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Estimation of Industrial Productivity: A Literature Survey in Indian Context

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Abstract

Industrial productivity is an essential component of economic growth and development process in any economy; therefore all economic policies in India as well as other countries have focussed to foster the productivity growth of industries. Productivity is the relationship between a flow of output produced and inputs which are used to achieve that flow of output. There are a number of empirical studies pertaining to estimate industrial productivity and its determinants in India during pre-reform and post-reform periods. The main objective of this paper is to review some of the important studies and thereby (1) identifying the major techniques employed to estimate industrial productivity and its determinants and (2) to explore the impact of economic liberalization on industrial productivity in India as observed by various studies. The studies have been reviewed under two categories; first, country level and second, regional level studies in India. After review the literature on pertaining to estimation of industrial productivity in India, it has been explored that translog index method, growth accounting approach, Malmquist productivity index, Levinshon-Petrin method, DEA and stochastic frontier analysis are the important techniques for estimating industrial productivity. As far as the impact of economic liberalization on industrial productivity in Indian is concerned, most of the studies have shown higher productivity during post-reform period indicating the positive impact of economic liberalization.

JEL Classification: C01, C02, C13, D24

Keywords: Productivity growth, Partial factor productivity, Total factor productivity (TFP), Economic liberalization

Introduction

Productivity growth is a sine-qua-non of economic growth and development of any economy and there exists an intimate link between the two. Therefore, the earlier has long been recognized as one the most important drivers of the later and a determinant of international competitiveness of a country relative to others. Nobel Laureate Kuznets (1966) has mentioned that rapid industrial productivity growth is an essential element in economic development and structural transformation of the now developed economies. Urata (1994) stated that productivity is a crucial factor required for sustainable economic

growth. Even without an increase in the use of inputs such as labour, capital, or intermediate inputs; production and thus the economy will grow if there is an increases in productivity.

Meaning of Productivity

Productivity is the relationship between a flow of output produced and the inputs which are used to achieve that flow of output. Changes in productivity refer to the relationship between changes in a flow of output and changes in the inputs used. Productivity is generally expressed as the ratio between output and input. Symbolically it may be expressed as: *Productivity = Net Output/Effort Inputs*

Productivity measurement is broadly classified into partial factor productivity and total factor productivity.

Partial Factor Productivity (PFP): PFP is the average productivity of the particular inputs in question. It is a technical concept which refers to the ratio of output to input. It is a useful tool because it throws significant light on whether the productivity of a factor is rising or declining over time. However, the number of partial productivities depends upon the specified production function i.e. number of inputs employed. Suppose the production function is as follows:

$$Y_{it} = f(L_{it}, K_{it}) \text{ ----------} (1)$$

Where Y_{it} is the output of firm/industry/country i at time t, and L is labour and k is capital inputs employed. In the above production function, there are two PFP equals to the number of inputs. **Labour productivity** is defined as a ratio between output and labour units and **capital productivity** is defined as a ratio between output and capital units. By using definition of partial factor productivity it follows that labour productivity and capital productivity are simply the average product of labour and capital.

$$\text{Labour productivity} = Y/L, \quad \text{Capital productivity} = Y/K; \quad L/Y = \text{labour coefficient},$$

K/Y capital coefficient; and K/L and L/K are factor-intensity.

The reciprocals of these ratios give information about respective input requirements per unit of output. The trends in the partial factor productivities are dominantly affected by the trend in factor intensity i.e. the capital labour ratio. However, the partial factor productivities suffer from limitations such as (1) there is danger of paying inadequate attention to what can be done to increase the volume of production other than labour, (2) there is danger of attributing all increases in output to labour input or capital input alone and (3) the partial productivities are very much affected by factor intensities.

Total Factor Productivity (TFP): TFP is the essence of economic notion of productivity and is used as a measure of technical progress. It shows the efficiency with which all inputs are used in a production function and is defined as the measure of increase in output not due to different input choices but due to increase in marginal products of factors of production. To put it formally, let us assume the following type of production function:

$$Y_{it} = A_{it}F(X_{it}) \text{ ----------} (2)$$

where

Y = output of a generic unit (firm/indu stry/countr y)

X = vector of inputs

A = output produced from certain amount of input given tech nological level

i = firm/indus try/countr y

t = time

The state of technology, embodied by the function *F(.),* is given and common to all firms/industries/countries; therefore the TFP index at time *t* is the ratio of produced output and total inputs employed:

$$TFP_{it} = A_{it} = \frac{Y_{it}}{F(X_{it})} \quad \text{----------} \quad (3)$$

Objectives

The major objective of this paper is to review various empirical studies pertaining to estimate industrial productivity in India at country as well as regional levels. The following are specified objectives of this paper:

1. To identify the major techniques employed to estimate industrial productivity and its determinants.
2. To explore the impact of economic liberalization on industrial productivity in India as observed by various studies.

Literature Survey of Studies Pertaining to Estimation of Industrial Productivity in India

A large number of empirical studies have been conducted to estimate industrial productivity and to identify its determinants in India at country level as well as regional levels. It is not possible to review all those studies. This paper attempts to review the available major studies especially conducted during post-reform periods in India.

Country Level Studies in India

Research on estimating industrial productivity has been done either on frim level or industry/sector levels. Some studies have estimated a frontier production function and they measure efficiency of firms as the distance between the frontier and the individual firms. These types of firm level studies support the hypothesis that efficiency levels are highest in industries experiencing large decrease in protection (Tybout, Melo and Corbo, 1991) or amongst exporting firms relative to domestic market-oriented firms (Haddad, 1993; Tybout & Westbrook, 1995).

Ahluwalia (1991) had calculated total factor productivity growth (TFPG) in Indian manufacturing industries based on pooled cross section and time series data taken from Annual Survey of Industries (ASI) using translog production function. The period of the study was 1964-65 to 1985-86. According to the estimates, TFP had increased at 3.4% per annum during the period of the study. She attributed this observed "turnaround" in productivity growth to the economic liberalization policies of 1980s.

Ramaswamy (1994) had compared the estimates of average efficiency levels of firms in machine tools, agriculture machinery, plastic products, and motor vehicles measured through Cobb-Douglas production function, deterministic frontiers, and stochastic frontiers. Average efficiency level of firms (1) in machine tools industry estimated through estimating Cobb-Douglas production function and applying linear programming was found to be 0.432, (2) in agriculture machinery, plastic products and motor vehicles industries estimated using deterministic frontiers were found to be 0.349, 0.608 and 0.638 respectively, and (3) in machine tools, plastic products and motor vehicles industries estimated applying stochastic frontier were found to be 0.727, 0.82 and 0.846 respectively.

Srivastava (1996) had estimated firm level productivity in Indian manufacturing during the period of 10 years from 1980-81 to 1989-90 further sub-divided into 1980-81 to 1984-85 (pre-reform period) and 1985-86 to 1989-90 (post-reform period). The author took a sample of 2521 firms (Public Limited Companies) which was finally reduced to 1941 firms due to absence of continuous time series data, unacceptable values of certain variables etc. He estimated TFPG using both Growth Accounting Approach and parametric methodology. This study reported increase in labour and capital productivity at an annual average rate of 9% and 6% for the aggregate data. The estimates of average TFPG across all industries were quite low in pre-reform period, ranging from -0.02% to about 1.00% while the same was higher during post-reform period, ranging from 0.10% to 2.00%. However, he concluded that growth of Indian industry was mainly attributed to growth of capital, the contribution of productivity growth was negligible or even negative.

Balakrishnan, Pushpangadan and Babu (2000) had assessed the impact of trade liberalization (tariff reduction) on firm-level productivity in Indian manufacturing during 1988-89 to 1997-98. The authors took a sample of 2300 firms from the industries experienced most significant tariff reduction. They estimated TFP using econometric methodology derived from Hall (1988) in a three inputs framework viz. capital, labour and materials. Their study did not reveal any acceleration in TFPG since 1991. They concluded that there was not significant improvement in productivity growth due to trade liberalization since 1991-92. They further emphasised that trade liberalization was mainly macroeconomic in nature while productivity growth had strong microeconomic foundations.

Pattnayak and Thangavelu (2001) had estimated productivity in 70 three-digit industries in organised Indian manufacturing sector during 1980-81 to 1996-97, sub-divided into 1980-81 to 1984-85, 1986-87 to 1990-91 and 1991-92 to

1996-97. They used 'Two Deflator' growth accounting framework developed by Harberger (1991, 1998). They found varying rates of TFP across different industries during various sub-periods. TFPG varied from -17.28% to 18.25% per annum during 1980-81 to 1984-85, from -18.19% to 25.94% per annum during 1986-87 to 1990-91 and from -16.34% to 28.77% per annum during 1991-92 to 1996-97 across various industries. TFPG in entire manufacturing was 3.40%, 3.68%, and 2.94% per annum during above three sub-periods respectively. The authors had also assessed the impact of economic liberalization policies of 1990s on productivity growth. They concluded that 'sluggish/negative productivity growth' before liberalization was mainly attributed to the restrictive trade practices and liberalization policies of 1990s opened the economy for international trade which positively affected TPFG.

Goldar and Kumari (2003) had estimated TFPG in Indian manufacturing for 17 two-digit industries group during the period from 1981-82 to 1997-98, sub-divided into 1981-82 to 1990-91 and 1990-91 to 1997-98. They used translog index in three-input (labour, capital, material including energy) framework to estimate TFP. TFPG estimated by them was 1.89%, 0.69% and 1.40% per annum during 1981-82 to 1990-91, 1990-91 to 1997-98 and 1981-82 to 1997-98 respectively. They had also examined the impact of import liberalization and gestation period on industrial productivity using multiple regression analysis. They found a positive relationship of TFPG with output growth, agricultural growth, real effective exchange rate (REER), non-tariff barriers (NTB) and variable showing period of economic reforms while there existed a negative relationship of TFPG with pace of investment and effective rate of protection (ERP). They concluded that the lowering of effective protection to industries had favourably affected productivity growth while underutilization of industrial capacity was an important cause of the productivity slowdown.

Kambhampati (2003) had examined the effects of economic reform on firm level manufacturing efficiency in cotton textile industry in India. The time period covered by them was from 1986 to 1994 (134 firms in 1986, 1987 and 1991; 193 firms during 1988-90 and 114 firms during 1992-94). They measured manufacturing efficiency through stochastic frontier model in translog production function framework. The average efficiency of the firms was 0.8061 in pre-liberalization period (1986-90) and 0.9031 in post-liberalization period (1991-94). She found import intensity, export intensity, location and age of firm, capital-labour ratio as the main determinants of manufacturing efficiency. She concluded that location of firm and capital-labour ration had significant impact on manufacturing efficiency of firm along with capital-labour ratio. Capital-labour ratio decreased efficiency by a greater amount in pre-liberalization period (37%) as opposed to post-liberalization period (17%). She had also established that there was considerable dispersion in efficiency levels before reforms among the firms which decreased during reforms period.

Hashim (2004) had estimated productivity growth and its determinants in cotton yarn, man-made textiles and garments industries in India during 1989-90 to 1997-98. He had used a panel data consisting of 16 States in cotton yarn and 13 in each man-made textiles and garments industries. He estimated TFPG using translog multilateral index in four inputs (labour, capital, energy, and materials) framework. He found that TFP in man-made textiles and garments sectors reached at the maximum level in 1993-94, whereas TFP in cotton yarn could never go beyond the base year level. He had also estimated partial factor productivity (PFP) and found that capital productivity declined and labour productivity increased in all three industries while productivity of energy and materials inputs declined in cotton yarn and garments, and increased in man-made textiles during the period of the study.

The author had also identified the determinants of productivity using fixed-effects regression models. The main determinants identified were output per firm (OPF), capacity utilization (CU), electricity available, road density (RDD), credit disbursement by commercial banks (ENRA), nominal rates of protection (NRP) and NTB for products and machinery. He found a positive relationship of TFP with OPF (except for cotton yarn industry), CU, ENRA, NRP and NTB in all three industries while the relationship of TFP with RDD in man-made textiles and garments sectors is not conclusive.

Banga and Goldar (2004) had examined the contribution of services to productivity and output growth in Indian manufacturing industries during 1980-81 to 1997-98. They constructed a multilateral TFP index with and without services employing four inputs model (KLEMS-capital, labour, energy, materials and services) using panel data for 148 three-digit industries. Their result indicated that services had significant favourable effect on output growth and industrial productivity which was about 1% in the 1980s and increased to about 25% in the 1990s. The results also that trade reforms significantly contributed to the rapid growth of use of services in 1990s.

Misra (2006) analysed the impact of economic reforms on industrial structure and productivity in India using ASI data covering two-digit and three-digit industries. He found that economies policies followed during reform period were responsible for the very low performance of Indian manufacturing sector.

Manjappa and Majesha (2008) estimated TFPG in 10 manufacturing industries in India using annual time series data during 1994 to 2004. The industries were classified into capital-

intensive and labour-intensive (five in each segment). They constructed Malmquist Productivity Index (MPI) on panel data. The study concluded that TFPG in capital-intensive industries segment grew moderately at 1.7% per annum, whereas labour-intensive industries had showed a productivity regress over the period of study.

Das and Kalita (2009) had computed aggregate productivity growth in 10 selected two-digit manufacturing industries in India during 1980 to 2000. They used Domar Aggregation technique. They compared the results with the estimates of traditional aggregated value added approach and found that estimates obtained by earlier approach were about half of that obtained by later approaches.

Hashim, Kumar and Virmani (2009) had estimated TPF and PFP (for capital, labour, energy, materials and services) in two-digit manufacturing industries in India. The study covered the time period from 1992-93 to 2005-06, further sub-divided into 1992-93 to 1997-98, 1998-99 to 2001-02 and 2002-03 to 2005-06. They applied translog index method and did 'J-curve analysis of liberalization and productivity' from import liberalization. During 1992-93 to 2005-06, TFPG was 0.81% per annum and partial factor productivity growth (PFPG) of capital, labour, energy, material and services was 1.2%, 5.6%, 5.0%, 0.7% and -1.4% per annum in all manufacturing industries.

While analysing the impact of import liberalization through J-curve analysis, they found that TFPG decelerated in the first sub-period (1992-93 to 1997-98) due to combined effects of BOP shock and the J-curve effect, arising from the dramatic import liberalization (removal of QRs on capital goods and intermediates, and tariff reduction) and exchange rate reforms of the early 1990s (from fixed rate to managed float). TFPG became negative (-0.14% per annum) during the second sub-period (1998-99 to 2001-02) due to removal of QRs on consumer goods and further reduction in import duties. TFPG accelerated sharply during the third sub-period (2002-03 to 2005-06) due to dissemination of new technologies and products progressed from early adopters to others. The study also resulted that materials had been the biggest source of output growth and other factors had showed varied contribution in different sub-periods.

Sahu and Narayanan (2011) had estimated firm level TFP for 2541 firms in Indian manufacturing. They used transcendental logarithmic production function, taking four inputs (labour, capital, materials and energy), using cross-sectional data in the year 2008-09. Their study indicated that labour and material had contributed more than capital and energy inputs towards TPF. They found that TPF had positive relationship with age of the firm, export intensity and disembodied technology import, whereas TPF had negative relationship with ownership, energy intensity, embodied technology import and R&D intensity.

Topalova and Khandelwal (2011) had estimated firm level productivity for two-digit 4100 manufacturing companies belonging to 116 industries in India. The time period of the study was 1989 to 1996. They tried to establish a causal link between productivity and trade liberalization. The authors constructed Hicks-neutral TFP by subtracting firm's predicted output from its actual output. The predicted output was estimated using Cobb-Douglas production function whose coefficients were estimated using Levinsohn-Petrin method. The trade liberalization was measured in terms of input tariff, output tariff and ERP.

The authors found that a 10% reduction in output and input tariffs raised TFP by 0.53% and 4.8% respectively during the period of the study. However, reduction in both input and output tariffs led a higher productivity levels but the coefficient of input tariffs is larger than that of output tariff across all specifications. They showed that output and input tariffs declined, on average, by 54% and 22% points during 1989 to 1996, and consequently these two policy variables increased firm level TFP by 1.7% and 10.6% respectively. While assessing the impact of reduction in ERP on TFP, they found that a 10% reduction in the same led to 0.25% increase in TFP.

Ray (2012) had measured TFPG in India's paper industry during1979-80 to 2006-07. She constructed MPI and decomposed TFP into technical change and technical efficiency change. She had also estimated capacity utilization adjusted TFPG by regressing the log-difference of the measured productivity growth on the log- difference of capacity utilization rate, a proxy for business cycle. As per her estimates, TFPG was 5.49% during pre-reform period (1980-81 to 1991-92) and declined to -3.3% during post-liberalization period (1991-92 to 2003-04). She found that difference between average annual growth rate (AAGR) between pre-reform and post-reform periods became smaller after incorporating effect of capacity utilization. The capacity adjusted TFPG improved by 0.14% following the trade reforms. She concluded that liberalization had adverse impact on TFPG and pulp industry experienced regress in technological progress along with stagnation in technical efficiency.

Regional Level Studies in India

Ray (1997) had estimated productivity using DEA based MPI in manufacturing sector of different States in India for the period 1969-84. The MPI was decomposed to separate the contribution of technical change, change in technical efficiency and change in scale efficiency. The analysis showed that productivity declined in most of the States due to technical regress. The regression results further suggested that greater urbanization and higher capital-labour ratio could promote

productivity in the country while higher incidence of industrial disputes and preponderance of non-production workers could hinder the productivity growth.

Trivedi (2004) had measured inter-state differences in productivity movements in organized manufacturing sector of 10 major States in India during 1980-1981 to 2000-2001. The study was focussed on employment and output trends. The outcomes empirically confirmed the existence of inter-state differences in productivity levels and growth rates. It was also pointed out that States, such as Bihar and West Bengal were diverging away rather than converging to the output growth rates of organized manufacturing sector at national level.

Kumar (2004) had estimated TFPG in manufacturing sector of 15 major States in India during the period from 1982-83 to 2000-01. The author used non-parametric linear programming approach. The study also identified the sources of TFPG and measured the biasness level in technical change. The results indicated significant improvement in TFP over the time. It was found that regional differences in TFP persisted in India, although the magnitude of variation had declined during post-reforms period. The study confirmed the tendency of convergence in TFPG among the Indian States during post-reforms period and only technically efficient States at the beginning of the reforms remained innovative.

Sehgal and Sharma (2011) made inter-temporal and inter-industry comparisons of TFP in organised manufacturing industries in Haryana State (India) applying MPI. They used pooled data during 1981-82 to 2007-08 named as Period-I which further sub-divided into pre-reforms period during 1981-82 to 1991-92 (Period-II) and post-reforms period 1992-93 to 2007-08 (Period-III). They found MPI less than unitary in majority of the years and TFPG declined at the rate of -1.455% per annum during the entire period of the study. TFPG was the highest in transport manufacturing (3.65% per annum) and minimum in manufacturing wood (-6.002% per annum).

They decomposed MPI into shift in frontier i.e. TECHCH and improvement in efficiency i.e. EFFCH. This decomposition showed that EFFCH was the major source of TFPG at aggregate manufacturing sector of Haryana during Period-I, and TECHCH was greater than EFFCH in all other industrial group except of food & beverage and cotton & textile during post-reform period which implies that TFPG was due to innovation rather than improvement in efficiency. They finally concluded that there were cyclical fluctuations in productivity growth rates in manufacturing sector of Haryana during the period of study.

Conclusion

Industrial productivity is an essential element of economic progress of any region, therefore public policies of all the countries have emphasised on taking measures to fasten it. Many techniques have been developed over the time to estimate industrial productivity at firm/plant as well as industry/aggregate economy levels. Since the seminal work of Farrell (1957), a number of empirical studies have been conducted to estimate industrial productivity across the world. In India, maximum studies to estimate industrial productivity have been conducted after 1991 especially to probe into the impact of economic liberalization. In this article, available major studies India at country level as well as regional level have been reviewed to identify the various techniques employed to estimate industrial productivity and its determinants.

After analysing the detailed literature survey on industrial productivity, it has been found that most of the studies have used translog index, growth accounting approach, Malmquist productivity index, DEA and stochastic frontier analysis techniques to estimate industrial productivity at industry/aggregate level and Levinshon-Petrin method at firm/plant level. The main determinants of industrial productivity growth explored by various studies are growth rate of output, effective rate of protection, non-tariff barriers, investment to capital stock ratio, real effective exchange rate, agriculture output growth rate, export-output ratio, import penetration, tariff rate, terms of trade, inflation rate, and investment in fixed assets, etc. It has been observed in most of the studies that productivity growth has been higher in post-reform period than pre-reform period in India which indicates that economic liberalization along with lower trade barriers are associated with higher industrial productivity.

References

Ahulwalia, I.J. (1991). *Productivity and growth in Indian manufacturing*. Oxford, New Delhi: Oxford University Press.

Balakrishnan, P., Pushpangadan, K. & Babu, M.S. (2000). Trade liberalization and productivity growth in manufacturing: Evidence from firm-level panel data. *Economic and Political Weekly,* October 7.

Banga, R., & Goldar, B. (2004). Contribution of services to output growth and productivity in Indian manufacturing: Pre and post reforms. *ICRIE Working Paper No. 139*, New Delhi.

Das, D.K. & Kalita, G. (2009). Aggregate productivity growth in Indian manufacturing: An application of Domar aggregation. *ICRIER New Delhi Working Paper* No. 239.

Goldar, B., & Kumari, A. (2003). Import liberalization and

productivity growth in Indian manufacturing industries in the 1990s. *The Developing Economies,* XLI (4), 436-60.

Haddad, M., 1993, '*How trade liberalization affected productivity in Morocco'*, *World Bank Policy Research Working Paper* No. 1096.

Hashim, A.H., Kumar, A., & Virmani, A. (2009). Impact of major liberalization on productivity: The J curve hypothesis. *Working Paper No. 5/2009-DEA*, Department of Economic Affairs, Ministry of Finance, India.

Hashim, D.A. (2004). Cost & productivity in Indian textiles: Post MFA implication. ICRIER *New Delhi Working Paper No. 147,* New Delhi.

Kambhampati, U.S. (2003). **Trade reforms and the efficiency of firms in India.** *Oxford Development Studies,* 31(2), 219-233.

Kumar, S. (2004). Decomposition of total factor productivity growth: A regional analysis of Indian industrial manufacturing growth. *Working Paper* No. *22*, National Institute of Public Finance and Policy, India.

Kuznets, S., 1966, *Modern economic growth,* Yale University Press, m145-m162.

Manjappa, D.H., & Mahesha, M. (2008). Measurement of productivity growth, efficiency change and technical progress of selected capital-intensive and labour intensive industries during reform period in India. *Indian Journal of Economics and Business,* 5(4), 57-65.

Misra, A. (2006). Growth and structural change in manufacturing industries since 1980- 81 to 2001-2002. *The Journal of SRMCEM* 1, 71-76.

Pattnayak, S.S., & Thangavelu, S.M. (2001). Economic liberalization and productivity growth: A disaggregated analysis of Indian manufacturing industries. *Presented at The 2001 Australasian Meeting of the Econometric Society.*

Ramaswamy, K.V., 1994, 'Technical Efficiency in Modern Small-Scale Firms in Indian Industry: Applications of Stochastic Production Frontiers', *Journal of Quantitative Economics* 10, 309–324.

Ray, S. (2012). Determinants of total factor productivity growth in selected manufacturing industries in India. *Research and Social Practices in Social Sciences,* 7(2), 25-43.

Ray, S.C. (1997). Regional variation in productivity growth in Indian manufacturing: A nonparametric analysis. *Journal of Quantitative Economics,* 13(1), 73-94.

Sahu, S.K. & Narayanan, K. (2011). Total factor productivity and energy intensity in Indian manufacturing: A cross-sectional study. *International Journal of Energy Economics and Policy,* 1(2), 47-58.

Sehgal, Sh. & Sharma, S.K. (2011). Total factor productivity of manufacturing sector in India: A regional analysis for the state of Haryana. *International Journal of Management Business Research,* 1(4), 241-256.

Srivastava, V., 1996, *Liberalization, productivity and competition: A panel study of Indian manufacturing,* Oxford University Press, Delhi.

Topolova, P., & Khandelwal, A. (2011). **Trade liberalization and firm productivity: The case of India.** *The Review of Economics and Statistics, 93(3), 995-1009.*

Trivedi, P. (2004). An inter-state perspective on manufacturing productivity in India: 1980-1981 to 2000-01. *Indian Economic Review,* 39(1), 203-237.

Tybout, J. & Westbrook, M., 1995, 'Trade Liberalization and the Dimensions of Efficiency Change in Mexican Manufacturing Industries', *Journal of International Economics* 39, 53–78.

Tybout, J., de Melo, J. & Corbo, V., 1991, 'The Effects of Trade Reform on Scale and Technical Efficiency: New Evidence from Chile', *Journal of International Economics* 31, 231–250.