Labour Productivity, Import Competition and Market Structure in Australian Manufacturing

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Abstract: Through altering competitive conditions, globalisation can have a significant impact on productivity of the domestic economy. Foreign competition can stimulate the productivity improvements by domestic firms or it can lead to the elimination of inefficient producers. Alternatively, the threat or reality of foreign competition can impede investment in new equipment and techniques, thereby slowing the adaptation of productivity improvements. Thus, the impact of globalisation on productivity growth needs to be explored empirically.

In this paper, we estimate the impact of import competition on labour productivity growth in Australian manufacturing using a panel data analysis for nearly three decades period. The estimates extend and complement earlier work by Bloch and McDonald (2001), which applies panel data analysis to a sample of Australian manufacturing firms for a one-decade period. The use of industry level data in place of firm-level data, allows us to include the effects of entry or exit of firms, while the longer time period allows determine whether the impact of import competition on productivity growth changes to following micro-economic reform in the Australian economy. As with Bloch and McDonald, we also examine whether the impact of import competition varies across industries with domestic market structure.

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1. Introduction

Growth in productivity enhances economic development. Productivity growth may occur due to competition from domestic as well as international markets. Domestic competition, foreign competition or the threat of foreign competition increases pressure to reduce costs or face reduced market share. Marginal firms may even be forced to exit the market.

The empirical literature on Total Factor Productivity (TFP) change has gathered a substantial body of ‘stylized facts’ about the change in productivity and output growth to economic performance. for various countries.[1] There is no consensus amongst empiricists regarding the changes in productivity. The role of trade policies in increasing growth and efficiency has long been a major focus for productivity changes. Tybout (2000) provides an excellent empirical research from developing countries.

Trade liberalisation has ongoing for three decades in Australia, albeit slow at the initial stage. Major tariff reform program started in early 1970s with a 25 per cent reduction program across-the-board, continued through 1990s. As a result, the average rate of assistance for Australian manufacturing fell from 36 per cent to about 5 per cent over those three decades. Between 1984-85 and 1999-2000, manufacturing sales to overseas markets increased from 16 to 27 per cent of the total sales. Import penetration has increased from 26 to 40 per cent for the same period. However, the extent of liberalisation varies substantially amongst industries. Australian industry provides an excellent setting for examining the link between trade reform and productivity growth. The purpose of this study is to add to the evidence of the impact of trade liberalisation by examining productivity growth in Australian manufacturing at the three-digit level between 1973 and 1999.

Most Australian studies such as Dixon and McDonald (1991), Chand (1999), Bloch and McDonald (2001) conclude that the effect of trade reform on productivity gains is positive. This paper makes two significant contributions compared to the earlier studies from Australia. Firstly, dividing samples into high and low concentration industry; we try to differentiate the effects of import competition on productivity for each group for a long panel covering two and half decades. Secondly, using dynamic panel model, we examine the persistence of productivity in the long run.

The rest of the paper is set as follows. Section 2 reviews the literature briefly. In Section 3, we provide some statistics on changes of related indicators in Australian manufacturing due to trade liberalisation program. Section 4 describes the econometric methodology and the data we use for empirical purposes. In Section 5, we analyse the empirical findings. The final section adds some concluding remarks.

2. Import Competition, Efficiency in Production and Market Structure: A Brief Overview of Literature

Industrial competition, productivity and their relation to trade link- is a widely tested hypothesis in the last few decades. What are the major links between trade reform and productivity performance in increasing competition? A popular hypothesis is to find a positive relationship between productivity changes and output growth (or labor productivity), and is known as 'Verdoorn's law'.[2] The trade link with productivity growth is explained by scale economies. The size of market increases through liberalisation.

Second argument for trade in improving competition in domestic market is through improvement in efficiency. Leibenstein (1966) was the first to state explicitly the idea of 'proper motivations' for disciplining firms, forcing them to become more efficient or perish. Since then, both developed and developing countries have adopted significant trade liberalisation strategies, which have implications on domestic competition policies and regulations. The literature is vast; we only discuss here few studies.

Levinsohn (1993) investigates the effects of trade policy on market competition using Turkish firm-level data. Import-as-market-discipline hypothesis is supported for relevant industries. Urata and Yokota (1994) analyse the factors affecting TFP growth for Thai manufacturing industries. Intensive competitive pressure from home and abroad, wider choice of intermediate goods, expansion of output base and R&D expenses are found to be the driving forces of productivity growth during 1980s.

MacDonald (1994) examines the effects of import competition on labor productivity growth both for high and low concentration industries from the U.S. manufacturing sector. The effects of import competition on productivity growth are significant in concentrated industries. Edwards (1997) analyses the effects of trade barriers on productivity growth for 93 countries. Countries with greater trade barriers are found to be associated with slower productivity growth.

Although most of the studies have established positive link between trade and productivity growth, results are somewhat mixed. In a study, Havrylyshyn (1990) identifies this problem:

The evidence [on the relationship between trade reform and efficiency] from studies of TFP is weak and ambiguous. Some evidence of positive links between trade policy and productivity growth certainly exists…But many cases… are ambiguous, and some suggest a negative relation.

Second group of empirical work is based on calibrated simulation models analysing link between trade and market structure. For example, Baldwin and Krugman (1988) study on semiconductor industry and Dixit (1988) study of automobile industry. They examine both normative and positive consequences of trade policy. As they are based on calibrated simulation model, they evaluate policies that could be implemented rather than estimating the effects of trade policies on domestic competition.

3. Tariff Reform and Productivity Growth in Australian Manufacturing

Traditionally, the manufacturing sector has focused on import replacement, protected by tariffs, which have been high by world standards. High tariff barriers protected domestic employment within the manufacturing industries for a long time period. By the early 1970s, development in new industrial policies emerged. The Industries Assistance Commission (IAC) Act in 1973, introduced a continuous tariff review program and followed by successive governments and related bodies.[3] Tariffs have declined from a level of 35 percent across manufacturing sector in the mid 1970s to 5 percent in 2001 (except for the motor vehicle and the textile clothing footwear industries).

The openness of the Australian economy has significantly increased since mid 1980s. This is reflected in the upward trends in export propensity and import penetration. Merchandise manufacturing exports as a fraction of sales has increased from 15 percent in 1984-85 to 25 percent in 1998-99. The share of merchandise (manufactured) imports in sales has increased from 26 percent to 37 percent for the same period. Gretton and Fisher

(1997) report manufacturing employment has declined by 27 percent over 1968/69 to 1994/95. Within manufacturing employment has shifted from import-competing industries, such as textiles, clothing and footwear, to resource-based industries taking advantage of local raw materials. During this period, employment in the TCF and transport equipment industries has declined by 60 and 40 percent, respectively. Resource-based industries like food, beverage and tobacco; petroleum, coal and chemical products and metal products together contributed 50 per cent of manufacturing value added in 1998/99 and forty-two percent of total employment. Contributions of textiles, clothing, footwear and leather (TCF) and wood paper products in total value-added and employment were only five percent during this period. [4]

Labor productivity in Australian manufacturing has increased significantly since 1985/86, with an annual average annual growth rate of 2.9 per cent till 1998/99. Studies from the Productivity Commission (1996) and previously Industry Commission (1997) show, multifactor productivity (MFP) growth in manufacturing is consistently higher than the total industrial sector in Australia.

4. Econometric Methodology and Data

4.1 Production ,Input Shares and Prices

Following Bloch and McDonald (2001), we start with a classical production model:

$$Q_{ijt} = \theta_{ijt} f_j (K_{ijt}, L_{ijt}, M_{ijt}) \tag{1}$$

The amount of output, Q, produced by firm i in industry j at time t in (1) depends on the amounts of capital, K, labor, L, and materials, M, it uses in production as well as on the firm's index of technology, θ. If the function, f, is linear homogeneous, the productivity of labor, Q/L, can be expressed as:

$$Q_{ijt} / L_{ijt} = \theta_{ijt} f_j (K_{ijt} / L_{ijt} , M_{ijt} / L_{ijt}) \quad (2)$$

In (2), differences in productivity across industries due to relative factor intensities are reflected in the capital-to-labor, K/L, and materials-to-labor, M/L, ratios. The effects of different input qualities and X-inefficiency are reflected in the technology index, θ. Also, there may be different production technologies applying to different industries, which are reflected in the f function.

4.2. Productivity, Domestic Competition and Technology

Under perfectly competitive market structure, each firm produces at the minimum average cost level, productivity across firms within an industry is similar and there is not much scope for increasing productivity level. With imperfect market structure, a firm can charge higher price compared to its marginal cost (and/or average cost). High concentration can be associated with lower efficiency if the firms within an industry enjoy market power. Productivity can also be spuriously related to the intensity of competition due to error in the measurement of labor productivity at the firm level with imperfect competition. The standard measure of real output for each firm is obtained by deflating firm revenues by an industry price index, as in $p_{ijt}Q_{ijt} / p_{jt}$. The measured labor productivity for the firm is then given by the following variation on (2):

$$(p_{ijt} Q_{ijt} / p_{jt}) / L_{ijt} = (p_{ijt} / p_{jt}) \theta_{ijt} f_j (K_{ijt} / L_{ijt}, M_{ijt} / L_{ijt}) \qquad (3)$$

Each firm's price can be expressed as marginal cost, x_{ijt}, times a markup on marginal cost, μ_{ijt}. Assuming that marginal cost is the same for each firm but that the mark-up differs, then reveals the potential impact of market power on measured productivity. The ratio of firm price to industry price in (3) can then be replaced by a firm's markup divided by the corresponding industry markup as follows:

$$(p_{ijt} Q_{ijt} / p_{jt}) / L_{ijt} = (\mu_{ijt} / \mu_{jt}) \theta_{ijt} f_j (K_{ijt} / L_{ijt}, M_{ijt} / L_{ijt}) \qquad (4)$$

Hall (1988) argues that imperfect competition leads to systematic bias in measurement of productivity growth. He notes that the marginal cost associated with a change in firm output, ΔQ, and labor input, ΔL, at a economy-wide wage rate, w, is:

$$x_{ijt} = w_t \Delta L_{ijt} / \Delta Q_{ijt} \qquad (5)$$

The influence of competition is isolated by rearranging (5) to solve for the rate of change of output in terms of the rate of change of labor, the markup of price on marginal cost and the share of labor cost in revenue, $\alpha_{ijt} = w_t L_{ijt} / p_{ijt} Q_{ijt}$, as follows:

$$\Delta Q_{ijt} / Q_{ijt} = (\mu_{ijt} \alpha_{ijt}) \Delta L_{ijt} / L_{ijt} \qquad (6)$$

When there are changes in capital, ΔK, and material inputs, ΔM, as well as technical change, $\Delta\theta$, the expression for marginal cost becomes:

$$x_{ijt} = \frac{w_t \Delta L_{ijt} + r_t \Delta K_{ijt} + v_t \Delta M_{ijt}}{\Delta Q_{ijt} - \Delta\theta_{ijt} Q_{ijt}} \tag{7}$$

In (7), r is the rental price of capital and v is the price of materials. Using this definition of marginal cost and solving for the expression equivalent to (6) yields:

$$\Delta Q_{ijt} / Q_{ijt} = \mu_{ijt} (\alpha_{ijt} \Delta L_{ijt} / L_{ijt} + \beta_{ijt} \Delta K_{ijt} / K_{ijt} + \gamma_{ijt} \Delta M_{ijt} / M_{ijt}) + \Delta\theta_{ijt} \tag{8}$$

where α_{ijt} is the share of capital cost , β_{ijt} is the share of capital cost in firm revenue and γ_{ijt} is the corresponding share for material inputs.

If there are constant returns to scale, the cost shares for all inputs sum to one. This means the product of the markup and the sum of the coefficients on the input changes in (8) sum to one, so we can solve for labor productivity growth as:

$$\Delta Q_{ijt} / Q_{ijt} - \Delta L_{ijt} / L_{ijt} = \mu_{ijt} (\beta_{ijt} (\Delta K_{ijt} / K_{ijt} - \Delta L_{ijt} / L_{ijt}) + \gamma_{ijt} (\Delta M_{ijt} / M_{ijt} - \Delta L_{ijt} / L_{ijt})) + \Delta\theta_{ijt} \tag{9}$$

Thus, it appears that by lowering the markup, competition decreases the impact on labor productivity growth of increases in capital and material intensity, provided that the shares of inputs in revenue are otherwise unaffected.[5]

4.3. Productivity and International Competition

We estimate the following version of the model incorporating the above factors, with time subscripts and industry subscripts deleted:

$$LABPROD=a_0+a_1*K_P+a_2*L_P+a_3*M_P+a_4*CR_4+a_5*IMPINT+a_6*EXPINT+\Sigma b_i*INTER+\Sigma c_i*D_i + TT \quad (10)$$

where LABPROD is the annual rate of labour productivity, K_P, L_P and M_P are annual price of rental capital, wages and material price.[6] CR_4 is four-firm concentration index, IMPINT is import share; EXPINT is export share, INTER variable includes all interaction terms, D is industry dummy and variable TT includes time trend.

We estimate the effect of competition on productivity levels by treating both mark-up and technology index as function of competition. Competition may arise from domestic, export and import market. CR_4 is considered as an inverse measure of competition in domestic market, while import share (IMPINT) and export share (EXPINT) include competition from import and export sectors. Also following MacDonald (1994), we include the interaction term between CR4 and IMPINT to incorporate the interactive effects between domestic and import competition. We also allow the influence of each variable to change over time by including cross product of each with a time trend (TT).

Empirical analysis is based on a panel data from 1973 to 1999 for Australian manufacturing industries at the three-digit level.[7] The database is sourced from the publications from the Industries Assistance Commission reports and published and unpublished sources from the Australian Bureau of Statistics. Equation (10) is estimated using the OLS and Panel Estimation Techniques in log-linear form.

4.4 Persistence of Productivity

Persistence of productivity level over a period of time may reflect economic growth and prosperity. Higher level of productivity in the previous period can induce competition and efficiency. To incorporate this, we consider a version of dynamic panel model using the Arellano-Bond GMM method.

5. Empirical Findings

Table 2 presents three sets of results for our main specification that are based on the full sample of industries. In the first column, estimation is by the OLS and the inclusion of a set of industry dummy variables at the 2-digit level will control for some sources of industry unobserved effects while still allowing identification of the time invariant terms. In the second column, estimation is by a fixed effects model, where unobserved fixed effects are allowed for each three-digit industry group. Because of the inclusion of these controls, no time-invariant terms can be identified. In the third column, we allow for a dynamic relationship between labour productivity and the regressors by incorporating a lagged dependent variable. In order to obtain consistent estimates, we estimate this dynamic panel data model using the Arellano-Bond GMM method.

Insert Table 2 near here

Focusing on the interactions of import share and concentration with the time trend, we find that there is general consistency across the various estimation techniques in both sign and magnitude of the estimated coefficients. In particular, the coefficient on the time trend alone is negative, the coefficient on trend interacted with concentration is positive, and the coefficient on trend interacted with concentration and import share is also positive and highly significant. Thus, labour productivity is increasing over time in both import share and industry concentration. Taken together, the results imply that when either import share or concentration is low, the trend in labour productivity over the sample period is close to zero or even negative. Higher concentration is associated with a higher positive trend in labour productivity, and the positive trend is magnified further when import share is high.

For the OLS results, the coefficients on the time invariant variables can be interpreted as the level of log labour productivity at the beginning of the sample period when the time trend takes the value zero. The interaction term makes inference less obvious. When concentration is less than 0.8, labour productivity is higher for high import share industries, while when import share is less than 0.29, labour productivity is higher for high concentration industries. Compared to an industry with import share and concentration at the sample average, labour productivity is higher for higher import share industries, and lower for higher concentration industries.[8]

In the dynamic panel estimation, lagged labor productivity is positive and significant at the one-percent level. This is also evident in Table (1), where it is shown that the change in productivity level is significant for different periods.

Estimates of the coefficients on the input price variables are generally positive although insignificant. The main exception is that higher materials prices are associated with higher labour productivity once unobserved industry effects are controlled for. In the OLS results, export intensity is positively related to labour productivity, although export share has no significant effect on the trend over time in labour productivity in any of the specifications.

In Table 3, we divide the sample roughly equally into 'higher' concentration industries, where concentration is greater than 0.6554, and 'lower' concentration industries, where concentration is less than this threshold. Because of the potential omitted variables problem inherent in OLS estimation of panel data, we focus on the fixed effects results.[9] Dividing the sample by concentration reveals significant differences in the determinants of labour productivity. For higher concentration industries, results are similar to what was reported in Table 2, although only the trend interacted with import share and concentration is significant. Within this group of industries, high concentration high import share industries exhibit significantly larger increases in labour productivity over time than the other industries in the group. However, when import share is low (less than 0.23 when concentration is at the lower bound for the industry group), the trend in labour productivity is close to zero.

Insert Table 3 near here

For lower concentration industries, the picture is markedly different for the key variable of interest: the interaction of trend with concentration and import share is negative and significant. Thus, given the magnitudes reported in Table 3, while labour productivity trends higher over time for higher concentration industries, higher import share is associated with a flatter trend in labour productivity.[10] Thus, higher import share delivers greater gains in labour productivity over time for industries that exhibit the highest level of industry concentration. Also notable is the result that labour productivity is trends lower with export share for industries in this subgroup, in contrast to the positive (but not significant) effect in the higher concentration subgroup.

6. Concluding Remarks

The manufacturing sector in Australia has traditionally been heavily protected. It is often argued that manufacturing firms performed poorly under protective market due to: (1) existence of inefficient firms within many industries; (2) there are few big firms within each industry who enjoy monopoly power; and (3) existing small firms are unable or not willing to grow and hence scale economies can not be exploited fully. Trade reform program has been a major focus in policy arena for the Australian economy since last three decades. Other than this, micro-economic reform, adoption of new information and technologies, work place reform program are the main sources of productivity surge in recent years. Using panel data from the manufacturing sector, we established a positive link between trade and productivity growth. This is more apparent for the industries with high concentration.

Appendix:

Table A1-Variable Means, Standard Deviation and Sources (n=675)

Variable	Mean	S.D.	Sources
Log (LABPRO)	-1.798	0.503	Bureau of Industry Economics (BIE, 1995), Australian Bureau of Statistics (ABS, cat. no. 8221.0)
K_P	6.286	2.222	Bureau of Industry Economics (BIE, 1986), ABS, (unpublished data)
L_P	0.691	0.391	Bureau of Industry Economics (BIE, 1986), ABS (cat. no. 6302.0).
M_P	0.617	31.096	ABS catalogue no.6427.0
CR_4	0.701	0.136	ABS unpublished data
IMPINT	0.481	0.586	ABS unpublished data
EXPINT	0.318	0.763	ABS unpublished data

Table 1: Changes in Labor Productivity, 1973-99

(Deflated revenue per employee measured in $'000)

1973-79	1.468
1980-86	0.776
1987-93	0.473
1994-99	0.210
1973-99	9.448

Table 2: Econometric Results for Full Sample

Estimation Technique	OLS	Panel Fixed Effects	Dynamic Panel Estimation
Independent Variables			
K_P	-0.014	0.012	0.003
	(-0.76)	(1.17)	(0.36)
L_P	0.285[c]	0.057	0.020
	(1.90)	(0.73)	(0.39)
M_P	0.001	0.002 [a]	0.001[b]
	(0.90)	(2.66)	(2.09)
CR_4	4.776[a]	-	-
	(9.01)		
IMPINT	13.256[a]	-	-
	(8.23)		
CR_4*IMPINT	-16.627[a]	-	-
	(-7.98)		
EXPINT	6.133[a]	-	-
	(9.88)		
TT	-0.016	-0.014[c]	-0.008
	(-1.00)	(-1.69)	(-1.13)
TT*CR4	0.021	0.018[a]	0.015[b]
	(1.48)	(2.46)	(2.30)
TT*IMPINT*CONC	0.054[a]	0.054[a]	0.026[a]
	(3.66)	(7.13)	(3.77)
TT*EXPINT	0.007	0.007	-0.008
	(0.48)	(0.83)	(-1.11)
Lagged LABPRO		-	0.445[a]
			(11.89)
2 digit industry controls	Yes	No	No
R^2 (adjusted)	0.690	-	-
F-statistic	82.08	212.04	-
Wald χ^2 -statistic	-	-	3374.09
Number of Industries	23	23	23
Number of Observations	621	621	575

Notes: Figures in parentheses are t-ratios.
a Indicates coefficient is significant at the 0.01 level using a two-tailed t-test.
b Indicates coefficient is significant at the 0.05 level using a two-tailed t-test.
c Indicates coefficient is significant at the 0.10 level using a two-tailed t-test.

Table 3: Econometric Results for subgroups of industries

Estimation Technique	Panel Fixed Effects	Panel Fixed Effects
	CR_4 >0.6554	**CR_4 <0.6554**
Independent Variables		
K_P	0.028[b]	-0.003
	(2.14)	(-0.16)
L_P	0.107	0.142
	(1.01)	(1.11)
M_P	0.001[c]	0.003[c]
	(1.70)	(1.95)
CR_4	-	-
IMPINT	-	-
CR_4*IMPINT	-	-
EXPINT	-	-
TT	-0.019	-0.017
	(-1.58)	(-1.20)
TT*CR4	0.016	0.105[a]
	(1.34)	(2.90)
TT*IMPINT*CONC	0.060[a]	-0.106[b]
	(4.62)	(-2.11)
TT*EXPINT	0.029	-0.053[a]
	(1.55)	(-2.69)
Lagged LABPRO	-	-
2 digit industry controls	No	No
R^2 (adjusted)	-	-
F-statistic	146.87	80.76
Wald χ^2 -statistic	-	-
Number of Industries	12	11
Number of Observations	324	297

Notes: Figures in parentheses are t-ratios.
a Indicates coefficient is significant at the 0.01 level using a two-tailed t-test.
b Indicates coefficient is significant at the 0.05 level using a two-tailed t-test.
c Indicates coefficient is significant at the 0.10 level using a two-tailed t-test.

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ENDNOTES

[1] See Nadiri (1970, 1972), Nelson (1981)
[2] Verdoorn (1949)
[3] See Freedman and Stonecash (1997) for a survey on the industral policies in Australian manufacturing sector.

[4] Australian Bureau of Statistics (ABS), Australian National Accounts, ABS catalogue 5206.0 and Labour Force Australia, ABS Catalogue 6203.0.

[5]In the simplest case examined by Hall (1988), there are constant returns to scale so the cost shares of inputs sum to one regardless of the markup. In this case, a rise in the markup leads to a rise in the ratio of revenue to cost and the revenue shares of the inputs are inversely related to the markup. However, with economies or diseconomies of scale, the markup and revenue shares may move independently.

[6] Price of inputs are used instead of shares to avoid simultaneity problem,
[7] Concentration, export and import shares are time invariant.
[8] The average import share for our sample of 23 industries is 0.38, while the average concentration ratio is 0.68.

[9] Results for OLS and Arellano Bond dynamic panel data estimations are available on request.

[10] The partial derivative with respect to concentration implies a time trend that is increasing in concentration as long as import share is less than 0.75, which it is for all industries in this subgroup.