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Energy use reduction and input productivity growth in Australian industries

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Abstract

A report by the Prime Minister's Task Group on Energy Efficiency (July 2010) emphasised the need for improved energy efficiency as a response to climate change to ensure a reduction in greenhouse gas emissions from energy consumption in Australia. However, empirical evidence on energy efficiency and its effect on energy use in Australia is scarce. Given this, estimates of the magnitude of the autonomous energy efficiency improvement parameter and the bias in technological change in Australia's agricultural and industrial sectors have been made, using statistical and econometric techniques.

The strong interaction prevailing between capital use and energy productivity in many industries indicates that energy use efficiency may be augmented by optimising capital use. This can be achieved by removing impediments to the use of new capital—that is, by making capital markets more flexible. This should ease the burden on energy efficiency policies or energy conservation measures by providing alternative ways to increase energy efficiency that do not focus on energy use as such.

Results of the estimates for overall productivity, input use productivity, the influence of capital on energy productivity, and energy-saving and energy-using bias revealed widely different energy productivity growth rates in different industries studied. Such results suggest a need to revise the 0.5 per cent a year autonomous energy efficiency improvement parameter assumed in most economic projection models used in Australia.

Key words: energy efficiency, energy demand, energy policy, climate change.

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1 Introduction

There has been increased emphasis on reducing energy use, and hence emissions, in the Australian economy. For example, a report by the Prime Minister's Task Group on Energy Efficiency (July 2010) emphasised the need for improved energy efficiency as a response to climate change to ensure the reduction of greenhouse gas emissions from energy consumption in Australia. Energy use in an industry can be reduced either by raising the overall productivity of the industry (producing more output for a given level of inputs) or by using energy more efficiently. Both these alternatives to reducing energy use require an understanding not only of overall productivity growth and energy productivity growth but also of the productivity growth of other inputs used in the industry.

This paper assesses the productivity performance of a few selected Australian industries using multifactor productivity growth, partial productivity growth and an analysis of the interrelationships among inputs. Both statistical and econometric approaches were used in this pursuit. Productivity growth and technological change in 12 Australian industries were examined, covering the period from 1985–86 to 2008–09. The industries selected include those for which Australian Bureau of Statistics (ABS) multifactor productivity and other necessary data were available. The agriculture, mining, manufacturing, construction and transport industries are covered, as well as seven other industries in the services sector: accommodation, communication, wholesale trade, retail trade, administration services, finance and water services. The study utilised ABS output, labour and capital use data (ABS 2010a, 2010b) and ABARES energy use data (ABARES 2009). These industries together account for more than 65 per cent of Australia's value-added and energy consumption.

The main objective of this exercise was to analyse the productivity of the main inputs used in the industries studied and to examine the interrelationships among the inputs to understand the possibility of increasing the efficiency of input use, particularly of energy.

Models of economic assessment are playing an increasingly important role in economic and energy projections and climate policy analysis. These models generally make assumptions about autonomous energy productivity among industries over the projection period with little or no empirical evidence. For example, in Australia most economic consultants using large projection models assume an autonomous energy efficiency parameter of around 0.5 per cent a year in most industries, barring a few energy-intensive industries. It is expected that the estimated energy productivity parameters outlined in this paper will provide information for these projection models.

The general or econometric methodology of measuring productivity and technological change is not addressed in this paper.

The implications of productivity growth for climate change analysis are straightforward. Carbon emissions are primarily the result of burning fossil fuels. In the absence of significant opportunities and resources being available for investment in energy efficiency and energy conservation, overall productivity growth and appropriate technological change will be relied on to reduce energy use.

It is important to realise that there are strong interrelationships among inputs. An increase in the productivity of one input may be caused by an increase in the quantity of other inputs used in the production process. For example, a rise in the productivity of energy or labour may not be the result of more efficient use of these individual inputs but the successive increase in the capital to energy use ratio or capital to labour use ratio respectively. Therefore, identification of the interrelationships of inputs in an industry may have a significant bearing on the development and implementation of energy efficiency policies.

It is important that the development of energy policies is consistent with the production realities prevailing in the industry. It is possible that despite rising energy prices energy consumption in an industry may increase over time. This is because of a number of factors outside the purview of energy policies alone, such as technological change in the industry and interactions among the production inputs, declining rates of capacity utilisation in running plants, bottlenecks and inadequate or unsuitable raw materials supply, and general growth in demand for the end product.

To reduce energy use and emissions, explicit energy efficiency policies may need to be implemented in industries where:

- multifactor (overall) productivity growth is low
- energy productivity growth is low
- an energy-using bias (as against the neutral or energy-saving bias) is embodied in technologies.

Energy efficiency policies may be based on:

- moderating energy input in the industry (for instance, through carbon-pricing)
- increasing overall productivity growth in the industry, among other things by reducing impediments in input markets (such as through addressing information asymmetries in the market)
- managing capital in industries where capital growth causes energy productivity growth (for example, through incentives or regulation).

The organisation of this paper is as follows: section 2 contains a brief rationale for studying productivity growth; section 3 outlines the derived analytical results; and section 4 contains some broad conclusions drawn from the analysis.

2 Rationale for studying productivity growth

Productivity reflects the relationship between output and the inputs used to generate that output. The close link between productivity growth and economic growth creates a need for studying productivity growth. Economic growth has implications for resource use in general and for energy use in particular. Energy use in turn has implications for emissions management and climate change policy.

Rapid increases in economic activity may lead to large increases in energy demand, particularly in growth industries such as mining, or energy-intensive manufacturing industries. Managing the use of energy in the economy has both economic and environmental implications.

The contribution of total factor productivity and partial factor productivity is generally investigated to better understand the importance of each factor of production and to evaluate substitution possibilities. In this context, the role of energy within the production process is gaining greater attention because of emissions reduction policies.

Multifactor productivity

Multifactor productivity is a measure of changes in output that are not directly attributable to changes in individual inputs. These non-input factors, such as technological progress, economies of scale, capacity utilisation, market efficiency and qualitative changes in inputs, make the use of inputs more efficient or effective and enable higher production using the same quantity of inputs. Multifactor productivity growth reflects this efficiency. A fall in multifactor productivity growth, or in partial productivity growth, indicates that resources are being used less efficiently in an industry.

There are three major approaches to measuring multifactor productivity: growth accounting, econometric estimation and efficiency frontier approaches (econometric and non-parametric).

Commonly, three major growth accounting approaches are considered for estimating multifactor productivity: the Translog Index, the Solow Index and the Kendrick Index. The three indexes differ in complexity and underlying economic assumptions. Kendrick and Solow involve restrictive assumptions; Translog is based on a more complex production function associated with only a minimum number of assumptions. It is therefore of a more general nature and is preferred as an accounting measure of productivity growth.

Multifactor productivity is measured in index form, which can be used to derive estimates of productivity growth. However, multifactor productivity growth exhibits annual fluctuations. In order to calculate a growth rate over a number of years a trend can be fitted using the multifactor productivity index. This growth rate trend can also be approximated by estimating the compound growth rate in the multifactor productivity index. The latter approach has been used in this paper.

Partial or single factor productivity and input relationships

The partial or single factor productivity of an input is indicated by the average ratio of output per unit of input. An increase in this ratio, other things remaining the same, implies increased efficiency of input use whereby the same level of output can be produced using a smaller quantity of a given input.

However, when other things cannot be assumed to remain the same, the interpretation of these input–output ratios as indicators of productivity becomes problematic. For example, an increase in labour productivity may only reflect capital deepening (a rise in the capital to labour use ratio). In these cases it becomes necessary to compute multifactor productivity.

Regarding the input substitution relationship, Chang (1994) concluded, 'although a number of econometric studies have focused on energy-non-energy substitutions in manufacturing, their results often conflict and disagree'. In the case of Taiwanese manufacturing, his own estimates showed that capital and energy use were substitutes.

Technological change does not affect all factors equally. When it does, it is considered neutral technological change. Otherwise, it may have a specific factor-using or factor-saving bias.

Growth in energy use over time has implications for environmental pollution. Productivity growth in industries has the effect of moderating growth in energy demand. The degree of this moderation depends on the magnitude and nature of technological change. If technological change is neutral, in the sense that it affects all inputs equally, the degree of energy moderation will depend on the overall growth in technological progress. If it has an energy-saving bias, there will be a significant degree of moderation in energy use. Conversely, technological change with an energy-using bias will increase energy use.

Knowledge of the nature of energy use bias in an industry is important for good policymaking.

If technological change has an energy-using bias, but the industry is experiencing strong multifactor productivity growth, energy productivity may still increase. However, in this case an opportunity may exist to significantly reduce energy use by implementing appropriate policies to switch the energy-using bias of the technology to an energy-saving bias.

3 Analytical results

The results of the estimation of productivity change and patterns of input substitution were derived from both statistical analysis and estimating a Translog production function with three input factors: capital, labour and energy. (Intermediate inputs were included in the case of gross output but not presented here, since the nature of the results did not change.)

ABS indexes of multifactor productivity (ABS 2010b) were used for Australian industries analysed in this paper as overall productivity was not estimated as part of this study. The ABS multifactor productivity measure is based on the growth accounting method.

The accounting framework employed for the derivation of total and partial factor productivities does not explain why factor demand changes over time. However, understanding substitution processes between input factors and relationships among factors is important for policy purposes to assist in manoeuvring the rate and direction of technological change and thus output productivity growth and input use efficiency. To understand this better, an attempt was made to estimate a Translog production function for each industry.

The relationship between capital and energy is particularly interesting in the context of energy efficiency policies and in reducing energy use and emissions.

Partial productivities were estimated using both value-added and gross output data. However, only the value-added estimates are presented in table 1, as the main results and relationships among inputs did not change. Growth rates have been calculated as compound growth rates.

Table 1 contains the estimated partial productivity growth for energy, labour and capital; multifactor productivity growth; and the growth in 'capital to energy use' and 'capital to labour use' ratios over the study period. The growth rates estimated for different industries varied widely from positive to negative. Neither the partial productivity (labour and capital) nor the multifactor productivity growth rates were examined for individual years in individual industries, since the objective here is to focus on the interrelationship between the capital to energy use ratio and energy productivity. For this reason growth in energy productivity and the capital to energy use ratio for each industry was examined in figure b in the appendix. All industries displayed a similar close relationship between these two variables.

It is likely that growth in the capital to energy use ratio will increase energy productivity in an industry where new capital or machines use energy conservatively to reduce energy costs. In an industry where capital does not economise on energy use—and also if it is subject to severe diminishing returns—growth in the capital to energy use ratio will not influence energy productivity growth.

Multifactor productivity declined or grew at low rates over the study period for many industries, including mining, manufacturing, construction, water, accommodation and food services, and wholesale and retail trades (table 1). Industries with low productivity growth rates may require targeted energy efficiency policies as productivity growth alone is unlikely to be sufficient to curb energy consumption.

1 Multifactor and partial productivity, capital to energy use ratio and capital to labour use ratio, compound growth rates (%), 1985–86 to 2008–09 (1989–90 to 2008–09 for energy)

Industry	MFP VA	LP	CP	EP	K/E	K/L
Agriculture, forestry and fishing	2.69	3.72	2.10	–0.79	–2.96	1.59
Mining	–0.14	1.43	–0.86	–2.24	–0.48	2.32
Manufacturing	0.36	2.03	–1.67	–0.32	1.65	3.76
Water and waste services	0.27	1.92	–0.86	–3.10	–1.38	2.80
Construction	0.28	0.77	–0.85	6.65	5.65	1.63
Wholesale trade	1.00	2.16	–1.23	0.61	1.60	3.43
Retail trade	1.01	1.93	–1.71	0.61	1.96	3.70
Accommodation and food services	–0.13	0.40	–1.51	–0.06	0.31	1.94
Transport, postal services	1.11	2.04	–0.19	1.28	1.25	2.23
Communications	2.21	5.75	0.02	2.00	2.32	5.74
Financial and insurance services	2.39	3.99	–0.25	0.74	0.62	4.25
Administrative and support services	1.49	2.24	–4.39	0.11	5.29	6.93

Note: MFP VA refers to multifactor productivity in relation to value added. LP, CP and EP refer to labour, capital and energy productivity, respectively. K/E andK/L refer to capital and labour ratio.

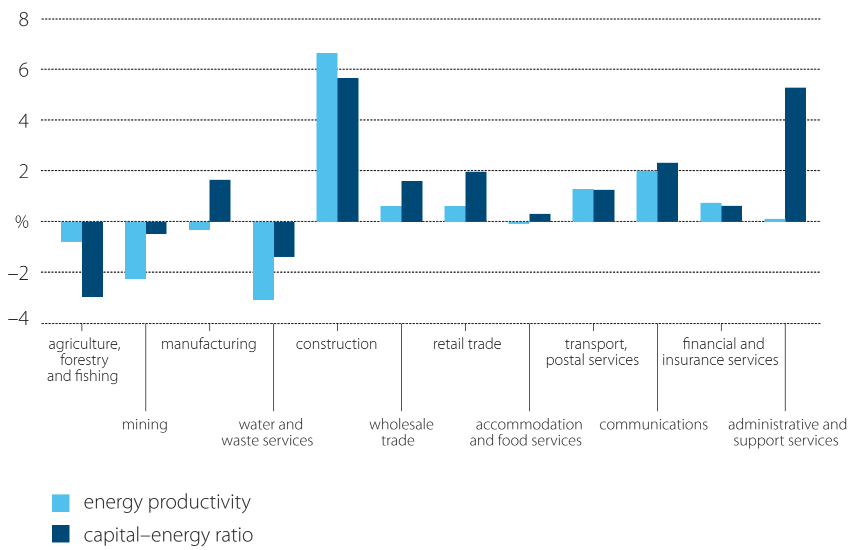
Table 1 shows a close relationship between the growth in capital to energy use ratio (K/E) and energy productivity (EP) growth. This relationship is plotted for all industries over the study period in figure a, and separately for each year for individual industries in figure b in the appendix.

Table 1 also reveals low or deteriorating capital productivity for most industries over the study period. This suggests that the use of capital becomes less efficient as production increases over time. It is normal to observe diminishing returns on a factor when its quantity increases in the production process.

The trend of increasing energy productivity growth, accompanied by declining capital productivity growth, results from the process of capital deepening (increase in capital intensity). Capital deepening is confirmed by growing capital–energy ratios, in table 1. Capital–energy ratios ranged between –2.96 per cent and 5.65 per cent over the study period in different industries. Energy productivity grew from –2.24 to 6.65 in various industries over the study period.

Declining energy use productivity in agriculture, forestry and fishing, mining, manufacturing, and water and waste services (table 1) can be explained. For example, in the mining industry, a couple of factors are likely to have contributed to a decrease in energy productivity. First, high-grade ores or those that can be accessed easily are generally extracted first. Over time, these deposits are depleted and mining shifts to lower-grade ores that consume more energy per unit of output (Saddler, Diesendorf and Denniss 2004). Second, as resources that are easy to access (generally those closer to the surface) are depleted, the extraction of resources that are harder to access (generally located deeper underground) is required to maintain or continue production. In order to sustain production, more energy will be required for those resources that are located deeper underground than those closer to the surface. Another reason for the increase in energy intensity in the mining sector is an increase in the production of liquefied natural gas (LNG). Over the period 1989–90 to 2005–06, exports of LNG increased at an average rate of 13 per cent a year (ABARE 2007). Extracting and liquefying natural gas are highly energy-intensive activities, and increases in its production result in increased energy intensity.

a Capital to energy use ratio and energy productivity, all industries, average growth from 1989–90 to 2008–09



Growth in output (value-added) in the agriculture, forestry and fishing, and manufacturing sectors was slower over the study period than growth in energy consumption. In the agriculture, forestry and fishing sector energy consumption is strongly influenced by changes in value-added. The severe droughts of 2002–03 and 2006–07, coupled with generally drier conditions for much of the study period, also contributed to lower energy use productivity. A reduction in output without changes in energy consumption in the latter case resulted in a decrease in energy productivity. In a broader sense, a decline in public investment in agriculture-related R&D relative to output value may also have contributed to reduced productivity generally in the sector (Nossal and Sheng 2010).

Drought and drought-like conditions might also have resulted in lower energy productivity growth in the water and waste services industry. In the water industry a lack of water in major storage dams reduced the value-added growth and increased energy requirements in transferring water to and from dams.

Finally, the manufacturing sector contains many energy-intensive industries, including LNG production. Growth in the production of energy-intensive items, such as LNG, and other export items, such as aluminium, and iron and steel, increased the need for energy consumption, resulting in a slight decline in energy productivity.

Causality tests

Figures a and b show that the capital to energy use ratio and energy productivity move closely together, but it is not clear whether one of them is driving the other. Granger causality tests were performed for each industry to test the causality between the capital to energy use ratio and energy productivity. With only a small sample (20 usable observations were available) the tests revealed mixed results for different industries.

In accommodation and food services, communication, water and waste services, and mining and finance services, the capital to energy use ratio appeared to cause changes in energy productivity. That is, as capital invested rose relative to energy use, so did energy productivity. In mining and finance, this relationship was statistically weak at the 95 per cent confidence level (table 2 in Appendix A). In manufacturing, energy productivity caused an increased capital to energy use ratio. In transport and wholesale trade, both variables caused each other. In the remaining industries, including agriculture, forestry and fishing, the Granger test found no strong causal link between the two variables.

The finding of a strong relationship between the capital to energy use ratio and energy productivity in the industries examined may have important energy policy implications. That is, there may be scope for using policies to influence the capital to energy use ratios, thereby increasing energy productivity.

Furthermore, when industry multifactor productivity is not increasing, or when energy productivity is not growing, there could be potential to use explicit energy efficiency policies to reduce energy consumption. As mentioned above, table 1 contains a few industries where both multifactor productivity and energy productivity are low.

Technological bias

To test for the technological neutrality of inputs, a Translog production function was estimated for each industry. Also, two or three industries were grouped together (pooled estimation). This was done to increase the number of observations needed for the Translog estimation.

Using Dicky–Fuller tests for most variables, the null hypothesis of non-stationarity could not be rejected on some of the variables defined in per capita form in the Translog equation specified in the text below. However, it is well known that the power of Dicky–Fuller tests is weak. For this reason, instead of specifying the model in differences of the variables, a method used in Coe and Helpman (1995) was used, specifying the Translog equation as the cointegration equation. Cointegration equations better capture long-term relationships in the data.

Coe and Helpman, after discovering their R&D and total factor productivity variables to be non-stationary, specified a cointegration equation that was found to be weakly cointegrated.

They maintained that, since the interest lies in discovering long-term relationships, short-term adjustments are not important. In addition, using the super-consistency property of coefficients given by Stock (1987), Coe and Helpman maintained that, if the independent variables are truly exogenous, then the estimates are super-consistent, and they are more powerful than OLS t-tests (Stock 1987). This super-consistency property is particularly helpful when the sample size is small (20 observations in the present case).

The Translog production functions for various industries were found to be cointegrated (but not all). However, since energy, labour and capital variables are exogenous to the value-added in industries, the dependent variable in the equation, the estimates are super-consistent. Because of the small number of observations in each industry (20 observations), the equations were also estimated using a reduced number of coefficients in the Translog function.

Given their weak significance nature, the first three terms after the constant were omitted from the following Translog function—leaving the input interaction terms and input–time interaction terms—to test for input complementarity/substitution and technological bias (input neutral, using or saving), respectively.

$$\ln (VA/L) = a_0 + a_1 \ln(K/L) + a_2 \ln (E/L) + a_3 T + 1/2\, a_4 \{\ln (K/L)\}^2 + 1/2\, a_5 \{\ln(E/L)\}^2 + a_6 \ln (K/L) \ln (E/L) + a_7 \ln (K/L)\, T + a_8 \ln (E/L)\, T + a_9 TT.$$

Where, ln refers to natural log, VA/L refers to value added to labour ratio, K/L refers to capital to labour ratio, E/L refers to energy use to labour ratio, and T stands for time. If the coefficients of input interaction terms (K/L) and (E/L) with T (a_7 and a_8) are zero, the productivity growth is neutral. If the coefficients are positive, the share of the input per unit of labour increases with time and there is input-using bias. If they are negative, then there is input-saving bias.

In addition, the full Translog function was also specified by combining two broadly similar industries at a time. These included manufacturing and construction (40 observations); wholesale trade, retail trade and accommodation (60 observations); communication, finance and transport (60 observations); and administration services and water services (40 observations). In these industries a Translog function with three input variables—energy, labour and capital—was estimated (not presented here).

The overall results in table 3 (Appendix A) revealed that in accommodation and food, manufacturing, wholesale trade and administration services, technology is biased toward higher energy use. The results for other industries were not statistically significant, but they were not all energy-using. In some industries, the results were statistically insignificant but energy saving.

In the transport industry capital and energy were found to be complementary, whereas in the administrative support industry they turned out to be substitutes.

No conclusive evidence could be obtained of the inputs (capital and energy) being complements or substitutes owing to the relatively small t-values of the coefficients and small number of observations in most of the industries.

Given the small sample size, the Translog function estimates cannot be relied upon entirely. However, the results showed that no uniform relationship exists in all industries as far as energy-saving and energy-using bias is concerned. Technology is energy-using in some industries and energy-saving in others. Similarly, energy and capital inputs are substitutes in some industries and complements in others.

Tables 1, 2 and 3 together show that, for most industries, where the capital to energy use ratio is not growing or has low growth (agriculture, forestry and fishing; mining and water services; and accommodation and food services), such industries reveal that energy productivity growth is low, multifactor productivity growth is low, energy-using technology prevails and the capital to energy use ratio influences energy productivity. Table 1 also shows that the capital to labour use ratio is growing in these industries. This may indicate that the capital as such is not lacking but the higher vintage capital (machinery) that uses less energy per unit of capital is not prevailing in the industry. Whether this is a (better) technology adoption issue or diffusion issue is outside the scope of this paper, and more research is needed to develop policy conclusions to encourage the use of the appropriate type of capital in the industry.

These results have an important policy dimension. They show that not all industries demonstrate energy-saving technological change. In industries where there is energy-using bias (for example, in accommodation and food, manufacturing, wholesale trade, and administration services), there are opportunities to reduce energy consumption by counteracting the energy-using bias of the technology, maybe by substituting other inputs.

4 Conclusions

The main objective of this paper is to analyse the productivities of the main inputs used in the industries studied and to examine the interrelationships among the inputs to understand the possibility of increasing the efficiency of input use, particularly that of energy. Both statistical and econometric techniques were used in the estimation of technological change and input relationships. Granger causality tests confirmed that the capital to energy use ratio influenced energy productivity in most of the industries examined. A Translog production function was estimated to reveal the technological input use bias in the industries studied, but it produced weak results.

The results for overall productivity, input use productivity, the influence of capital on energy productivity, and energy-saving and energy-using bias revealed widely different energy productivity growth rates in the different industries studied. Such results suggest a need to revise the 0.5 per cent a year autonomous energy efficiency improvement parameter assumed in most economic projection models used in Australia.

In the agriculture, forestry and fishing sector, multifactor productivity grew over the study period—albeit more slowly in the latter years than in the earlier ones—even though energy productivity declined. Technological progress in the sector appears to have been relatively energy intensive over the study period. The sector experienced a decline in the capital to energy use ratio and energy productivity. Some of the decline in energy productivity no doubt reflected the poor seasonal conditions prevailing in the latter part of the study period.

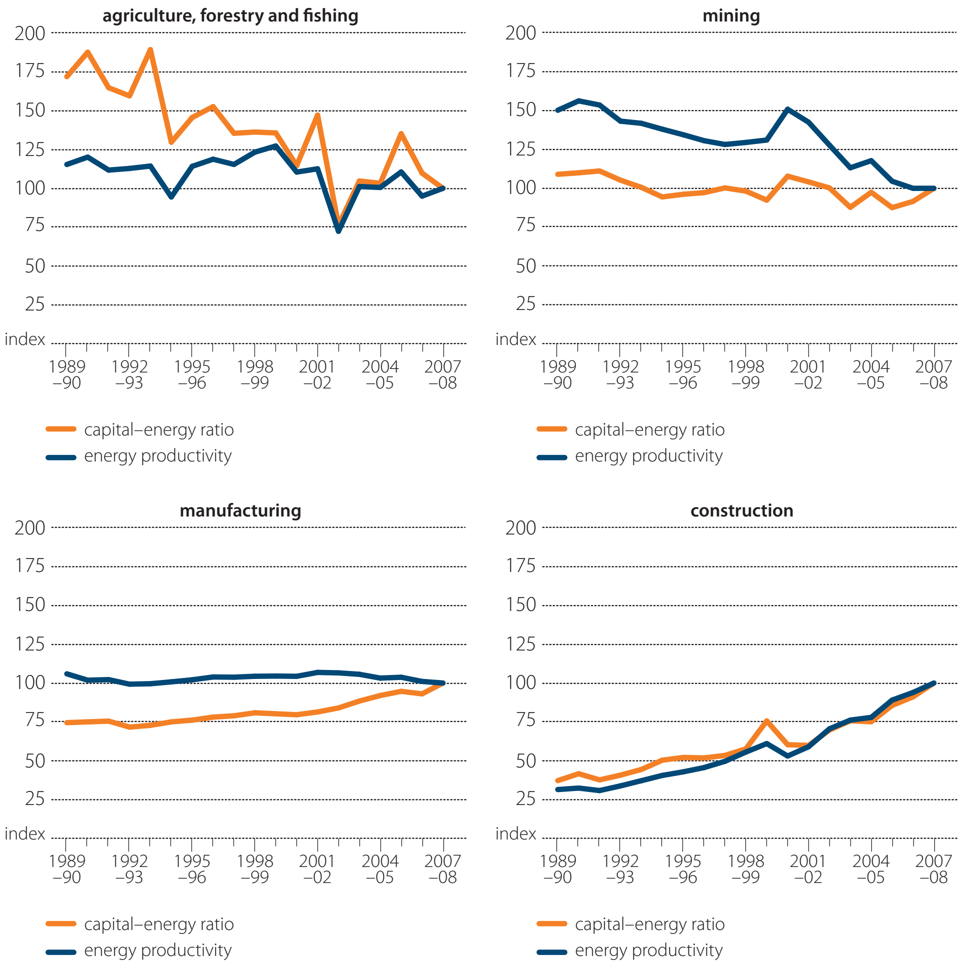
It is important that energy policies be developed that are consistent with the production realities prevailing in an industry. It is possible that despite rising energy prices energy consumption in an industry will increase over time. This is because of the various factors outside the purview of energy policies alone, such as the nature of technological change in the industry and the interactions within the production inputs, declining rates of capacity utilisation in running plants, bottlenecks in other inputs and inadequate or unsuitable raw material supplies.

Factors that may play an important role in energy efficiency improvement across industries include input interactions in the industry, capacity utilisation, types of raw material used, the technology employed, size and vintage of the plant, flexibility in the availability of raw materials, and the mix and quality of final products.

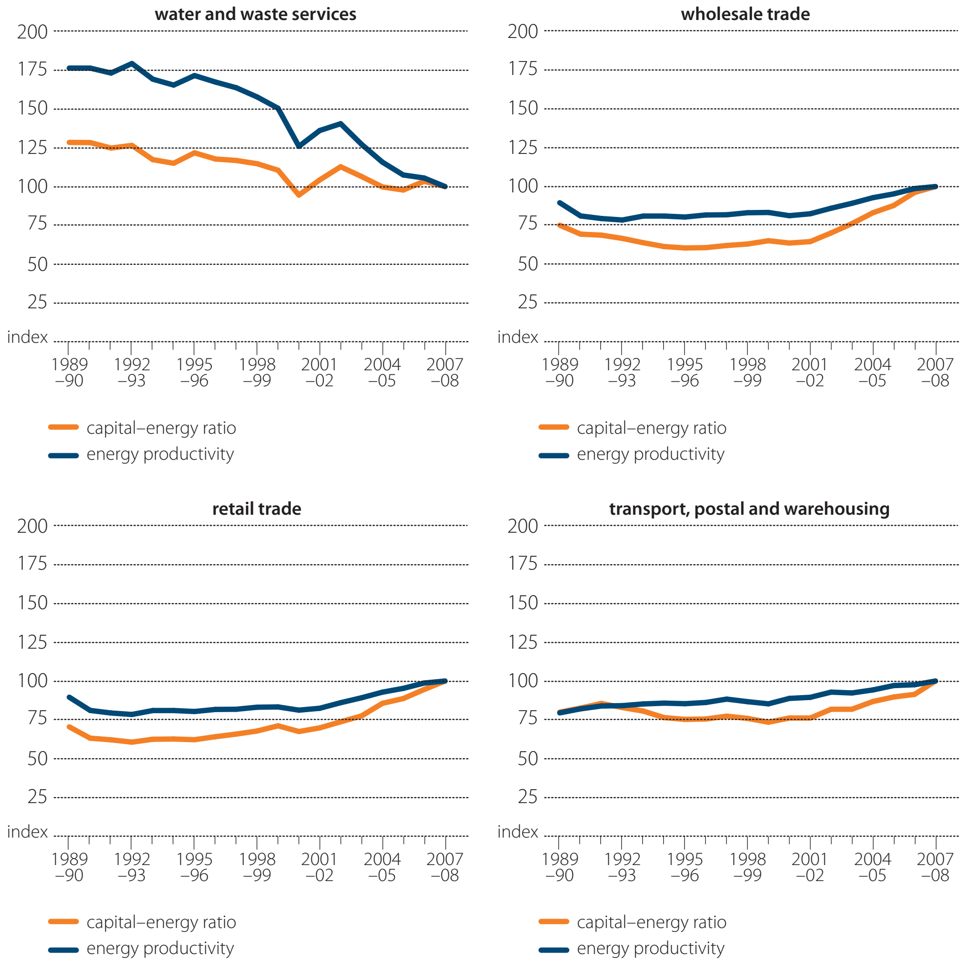
The main policy implication of this paper is that energy policies should not concentrate only on the historical energy productivity. Even where energy productivity is increasing (energy intensity is declining), the rate of this productivity increase may be accelerated by facilitating multifactor productivity growth in the industry, by increasing capital investment in the industry or by altering the energy-using bias of technology prevailing in the industry.

Appendix A

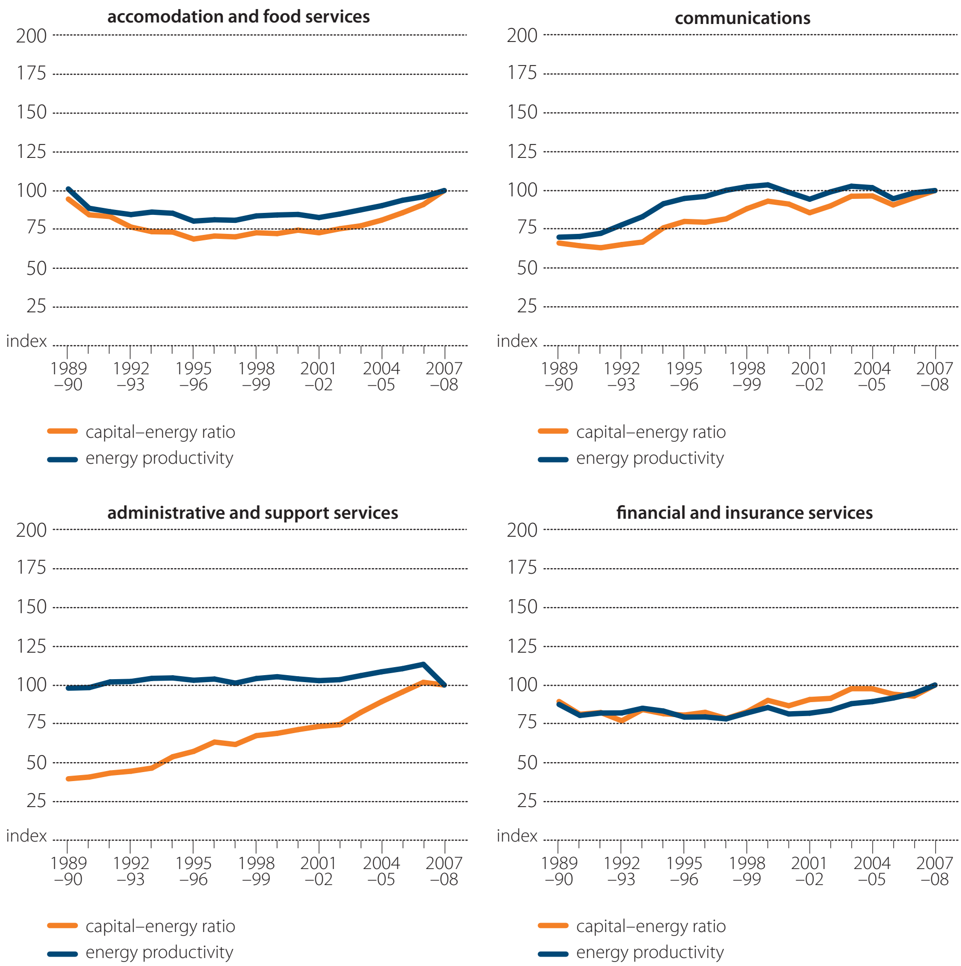
b Relationship between capital to energy use ratio and energy productivity, individual industries



b Relationship between capital to energy use ratio and energy productivity, individual industries *continued*



b Relationship between capital to energy use ratio and energy productivity, individual industries *continued*



2 Granger causality results a (only significant levels of t-values b are provided in the table)

Industry (K/E)	Dependent variable = log energy productivity (VA/E)	Dependent variable = log capital–energy ratio
Accommodation and food services	*	-
Communications	*	-
Manufacturing	-	*
Transport, postal services	*	*
Water and waste services	*	-
Administrative and support services	**	*
Construction	**	*
Mining	**	-
Wholesale trade	*	*
Agriculture, forestry and fishing	-	-
Financial and insurance services	**	-
Retail trade	-	-

a The Granger causality test is an F-test on the joint significance of all the lagged values of the independent variables (capital–energy ratio in column 2, and energy productivity in column 3). However, since only one lag is included in each model, this test changes to a t-test. If the value in the table is significant, the corresponding lagged value significantly affects (Granger causes) the dependent variable. **b** The * refers to a t-value significant at the 95 per cent confidence level or more. The ** refers to the t-value significant at the 90 per cent confidence level.

3 Estimated parameters for the Translog production function [a]

Industry	T	Ln KL Ln EL	Ln KL T	Ln EL T	Ln TT	R^2
Accommodation and food services	0.44	–0.097	–0.42	0.07	0.002	0.95
	(2.69)	(–1.55)	(–1.25)	(3.07)	(2.25)	
Communications	0.64	–0.16	–0.01	0.10	–0.004	0.98
	(0.93)	(–0.77)	(–0.15)	(1.3)	(–2.23)	
Manufacturing	0.62	–0.20	–0.07	0.19	–0.001	0.99
	(3.53)	(–1.23)	(–3.38)	(3.20)	(–1.68)	
Transport, postal services	–0.19	0.19	0.04	–0.01	–0.01	0.98
	(–4.23)	(2.88)	(3.91)	(–0.73)	(–2.01)	
Wholesale trade	0.18	–0.01	0.01	0.05	–0.001	0.98
	(1.10)	(–0.12)	(0.57)	(1.96)	(–1.50)	
Administrative and support services	0.73	–0.77	–0.33	0.16	0.03	0.99
	(2.37)	(–6.25)	(–3.98)	(3.22)	(5.53)	
Construction	0.03	0.08	0.006	0.001	–0.00008	0.82
	(0.06)	(0.36)	(0.007)	(0.02)	(–0.02)	
Mining	–0.37	0.07	0.065	–0.006	–0.003	0.96
	(–4.01)	(1.15)	(5.34)	(–0.37)	(–1.84)	
Agriculture, forestry and fishing	2.06	–0.70	–0.16	0.29	–0.009	0.92
	(1.70)	(–1.75)	(–1.42)	(1.90)	(–2.07)	
Financial and insurance services	0.48	–0.09	–0.04	0.05	–0.001	0.99
	(1.14)	(–0.82)	(–0.82)	(1.15)	(–1.25)	
Retail trade	0.06	0.09	0.03	0.02	–0.0009	0.97
	(0.50)	(0.68)	(1.06)	(1.20)	(–1.2)	
Water and waste services	–0.76	0.08	0.10	–0.04	–0.77	0.98
	(–3.31)	(1.53)	(5.02)	(–1.62)	(–6.94)	

a Variables with interaction terms and time are presented in the table. Ln refers to natural log. Other notations have been defined earlier in the text.
Note: Figures in parenthesis are t-values.

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