Sectoral Productivity Changes in Iran

Bazzazan F. [1]

Paper to be presented at the Seventieth International Input-Output Conference, 13-17th July 2005, Sao polo, Brazil.

PRELIMINARY VERSION[2]

ABSTRACT

Productivity is defined as the amount of output produced with certain combinations of input resources (capital, labor, etc.). Although the topic of Iran's productivity has never been absent in academic and governmental studies, most research used TFP aggregated production function method at the national or manufacturing levels and have excluded industry levels. The objective of this paper is to measure the growth of TFP by industries and the whole of the economy of Iran during 1988–2004 by using detailed sectoral data that are adjusted in order to account for input–output tables. Three input-output tables Central Bank of Iran, 1988, 1999, and 2004 are going to be employed. The main restriction in Iran, like many other countries, on the number of industries would be data on employment and capital stock by industry.

Key word: TFP productivity, labor and capital productivity, input-output, Iran

[1] Department of Economics, Alzahra University, Tehran, Iran. E-mail:fbazzazan@alzahra.ac.ir

[2] I should note to the reader that this paper is a preliminary version. Some changes, updates, and additions may be expected for the final version after presenting in the conference.

1. Introduction

A broad range of factors plausibility could be important in order to determine the source of growth rate. Countries with higher level of production tend to have a larger capital stock, more roads, bridges, power generators, manufacturing, ports and the like. Moreover production is also influenced by the number of workers and their productivity that depends on the levels of education and the general health of worker population. Natural resource endowments also are important. In addition, countries that can develop and invent new technologies more likely to grow rapidly. Most of the economist would believe that government policies through the allocation of economic resources influence the output growth. A country's history, culture, political system, and geography may play important roles, too (Todaro & Smith 2001). In the recent literature the degree of openness to world market is also one of the main factors of growth (Dowrick 1994 and Jbili *et. al* 2005). According to the new growth theories all of these factors besides economic institutions and reform process can exert a sustained and positive effect on the long term growth of the economy (Rebelo 1991), along with more investment in information technology and telecommunications (ITT) (Green and Spiller 1995, Karunaratne 1995, Parham *et. al* 2001). For oil exported countries whose economy is mainly based on oil revenue, the oil price is one additional element for economic growth and most of the period causes volatility in the economic growth.

Productivity, which can be defined as production capability of a unit factor, has been the most important toolkit for long time to capture the qualitative of the economy. The first theoretically founded research on productivity dates back to Solow (1956, 1957), Nobel Prize. In the Solow's simple neoclassical formulation, total factor productivity (TFP), is certainly a breakthrough in the analysis of productivity. By adding capital as a factor he defined technological development a residual of output growth unexplained by the growth of factors. So, he simply explained the total factor of production as combination of labor and capital factors (or partial productivities). The factors those raise the growth rate would also promote the factor productivity.

The main purpose of this paper is to analyze the total factor productivity of Iranian economy in different sectors using input-output framework in the last two decades. In this paper we used input-output models, which is more suitable for data limitations, especially employment and capital, in Iran and also have in meantime more reliable and details results.

For the above purpose, the structure of this paper is as follows. In section 2 focuses on an overview of the Iranian economy regarding the labor and capital and total factor productivity at the national level. Section 3 deals with the productivity in the input-output framework. Section 4 provides summary and conclusions.

2. Overview of the Iranian Economy

There are two ways for a country to grow. It can increase its output if increases the quantity of resources at its disposal (i.e. more workers or more machines) or uses existing resources much more efficiently. TFP is a measure of the latter.

- TFP reflects the efficiency and effectiveness with which factors of production are jointly used to produce the output of goods and services.
- TFP encompasses all the *qualitative factors* that enable existing resources to be used optimally to produce more output per unit of input.

TFP captures the effects of *qualitative* improvements that allow output to increase without any use of additional inputs. It means making smarter and better use of resources available, such as: introducing new technology or upgrading of existing technology, innovation, better management techniques, gains from specialization, improvements in efficiency, workers' education, skills and experience, and advancement in information technology.

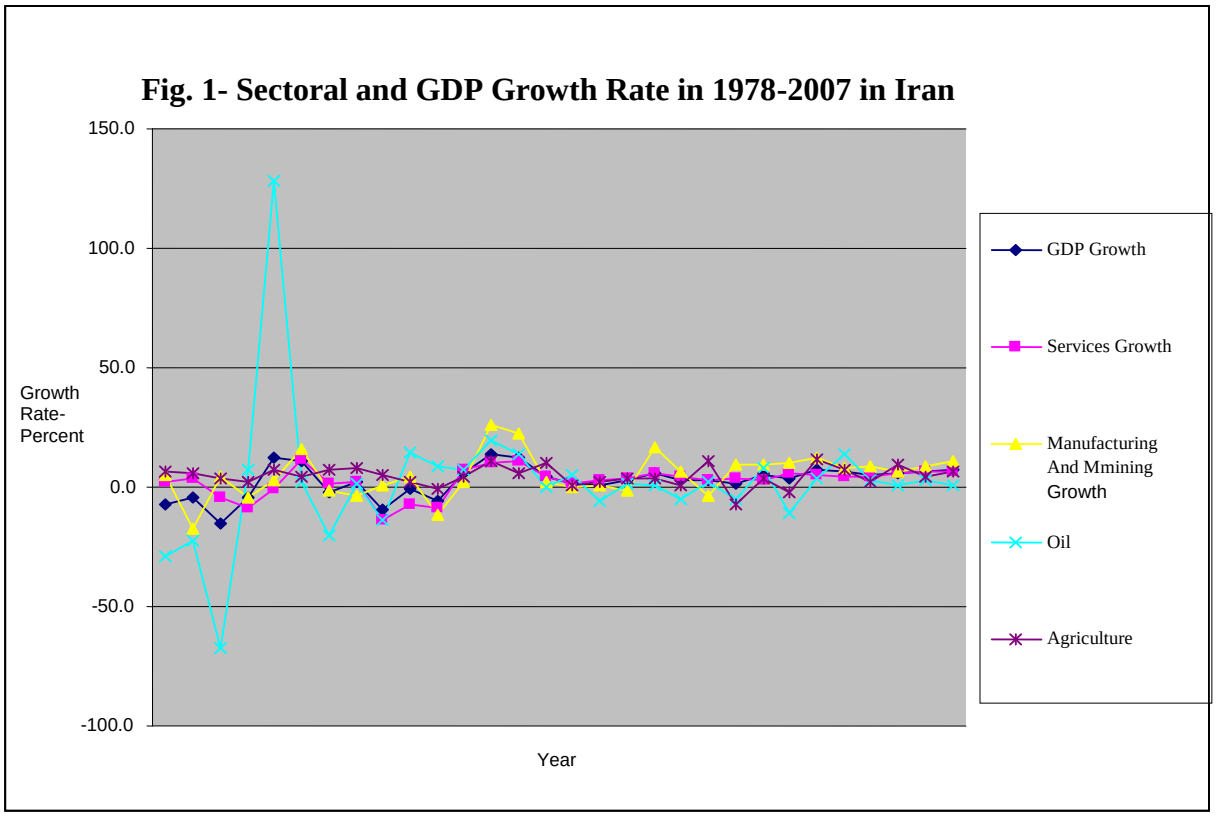
Table 1. Sectoral and GDP Growth Rate in 1978-2007 Period-percentage

Year	Agriculture	Oil	Manufacturing and Mining	Services	GDP (Gross Domestic Production)
1978	6.7	-29.0	5.1	2.3	-7.4
1979	6.1	-22.3	-17.6	3.4	-4.2
1980	3.7	-67.3	4.5	-4.6	-15.1
1981	1.9	6.9	-4.1	-8.7	-4.4
1982	7.1	128.1	2.8	-0.7	12.6
1983	4.6	2.0	16.0	11.9	11.1
1984	7.3	-20.5	-1.6	1.3	-2.0
1985	7.9	1.8	-3.9	1.9	2.0
1986	4.8	-13.7	0.7	-13.7	-9.1
1987	2.5	14.4	4.5	-7.1	-1.0
1988	-0.6	8.8	-11.3	-8.7	-5.5
1989	4.3	7.1	2.2	7.0	5.9
1990	11.0	19.6	26.4	10.0	14.1
1991	5.6	14.0	22.7	10.5	12.1
1992	10.3	0.0	1.9	4.3	4.0
1993	1.0	5.0	-0.1	1.2	1.5
1994	2.1	-5.9	0.8	2.6	0.5
1995	3.7	1.5	-1.5	3.8	2.9
1996	3.3	0.7	16.4	5.6	6.1
1997	1.0	-5.3	6.6	4.7	2.8
1998	10.6	2.4	-3.8	3.1	2.9
1999	-7.3	-5.3	9.2	3.6	1.6
2000	3.5	8.3	9.5	2.9	5.0
2001	-2.3	-11.1	10.2	5.7	3.3
2002	11.4	3.6	12.6	5.4	7.6
2003	7.1	13.4	7.8	4.7	6.8
2004	2.2	2.6	8.4	4.6	4.8
2005	9.3	0.6	6.7	5.6	5.7
2006	4.7	3.0	8.5	6.5	6.2
2007	6.2	0.8	10.8	6.8	6.9

Source: Central Bank of Iran, web Data Base

According to the data from Central Bank of Iran the sectoral and GDP growth rate in the last three decades has been very unstable due to dependency of GDP to income from oil exporting. The dimension of GDP growth rates are varied from large negative 15.1% to large positive 14.1%. To some extent this phenomenon can be accounted for negative or low GDP growth rate during last three decades; the 1979 Islamic Revolution, and its impacts on the economy and the destructive eight-year war with Iraq 1980-88, freezing country's foreign assets, a volatile international oil market, economic sanctions and economic isolation. As Table 1- and Figure 1. show the highest growth rate can be seen in 1990 first year of the Five Year Economic plan after Islamic Revolution. The most non sustainable growth rate is for oil sector in which the growth rate is varied from (67.3%) to (128.1%). The gap between oil sector growth and other sectors can observed clearly in Figure 1.

Fig. 1- Sectoral and GDP Growth Rate in 1978-2007 in Iran



Source: Central Bank of Iran (CBI)- Data Base

When we reach to the labor or capital productivity in Iran like many other developing countries there is no official perfect source to obtain a time series measure of labor volume as a result labor productivity. A few data is available for total and partial productivities, which is mostly due to the lack of enough information on employment and capital stock not only at the sectoral level but also at the national level. Such data shortage made research on productivity difficult and oblige researchers to use non-official data e.g. Valadkhani (2006) or uses proxy variable and panel data e.g. Rahmani and Hayati (2007). To overcome on the data limitation in this study we use input-output model, since number of input-output tables for different years are available. We use input-output approach not only to overcome data limitation but also focus on labor,

capital, and changes in the organization of production and in the development of new products (Cater 1970). We look at a single economy, Iran, at a sectoral level, with the sectors encompassing the whole economy. This aggregated perspective recognizes not only that labor productivity growth changes at varying rates in different sectors but that its internal changes across sectors. Other advantage of this approach is appropriate method for analysis of total factor productivity growth in an economy with intermediate products in which the whole is more than the simple sum of the parts due to inter-sectoral impacts of technical change (Hulten 1978). Our empirical framework is based on the national input-output tables for Iran for 1988, 1999, and 2004. These tables provide coverage of the economy as a whole combined with sectoral disaggregation.

3. Input-Output Model for Total Productivity Growth

The analysis of structural change using input–output tables goes back to Leontief's early work on US data (1941 and 1951). In the structural change in the form of decomposition techniques, decomposes the changes in the volume of outputs. Decomposition techniques were applied over time, using national input–output tables, to analyze output changes. The decomposition analysis can be extended to the cost structures; the primary inputs of labor and capital and intermediate inputs. In the input-output literature the rate of technological changes for each activity (or each sector) is defined as difference between the growth rate of gross output and the weighted average growth rate of the various inputs of the activity. This measure is called the growth rate of total factor production (TFP). TFP measure in the input-output framework works under two assumptions: first the market for output and factors are is perfect competition and the second production function is constant returns to scale. By the first assumption, the factors inputs are priced according to their marginal productivities. Whereas, by the second assumption, the output has a well-defined growth rate. The input growth rate must be some weighted average of the labor growth and capital growth rates in which both are considered as value shares in national income (Ten Raa 2004).

For measuring the labor productivity growth first we start with the sectoral labor use for the t period. This can be defined as;

$$L_t = W_t X_t = W_t (I - A)^{-1} F_t$$

in which, L_t is total labor use, W_t is a diagonal matrix of direct labor coefficients by sector or inverse of labor productivity, X_t and F_t is column vectors of gross output and final demand for domestic output by sector at t period. The sectoral labor coefficients or inverse of labor productivity changes between two periods of t and $(t-1)$ can be defined as follows;

$$\Delta W_t = W_t - W_{t-1} \qquad (1)$$

Measuring capital productivity growth, computation is the same for labor productivity. If we denote K_t as total capital use in the t period and C_t as a diagonal matrix of direct capital coefficients by sector or the inverse of capital productivity, then the sectoral capital productivity changes between two periods of t and $(t-1)$ can be obtained from,

$$\Delta C_t = C_t - C_{t-1} \quad (2)$$

At the industry level, we need to broaden the definition of output as gross output which is defined as the sum of intermediate inputs, and the value added from each industry.

$$X_{j,t} = \sum_i X_{ij,t} + L_{j,t} + K_{j,t}$$

The rate of TFP growth for sector *j* can be formulated as (Kuroda & Nomura 2004);

$$\left(\frac{\dot{T}_j}{T_j}\right)_t = \left(\frac{\dot{X}_j}{X_j}\right) - \sum_i \frac{X_{ij,t}}{X_{j,t}}\left(\frac{\dot{X}_{ij}}{X_{ij}}\right)_t - \frac{L_{j,t}}{X_{j,t}}\left(\frac{\dot{L}_j}{L_j}\right) - \frac{K_{j,t}}{X_{j,t}}\left(\frac{\dot{K}_j}{K_j}\right)_t \quad (3)$$

where, X_j denote the gross output of sector *j*. likewise X_{ij}, L_j, and K_j denote for sector *j*, respectively, the intermediate input *i*, the input of labor, and input of capital. In equation (3) the weights of each input in the monetary term, which are defined by the nominal cost shares of the components in intermediate, labor and capital inputs sum to unity.

if we rewrite the equation (3) at matrix form of input coefficients A, Labor coefficients B^L, and capital coefficients B^K, then we have;

$$\left(\frac{\dot{T}_j}{T_j}\right)_t = \left(\frac{\dot{X}_j}{X_j}\right) - \sum_i \frac{X_{ij,t}}{X_{j,t}}\left(\frac{\dot{a}_{ij}}{X_{ij}}\right)_t - \frac{L_{j,t}}{X_{j,t}}\left(\frac{\dot{b}^L{}_j}{b^L{}_j}\right) - \frac{K_{j,t}}{X_{j,t}}\left(\frac{\dot{b}^K{}_j}{b_j}\right)_t \quad (4)$$

equation (4) shows that the sectoral growth rate of total factor productivity (TFP) is defined by the weighted average of the growth rates of partial productivities of all the inputs. The equation (4) is clearly shows the importance of intermediate input and its changes in the factor productivity and make it to be different from Domar-weighted sum of industrial productivity growth equal the productivity growth of the hypothetically integrated economy when all transactions of intermediate inputs disappear (Domar. Equation (4) can also rewrite according to the final demand;

$$\left(\frac{\dot{T}_j}{T_j}\right)_t = \sum_i \frac{F_{i,t}}{F_t}\left(\frac{\dot{F}_i}{F_i}\right)_t - \frac{L_{j,t}}{X_{j,t}}\left(\frac{\dot{b}^L{}_j}{b^L{}_j}\right) - \frac{K_{j,t}}{X_{j,t}}\left(\frac{\dot{b}^K{}_j}{b_j}\right)_t \quad (5)$$

4. Data Sources and Adjustment

We have used1988, 1999, and 2004 input-output tables at the national level. All of the tables are constructed by Central Bank of Iran (CBI) and are based on in current prices only (Central Bank of Iran 1992, 2004, and 2008). Although the tables for all three years are based on the same Standard Industrial Classification they contain difference in commodity dimension: 94 commodities in 1988, 54 in 1999, and 56 in 2004. Three tables are reduced to 9 main sectors by the limited availability of sectoral price deflators. A 9 sector level of aggregation has been applied in all computations. Sectors are as follows: Agriculture, mining, manufacturing, utilities, construction, wholesale, transportation and communications, banking, and other services. This is close to the maximum level of

disaggregation consistently attainable as limited by the price indices. Three tables are converted to real terms by revaluation at constant 1988 production prices.

In three tables there is only one row for payment to the labor and one row for depreciation (or capital consumption) by sectors. The payment to the labor by sector in the input-output context in Iran does not include self-employment payment as well as operating surplus. So the labor ratio may can see small measure but as in three tables the structure of value added matrix is the same, they are comparable.

Analyses are divided into two periods: 1988-1999 and 1999-2004. Calculations are made by using equations (3), (4) or (5) and three input-output tables 1988, 1999, and 2004 in which 1999 and 2004 input-output tables are at the 1988 constant price. Results analyses are shown separately.

a. Results I- Labor, Capital, Intermediate Inputs Productivity Growth Rates by Sector in the Period of 1988-1999

In the first period growth rates are for 11 years. The results for this period are shown in the Table 2- and include: output, intermediate inputs, labor and capital productivities growth rates for 9 sectors. In this period sectoral output growths are very different for the sectors. The highest output growth rate is for utilities with 195.9% growth, which is very reasonable for the period when war with Iraq ended and needs more basic constructions. And, rising the price of oil is the other reason not only for high output growth rate of utilities but also for other services (health, education, and the rest of services sectors) and wholesale which have the second and third highest output growth rate. Wholesale activities mostly rely on the income from oil export. The lowest output growth rate belongs to the agriculture sector with about less than 3% growth rate for each year.

Table 2- Output, Intermediate Inputs, Labor, and Capital productivity Growth Rates in Period 1988-99-percent

Sector	output growth	intermediate inputs productivity growth	Labor productivity growth	Capital productivity growth	Total Factor productivity Production
Agriculture	35.0	0.6	4.9	0.3	29.2
Mining	54.3	0.0	8.7	-3.7	49.3
Manufacturing	84.2	2.8	24.9	4.4	52.0
Utilities	195.9	4.1	10.4	17.7	163.7
Construction	92.7	6.7	11.4	-0.6	75.1
Wholesale	114.3	2.0	44.4	5.0	62.9
Transportation and Communications	107.9	2.2	42.6	32.3	30.8
Banking	99.5	0.9	41.7	2.3	54.5
other services	146.8	0.2	1020.7	32.9	-907.0

Source: 1988 and 1999 National Input-Output Tables and Author's Calculations

The results on labor productivity are different with output growth. Other services made a huge progress in this period may due to very much progress in the education system and

the number of graduates from universities. Wholesale and transportation and communications are the second and third highest labor productivity growth. Unfortunately agriculture sector has the lowest labor productivity growth.

Intermediate input productivity growth by sector has made a few progress. This item shows the technological change in the production process. It seems agriculture, mining, banking, and other services have no main changes in the11- year period. The highest progress can be seen in the construction, utilities and manufacturing sectors.

Capital productivity growth has different results. As table 2- displays for some of sectors negative capital productivity growths are observed. The largest negative value is for mining. Mining sector in this classification includes oil sector. To some extend this phenomenon can be explained not only by volatile international oil market but also sanction impact as the oil sector is highly depend on the imported high technology capital which is produced under US and his allies. Other services has also highest growth rate.

Total factor productivity is almost in the same direction as growth rate expect for other services. For other services, there is a big difference between labor productivity growth and output growth that makes the TFP negative. Utilities, construction, and wholesales exhibit the three highest TFP in the economy in the period 1988-99.

b. Results I- Labor, Capital, Intermediate Inputs Productivity Growth Rates by Sector in the Period of 1999-2004

The second period includes only 5 years and compared with the first period (11 years) is shorter period and expected the output and other input factors growth would be lower. This period covers third five year and reformist group on power. The results for this period are shown in the Table 3- and same as table 2- includes output, intermediate inputs, labor and capital productivities growth rates for 9 sectors. In this period sectoral output growths are different for the sectors from negative to positive. The highest output growth rate is for Banking and wholesale with 95.39% and 91.14% growth rates, which is very reasonable for the period when the oil price increased and more different commodities are imported and some private banks begin to work. The manufacturing sector is in the third place with 73.91% growth rate due to high investment in the First and the Second Five Year Plans. In this period agriculture and transportation and communications have not been made progress and faced negative output growth.

The results exhibit the labor productivity in this period has made some progress in all sectors. Other services and banking have the first and the second highest growth rate may due to computerize the system of their services. Mining located in the third place, that is due to more growth rate and high technology of capital stock used in this sector.

Intermediate input productivity growth by sector has made a few progresses. It seems agriculture and mining have no main production structural changes in the5-year period. The highest progress can be seen in the manufacturing and transportation sectors.

Table 3- Output, Intermediate Inputs, Labor, and Capital productivity Growth Rates in Period 1999-2004-percent

Sector	output growth	intermediate inputs productivity growth	Labor productivity growth	Capital productivity growth	Total Factor productivity Production
Agriculture	-16.09	-0.20	3.84	-0.38	-19.35
Mining	17.97	0.00	13.02	-0.07	5.02
Manufacturing	73.91	2.53	6.37	0.66	64.35
Utilities	19.57	1.47	4.55	-5.07	18.62
Construction	39.06	1.07	8.17	0.90	28.92
Wholesale	91.14	0.46	14.63	2.81	73.24
Transportation and Communications	-5.99	2.42	14.32	3.71	-26.44
Banking	95.39	1.29	20.61	1.82	71.67
other services	42.75	0.50	29.63	6.89	10.89

Source: 1999 and 2004 National Input-Output Tables and Author's Calculations

Capital productivity growth has different results like for the period of 1988-99. As table 3- displays for some of sectors negative capital productivity growths are observed. The largest negative value is for utilities and agriculture and mining are followed. To some extend this phenomenon can also explained by sanction impacts.

Total factor productivity is mostly in the same direction as growth rate. Transportation and communications (-26.44%) and agriculture (-19.35%) have negative TFP growth rates. Highest TFP growth rate for wholesale (71.67%), banking and manufacturing are followed respectively with (71.67%) and (64.35%) growth rates.

5. Conclusions Remarks and Limitations

In this paper partial and total factor productivities have been examined by using input-output productivity model. The most advantage of input-output model is to be able to calculate not only labor and capital productivities but also intermediate inputs productivities. Three national input-output tables for the years of 1988, 1999, and 2004 have been used to analyze total factor productivity. Calculations are considered for two periods: 1988-99 and 1999-2004. The results for the first period show that sectoral output growths are very different, and the highest growth rate is for utilities. Whereas the lowest output growth rate belongs to the agriculture sector. The results on labor productivity were different from output growth, other services had highest and agriculture sector the lowest labor productivity growth. Capital productivity growth has different results for some of sectors negative and for some others positive. The largest negative growth rate was for mining. Total factor productivity is almost in the same direction as growth rate expect for most of the sectors especially other services. For other services, there is a big difference between labor productivity growth and output growth that makes the TFP negative. Utilities, construction, and wholesales exhibit the three highest TFP in the economy in the period 1988-99.

The results for the second period show that sectoral output growths are different for the sectors from negative to positive. The highest output growth rate is for Banking whereas agriculture lowest and negative output growth rate. The results exhibit the labor

productivity has made some progress in all sectors. Other services has the highest and the agriculture the lowest growth rate. For intermediate input productivity growth has not seen considerable progresses. Capital productivity growth rates had different results like for the period of 1988-99, for some of sectors were negative. Total factor productivity in this period is also in the same direction as output growth rate. Some of them were negative and the others were positive. Highest TFP growth rate was for wholesale.

Finally, there is not enough reason for an expansion path of output, labor, capital, and total factor productivity growth in general. The main reason for such conclusion is high economic dependency of growth in all sectors in to the oil price and the oil revenue. As oil market is not an stable market so sectoral growth as a results their productivities are affected. Moreover there is no specific development strategy in the national five year plans. Most of the governments believe to import substitution strategy which has not been successful to guarantee productivity growth in the protected industries.

The main limitation of this study was no access to the highly disaggregated and same time interval input-output tables. We apply three input-output tables with different dimension 94, 54, and 56 commodities respectively for 1988, 1999, and 2004. The first and the second table have an eleven years distance whereas for the second and third tables only five years. So, according to the time distance the results were not exactly comparable.

References

Carter A. P. 1970, *Structural Change in the American Economy*, Harvard University Press, Cambridge, Mass.

Central Bank of Islamic Republic of Iran 1991, *Input- output Table 1988*.

Central Bank of Islamic Republic of Iran 2004, *Input- output Table 1999*.

Central Bank of Islamic Republic of Iran 2007, *Input- output Table 2004*.

Dowrick, S. (1994), *Openness and Growth*, International Integration of the Australian Economy, Lowe P., and Dwyer J., Eds. (Sydney: Reserve Bank of Australia). Hulten C. R. (1978. Growth Accounting with Intermediate Inputs, *Review of Economic Studies*, Vol. 45 pp. 511-18.

Jbili A., Kramarenko V., Bailen J. (2004), *Islamic Republic of Iran- selected Issues*, IMF Country Report No. 04/308, (Washington DC).

Karunaratne N. D. (1995), *Growth Dynamics Under Shifting Telecommunications and Trade Regime Shifts in Australia*, in Beyond Competition: The Future of Telecommunications, Lamberton D. Ed., (Amesterdom: North-Holland).

Kuroda M. & Nomura K. 2004, *Technological Change and Accumulated Capital: A Dynamic Decomposition of Japan's Growth,* in Dietzenbacher E. & Lahr M., Wassily Leontief and Input-output Economics, Cambridge University Press.

Parham D., Roberts P., and Sun H. (2001), *Information Technology and Australia's Productivity Surge, Productivity* Commission Staff Research Paper, (Canberra: AusInfo).

Rebelo S. (1991), Long-run Policy Analysis and Long-run Growth, *Journal of Political Economy*, 99, pp. 500-21.

Solow R. 1957, Technical Change and Aggregate Production Function, *Review of Economics and Statistics*, Vol. LXX, pp. 312-20

TEN Raa T. 2004, *A Neoclassical Analysis of Total Factor Productivity Using Input-Output Prices*, in Dietzenbacher E. & Lahr M., Wassily Leontief and Input-output Economics, Cambridge University Press.

Valadkhani A. 2006, Labor Productivity in Iran, Economic *Working Paper Series 2006*, No. 06-13, University of Wollongong.