LIPI

Akreditasi No. 273/AU1/P2MBI/05/2010

Warta Kebijakan Iptek & Manajemen Litbang

Journal of S&T Policy and R&D Management

Vol. 9 No. 2
Tahun 2011

ISSN : 1907-9753

Warta Kebijakan Iptek & Manajemen Litbang	Vol. 9	No. 2	Hlm. 113 — 199	Jakarta, Desember 2011

Warta Kebijakan Iptek & Manajemen Litbang
Journal of S&T Policy and R&D Management

LIPI

Vol. 9 No. 2 / Desember 2011 ISSN : 1907-9753

SUSUNAN REDAKSI

REDAKSI WARTA KEBIJAKAN IPTEK & MANAJEMEN LITBANG
Pusat Penelitian Perkembangan Ilmu Pengetahuan dan Teknologi—LIPI
Jln. Jend. Gatot Subroto No. 10, Widya Graha LIPI Lt. 8, Jakarta 12710
Telepon +62(021) 5201602, 5225206, 5251542 ext. 704
Faksimile +62(021) 5201602
Pos-el *(Email)* : wartakiml@mail.lipi.go.id
URL : http://situs.jurnal.lipi.go.id/wartakiml/

Warta Kebijakan Iptek dan Manajemen Litbang (KIML) adalah jurnal ilmiah yang dimaksudkan untuk menjadi forum ilmiah tentang teori dan praktik kebijakan ilmu pengetahuan dan teknologi (Iptek) dan manajemen penelitian dan pengembangan (litbang) maupun manajemen inovasi di Indonesia. KIML dimaksudkan sebagai wadah pertukaran pikiran peneliti, akademisi dan praktisi kebijakan iptek untuk pembangunan ekonomi. KIML juga berisi sumbangan ilmiah dalam manajemen litbang dan inovasi untuk daya saing eknonomi. Tulisan bersifat asli berisi analisis empirik atau studi kasus dan tinjauan teoretis. Redaksi juga menerima tinjauan buku baru tentang kebijakan iptek dan manajemen litbang dan inovasi. Terbit dua kali setahun pada bulan Juli dan Desember.

Warta Kebijakan Iptek & Manajemen Litbang
Journal of S&T Policy and R&D Management

Vol. 9 No.2/ Desember / 2011

PENGANTAR REDAKSI

Pada Warta KIML vol. 9 no. 2 Desember 2011 ini, redaksi menampilkan tulisan-tulisan yang terpilih dari sejumlah tulisan yang dipresentasikan pada Seminar Nasional dengan tema 'Peran Jejaring dalam Meningkatkan Inovasi dan Daya Saing Bisnis' yang diselenggarakan dalam rangka Forum Tahunan NSTD (*National Science and Technology Development*) yang digagas oleh PAPPIPTEK-LIPI pada tanggal 10 Oktober 2011.

Naskah pertama merupakan hasil penelitian yang menganalisis hubungan antara stok pengetahuan (jumlah paten) dan pertumbuhan produktivitas industri manufaktur di Indonesia. **Lutfah Ariana** menggunakan konsep *Total Factor Productivity* dan model ekonometrik menemukan bahwa tidak ada pengaruh paten (domestik dan asing) terhadap produktivitas industri manufaktur di Indonesia, hal ini bertentangan dengan perilaku yang umum terjadi di negara maju. Penulis berpendapat bahwa lemahnya upaya penegakan Hak Kekayaan Intelektual (HaKI) berkontribusi terhadap fenomena paradok tersebut. Sementara itu, **M. Arifin** mengkaji hubungan antara intensitas dana litbang Indonesia dan daya saing. Dengan membandingkan antara dana litbang dan produk domestik bruoto menggunakan model statistik, penulis menunjukkan bahwa intensitas dana litbang di Indonesia masih rendah yang berdampak pada rendahnya kemampuan inovasi dan daya saing.

Tulisan berikutnya mengungkapkan fenomena inovasi terbuka (*open innovation*) yang telah menjadi bahasan yang cukup intensif beberapa tahun terakhir. **Rizka Rahmaida** mengangkat tema ini dalam mempelajari inovasi di industri farmasi Indonesia. Penulis menggunakan satu studi kasus di industri farmasi dan menemukan bahwa sebagian besar (tiga) karakter utama inovasi terbuka ditemui pada industri farmasi tersebut, yakni jaringan, kerjasama dan kegiatan litbang. Selanjutnya **Purnama Alamsyah** dan **Wati Hermawati** membahas berbagai pola pembiayaan yang umum ditemukan di sektor industri energi khususnya biogas. Bahasan ini bersumber pada suatu studi kasus di sebuah desa di Jawa Barat dan menemukan bahwa sebagian besar pola pembiayaan yang digunakan adalah pembiayaan mandiri oleh masyarakat ketimbang bersumber dari pola kemitraan. Dibagian akhir edisi ini, aspek metodologi sistem menjadi bahasan **Purnama Alamsyah** dan **Iin Surminah**. Dengan memanfaatkan studi kemitraan antara lembaga litbang dan industri, penulis mencoba membantu pembaca dalam menerapkan penggunaan SSM untuk memahami kompleksitas permasalahan kemitraan tersebut. Dengan demikian diharapkan para pembaca akan lebih mudah memahami langkah-langkah penerapan SSM tersebut.

Demikian pengantar dari Redaksi, semoga tulisan-tulisan tersebut dapat menambah wawasan para pembacanya.

Redaksi

THE INFLUENCE OF KNOWLEDGE STOCK ON THE GROWTH OF PRODUCTIVITY IN INDONESIAN MANUFACTURING INDUSTRIES

Lutfah Ariana
lutfah.ariana@lipi.go.id; juffrow@yahoo.com

Pusat Penelitian Perkembangan Ilmu Pengetahuan dan Teknologi – Lembaga Ilmu Pengetahuan Indonesia

Naskah masuk: 12/12/2011 Naskah Revisi : 3/1/2012 Naskah Terima :24/1/2012

ABSTRACT

Endogenous growth theory emphasized the externalities related to access to knowledge as the source of economic growth. This paper tried to investigate the relationship between knowledge stock and productivity growth by considering the declining trend of technological capability in the manufacturing sector. In analogy with physical assets, we present a model of knowledge capital formation which allows the calculation of the patent number. In this paper we analyzed the contribution of patents to the performance of productivity in Indonesian manufacturing industry for the period of 1995 - 2005, using industrial panel data. The results show that both domestic and foreign patents have negative effects on productivity in Indonesian manufacturing. There is an evidence that foreign resident patent applications have significant effect comparing to domestic patents in improving the TFP.

Keywords: *Total Factor Productivity, knowledge stock, patent, manufacturing*

SARI KARANGAN

Tulisan ini berawal dari teori pertumbuhan endogen yang menyebutkan bahwa faktor eksternal dianggap sangat berpengaruh dalam meningkatkan kinerja ekonomi, terutama yang terkait dengan akses terhadap knowledge sebagai sumber pertumbuhan ekonomi. Selanjutnya dengan melihat adanya fenomena semakin melemahnya kapabilitas teknologi sektor manufaktur, tulisan ini akan menggali hubungan antara stok pengetahuan (knowledge stock) dan pertumbuhan produktivitas yang ada di industri tersebut. Sebagaimana analogi yang digunakan dalam perhitungan aset fisik, tulisan ini akan menjelaskan model pembentukan modal pengetahuan (knowledge capital) melalui variabel proxy berupa jumlah paten perusahaan manufaktur di Indonesia yang didaftarkan di European Patent Office (EPO). Tulisan ini lebih jauh akan menganalisa pengaruh paten terhadap kinerja dari produktivitas industri manufaktur Indonesia selama periode 1995 – 2005 menggunakan data panel. Melalui pendekatan ekonometrik yang meregresikan pertumbuhan Total Factor Productivity (TFP) dan pertumbuhan patent stock, hasil penelitian ini menunjukkan bahwa baik paten domestik maupun paten asing tidak memiliki pengaruh terhadap peningkatan produktivitas sektor manufaktur. Hal ini bertolak belakang dengan kebanyakan studi

yang menyebutkan bahwa aplikasi paten yang dimiliki suatu perusahaan seharusnya bisa meningkatkan produktivitas perusahaan terutama dalam melindungan Hak atas Kekayaan Intelektual yang dihasilkan dari proses riset. Oleh karena itu, pada bagian akhir tulisan ini akan dijelaskan beberapa kemungkinan kondisi spesifik yang dialami industri manufaktur terutama dalam penegakan HaKI.

Kata kunci : Total Factor Productivity, stok pengetahuan, paten, manufaktur

1. Introduction

For many years, productivity has been recognized a critical indicator in any economic activity. In addition, much literature has discussed the relationship between productivity and economic growth. Why productivity important is a question related to the ability of a country to catch up on global competitiveness. Therefore, every country largely makes an effort to accelerate their competitiveness by increasing their sustainability in economic growth. However, Krugman (1994) as quoted by Srivastava (2001) argued that Southeast Asian countries' economic growth was mainly based on input factors, not because of increasing productivity. Many critical studies have tried to prove that productivity has contributed to the growth of an economy by proposing various estimation methods (Timmer, 1999; Van der Eng, 2009; Vial, 2005).

In contrast, the endogenous growth theory emphasized the externalities related to access to knowledge as the source of economic growth (Romer, 1986; Lucas, 1988). One measurement of productivity is Total Factor Productivity (TFP). Result of TFP in Indonesia is different based on the output of different studies. Dasgupta, Hanson, and Hulu (1995) found that the annual rate of TFP growth in 1985–1992 was only around 1.1%. In addition, Osada (1994) estimated the TFP growth is even negative (-2.7%) during 1985–1990 and Kawai (1994) also supported the previous study by resulting -0.1% in the same period. Moreover, compared to other Asian countries, this number was below Thailand and Malaysia which has 2% and Korea has 3% (Timmer, 1999).

TFP growth as a residual factor depends mainly on the appropriate measurement of factor inputs. In other words, the availability and choices of data will basically determine the final result of TFP growth. Moreover, some difficulties have arisen when it comes to the actual estimation of TFP growth. Even the basic concept is, in fact, not overly complicated; its application to real economic situations needs deeper understanding and flexibility to tackle some of data limitations.

Comparing to the previous studies, this paper will present TFP growth estimation for medium and large-scale establishments in the manufacturing sector at the two-digit level of ISIC revision 2 from 1995–2005. The important parts of this study are the data sources and methodology used to obtain capital stock. I then used these capital input growth estimations to determine TFP growth rates for 1995–

2005. In the following section, I estimate sources of TFP from a particular variable (knowledge stock), which is represented by the number of patents. In this issue, I concerned with the flow of "pure knowledge". In the sense of Griliches (1979), we need some measure of technological closeness between the receiving and emitting sectors. In the literature, such closeness-measures are derived from the type of performed R&D, the qualifications of researchers, the distribution of patents between patent classes, and so forth. Therefore, I used a patent-based measure derived by Verspagen (1997) from EPO (European Patent Office) data.

Regarding the emerging issue of weak intellectual property rights protection in developing countries of which there is a general lack of awareness, I consider it is critical to employ knowledge stocks that should be emphasized in enhancing TFP growth of manufacturing. Therefore, besides estimating TFP growth, the objective of this study is identification the relationship between TFP growth and knowledge stocks by regression analysis.

2. Total Factor Productivity (TFP)

TFP as a measure of overall productivity in the production process has been recognized and accepted for theoretical justification and its practicality for economic analysis (Asian Productivity Organization, 2006). However, some differences of TFP have resulted from different sample periods, definitions of input and output variables, estimation methods, and the selected aggregated and disaggregated sectors. Therefore, it is important to be careful in interpreting those figures to get the best result of TFP growth estimation.

For measuring TFP growth, I adopted the growth accounting method of the standard Solow model (Romer, 1990).

$$Y_{it} = A_{it} F(K_{it}, L_{it})$$

A_{it} is the TFP and I consider a traditional Cobb-Douglas production function with constant return to scale $(\alpha + \beta = 1)$ (Griffith et. al., 2000).

$$Y_{it} = A_{it} K_{it}^{\beta} L_{it}^{\alpha}$$

Consequently, TFP is simply defined by $A_{it} = \frac{Y_{it}}{K_{it}^{1-\alpha} L_{it}^{\alpha}}$

To estimate the TFP levels, I just need a value for which is assumed from labor share in each manufacturing sector. Then, by using the natural logarithm concept, TFP growth can be obtained by subtracting the contributions of capital and labor growth from the total value added growth in manufacturing sectors.

$$\dot{TFPG}t = \dot{Y}t - \alpha\dot{L}t - (1 - \alpha)\dot{K}t$$

According to an Asian Productivity Organization report (APO, 2006), there are many possible factors that affect TFP growth: degree of openness of an economy, foreign direct investment (FDI), R&D activities, change in economic structure, economic and political stability, economy of scale, and education and job training. For this study, I did not analyze all the possible variables, but I used knowledge stock as the indicator of R&D activity.

Initiating this idea, Griliches (1998) studied the relationship between output, employment, and physical and R&D capital, for a sample of 133 large United States (US) firms for 1966–1977, and he found that there was a strong relationship between firm productivity and its level of R&D investment.

3. Patent as Knowledge Stock

To some extent, defining "knowledge stock" of research and development and developing appropriate deflators for it are not an easy study. Knowledge stock in this paper is defined as knowledge creation in every sector by considering to some extent that could be measured and justified as economic activity, particularly through patent stock. However, this proxy has some weaknesses that the identification of knowledge stock in industrial sectors can be produced by various activities, not only towards patent application. Most papers in having the proxy of the source of knowledge stock is related to R&D budget, scientific publication, industrial design and other intellectual capitals. In further, the availability of patent application data itself in manufacturing sectors in Indonesia before 1990 is difficult to be accessed.

Another important condition that should be tackled in estimating knowledge stock is dealing with the classification of patent data since all the data in this study is approached at the 2-digit ISIC level. In this case, the patent data for every sector is gathered from PATSTAT provided by the European Patent Office (EPO), which contains domestic and foreign patents. These patents are categorized as legal protection for technologies and their classifications are based on specific technologies. Foreign patent is a kind of patent applied by foreign applicants and domestic patent is applied by domestic applicants including national universities, R&D institutions, etc.

Classification of these patents follows a systematic regulation from the International Patent Classification (IPC). It refers to several basic requirements based on World Intellectual Property Organization (WIPO) in which the classification covers all technology fields, based exclusively on IPC codes.

To do this classification, I modeled my process after Verspagen (1997) and I derived three matrices to capture sectoral knowledge spillovers using patent data from the EPO. A concordance scheme between the technology classes (IPC codes) and industries (ISIC revision) assigns the main technology class and the supplementary technology class to industrial sectors. These two classes can be linked with the emitting sectors in the rows and the receiving sectors in the columns. From the resulting matrix as we can see in Table 1, I derived a technological distance matrix by dividing the number of patents in each cell by its row total (Jacob, 2006). As a result, there are 43 industrial codes and technological fields, these data are then converted into ISIC revision 2 (ISIC 31–39) by taking average of the same classification.

Table 1 *Linkage structure between technological fields and industrial sectors in matrix form*

		Technological fields						
		1	**2**	**3**	**4**	**5**	**6**	**7**
Industrial fields	**1**	**D1**	N11	N12	N13	N14	N15	N16
	2	N21	**D2**	N22	N23	N24	N25	N26
	3	N31	N32	**D3**	N33	N34	N35	N36
	4	N41	N42	N43	**D4**	N44	N45	N46
	5	N51	N52	N53	N54	**D5**	N55	N56
	6	N61	N62	N63	N64	N65	**D6**	N66
	7	N71	N72	N73	N74	N75	N76	**D7**

Note. Schmoch et.al. (2003).

4. Methodology

4.1 Source of Data

The estimation of TFP growth requires data on capital stocks, labor and output. These data are an annual census of all manufacturing firms in Indonesia with 20 or more employees and capture the formal manufacturing sector with plant-level data on output, intermediate inputs, labor, capital, imports, exports and foreign ownership. Then, they are classified based on two-digit ISIC revision 2, following the ISIC code from the previous study (Timmer, 1999) which covers a ten years period (1995–2005). The classification can be seen in Table 2.

Table 2 *Classification of 2-digit ISIC revision 2 in Manufacturing*

2-digit ISIC	Sector by revision 2
31	Food, beverages, and tobacco
32	Textiles, garments and leather
33	Wood products
34	Paper, printing, and publishing
35	Chemicals, rubber and plastic
36	Non-metallic minerals
37	Basic metals
38	Metal products
39	Other manufacturing

Note. Central Bureau of Statistics (BPS, 2005).

Data for Capital

By definition, capital stock is accumulation of investment in previous years after taking account of depreciation. Investment or gross domestic capital formation (GDCF) equals domestic fixed capital formation and increase in stock (Van der Eng, 2009). I gathered data on investment of each type of capital asset from estimated value of fixed capital and addition/reduction/major repairs during 1995–2005 including the addition of new and old stock. However, because I was only concerned with gross fixed capital, I did not include major repairs, reduction, and sale of capital goods in the calculation of capital stock.

Deflators

According to Timmer (1999), there are three types of capital assets: (i) land and buildings, (ii) machinery and other fixed capital, and (iii) vehicles. In order to measure those capital stocks in real terms, different deflators for each asset type is necessary. For land and buildings, I used implicit deflator for GDP construction. For machinery and other fixed capital, I used the import price index and for vehicles, I employed wholesale price indices of transport equipment.

In the Industrial Statistics Volume III 1995–2005, all of the classifications still refer to ISIC revision 3. Therefore, in order to generate the deflators in terms of 2-digit ISIC codes based on revision 2, I classified 22 sectors of ISIC revision 3 into 9 sectors of ISIC revision 2. The number represented in 2-digit ISIC is measured by taking averages of the sectors which are categorized in the same classification.

Data for Labor

Time series for labor input in the medium and large scale manufacturing sector is based on the annual Industrial Statistics which is annually revised on the basis of a back-casting project (Jammal, 1993). This data is approached by the number of workers in production sector. In addition, I also need labor expenditures in every sector to estimate the labor share. Then, the share of capital can be obtained by holding constant return to scale where the total number of labor is equal to one.

Data for value added

In representing output, I used value added at factor prices. To eliminate the influence of prices, I used the wholesale price index for deflating value added in different manufacturing sectors. These indices were collected from BPS' *Economic Indicator (Indikator Ekonomi)*, from 1995–2005. Since the data series are given in base years 2000, 1993, and 1983, they must be first adjusted to obtain uniform 1983 base year pricing. Furthermore, this adjustment is important to cover the problem of underestimation value in converting data of 2000 and 1993 base years to 1983 constant prices.

However, there are some missing observations because of the absence of printed publication in certain years, such as in 1996. In such cases, factor input was estimated by taking average from the previous year (1995) and the following year (1997). This result possibly creates some underestimation or overestimation to the estimation of TFP growth in several sectors.

4.2 Estimating Capital Stock and TFP growth

As explained before, capital stock is estimated from the total value of three types of fixed capital assets after deflated. In this study, initial capital stock or so called benchmark capital stock is derived from estimated capital stock for 1995 of Timmer's study. In addition, the role of depreciation is very crucial. Depreciation rates are determined by considering the economic or technical lifetime of each type of capital goods.

The vintage of capital stock based on investment series (1995-2005) is arranged by assuming a constant depreciation rate of 3% per year in which every asset type of investment has the same service life. The different assumption leads to obvious different results of capital stock growth. The estimation referred to Sigit (2004) and Aswicahyono (1998) studies which determined the capital stock with this formula:

$$K_t = (1 - \delta)K_{t-1} + I_t$$

where K_t capital is stock at the end of year t; I_t is the gross investment in year t; and δ is the depreciation in year t.

However, Vial (2005) explained some limitations of using fixed assets data as a given nominal value of assets and misrepresentation of actual capital stock, particularly in the absence of strict valuation guidelines.

TFP growth estimation followed Jorgenson, Gollop, and Fraumeni (1987) method based on trans-log value added production function with 2 inputs, labor and capital.

$$\dot{TFP}_t = \dot{Y}_t - \alpha \dot{L}_t - (1-\alpha)\dot{K}_t$$

It is recognized that TFP growth analysis often produce different results due to some assumptions related the determination of labor share (α) in various sectors. In several sectors, the share seems rather low and it may indicate a failure of some industries to report certain types of income (Timmer, 1999). In estimating TFP growth, I employed different labor share for every sector during different periods.

4.3 Estimating Patent Stock

One literature defines R&D capital as the knowledge stock of a sector during a period of time combined with other factor inputs in order to produce output (Goto & Suzuki, 1989). Different from the previous study, knowledge stock in this study is estimated from the number of patents, either domestic patent or foreign patent in every sector based on the 2-digit ISIC and it is not simultaneously derived from production function.

The increase of knowledge stock in period t reflects not only covering the knowledge stock of period t, but also including previous knowledge stock. Therefore the distributed lag is obtained by assuming the growth rate of knowledge stock in period t is the same as the growth rate of the initial amount of knowledge stock (P_0).

$$P_0 = \frac{P_{t-1}}{g+\delta}$$

where g is the average growth rate of knowledge stock (patent) and is depreciation rate (assumed 15%).

According to Pakes and Schankerman (1984), the rate of obsolescence of knowledge stock must be higher than that of physical capital. In line with this, Goto and Suzuki (1989) explained that knowledge stock depreciates because of the replacement of old knowledge and the appropriability of knowledge decreases.

Bosworth (1978) initially estimated the rate of obsolescence of knowledge stock using patent renewal data. However, he realized that this method would have some problems in that individual patent holders in the respective of type of patent holders and renewal patent fee. Because data on patent renewal fees is not publicly available, in this research I used data on foreign and domestic patents that have been registered with the International Patent Office.

According to Goto and Suzuki (1989), the rate of obsolescence reflects the "life span" of technology. They further explained that "life span" is not the length of time a patent is renewed, but the length of time that a patent generates royalty revenues or the average length of time when one product embedding patented technology can generate profits. The depreciation rate is assumed to be 15% and it depreciates 3 to 4 years. Mansfield (1980) implied an R&D lagged structure reaches between three and five years, and after which then declines rather rapidly. Finally, the patent stock in year t can be estimated by using this following formula (Goto & Suzuki, 1989),

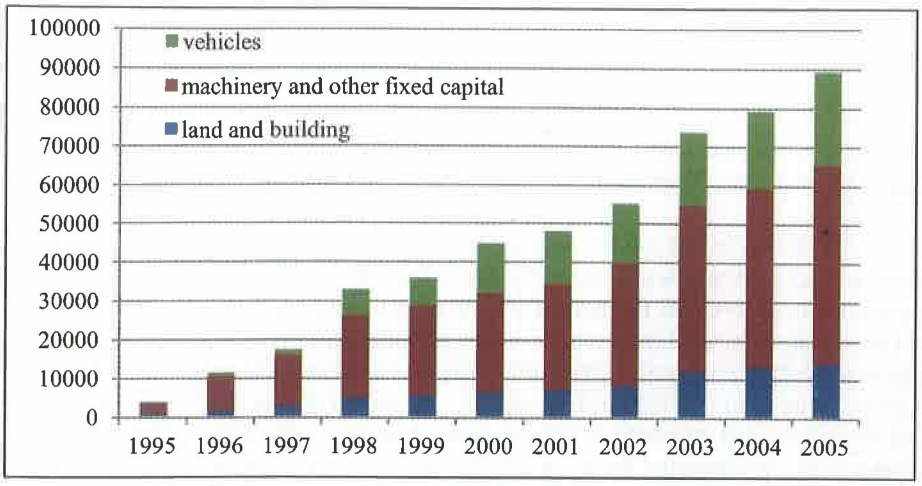
$$P_t = E_{t-\theta} + (1 - \delta)P_{t-1}$$

where $E_{t-\theta}$ is the number of patents in period t and $P_{t-1}$is patent stock in previous year.

5. Results

According to Figure 1, in early 1995, capital stock was growing very slowly, particularly vehicles. It may be said that the growth was stagnant. When the growth of machinery and other fixed capital were significant before the 1997-1998 crisis, during the crisis period the growth of those capital stocks were very slow. This would continue until the crisis was over, especially for the growth of machinery/other fixed capital and land/building stocks. In fact, the recovery made those capital accumulations grow faster, in particular machinery and vehicles since 2002.

This result is in line with the Van der Eng (2009) study which showed a significant increase in capital stock indicating its more capital-intensive nature and depended on the mobilization of productive capital. He argued that it was possibly supported by the export growth in manufacturing industries since the 1980s.

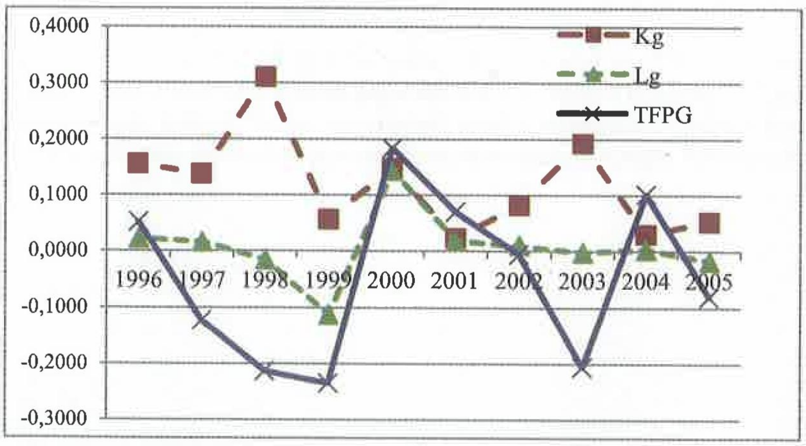


Source: Author's calculation based on Industrial Statistic Year Book (1995-2005)

Figure 1. Capital stock accumulation in 1995–2005 (billion rupiahs)

5.1 *TFP Growth as Residuals in Different Sector*

As explained previously, I derived the contribution of output growth in manufacturing sectors from capital, labor and TFP growth. According to Figure 2, the highest capital growth occurred in 1998 by 31%, when the crisis hit the economy. Furthermore, labor growth in the early economic crisis slowly declined until it hit -11.35% in 1999, because many multinational companies laid off their employees. However in the following year, it quickly grew up to 17.70%. The rapid increase in the capital input has not been accompanied by increases in labor input. After the crisis, the growth came back to decrease significantly until 2005.



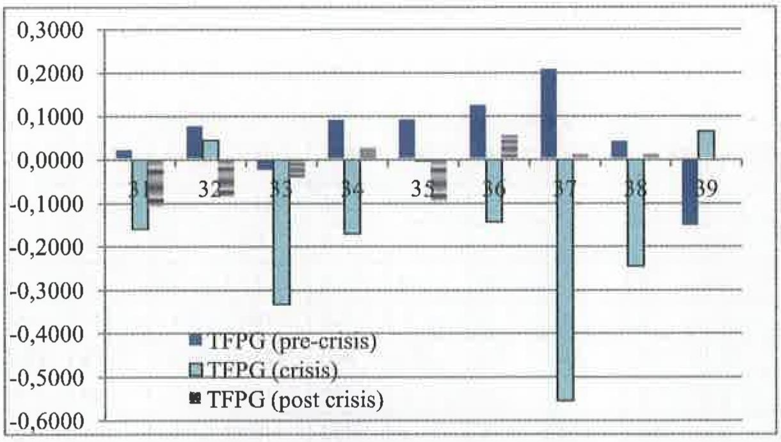
Source: Author's calculation based on Industrial Statistic Year Book (1995-2005)

Figure 2. *Growth accounting result during 1995–2005*

Capital growth showed positive growth until 2005 as seen in Figure 2. On the other side, TFP growth reflected a different pattern from capital growth's pattern, in which most of the value is negative. Only in 2000 and 2004, after the crisis, TFP growth positively contributed to the growth of output in manufacturing. A negative value indicated that the TFP growth was in the opposite direction of GDP growth (APO, 2006). In other words, the negative values of TFP expressed that the productive efficiency deteriorated and went down in the economic activity.

In the following discussion, TFP growth is described by sector as we can see in Figure 3. In this case, TFP growth was further analyzed by differentiating three time periods. Before the 1997–1998 crisis, TFP growth in most sectors positively contributed to the growth of output, especially ISIC 37 (basic metal sector), which had the best performance compared to other sectors. It is only ISIC 33 (wood products) and ISIC 39 (others) that had negative results. During the crisis period, annual TFP growth rates plummeted for all sector levels, except ISIC 32 (textiles) and ISIC 39 (others). In particular, the basic metal sector rapidly grew in the previous year, but suddenly it dropped to -55%. However, up to the recovery period, several sectors were still experiencing a difficult period of time.

However, during 2001–2005, TFP levels appeared to be rising gradually in some sectors (ISIC 34 and ISIC 36) and lagging behind others. The latter condition can be seen in several sectors such as ISIC 31 (food, beverages and tobacco), ISIC 32 (textiles), ISIC 33 (wood products) and ISIC 35 (chemicals sectors) that still had negative growth of TFP. From the overall conditions, only non-metallic minerals (ISIC 36) still attracted major investment of total manufacturing investment in post-crisis period.



Source: Author's calculation based on Industrial Statistic Year Book (1995-2005)

Figure 3. *TFP growth by 2-digit ISIC sector in different periods*

5.2 *Domestic and Foreign Patent Stock in Indonesia*

Patent data in Indonesia is published in terms of number of patents registered in the patent office. There is no publication of patents in 2-digit ISIC published by either the Central Bureau of Statistics (BPS) or Indonesian Patent Office under the General Directorate of Intellectual Property (Ditjen HAKI). Therefore, the concordance matrix is very important to generate the number of patents by 2-digit ISIC from PATSTAT data. However, I excluded the period before 1991 because of the poor quality of the Indonesian patent data, and the years after 2001 have not yet been published, so no data can be recorded.

Table 3 *Number of domestic patent in Indonesia by 2-digit ISIC (1991–2001)*

ISIC code	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
31	3	0	0	0	0	0	0	2	4	2	3
32	12	0	0	0	0	0	0	1	1	1	0
33	0	0	0	0	0	0	0	0	1	0	0
34	0	0	0	0	0	0	2	1	1	0	0
35	2	1	1	0	1	7	29	37	15	14	15
36	0	0	0	0	0	0	3	3	2	2	0
37	0	0	0	0	1	1	5	3	4	3	0
38	2	0	1	0	4	9	33	29	65	27	2
39	0	0	0	0	1	1	2	1	2	1	0

Note. Author's calculation based on data from PATSTAT (1991-2001).

Table 4 *Number of Foreign Patent in Indonesia by 2-digit ISIC (1991–2001)*

ISIC code	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
31	6	10	3	6	2	30	328	354	375	135	23
32	1	1	1	1	0	6	68	57	53	26	10
33	0	0	0	0	0	2	11	9	9	4	1
34	2	5	1	2	2	12	148	137	127	51	14
35	52	97	40	33	33	340	4219	4226	4376	1346	258
36	2	4	3	4	2	15	179	161	140	57	17
37	5	10	3	5	4	35	387	342	295	122	30
38	42	65	26	29	23	353	3389	2851	2625	1338	310
39	1	1	1	1	1	11	85	57	67	27	7

Note. Author's calculation based on data from PATSTAT (1991-2001).

According to the result of patent number, either domestic patent or foreign patent, the dominant sector which produced more patents are chemicals, rubber and plastic sector (ISIC 35) and metal products sector (ISIC 38). In fact, the number of domestic patents in Indonesia in the 1990s was very small compared to that of foreign patents as represented in Table 3. This result indicates that domestic industries have not put much attention toward protecting their own intellectual property rights. In particular, the other possible reasons are the high costs of R&D investment and uncertainty of economic gain of R&D activity. Surprisingly, foreign patent in Indonesia were more dominant and their numbers increased even in the crisis period (see Table 4). One underlying background for this is that Intellectual Property Rights protection came up as a response from law enforcement in Indonesia's bureaucracy during the reformation era. This then encouraged foreign companies to apply their patents in Indonesia.

6. **Analysis**

By considering the declining trend of technological capability in the manufacturing sector, a simple regression is employed to identify what causes that make productivity of manufacturing sectors seemed low during the crisis period. Therefore, one possible condition to examine this cause is conducted by estimating the relationship between TFP growth and knowledge stock (domestic patent and foreign patent). The analysis is divided into two categories, before the 1997-1998 crises and after the crisis.

As previously explained, knowledge stock is represented by the number of patents which are not directly implemented in industrial application. In this study, I considered the time to be lagged 3-4 years before patent is realized. Therefore, in the estimation process, the lag order starts from t-1 until t-3 period. The analysis of these two variables can be expressed in the following model.

$$TF\dot{P}G_t = \beta_0 + \beta_1 \dot{P_{t-1}}$$

where is TFP growth in year t and is the growth of patent stock in previous year (t-1).

Table 5 *Estimated Result of the Relationship between TFPG and Knowledge Stock*

No	Types of Patent Growth	Coefficient	Std. Error	t-stat	Adj. R^2
1.	Foreign patent (t-1)	-.06256	.03193	0.052*	0.0207
2.	Foreign patent (t-2)	-.06609	.03198	0.041*	0.0238
3.	Foreign patent (t-3)	-.06641	.03191	0.039*	0.0243
4.	Domestic patent (t-1)	-.03729	.02912	0.203	0.0048
5.	Domestic patent (t-2)	-.03740	.02921	0.203	0.0047
6.	Domestic patent (t-3)	-.05657	.03406	0.099**	0.0130

Note. Author's calculation based on data from PASTAT (1991-2001).
* significant at 5% level of confidence ** significant at 10% level of confidence

According to the results (Table 5), foreign patents are statistically significant in influencing the TFP growth starting from year t-1 until year t-3. It means the patent is still possible to influence the productivity until 3 years period. Some possible issues will probably come up regarding questioned role of patent as knowledge stock which can be described as follows (Griliches, 1998); (1) R&D activity takes time and its result may not have an effect on productivity until several years, (2) previous R&D investments depreciate and become obsolete, so the "net stock" of R&D capital is not equal to the gross level of current resources, and (3) the knowledge level of every sector is not only influenced by its own knowledge creation, but it is also possible coming from other industries. In this case, in order to have an appropriate reason for this case, it needs further study.

However, different result described domestic patents do not have a statistical significant relationship in expressing the TFP growth. One possible cause can be explained from the low growth of domestic patents, as resulted in Table 3. The low level of this growth has been occurred since 1991 and it implied the lack of R&D activities in domestic sectors.

Even though the relationship between TFP growth and foreign patents is significant, the *adjusted* R^2 of the estimated value is very small (6.8%). This condition is caused by the number of samples used in the estimation only covers 10 time periods with nine sectors of 2-digit ISIC. However, those relationships are negative. These results seem to be different from what should be expected. The growth in the number of patents, especially foreign patent stock, should positively affect the productivity of any sector. Why is this not the case here?

According to the simple regression result, if the growth in the number of foreign patents increases by 1%, the growth of TFP will decrease by 15.32%. One possible reason underlying this estimated result is the lack of investment on R&D activity in the manufacturing industries so that the industrial needs for capturing economic benefits from patents are ignored. Another possible cause is explained as follows. In order to minimize the effect of the crisis period, I excluded the data on the crisis period (1997–1998). As a result, it is not enough to explain the relationship between TFP growth and the patent growth. Then, I included the data on the crisis period in which the TFP growth during 1997-1999 indicates negative estimation. However, the relationship between TFP growth and foreign patent growth performed differently from the estimated result.

7. Conclusion

The fundamental difficulties of having different results of TFP growth come from measuring capital input and converting ISIC classifications from revision 3 to revision 2. In fact, there were some revisions in the official data from the Central Bureau of Statistics related to price indices in different sectors during the crisis period. Therefore, in order to improve the performance of future study in estimating TFP growth, government towards Central Bureau of Statistics should be capable in providing sufficient and reliable data especially in manufacturing sectors. It will be important in having estimation of industrial performance of the country and its competitiveness across sectors.

Instead of the insufficient availability of the data, the hit of crisis in Asian countries makes the result of TFP growth estimation different from previous studies. However, the discrepancy of period has been capable in reflecting the productivity performance of each sector. It implied that productivity estimation required appropriate conditions, not only methodology and input factors, but also external condition influencing the growth of productivity as a whole.

Even though the growth in the number of domestic patents in Indonesia is lower than that of foreign patents, it does not mean that government has no concern in encouraging industrial capabilities especially in creating new knowledge products and innovation. Government could establish policies to enforce intellectual property rights laws and increase the capacities of sectors that have good potential in generating knowledge intensive activities. One of the strategic planning for improving knowledge creation activities is employing "petty patent" for sectors with less advanced technology. This application is considered more achievable for most industries in Indonesia in term of the cost and its use for product standard and legal ownership.

It is clear that most manufacturing sectors in Indonesia are still pessimistic in conducting R&D activities, particularly in seeing benefits from patents, because of uncertainty and somewhat delayed return on investment. Therefore, government should accelerate industry by giving some incentives that support the success of the patenting process. In recent, Ministry of Research and Technology has initially conducted the "Incentive Program" to improve the awareness of Small Medium Enterprises (SMEs) in protecting knowledge and innovation. In this case, government gives some allocation for SMEs that has successfully implemented intellectual property rights application for their companies.

References

Asian Productivity Organization (APO). (2006). Indonesia: Total Factor Productivity. *Asian Productivity Survey Report.* Tokyo.

Aswicahyono, H. H. (1998). *Total Factor Productivity in Indonesia manufacturing, 1975-1993.* Unpublished PhD dissertation, Australian National University. Canberra

Bosworth, D.L. (1978). The rate of obsolescence of technical knowledge – A Note. *Journal of Industrial Economics,* 26, 273–279

BPS. (various issues). Indikator Ekonomi. Jakarta.

BPS. (various issues). Statistik Industri. Jakarta

Dasgupta, D., Hanson, J., and Hulu, E. (1995). *The rise in TFP during deregulation: Indonesia 1985-92.* Paper presented on 26-28 April 1995 at the conference Building on success: Maximizing the gains from deregulation, Jakarta.

Goto, A. & Suzuki, K. (1989). R&D capital, rate of return on R&D investment and spillover of R&D in Japanese Manufacturing Industries. *The Review of Economics and Statistics,* 71(4), 555–564

Griffith, R., 2000. *How important is business R&D for economic growth and should the government subsidies it?* Institute of Fiscal Studies Briefing note 12, London.

Griliches, Z. (1998). *R&D and Productivity: The Econometric Evidence.* A National Bureau of Economic Research Monograph. London: The University of Chicago Press.

Jammal, Y. (1993). *Backcasting manufacturing growth, 1975-1990.* DSP Statistical Paper no 46. Jakarta: DSP/BPS.

Jacob, J. (2006). *International Technology Spillovers and Manufacturing Performance in Indonesia.* CIP-Data Library Technische Universiteit Eindhoven.

Jorgenson, D. W., Gollop, F. M. and Fraumeni, B. M. (1987). *Productivity and US Economic Growth.* Cambridge, Massachusetts: Harvard University Press.

Kawai, H. (1994). International comparative analysis of economic growth: Trade liberalization and productivity. *The Developing Economies,* 32(4), 373-397

Mansfield, E. A. (1980). Basic research and productivity increase in manufacturing. *American Economic Review,* 70, 863 – 873

Osada, H. (1994). Trade liberalization and FDI Incentives in Indonesia: The impact on industrial productivity. *The Developing Economies*, 32(4), 479–491

Pakes, A., & Schankerman, M. (1984). The rate of obsolescence of knowledge, Research Gestation lags and the private rate of return to research resources. In Goto, A., & Suzuki, K. (1989), *R&D capital, rate of return on R&D investment and spillover of R&D in Japanese Manufacturing Industries*. Cambridge, Massachusetts: MIT Press.

Romer, P. M. 1990. Capital, Labor and Productivity. *Brookings Papers Econ. Activity*, in press.

Schmoch, U., Laville, F. Patel, P., and Frietsch, R. (2003). *Linking technology areas to industrial sectors*: Final report to the European commission, DG Research. Germany. pp 19-29.

Sigit, H. (2004). *Indonesia, in Total Factor Productivity Growth: Survey Report,* edited by N. Oguchi. Asian Productivity Organization Survey Report, 98–133. Tokyo: Asian Productivity Organization.

Srivastava, V. (2001). *Measuring Total Factor Productivity: Survey Report of India*. Asian Productivity Organization Survey Report. Tokyo: Asian Productivity Organization.

Timmer, M. P. (1999). Indonesia's Ascent on the technology ladder: Capital stock and Total Factor Productivity in Indonesian Manufacturing, 1975 - 1995. *Bulletin of Indonesian Economic Studies, 35(1)*, 75-97

Van der Eng, P. (2009). Capital formation and capital stock in Indonesia, 1950–2008. Bulletin of Indonesian Economic Studies, 45(3), 345–371

Verspagen, B. 1997, Estimating International Technology Spillovers Using Technology Flow Matrices, *Weltwirtschaftliches Archiv*, 133(2).

Vial, V. (2006) 'New Estimates of Total Factor Productivity Growth in Indonesian Manufacturing', *Bulletin of Indonesian Economic Studies,* 42(3), 357-69