26**	**60.68**
United States	3.68	2.38	1.76	33.88	30.58	25.67	62.44	67.04	72.57	**2.61**	**30.04**	**67.35**

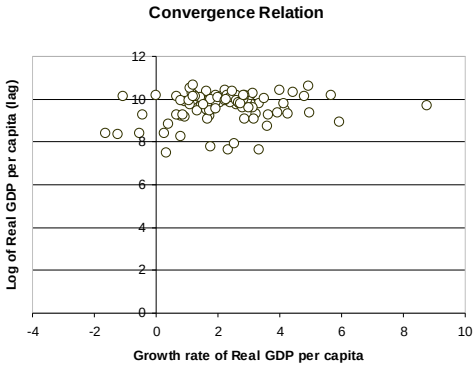


Figure 4.1 This figure is based on the extended neo classical idea about convergence.

Negative pattern represents convergence among sample counties but there is no significant pattern in this figure. Source is IBRD (*World Development Indicator*)

The relationship between sectoral shares and growth rate of GDP is shown in figure 2. The first observation from the figure is that structure of all the sample countries is quite similar. A service sector is quite dominating in all the countries where as the share of agricultural sector is very small in almost all the economies. The share of industrial sector lies between agricultural and services shares. It will be quite interesting to see if the dynamics of the structural shares is related with growth rate of output. Visually we can see a little negative pattern between the share of services sector and growth rate where industrial shares are showing little bit positive relation. Agriculture sector is also showing some negative pattern.

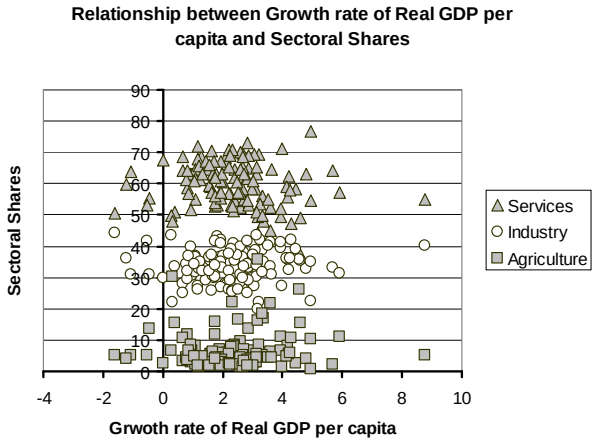


Figure 4.2

There is one more interesting figure that shows the relationship between GDP per capita and sectoral shares. It is represented in figure 3. This figure show quite clear pattern. Services sector is clearly positively related with GDP per capita. This is due to the fact that GDP per capita for all the developed countries is increasing (but growth rate is falling) over the last three decades and share of services sector is increasing. Industrial and agricultural shares are showing quite negative pattern.

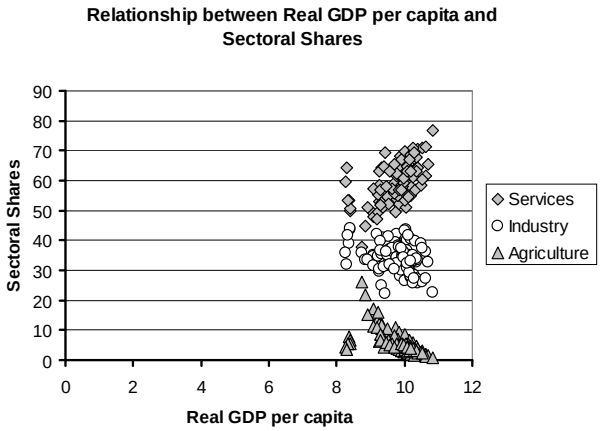


Figure 4.3

METHODOLOGY

This section explains the methodology used in the current study to obtain the empirical results. First, in order to see the direction of causality between sectoral shares and growth rate we will apply Granger causality test developed by Granger (1969). Second, we will model these sectors by using econometric techniques. In the literature, there are different ways of modeling these variables. We can divide these methodologies in two main categories i.e. standard barro equation for cross county regression and other non-barrow regressions.

Direction of Causality

It is already mentioned above that there exits a debate whether change in sectoral shares is an unimportant by product of economic growth or economic growth is brought about by the changes in the sectoral shares. In order to answer this question we will apply well known test proposed by Granger (1969). This test is based on the estimation of following regressions:

$$G(Y)_{i,t} = \alpha_i + \sum_{j=1}^{n} \rho_j Z_{i,t-j} + \sum_{j=1}^{n} \delta_j G(Y)_{i,t-j} + \varepsilon_{i,t} \ldots\ldots\ldots 1(a)$$

$$Z_{i,t} = \alpha_i + \sum_{j=1}^{n} \rho_j Z_{i,t-j} + \sum_{j=1}^{n} \delta_j G(Y)_{i,t-j} + \mu_{i,t} \ldots\ldots\ldots\ldots 1(b)$$

Where G(Y) is the growth rate of per capita GDP. $Z_{i,t}$ measures the relative change of different sectoral shares. "i" stands for country, "t" for time and "j" represents the lag length used for the analysis and we have to include enough lags so that error term of the model become white noise or at least non-auto correlated. The null hypotheses that sectoral share does granger cause growth rate uses regression 1(a). The null hypothesis is accepted if the joint hypothesis of $\rho_j = 0$ for all j is accepted. Similarly the hypothesis that growth rate does granger cause is based on the regression 1(b) and this hypothesis corresponds to test the same joint hypothesis to test $\delta_j = 0$ for all j. Testing this joint hypothesis uses F-distribution and F-statistics is given by the following expression:

$$F = \frac{SSE_R - SSE_{UR} / K}{SSE_{UR} / N - 2K}$$ with (K, N-2K) degree of freedom.

Where SSE_R and SSE_{UR} are the sums of squared residual from restricted and unrestricted model respectively.

Barro Regression

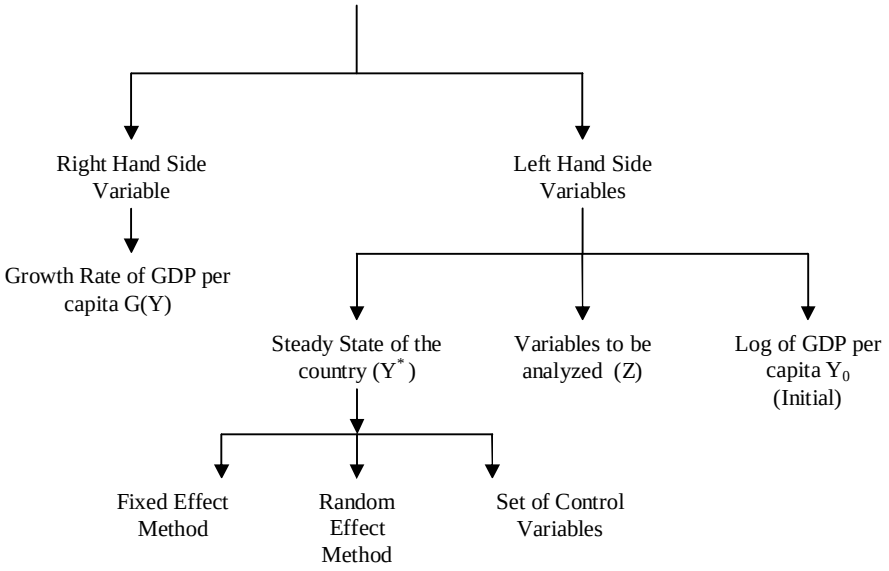
Barro regression for cross country analysis is based on the extended neo-classical model of economic growth (see for detail, Barro and Salai-Martin 1995). The basic assumptions of the neo-classical model are that there are Diminishing returns to capital and constant returns to scale are the basic assumptions of this model. The basic feature of this model is conditional convergence which means countries will converge towards their own steady state in the long run. If different counties have the same steady

state level of output then they will converge to each other. This convergence relation can be written in the following general functional form: $G(Y) = f(Y^*, Y_0)$

Wwhere G(Y) is the growth rate of output, Y* is the steady state level of output of the country and Y_0 is the initial level of output. The steady state level of output for a country depends upon different variables that can control for country differences. There are three different possibilities to control country differences. First, we can treat each country completely different in this case we only need to use dummy variables for each country. This procedure of controlling country differences is known as fixed effect method. In panel data we can consistently estimate the coefficient of these dummy variables if we have sufficiently enough observation over time. Second, a pure econometric technique to control for country differences is random effect[5]. Third, we can also use set of control variables that can describe the steady state of the country for example inflation, openness, education, fertility, etc. (for detail see, Barro and Sala-i-Martin 1995 Ch. 12).

If one can control for steady state properly then the nature of relationship between G(Y) and Y_0 will tell us about the convergence feature of the model. If this relationship is found to be negative then it means that poor country in the sample will catch up to rich countries where as if this relationship is found to be positive then it will be a sign of divergence between the sample countries. The above discussion can be represented in the following figure.

Format of Barro Regression



The pacific form of the convergence equation in panel observations can be written as follows:

$$G(Y_{i,t}^T) = \alpha + \varphi_t + \gamma x_{i,t}^T + \gamma Z_{i,t}^T + \beta Y_{i,t-1} + u_{i,t}$$

where "i" is the country index, "t" is for time of the observations and superscript "T" represents interval length used to average the variables in order to avoid short period correlation. φ_t is used to control for time specific attributes such as international business cycles. $X_{i,t}$ is the set of control variables that can capture the country differences. The negative value of β would imply the convergence and positive value would give the meaning of divergence among the countries. The variable(s) $Z_{i,t}$ is those variables that we want to analyze in this growth equation. In our study this $Z_{i,t}$ variable is actually the share of different sectors.

If we control for country difference by including country dummy variables then the regression can be written as follow:

$$G(Y_{i,t}^T) = \alpha_i + \gamma Z_{i,t}^T + \beta Y_{i,t-1} + u_{i,t}$$

[5] For more detail discussion on random effect panel data estimation see for example Wooldridge (2002).

In the case of panel observations we can consistently estimate this parameter α_i with the help of fixed effect estimation procedure if we have sufficiently large observations.

Non Barro Regressions

If we analyze the cross-country regression without the standard format of the barro equation then we can classify it as non-barro regressions. All the cross-counties study before barro (1991) were using non-barro regression. The pioneer in this work is Kaldor (1966) Aafter the study of barro (1991) most of the studies have followed his regression but still researcher analyze with empirical issues using non-barro regression. One possibility is to estimate cross country growth equation without using the initial value of output as an explanatory variable for example Wilber (2002) has tried to model the growth rate of 25 OCED countries to see the effect of services sector on growth rates but he has not used initial value of output as right hand side variable.
We will use both Barro and non-barro regression formats to model our variables and we will use set of control variables and fixed effect estimation technique to see if we can get some robust results. We can write our model as follows:

$$G(Y_{i,t}) = \alpha_i + \gamma_j \sum_j Z^T_{i,t,j} + \beta Y_{i,t-1} + u_{i,t}$$

where j = jth sector share. (Agricultural, Industrial and Services sector)
T = we will use 3, 4, 5, year averages.

In the above regression the total share of all these sectors add up to one hence in order to avoid singularity problem we have to exclude one of the sector from the growth equation.

Identification Problem

We have to be very careful while interpreting the results as the coefficient of sectoral shares included in the above regression can not be identified and we have to interpret them with respect to the coefficient of excluded sector. We can explain this identification issue as follow[6]:

Let j = 1, 2, 3 and 1 = Agricultural sector, 2 = Industrial sector, 3 = Services Sector
and $\sum_j Z^T_{i,t,j}$ = 1 for j = 1, 2, 3

$$G(Y_{i,t}) = \alpha_i + \gamma_1 Z^T_{i,t,1} + \gamma_2 Z^T_{i,t,2} + \gamma_3 Z^T_{i,t,3} + \beta Y_{i,t-1} + u_{i,t}$$
$$Z^T_{i,t,3} = 1 - Z^T_{i,t,1} + Z^T_{i,t,2}$$

substituting in above regression

$$G(Y_{i,t}) = \alpha_i + \gamma_1 Z^T_{i,t,1} + \gamma_2 Z^T_{i,t,2} + \gamma_3 (1 - Z^T_{i,t,1} + Z^T_{i,t,2}) + \beta Y_{i,t-1} + u_{i,t}$$

after re arranging

$$G(Y_{i,t}) = (\alpha_i - \gamma_3) + (\gamma_1 - \gamma_3) Z^T_{i,t,1} + (\gamma_2 - \gamma_3) Z^T_{i,t,2} + \beta Y_{i,t-1} + u_{i,t}$$

from the above regression we can see that we can avoid the problem of singularity by excluding one of the sector from the regression but we can not identify the coefficient of single sector but we get the relative coefficient with respect to the excluded sector.

Robustness Test

It has been argued in the literature that growth analysis are not robust with respect to control set, specification, time period (see Levine and Renelt (1992), Sala-i-Martin (1997), Kalaizidakis et. al. (2000), Islam (2003)). Recently it is now been pointed out that these finding are not robust with respect to source of data set (see Knowles (2001), Akinson and Brandolini (2001). In order to see the robustness of our findings we would also like to do robustness test with respect to control set and fixed effect method estimation method.

ESTIMATION RESULTS

The current section provides the estimation results based on the methodology explained in the previous section.

Test Results for direction of Causality

Table 6.1(a) and 6.1(b) give the test results of hypothesis that sectoral shares do not granger cause economic growth and the reverse causality respectively. The test results have suggested that agricultural and services share do cause growth rate where as

[6] We would like to thanks Allan Würtz who helped us understanding the identification problem in modelling sectoral shares.

industrial share does not causing growth rate. The reverse causality tests have shown that growth rate does not cause any of the three sectoral shares.

Table 6.1(a) Test Results of Granger Causality

Null Hypothesis: *Sectoral Share Does Not Granger Cause Growth Rate*			
	Agriculture	**Industry**	**Services**
Lag length	3	3	**3**
Test Statistic	6.29	2.68	**9.37**
observation	60	60	**60**
p-value	0.098	0.442	**0.024**
Result	Agricultural share ***does*** Granger Cause Growth rate at 10 % but not at 5 %	Industrial share ***does not*** Granger Cause Growth rate	Services share ***does*** Granger Cause Growth rate at 5%

Table 6.1 (b) Test Result for Reverse Granger Causality

Null Hypothesis: *Growth Rate does not Granger cause Sectoral Shares*			
	Agriculture	**Industry**	Services
Lag length	2	2	2
Test Statistic	3.29	1.28	1.13
observation	80	80	80
p-value	0.192	0.525	0.568
Result	Growth rate ***does not*** Granger cause Agricultural share	Growth rate ***does not*** Granger cause Industrial share	Growth rate ***does not*** Granger cause Services share

Results for Economic Growth and Sectoral Shares

After doing causality analysis now we will proceed to analyse that how sectoral shares are affecting economic growth. We will start estimation with set of control variables and then we will use fixed effect estimation to see if the results are robust or not. We will also do the estimation with both using 5 and 3 years averaging of the data. We will also report the results of non-barro regression. We will try to model the effect of each sector separately since they are correlated with each because they add up to one.

Modeling Services Sector

In this section we will report and explain the results of modeling services sector. The control set consists of following variables: inflation, trade openness (sum of export and import of goods and services) as percentage of GDP, fertility, and public expenditure as percentage of GDP and life expectancy. We have tried human capital (average year of schooling age 25 and over taken from barro and lee data set 2000) as a control variable but it turned out to insignificant in all the models hence we have excluded that variable from the model.

We have estimated different models with different possibilities of control set and the results are reported in table 6.2. We have also estimated these models with five year average (5. Y. A) and three year average (3. Y. A) to see the robustness of the results with respect to averaging of the data. Model (1) is estimated with set of control variables by including all the variables mentioned above. We get quit reasonable and significant coefficient of convergence. We get a negative coefficient of services share as we expected but it is only significant at 10% level of significance. The value of coefficient is -0.061 which means that one- percent increase in share of services sector relative to the other sector will decrease the growth rate by 0.06 %. These results are different from the study by Wilber (2002) who did his analysis in non barro regression. He modeled growth rate of 17 OECD countries without taking the lag value of log of GDP per capita as an explanatory variable and found that one percent increase in the share of services sector decreases the growth rate by 0.017 %. This difference could be due to the fact that we are using different sample and different set of control variables, as we will show that these results are not robust with respect to set of control variables.

Table 6: Results of Modeling Services Share

Variables	**Estimation with Control Set**						**Fixed Effect**		**Non Barro Regression**
	Model (1)		**Model (2)**		**Model (3)**				
	5 Y. A	**3 Y. A**	**5 Y. A**	**3 Y. A**	**5 Y. A**	**3 Y. A**	**5 Y. A**	**3 Y. A**	**5 Y. A**
Log GDP-pc- (lag)	-1.11 (-2.20)**	-0.84 (-1.90)*	-0.58 (-1.10)	-0.426 (-0.96)	-0.284 (-0.47)	-0.211 (-0.44)	-2.114 (-1.19)	-1.299 (-0.83)	
Share of Services (%) of DP	**-0.061 (-1.72)***	**-0.053 (-1.51)**	**-0.083 (-2.17)****	**-0.078 (-2.25)****	**-0.087 (-1.98)****	**-0.074 (-1.91)***	**-0.051 (-0.83)**	**-0.017 (-0.33)**	**-0.098 (-3.78)****
Trade Openness (%) of GDP	0.022 (6.07)**	0.021 (5.52)**	0.013 (4.01)**	0.013 (4.03)**					0.015 (5.32)**

Public Expenditure (%) of GDP	-0.084 (-4.73)**	-0.076 (-4.04)**							-0.054 (-3.50)**
Inflation rate	-0.031 (-2.00)**	-0.037 (-2.51)**	-0.017 (-0.99)	-0.024 (-1.63)	-0.023 (-1.19)	-0.030 (-1.84)*			-0.011 (-1.03)
Life Expectancy (total)	0.127 (2.38)**	0.068 (1.90)*	0.104 (1.81)*	0.072 (1.93)*	0.051 (0.788)	0.048 (1.24)			0.105 (2.71)**
Fertility rate	-0.831 (-2.59)**	-0.531 (-1.72)*	-0.45 (-1.31)	-0.148 (-0.48)	-0.697 (-1.88)**	-0.255 (-0.78)			-0.127 (-0.47)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	No	No	No	No	No	No	Yes	Yes	No
R^2	0.559	0.38	0.44		0.36	0.26	0.599	0.42	0.48
Number of observations	100	180	100	180	100	180	100	180	120

- ** significant at 5 % level of significance , * significant at 10 level of significance
- 5. Y. A = 5 years average of the data, * 3. Y. A = 3 year average of the data.
- t-statistics is reported in the parenthesis

We can see that results do not change much with respect to different averaging of the data but the results with 5 year averaging are little bit more significant. This could be due to the fact that in 5-year averaging the changes in the variables are more prominent than in the 3-year averaging of the data.

Model (2) is estimated without public expenditure since we know that services sector share also includes the services provided by the government sector. By excluding public expenditure we are expecting more significant coefficient for services share. Results have show that it is actually the case and now we have more significant negative coefficient of services share but now convergence coefficient became insignificant.

Trade openness is looking highly significant so we have estimated model 3 by excluding this variable. We can see that explanatory power of the model is reduced very much and all other coefficients have become insignificant.

In order to see the robustness of our results we then estimated fixed effect model without control set and now we can see that the results are not robust. These results heavily depend upon the set of control variables. The estimation results in the non-barro regression shows more significant results than the results obtained in the barro regression.
All these estimated give different results with respect to the robustness of the estimated coefficients but it is quite clear in all the models that services share have negative relationship with growth rate of per capita GDP.

Modeling Agricultural Sector

We used same set of control variables to model share of agriculture sector and estimated results of different models are reported in table 6.3. Model (1) reports the results with all control variables. The coefficient for the share of agriculture sector turns out to be positive but it is statistically insignificant. All the other variables are significant and have expected signs including the convergence coefficient. We then estimated various models in order to have significant coefficient of agriculture share by using different set of control variables.

Model (2) is giving little bit more significant coefficient for agriculture share but still it is insignificant at 10% level of significance. In this model we have not included life expectancy. In estimation of Model (3) we have excluded both inflation rate and life expectancy but still we get insignificant coefficient for agricultural share.

Fixed effect estimation shows quite different and significant results for the coefficient of agricultural share. It is negative and highly significant. These finding again suggest that the results are not robust with respect to control variables. The results in non-barro regression give positive and significant coefficient for share of agriculture sector.

Table 7: Results of Modeling Agriculture Share

Variables	**Estimation with Control Set**						**Fixed Effect**		**Non Barro Regression**
	Model (1)		**Model (2)**		**Model (3)**				
	5 Y. A	**3 Y. A**	**5 Y. A**	**3 Y. A**	**5 Y. A**	**3 Y. A**	**5 Y. A**	**3 Y. A**	**5 Y. A**
Log GDP-pc- (lag)	-1.449 (-2.64)**	-0.937 (-2.02)**	-0.644 (-1.50)	-0.614 (-1.42)	-0.277 (-0.74)	-0.025 (-0.06)	-2.77 (-1.62)	-1.74 (-1.11)	
Share of Agriculture (%) of GDP	**0.013 (0.28)**	**0.042 (1.05)**	**0.052 (1.15)**	**0.055 (1.36)**	**0.031 (0.72)**	**0.044 (1.12)**	**-0.186 (-2.72)****	**-0.105 (-1.75)****	**0.089 (3.03)****
Trade Openness (%) of GDP	0.023 (6.06)**	0.022 (5.64)**	0.022 (5.51)**	0.022 (5.44)**	0.021 (5.36)**	0.020 (5.17)**			0.017 (5.23)
Public Expenditure (%) of GDP	-0.092 (-4.98)**	-0.085 (-4.40)**	-0.093 (-4.82)**	-0.087 (-4.47)**	-0.088 (-4.58)**	-0.076 (-4.01)**			-0.066 (-3.96)**

Inflation rate	-0.034 (-2.07)**	-0.040 (-2.65)**	-0.028 (-1.68)*	-0.038 (-2.51)**					-0.017 (-1.43)
Life Expectancy (total)	0.139 (2.38)**	0.066 (1.83)*							0.072 (1.78)
Fertility rate	-0.82 (-2.42)**	-0.596 (-1.87)*	-1.25 (-4.11)**	-0.840 (-2.88)**	-1.145 (-3.82)**	-0.661 (-2.33)**			-0.361 (-1.23)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	No	No	No	No	No	No	Yes	Yes	No
R^2	0.54	0.38	0.52	0.37	0.50	0.34	0.63	0.42	0.45
Number of obs	100	180	100	180	100	180	100	180	120

- ** significant at 5 % level of significance , * significant at 10 level of significance
- 5. Y. A = 5 years average of the data, 3. Y. A = 3 year average of the data.
- t-statistics is reported in the parenthesis

Modeling Industrial Sector

The results of modeling industrial sector with full set of control variables are reported table 6.4 under the column model (1). The results shows that industrial sector is not showing significant effect on growth rate where as all other variables have the same and expected coefficient. We then estimated many models to get significant coefficient of industrial share and results of the few models are reported here. In model (2) we only included trade openness, public expenditure and life expectancy as control variables. Now the coefficient of industrial share little bit more significant as compared to model (1). In model (3) we have also excluded public expenditure from the model and coefficient of industrial share has become more significant than the previous models at 10 % level of significance. Magnitude of the coefficient is almost same as we obtained for the share of services sector but with opposite sign. This could be due to the fact that industry and services sectors have very strong negative correlation where as the correlation between industry and agriculture is very week. The correlation matrix between these sectoral shares is reported in the appendix along with scatter diagram of relationship between them.
The results of fixed effect estimation have shown that these results are robust and more significant than we found by using the set of control variables. The magnitude of the coefficient is also higher and the interpretation of the coefficient is that one percent increases in the share of the industrial sector increases the growth rate of a country by 0.13 %. These findings support Kaldor's engine of economic growth theory.

Table 8: Results of Modeling Industrial Share

Variables	**Estimation with Control Set**						**Fixed Effect**		**Non Barro Regression**
	Model (1)		**Model (2)**		**Model (3)**				
	5 Y. A	**3 Y. A**	**5 Y. A**	**3 Y. A**	**5 Y. A**	**3 Y. A**	**5 Y. A**	**3 Y. A**	**5 Y. A**
Log GDP-pc- (lag)	-1.515 (-3.1)**	-1.191 (-2.71)**	-0.772 (-2.4)**	-0.333 (-1.05)	-0.75 (-2.08)**	-0.435 (-1.33)	-2.91 (-1.69)*	-1.77 (-1.13)	
Share of Industry (%) of GDP	0.036 (1.18)	0.011 (0.37)	0.049 (1.65)*	0.017 (0.56)	0.058 (1.77)*	0.032 (1.02)	0.135 (2.71)**	0.075 (1.63)	0.010 (0.36)
Trade Openness (%) of GDP	0.023 (6.05)**	0.023 (5.49)**	0.020 (5.87)**	0.020 (5.14)**	0.014 (4.04)**	0.014 (3.80)**			0.017 (4.58)**
Public Expenditure (%) of GDP	-0.088 (-4.83)	-0.088 (-4.33)	-0.068 (-4.01)	-0.068 (-3.64)					-0.069 (-3.73)**
Inflation rate	-0.031 (-1.92)*	-0.041 (-2.70)**							-0.005 (-0.45)
Life Expectancy (total)	0.152 (2.85)**	0.069 (1.95)*	0.187 (4.33)**	0.082 (2.51)**	0.153 (3.24)**	0.073 (2.18)**			0.075 (1.72)*
Fertility rate	-0.748 (-2.3)**	-0.535 (-1.71)*							-0.066 (-0.22)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	No	No	No	No	No	No	Yes	Yes	No
R^2	0.55	0.38	0.51	0.37	0.42	0.29	0.63	0.42	0.41
Number of obs	100	180	100	180	100	180	100	180	120

- ** significant at 5 % level of significance , * significant at 10 level of significance
- 5. Y. A = 5 years average of the data, 3. Y. A = 3 year average of the data.
- t-statistics is reported in the parenthesis

Modeling Agriculture and Industrial sector jointly

So for we have modeled single sector in the barro regression and it would be interesting to model two sectors at the same time. The question is which sector we should model together. As mentioned earlier that services sector has relatively high negative correlation with both agriculture and industrial sector (-0.68 and -0.59 respectively) where as there is week negative correlation between agriculture and industry (-0.18). The correlation matrix and sector diagram is reported in the appendix. We then

decided to model agriculture and industrial sector together in the same model. The results would be interesting in the sense that we can know that how agriculture and industrial sector affect the growth rate if we substitute them with services sector.
The results are reported in table 6.5 and the coefficients of agricultural and industrial shares are not significant with full set of control variables. In order to get more significant results we then delete excluded life expectancy from the model and we now have more significant results and both agricultural and industrial share have positive effect on growth rate. Industrial share have relatively higher coefficient than agricultural share. The interpretation of the coefficients is that one percent increase in agriculture (industrial) share relative to services share will increase the growth rate by 0.11 (0.07) percent. This result is quite consistent with the model for services sector where we found that one percent decrease in services share will increase the growth rate by 0.06 percent. The magnitude of effect is looking very small but it matters much in the long run.
In Model (3) we have reported the results without public expenditure and now the results are similar but more significant. In order to see if the results are robust with respect to fixed effect but again these results are not robust.

Table 9: Results of Modeling Services Share

Variables	Estimation with Control Set						Fixed Effect		Non Barro Regression
	Model (1)		Model (2)		Model (3)				
	5 Y. A	3 Y. A	5 Y. A	3 Y. A	5 Y. A	3 Y. A	5 Y. A	3 Y. A	5 Y. A
Log GDP-pc- (lag)	-1.06 (-1.91)**	-0.648 (-1.40)*	-0.330 (-0.77)	-0.331 (-0.77)	0.022 (0.05)	0.112 (0.26)	-3.084 (-1.79)	-1.90 (-1.21)	***
Share of Industry (%) of GDP	**0.060 1.69)***	**0.048 (1.35)**	**0.073 (1.99)****	**0.052 (1.48)****	**0.093 (2.37)****	**0.078 (2.22)***	**0.085 (1.43)**	**0.044 (0.82)**	**0.090 (3.05)****
Share of Agriculture (%) of GDP	**0.068 (1.25)**	**0.086 (1.86)**	**0.115 (2.24)**	**0.102 (2.23)**	**0.128 (2.34)**	**0.126 (2.77)**	**-0.119 (-1.45)**	**-0.073 (-1.03)**	**0.161 (4.99)**
Trade Openness (%) of GDP	0.022 (6.04)**	0.020 (5.57)**	0.020 (5.55)**	0.020 (5.35)**	0.012 (3.62)	0.012 (3.81)			0.017 (5.54)**
Public Expenditure (%) of GDP	-0.083 (-4.70)**	-0.076 (-4.04)**	-0.083 (-4.52)	-0.075 (-4.05)					-0.060 (-3.71)**
Inflation rate	-0.031 (-1.95)**	-0.037 (-2.51)**	-0.027 (-1.68)	-0.035 - 2.38)	-0.014 (-0.821)	-0.022 (-1.46)*			-0.029 (-2.46)
Life Expectancy (total)	0.123 (2.13)**	0.063 (1.76)*							0.044 (1.39)**
Fertility rate	-0.842 (-2.48)**	-0.568 (--1.81)*	-1.249 (-4.24)	-0.817 (-2.89)	-0.831 (-2.75)**	-0.44 (-1.62)			-0.606 (-2.26)
Time Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummies	No	No	No	No	No	No	Yes	Yes	No
R^2	0.55	0.38	0.53		0.36	0.31	0.64	0.43	0.48
Number of obs	100	180	100	180	100	180	100	180	120

SUMMARY AND CONCLUSION

The objective of this study was to see how sectoral shares are related with economic growth. We have used the data of 20 developed countries to have evidence. The results have suggested that causality of relationship runs from sectoral shares to growth rate and reverse causality does not hold for any of the three sectors. Both agricultural and services do cause economic growth where as industrial sector does not cause growth rate.

The results of barro and non-barro regression with standard set of control variables have suggested that services sector is negatively related with economic growth where both agricultural and industrial sectors are positively related with growth rate. The results are robust with respect to the averaging of the data. The results with set of control variables are not robust since fixed effect estimation has not supported them.

We can conclude from this study that increase in services share could be a reason for declining trend of the growth rate of developed countries since services share is increasing in all most all the developed countries. The question is that whether we can stop this increasing trend in services share since higher per capita income requires more services.

REFERENCES

Atkinson Anthony B. and Andrea Brandolini (2001). Promise and pitfalls in the use of secondary data-sets: Income inequality in oecd countries as a case study, *Journal of Economic Literature*, 39(3):771–799, September 2001.

Barro Robert J. and Xavier Sala i Martin (2003). *Economic Growth, 2nd Edition*, volume 1 of *MIT Press Books*. The MIT Press, 2003.

Barro Robert J. (1991). Economic growth in a cross section of countries. NBER Working Papers 3120, National Bureau of Economic Research, Inc, September 1991.

Barro Robert J (1991). Economic growth in a cross section of countries. *The Quarterly Journal of Economics*, 106(2):407–43, May 1991.

Baumol William J, Sue Anne Batey Blackman, and Edward N Wolff (1985). Unbalanced growth revisited: Asymptotic stagnancy and new evidence. *American Economic Review*, 75(4):806–17, September 1985.

Baumol William J. (1967). Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis. *The American Economic Review*, 57(3):415–426, 1967.

Bernstein Michael A. (2001). The way it worked and why it won't: Structural change and the slowdown of u.s. economic growth. by gordon c. bjork. westport, ct: Praeger, 1999. pp. xviii, 299. 69.50, *cloth*; 27.95, paper. *The Journal of Economic History*, 61(02):568–571, 2001.

Cristina E. Echevarria (1997). Changes in sectoral composition associated with economic growth. *International Economic Review*, 38(2):431–52, 1997.

Granger C W J (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, 37(3):424–38, July 1969.

Islam Nazrul (2003). What have we learnt from the convergence debate? *Journal of Economic Surveys*, 17:309–362, 07 2003.

Kalaitzidakis P., T.P. Mamuneas, A. Savvides, and T. Stengos (2000). Measures of human capital and nonlinearities in economic growth. Technical report, 2000.

Kaldor Nicholas (1966). *Causes of the slow rate of economic growth of the United Kingdom : an inaugural lecture*. Cambridge U.P., [London] :, 1966.

Knowles Stephen (2005). Inequality and economic growth: The empirical relationship reconsidered in the light of comparable data. *The Journal of Development Studies*, 41(1):135–159, 2005.

Dutt Krishna Amitava and Keun Young Lee (1993). The service sector and economic growth: some cross-section evidence. *International Review of Applied Economics*, 7(3):311–329, 1993.

Levine Ross and David Renelt (1992). A sensitivity analysis of cross-country growth regressions. *American Economic Review*, 82(4):942–63, September 1992.

Lewis, W. Arthur (1954). "Economic Development with Unlimited Supplies of Labor,". *Manchester School of Economic and Social Studies*, Vol. 22, pp. 139-91

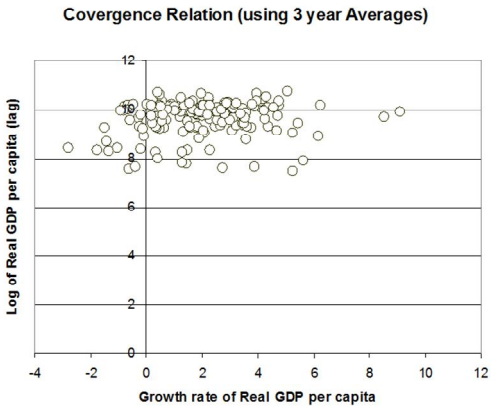
Necmi S. (1999). Kaldor's growth analysis revisited. *Applied Economics*, 31(5):653–660, 1999.

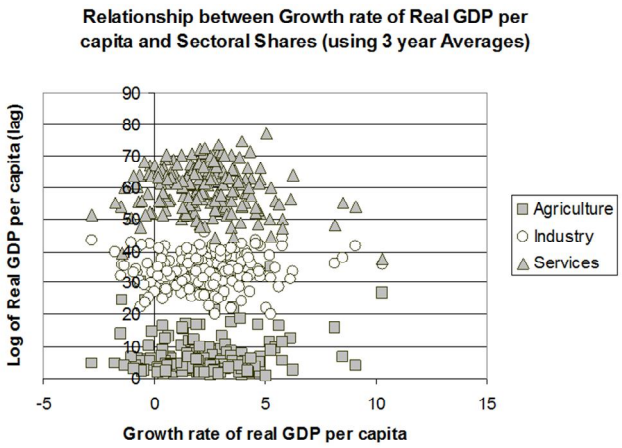
Verdoorn, J. P. (1949), "On the Factors Determining the Growth of Labor Productivity," in L. Pasinetti (ed.), Italian Economic Papers, Vol. II, Oxford: Oxford University Press, 1993.

Wilber S. (2002). *Are Services Bad for Growth? Evidence from a Panel of OECD Economies*. PhD in economics, Georgetown University Washington, DC., 2002.

Wolff Edward N (1985). Industrial composition, interindustry effects, and the u.s. productivity slowdown. *The Review of Economics and Statistics*, 67(2):268–77, May 1985.

APPENDIX





Correlation matrix of Sectoral Shares

	Agriculture	**Industry**	**Services**
Agriculture	1.00	-0.18	-0.69
Industry	-0.18	1.00	-0.59
Services	-0.69	-0.59	1.00