Firm Size and Export Performance: Some Empirical Evidence

Staff Research Paper

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PRODUCTIVITY COMMISSION

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Abbreviations

ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
ANZSIC	Australian and New Zealand Standard Industry Classification
BLS	Business Longitudinal Survey
CURF	Confidentialised unit record file
EMDG	Export Market Development Grant
FTE	Full-time equivalent
GDP	Gross domestic product
GMM	Generalised methods of moments
IMF	International Monetary Fund
MURF	Main unit record file
NEIS	New Enterprise Incentive Scheme
NIES	National Industry Extension Service
OLS	Ordinary least squares
PC	Productivity Commission
PPP	Purchasing power parity
R&D	Research and development
SITC	Standard International Trade Classification
UN	United Nations
US	United States (of America)
WTO	World Trade Organization

Explanations

Billion   The convention used for a billion is a thousand million (10^9).

nss   not statistically significant

SUMMARY

Key points

- Global and Australian exports have increased greatly over the last two decades. The range of products exported has also increased markedly, particularly in manufactured goods and services.

- The growth and changing composition of exports has focused attention on the relationship between firm size, the size of firms' domestic base and export performance.

- This study uses firm-level data from the Australian Business Longitudinal Survey (1994-95 to 1997-98) to form some tentative observations about these links.

- On average, firm size and the magnitude of domestic sales were not found to be major influences on exporting by manufacturers once account was taken of other factors, although many significant exporters also happen to be larger firms.

- While confined to a sample of manufacturing firms, this study does not support the proposition that to succeed internationally a firm will typically need to first secure a large domestic-sales base.

- This study suggests that the main influences on export performance of Australian manufacturing firms are likely to lie with a range of 'firm-specific' factors. These potentially include the kind of activity, product design and quality, marketing expertise and the motivation of management.

- Further research would be needed to clarify the linkages between 'size', other firm characteristics and exporting.

Summary

Reductions in trade barriers and technological advances have facilitated the movement of goods, services and people between countries and have contributed to a substantial increase in international trade. Associated with these developments has been a significant growth in global exports — from 14 per cent of the value of global production in 1970 to 25 per cent in 2000.

There has also been a significant increase in the relative importance of Australian exports, which have grown from around 15 per cent of the value of domestic production in 1969-70 to over 20 per cent in 2001-02. Notwithstanding this growth, because exports from some economies increased even faster, Australia's share of global exports declined from 1.6 per cent to about 1 per cent. This is in line with Australia's share of global production.

Exports of primary produce and minerals have been a traditional feature of the Australian economy. However, over the last couple of decades, exports of manufactures and services as a share of the value of Australian exports have increased significantly — from nearly 30 per cent in 1979-80 to over 40 per cent in 2001-02. Nonetheless, primary produce and minerals exports remain significant, accounting for over 50 per cent of the value of exports, well above the global average of a little under 20 per cent in 2000.

The growth and change in composition of Australia's exports has focused attention on factors that may influence the success of firms in offshore markets. In particular, it has focused attention on possible links between the size of firms' domestic base and their export performance, and the possible need for firms to grow domestically to be successful internationally. In this context, there is a concern that government policies that restrict the growth of firms domestically may also inhibit export growth. For example, some argue that the merger guidelines set out in section 50 of the *Trade Practices Act 1974*, by prohibiting acquisitions that are assessed by the ACCC as substantially reducing competition in a significant market, may restrict firms' size and reduce their international competitiveness. Similarly, some consider that immigration policies that limit population growth may also restrict the size of some firms and hinder their international performance.

The examination of these issues in Australia has been hampered by a paucity of information. This study is intended to help overcome that information gap by

providing an empirical analysis of firm size, domestic sales and export activity for a sample of manufacturing firms. It uses firm-level data from the Business Longitudinal Survey (BLS) to complement analyses of aggregate data which cannot deal explicitly with the relationship between firm size and export performance (see box 1).

Box 1   **Business Longitudinal Survey and its use**

The BLS provides details for a sample of firms for the four years from 1994-95 to 1997-98. The survey covered 11 industry sectors, mainly comprised of firms providing marketed goods and services. The core sample comprised around 4000 firms that operated in each year of the survey. The sample also included some other firms which did not operate for the full period or which were included in selected years to meet survey coverage requirements.

The BLS provides a range of information across all survey years on firm performance and involvement in exporting. It also provides general information on business practices, employment and manager qualifications. On the other hand, the survey does not explicitly cover many 'firm-specific' (but difficult to measure) factors such as kind of activity, product design and quality, marketing expertise and motivation of management for exporting which are also relevant to a comprehensive analysis of exporting. In the current study, the importance of such factors to exporting are examined using panel data regression techniques (box 2).

This study used firm-level information from the BLS in two ways:

• to decompose growth in exports over the mid-1990s for all industry sectors reporting to the BLS; and

• to assess the relationship of exporting to the size of firms' domestic base and overall firm size. This aspect of the analysis focused on manufacturing, given the significant increase in the importance of exports of manufactures, the tendency for manufacturers to be direct exporters and the significant number of manufacturers that export included in the BLS sample. The sample comprises over 1500 manufacturing firms. Of these firms, about 780 exported in at least one year, while over 460 firms exported in each of the four years. The sample was scientifically selected to represent just under 30 000 Australian manufacturers.

Firm contributions to exporting

Larger exporters and those that export regularly are the main contributors to Australia's total exports:

• For the financial year 2001-02, fewer than 1 per cent of exporters accounted for over 60 per cent of Australia's merchandise exports. Conversely, over half of

Australia's exporters collectively contributed less than 1 per cent of merchandise exports.

- For the period 1994-95 to 1997-98 a relatively small number of firms that exported in each of these years ('regular' exporters) made a substantially larger contribution to national exports than those that did not export every year. On average, the export intensity of both regular and other exporters increased over the four years to 1997-98.

Overseas studies also suggest that larger firms are more involved in exporting than smaller firms. However, existing analyses do not provide information on the link between the *domestic-sales base* of firms and their export involvement. In particular, they do not indicate the extent to which it is size as such, or other firm characteristics, that determine export performance.

Does export participation increase with domestic sales?

Casual observation of the BLS data indicates that, over the period 1994-95 to 1997-98, manufacturing firms with relatively large sales in the Australian market were more likely to be involved in exporting than firms with smaller domestic sales (figure 1). For example, around:

- 40 per cent of firms in the top domestic sales quartile were exporters, whereas around 5 per cent of firms in the lowest quartile were exporters.

- one quarter of firms in the highest quartile were regular exporters.

However, a wide range of other 'firm-specific' factors independent of the size of domestic sales, such as the age of a firm, its capital intensity and the skills of its workforce, could also have a bearing on the threshold question of whether or not a firm *participates* in exporting. Nevertheless, after controlling for the influence of a number of such factors, it was confirmed that the *likelihood* of a firm being an exporter and a regular exporter increased with the scale of domestic sales. The more comprehensive analysis also found that larger firms (in terms of total employment, sales and assets) were more likely to be exporters than smaller firms.

Figure 1   Incidence of manufacturing exporters by domestic-sales quartile, 1997-98[a]

Per cent of firms in each quartile
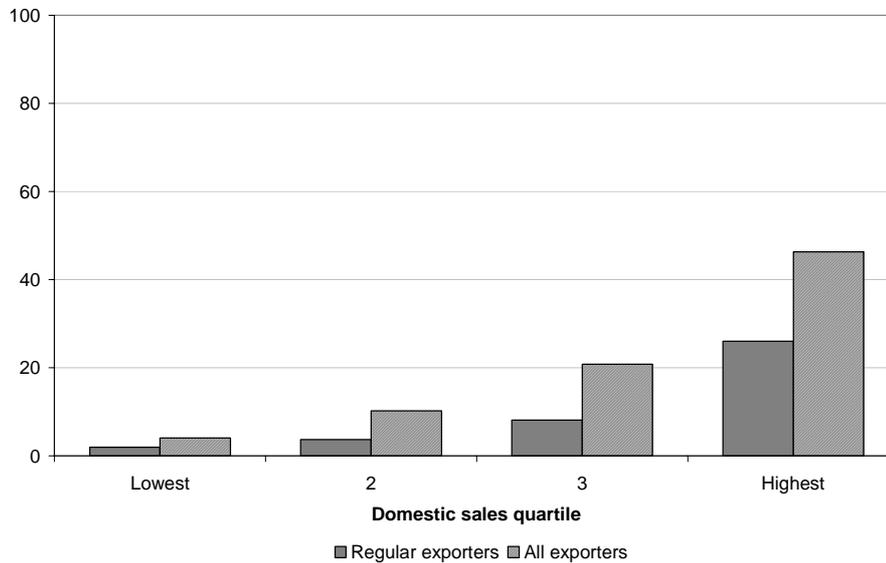
a Regular exporters: firms that exported in each year over the period 1994-95 to 1997-98. All exporters: firms that exported in at least one year (includes regular exporters).

Extent of export involvement

Turning from whether firms export to the extent of export involvement, some simple statistical tests suggest a positive correlation between domestic sales and exports. However, this analysis risks attributing to firm size the affect of factors excluded from this form of analysis (box 2). Indeed, after controlling for such factors and focusing on regular exporters — the main contributors to manufacturing exports — this study found:

- No statistically significant relationship between domestic sales size and the level of exports of regular manufacturing exporters; and

- A *negative* and significant relationship between the domestic sales of regular manufacturing exporters and the intensity of exporting (ie on average, firms' export intensity falls as their domestic sales increase).

Consistent with overseas studies, this more comprehensive analysis suggests that 'other', non-size, factors were by far the most important contributors to firms' export involvement. Those factors would mainly comprise the quality of firm-specific assets and management. However, the BLS data were not sufficiently detailed to permit the identification of the individual factors. In aggregate, these far outweighed the influence of financial performance and other firm characteristics detailed in the collection in explaining the variability of the value of exports and export intensity.

Some implications

The results for manufacturing as a whole do not support the general proposition that to succeed internationally a firm needs to secure a large domestic base. Moreover, in some circumstances, concentration on securing a domestic base may not improve export performance. This is not to deny that there may be individual cases or types of activity where size of the domestic base is important. There is also the possibility that the findings of this study are not generally applicable to non-manufacturing activities.

The results are consistent with the view that to succeed internationally firms must develop specialist skills and possess some advantages that make it feasible for them to overcome the inherent disadvantages they face in competing in overseas markets.

However, as indicated, many of the firm-specific attributes necessary to succeed internationally are not easily measured and were not detailed in the BLS. Assessing the nature of firm-specific assets, how they evolve and how they may be linked indirectly to firm size across all sectors may therefore benefit from further research.

1   Introduction

It is sometimes suggested that the ability of Australian firms to grow domestically influences their capacity to compete in export markets. Similarly, some contend domestic policies that restrict the size of firms' local operations may adversely affect the international competitiveness of Australian exporters. For example, some argue that the merger guidelines set out in section 50 of the *Trade Practices Act 1974*, by prohibiting acquisitions that substantially reduce competition in a significant market in Australia, may restrict firms' size and impact on their international competitiveness, especially in price sensitive export markets.[1] Similarly, some consider that immigration policies that limit population growth may also restrict the size of some firms and hinder their international performance.

An important first step in assessing such concerns is to gain an understanding of the factors underlying export performance, including the influence of domestic-sales. Box 1.1 briefly outlines the possible sources of competitive advantage that firms must possess if they are to overcome the inherent disadvantages of competing in foreign markets through exporting. Box 1.2 outlines the relationship between firm size and international competitiveness that may arise from economies of scale and scope. However, these considerations do not establish whether there is a link between the domestic sales of Australian firms and their export performance in practice. Furthermore, there is little empirical information to test for such a link.

This study is intended to help fill this information gap by providing an empirical analysis of the association between firm size, domestic-sales and export activity.

To help place this study in perspective, chapter 2 outlines some global and Australian export trends, while chapter 3 outlines the findings of other empirical studies which have examined the relationship between export performance and firm size. Chapter 4 reports results of an empirical analysis of the relationship between firm size and export performance based on Australian firm-level data for the period 1994-95 to 1997-98 from the Business Longitudinal Survey (BLS) published by the Australian Bureau of Statistics (ABS 2000). It does so by analysing whether export performance systematically varies with firm size in the data set used. It does not,

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[1] See the Productivity Commission submission to a review of the Trade Practices Act (PC 2002, p. 47).

however, assess what might have happened if economic and institutional circumstances had been different. Appendices provide supporting material.

Box 1.1   Features of exporting

To export successfully, firms need to possess a competitive advantage to overcome the advantages typically enjoyed by rival firms located in the country into which they export (eg greater familiarity with local laws and customs). Sometimes the source of competitive advantage can arise within the firm (eg through product design and quality, marketing expertise and strategy, and motivation and commitment of management for exporting). At other times, the source of this advantage can arise outside the firm. For example, some economies have developed expertise in supplying particular goods or services, thereby creating a pool of skilled labour, networks and a reputation for the firm to draw on. When it is feasible to supply an export market, the expected return from exporting would have to outweigh that obtainable from supplying the market by alternative means, such as through foreign investment or entering into licensing arrangements.

The competitive advantages of firms and their assessment of those advantages — which collectively may be referred to as 'firm-specific factors' — are likely to have a pervasive influence on their export performance.

Exporting entails additional costs and risks above those incurred in supplying the domestic market. For example, exporting involves additional transport, distribution and marketing costs and, depending on the country, additional financial and legal risks. While some of these additional costs vary with the volume exported (eg production and transport costs), many do not. That is, they are 'fixed' costs in the sense that they do not vary with the volume exported.

Some fixed costs can be recovered if the firm does not succeed internationally (eg by selling fixed assets). However, others are 'sunk costs' in the sense that, once incurred, they cannot be recovered if exporting turns out to be unsuccessful (eg the time and money spent on international market research and advertising). The theoretical literature argues that many of these costs are likely to be significant and, hence, may deter many firms from exporting (eg Baldwin 1988, 1989, Baldwin and Krugman 1989, Dixit 1989a, 1989b, Krugman 1989).

The existence of fixed costs, and especially sunk costs, may have a bearing on the relation between export performance and firm size. In the presence of such costs, there would be a range over which the average cost per unit exported would be declining. This suggests that export performance would increase — that is, be positively correlated — with firm size, at least over some range.

Box 1.2   **Firm size and economies of scale and scope**

Economies of scale

The effect of firm size on export performance hinges on what happens to average production costs (cost per unit of output). If there are untapped economies of scale present, firms may lower average production costs (cost per unit of output) and improve their international competitiveness by getting bigger.

For a given technology, three conditions need to hold for export performance to be influenced by firm size. First, economies of scale need to be present. That is, for given technologies and ways of working, the average cost of production needs to decrease as output increases. This would enable 'larger' firms to have lower average unit costs than 'smaller' firms. Secondly, these economies of scale need to arise at the plant level (factory, shop or office). If they arise at the organisation level (the firm), they are not tied to individual plants or activities and should be accessible through other means (eg varying the number of plants or activities, including through export activity or foreign investment). Thirdly, current firm-level production must be less than the level at which the average cost of production stops falling (minimum efficient scale), so that an increase in output would reduce average unit costs.

If these conditions are present, then any restrictions preventing firms from increasing their size would reduce their international competitiveness in the absence of a new technology or way of working that enabled a firm to lower its costs without an increase in firm size.

Economies of scope

Economies of scope refer to the situation where it is more efficient for one firm to produce or engage in a number of different, usually related, products or activities than it is for a number of firms to produce the products or engage in the activities separately.

Joint costs lie at the core of economies of scope. They are costs incurred in the production of two or more products that cannot be directly attributed to either product in an economically meaningful way. For example, functional distillation column(s) used in oil refining simultaneously produce multiple outputs (eg butane, propane, naphtha, kerosene, diesel and bitumen) at different temperatures from common inputs. This means that it is typically optimal to obtain refinery products through joint-production facilities rather than through facilities specialising in individual product lines.

Similarly, non-trivial joint marketing and distribution costs involved in selling into overseas markets often make it more cost effective to export a range of products or brands rather than to export them separately. The Australian wine industry has successfully employed collective marketing strategies in exporting.

Hence, restrictions on firm size that limit the achievement of economies of scope and attainment of an optimal product mix may reduce competitiveness.

2   Trends in exports

To provide some context for the analysis of the relationship between firm size and export performance, this chapter outlines global and Australian export trends.

2.1   Global trends

The volume of world merchandise exports grew at an average annual rate of 5.7 per cent over the thirty-year period to 2000 (figure 2.1). Export volume growth followed a relatively steady path and exceeded average growth in global production (3.6 per cent per year).[1] Over the same period, export prices increased at an annual average rate of 4.5 per cent (with most of the rise occurring before 1980). In value terms, merchandise exports increased from around 10 per cent of global production in 1970 to around 20 per cent in 2000.[2] Most of this increase occurred before 1980. Over the same period, global exports of goods and services is estimated to have increased from 14 per cent of global production to 25 per cent.[3]

There have been significant changes in the sectoral composition of global merchandise and commercial service export flows (figure 2.2). In particular, the share of manufacturers increased from 45 per cent of the value of global exports in 1980 to 61 per cent in 2000. Over the same period, the share of 'commercial services' increased from 15 to 19 per cent. With the increased significance of manufactures and commercial services, the share of agricultural and mining and metals processing exports declined. An important contributing factor to this decline was a reduction in commodity prices relative to other items of trade.

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[1] GDP volume measures are estimated from country series weighted by the purchasing power parity (PPP) value of GDP expressed in US dollars.

[2] Estimates based on GDP at current prices expressed in current US dollars from the *World Bank World Tables* database (EconData July 2002) and the IMF *World Economic Outlook* database (IMF 2002b). The country coverage of export and GDP flows is as defined in those databases. In particular, data for economies of Central and Eastern Europe and the former Soviet Union were typically not included for years before 1990, but have been included subsequently.

[3] Ratio of global exports of goods and services to GDP both expressed in US billion dollars using market exchange rates (IMF 2002b).

Figure 2.1   **Volume and average unit price of global merchandise exports, 1970 to 2001[abc]**

Indexes 1970=100
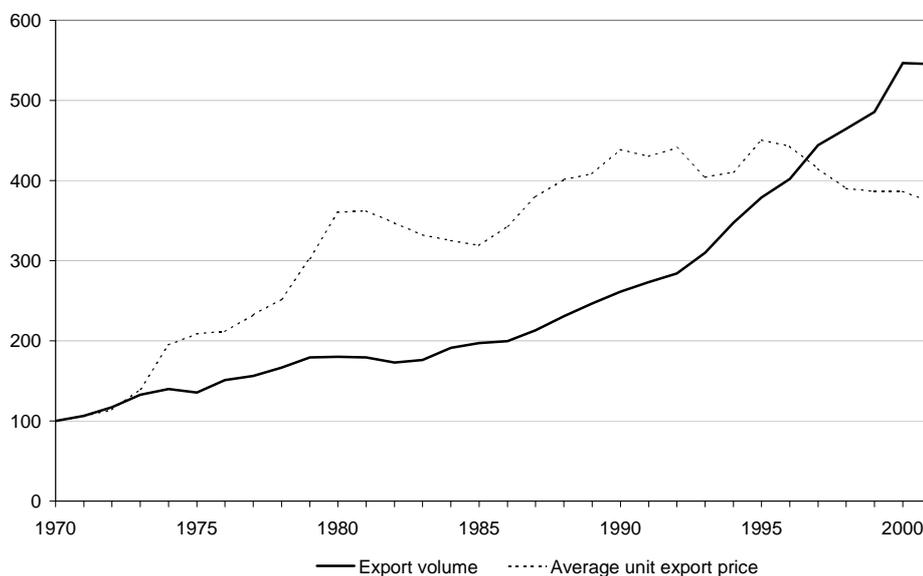
a Merchandise exports are compiled by the IMF according to United Nations definitions for international merchandise trade statistics (UN 1998). In broad terms, they cover transportable goods that are transacted across a custom's frontier. **b** Export prices/export unit values are based on country index numbers expressed in US dollars. The basic data are typically derived from unit value data, although some country data are based on wholesale price indexes. The global index is an average of component country measures weighted by the value of exports expressed in US dollars. **c** The volume series is calculated by deflating the IMF value of exports expressed in US dollars by the IMF export price/unit value index.

Sources: Estimates based on IMF(2000b, 2001, 2002a).

Figure 2.2   **Composition of global exports of merchandise and commercial services, 1980 and 2000[a]**

Value share, per cent

1980   2000
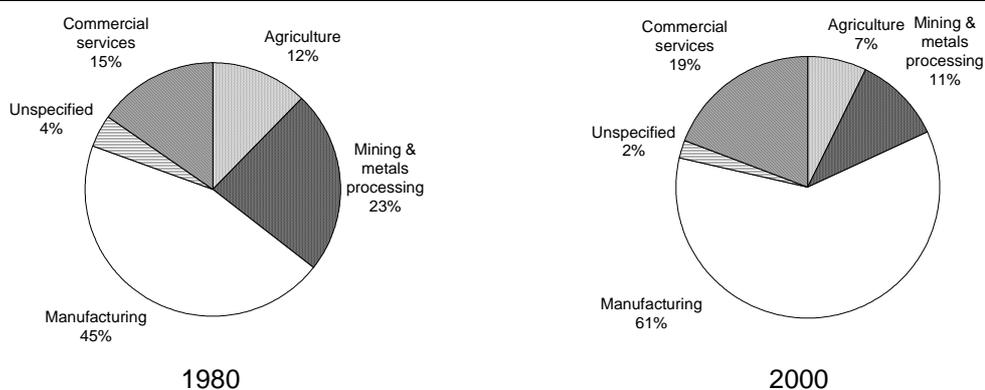
a The SITC-based product classification includes Iron and steel (SITC 67) in the 'Manufacturing' group. 'Commercial services' includes transportation, travel and other services (communication services, construction services, insurance services, financial services, computer and information services, royalties and licence fees, other business services, personal, cultural, and recreational services), but excludes government services not included elsewhere.

Sources: Estimates based on WTO (2001, 2002).

2.2 Australian trends

The volume of Australian merchandise goods exports grew at an average annual rate of 5.3 per cent per year over the three decades from 1969-70 to 2001-02 (figure 2.3).

Over the same period, the volume of Australian exports of goods and services grew at an average annual rate of 5.5 per cent per year — ahead of merchandise exports due mainly to the influence of growth in services exports (figure 2.3). The value of goods and services exports increased more rapidly (10.8 per cent per year) and the volume and value measures increased ahead of comparable measures of domestic production. The value of exports, therefore, rose from around 14 per cent of domestic production in 1969-70 to over 21 per cent in 2001-02, when exports amounted to $152 billion. The increase in the importance of exports was associated with substantial liberalisation of external transactions, including deregulation of Australian financial markets, the floating of the Australian dollar in the early 1980s, and progressive reductions in Australian customs tariffs.

Because exports from some economies increased even faster, Australia's share of global exports declined from 1.6 per cent in the early 1970s to its current level of around 1 per cent. Most of this decline in relative importance occurred during the 1970s (IMF 2001, pp. 130–1; IMF 2002a, pp. 126–7).

Australian export activity has historically been concentrated in agriculture and mining. Nevertheless, in line with international trends, the relative importance of these exports declined, while that of manufactures and services increased over the two decades to 2000 (figure 2.4). For example, around 1980, agricultural, mineral and processed mineral products accounted for 70 per cent of Australian exports by value compared to 35 per cent of the global total. By 2001-02, the share of products from these divisions had declined to 51 per cent for Australia, compared to 18 per cent for the global economy. On the other hand, in line with global trends, Australia's exports of manufactures increased from 14 to 23 per cent of export values over the same period. Growth in exports of wine, passenger motor vehicles and other machinery and equipment were significant contributors to the increased importance of manufactured exports. In line with international trends, the relative importance of services exports also increased substantially.

Figure 2.3   **Volume of Australian exports and share of GDP, 1969-70 to 2001-02[ab]**

Indexes 1969-70=100 (LHS) and Value share, per cent (RHS)
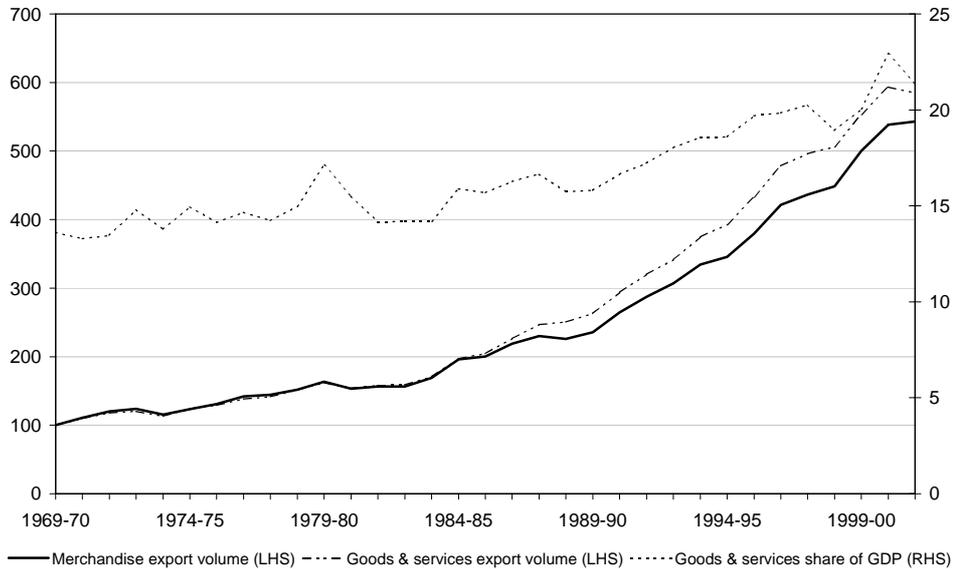
a Merchandise exports of goods cover transportable goods that are transacted across a custom's frontier as published in the ABS's 'General merchandise' exports series. This series includes all rural and non-rural exports excluding 'Other goods' (goods for processing, repairs on goods, goods procured in ports, and non-monetary gold). The merchandise and goods and services export volume indexes shown are calculated from ABS chain volume measures (2000-01 reference year). The export share of GDP is calculated from current period values for goods and services exports and GDP. **b** The 'General merchandise' volume series published by the ABS commences in the September Quarter of 1974. Merchandise trade data reported here for 1969-70 to 1973-74 include a small amount of 'Other goods' exports not included in the later series.

Sources: ABS (*Australian National Accounts: National Income, Expenditure and Product*, Cat. no. 5206.0 in EconData dX database 5206-55) and ABS (*Balance of Payments and International Investment Position, Australia*, Cat. no. 5302.0 in EconData dX databases 5302-01, 5302-06 and 5302-10).

Figure 2.4   **Composition of Australian exports of goods and services, 1979-80 and 2001-02[a]**

Value shares, per cent

1979-80

2001-02
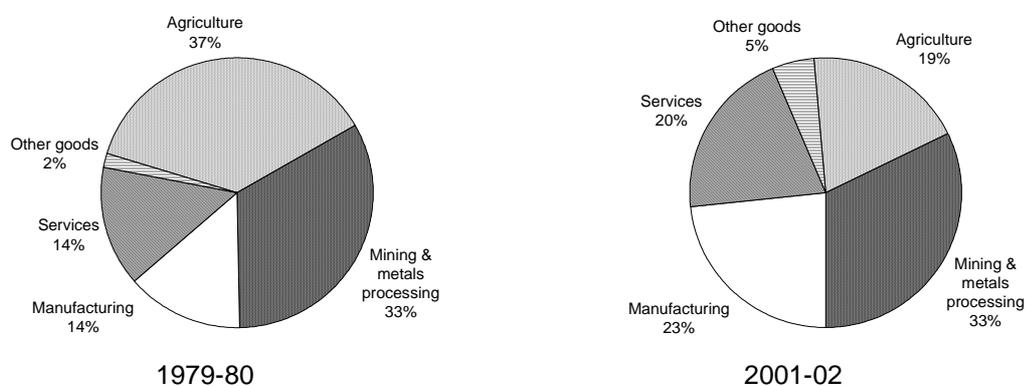
a SITC-based product classification. Exports of goods are defined as 'General merchandise' (rural and non-rural exports) and 'Other goods' (excluding goods for processing, repairs on goods, goods procured in ports, and non-monetary gold). The total of Australian 'General merchandise' exports is broadly comparable with the IMF's definition of (total) 'Merchandise exports' in figure 2.2. However, Iron and steel (SITC 67) is included in 'Mining and metals processing' in the Australian data series (where it accounted for about 8 per cent of the group value in 2001-02), but it is included in the WTO category 'Manufacturing' in figure 2.2. **b** Exports of services includes transportation, travel, communication services, construction services, insurance services, financial services, computer and information services, royalties and licence fees, other business services, personal, cultural, and recreational services and government services not included elsewhere (n.i.e.). The Australian definition of 'Services' includes 'Government services n.i.e.', whereas the IMF/WTO definition of 'Commercial services' does not. (Government services n.i.e. accounted for 2.5 per cent of Australian exports of 'Services' in 2001-02.)

Source: ABS (*Balance of Payments and International Investment Position, Australia,* Cat. no. 5302.0, time-series spreadsheet, 30 September 2002).

2.3   Exporting by Australian firms

Firm participation in exporting

The ABS has recently produced 'experimental' statistics, based on the new tax system, which provide new information about firm participation in the export of merchandised goods from Australia. These are summarised in table 2.1 and figure 2.5.[4] This new information shows that the $119 billion of merchandise goods exports over the 12 months to June 2002 was contributed by over 30 200 Australian firms (table 2.1). The relative contribution of individual firms to the export total

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[4] The 'experimental' estimates incorporate firm-level information from the new tax system to classify firms to industry. This development enables foreign trade data to be cross-classified by the industry sector of the exporter (eg manufacturing, wholesale trade). Traditionally, trade data classified by industry reflected only the industry-of-origin of traded items (eg manufactures exported by wholesalers would have been classified to a manufacturing industry of origin). Underlying data on export values are consistent with the ABS international trade statistics.

varied substantially and was highly skewed toward a small number of major exporters (figure 2.5). For example, the 209 firms that had exports of over $100 million accounted for around 70 per cent of all merchandise exports for the 12 months. At the other extreme, over 16 600 firms had exports of less than $100 000 and, collectively, accounted for less than one per cent of total merchandise exports.

The new information also indicates the extent to which firms export products directly or sell their products via intermediaries (eg wholesalers) for export. The new data indicate that the majority of mining and manufacturing exports during 2001-02 were undertaken directly by firms in those sectors. On the other hand, less than 15 per cent of agricultural exports were undertaken directly by rural industry firms, with wholesale firms accounting for most of the remainder (ie around three-quarters of rural exports). This reflects the fact that a substantial proportion of rural exports are relatively standardised products supplied by a large number of smaller businesses that depend on wholesalers to establish and maintain export links.

The role of wholesalers in exporting, nevertheless, is not limited to rural commodities. Indeed, around half of merchandise 'exports' of wholesale firms were manufactured goods, while 7 per cent were mineral and processed mineral products. The remaining 41 per cent of export sales by wholesalers were agricultural goods.

Decomposition of firms' export growth

The ABS has also published information about the export activity of firms over a number of years. This information was obtained from the Business Longitudinal Survey (BLS) for the years 1994-95 to 1997-98 (discussed in appendix A). Overall, the Main Unit Record File (MURF) covered around 55 per cent of Australian exports of goods and services by just under 21 000 exporters in 1997-98.[5] Firms in the manufacturing sector contributed 40 per cent to this total, mining firms 28 per cent, with service industry firms contributing the remaining 32 per cent.

The BLS survey data presented in table 2.2 show that export sales were mainly accounted for by regular exporters (ie firms that exported in each of the BLS years). For these firms, exports contributed around thirty per cent of total sales. Firms that did not export each year exported less in total over the four-year period and, on average, derived around only one-twentieth of their sales revenue from exporting.

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[5] The BLS sample data were weighted to form population totals. The weights used were those assigned to each firm by ABS sampling procedures.

Table 2.1   **Australian merchandise exporters, 2001-02ᵃ**

Size of exports	Exporters		Exports		Average exports
	No.	%	$ million	%	$000 per firm
$100 million or more	209	0.7%	83 633	70.1%	$400 158
$1m and less than $100m	4 187	13.8%	31 910	26.8%	$7 621
$100 000 and less than $1m	9 202	30.4%	3 026	2.5%	$329
$10 000 and less than $100 000	16 642	55.0%	661	0.6%	$40
Total	**30 240**	**100.0**	**119 230**	**100.0**	**$3 943**

a Excludes $1 876 million of 'Other goods' exports otherwise included in merchandise goods trade.

Source: ABS (*International Merchandise Trade, Australia*, December quarter 2002, Cat. no. 5422.0, p. 11).

Figure 2.5   **Australian merchandise exports by firm size, 2001-02ᵃ**
Per cent
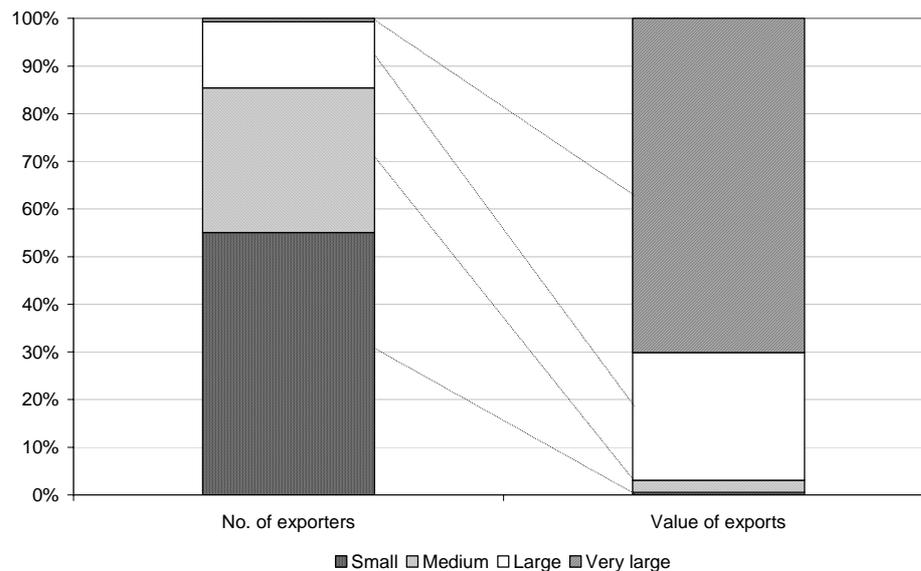
a Small: exports between $10 000 and less than $100 000. Medium: $100 000 and less than $1 million. Large: $1 million and less than $100 million. Very large: $100 million and over.

Source: ABS (*International Merchandise Trade, Australia*, December quarter 2002, Cat. no. 5422.0, p. 11).

Both regular and other exporters increased export sales substantially over the period. Regular exporters increased export sales by 10 per cent, from around $42 billion to nearly $46 billion (table 2.2). Firms that only exported in some years (ie other exporters) collectively increased their export sales (albeit from a low base) by 135 per cent, to reach $6.7 billion by 1997-98.

A significant proportion of the increase in export sales was associated with increased export intensity, that is, a higher export to total sales ratio (figure 2.6, right-hand column). Specifically, increased export intensity accounted for just under

25 per cent of the change in exports for regular exporters and 68 per cent for other exporters. The remainder of the increase was contributed by general increases in the scale of firm operations, as measured by the value of their total sales.

A further decomposition of export growth by survey year shows that the contribution of general sales growth and changes in export intensity varied substantially from year to year (figure 2.6, left-hand columns). For example, the major contributor to export growth from 1994-95 to 1995-96 was the substantial increase in the export intensity of regular and other exporters. In later years, export growth was sometimes less than general sales growth, suggesting lower export intensity (for the surveyed firms).

Table 2.2   Total exports, sales and export intensity, 1994-95 to 1997-98[a]

	1994-95	*1995-96*	*1996-97*	*1997-98*
National exports ($ billion):	87.7	99.1	105.2	113.7
Business Longitudinal Survey (MURF)				
Number of firms (000):				
Regular exporters[b]	8.0	7.6	7.6	7.6
Other exporters[c]	6.0	6.2	5.2	7.0
Exports ($ billion):				
Regular exporters[b]	42.0	46.2	45.3	46.4
Other exporters[c]	2.9	4.0	3.2	6.7
Sales ($ billion):				
Regular exporters[b]	150.9	154.1	156.0	162.8
Other exporters[c]	74.5	89.2	96.7	97.1
Export intensity:[d]				
Regular exporters[b]	28%	30%	29%	29%
Other exporters[c]	4%	5%	3%	7%

a Based on BLS sample data weighted to form population totals. The weights used were those assigned to each firm by ABS sampling procedures. **b** Regular exporters: firms that exported in every year of the BLS. **c** Other exporters: firms that were surveyed for all four years of the BLS, but did not export every year. **d** Export intensity: the percentage contribution of exports to total sales.

Sources: ABS (*Australian National Accounts: National Income, Expenditure and Product*, Cat. no. 5206.0 in EconData dX database 5206-55) and estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

Figure 2.6   **Contribution of changes in firm scale and export intensity to export growth[a][b]**
$ billion
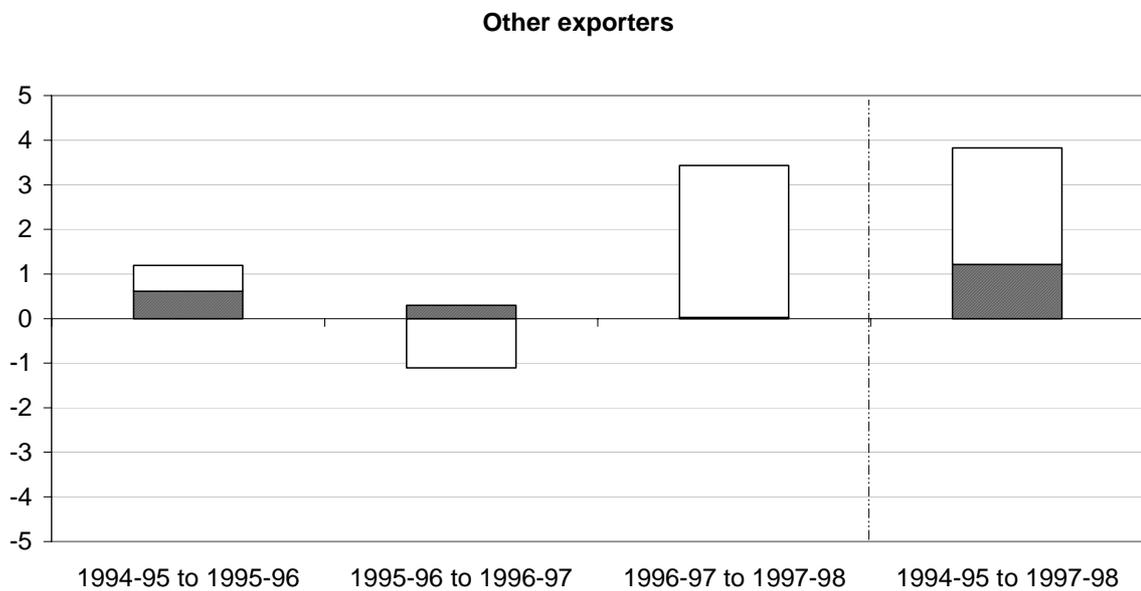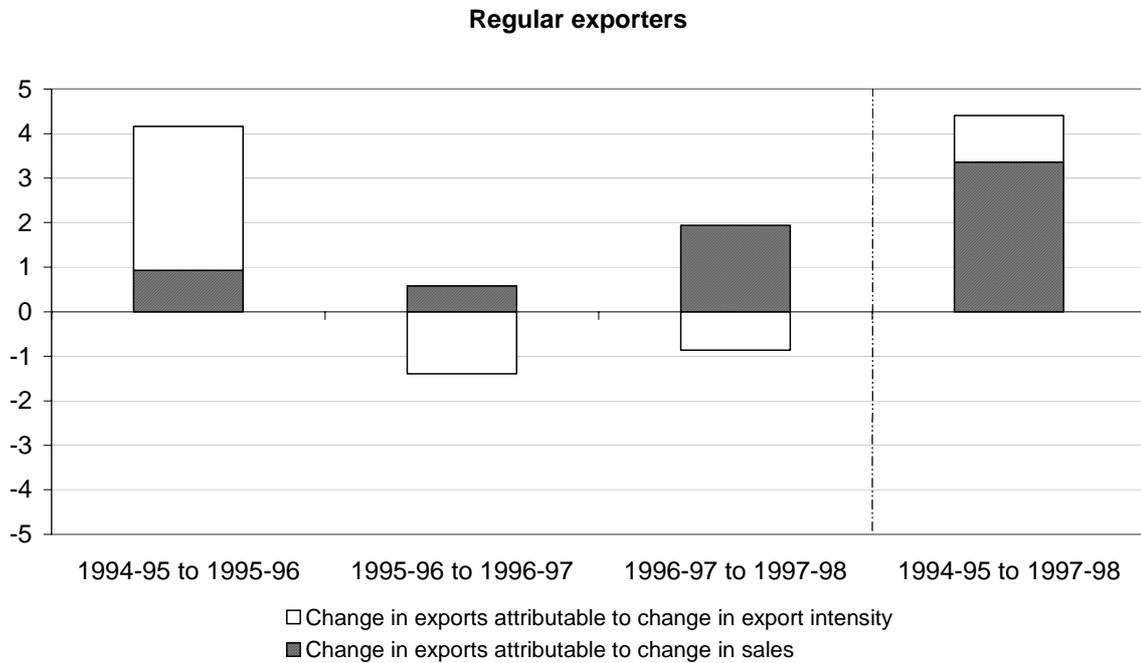
Regular exporters

☐ Change in exports attributable to change in export intensity
■ Change in exports attributable to change in sales

Other exporters

a Based on BLS sample data weighted to form population totals. The weights used were those assigned to each firm by ABS sampling procedures. **b** Regular exporters: firms that exported in every year of the BLS. Other exporter: firms that were surveyed for all four years of the BLS, but did not export every year.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

2.4 Summing up

The last two decades have witnessed substantial changes in the level and composition of global exports. The available evidence suggests that export volumes have increased ahead of global production. Trends in exports from Australia have broadly corresponded with international trends. In particular, exports of manufactures and services have increased in importance and now make up nearly half of the value of Australian exports.

Recent evidence indicates that most of Australia's exports are contributed by a relatively small number of very large exporters. Nevertheless, there is a large number of small to medium sized exporters that collectively contribute less than 5 per cent of exports by value. The more significant contributors to exporting also appear to be regular exporters. In line with national trends, micro-data suggest that firms' export intensity increased over the four years to 1997-98.

3   Selected empirical studies

This chapter briefly outlines the summary findings of selected empirical studies of the relationship between firm size and export performance.

3.1   Main findings

Several major reviews of the empirical literature on firm size and export performance have been undertaken (eg Bilkey 1978, Aaby and Slater 1988, Miesenbock 1988, Zou and Stan 1998 and Roper and Love 2002).

These reviews identify over 60 studies that look at, among other things, the link between firm size and export performance. The empirical methods have typically focused on explaining the relation between export performance and a single firm-size variable, after controlling for other firm-specific factors. The measures of exports investigated include export intensity and the value of exports, while the measures of overall firm size examined include total sales, the number of employees or total assets. Firm-specific control variables have varied widely between studies and have included factors such as kind of activity, firm research and development, innovation, management and marketing practices, and market conditions. Virtually all of the studies deal with manufacturing industries and most are from the United States. The studies have been undertaken over a long period and have significant differences. No single or standard methodology appears to have emerged.

The majority of studies reviewed show a positive and statistically significant relationship between measures of firm size and export performance (table 3.1). Nevertheless, some studies found no statistically significant relationship, while others suggest a negative relationship between firm size and export performance.

Most of the studies identified in the literature that find a positive and statistically significant relation between absolute measures of firm size and exporting do not appear to explicitly control for possible 'unobservable' firm-specific factors. Failure to control for such factors (eg by the use of panel data techniques) may have resulted in attributing to firm size (and other explanatory variables specified in analyses) a degree of influence that should rightly be attributed to other (unspecified) factors.

Differences also exist between studies not covered by the above reviews. For example, Pant (1993) found that the probability of exporting in the Indian chemicals and machinery industries *increased* with firm size (as measured by annual sales), while the export intensity *decreased* with firm size, as larger firms focused on meeting domestic demand. Athukorala, Jayasuriya and Oczkowski (1995) found a similar result for manufacturing firms in Sri Lanka.

One concern for drawing inferences from the wide range of available studies is the potential sensitivity of results to differences in firm circumstances and the methodology applied. These issues were examined by Roper and Love (2002) in a study of United Kingdom and German manufacturing firms. They found a positive, and generally statistically significant, relationship between export intensity and employment in both countries. However, they also found that these general results did not hold for 'innovative' United Kingdom firms, suggesting that other factors were more important to export performance than their measure of firm size.

The reviews identified one study of Australian exporters — Atuahene-Gima (1995). This study found no relationship between firm size measured by annual sales and export performance, after controlling for a range of other firm and product factors (eg R&D intensity, international experience, and the domestic market performance of new products). It used cross-sectional data drawn from a survey of firms in the Dun and Bradstreet directory. The study found domestic market performance of new products to be less important in explaining export performance of firms than firm characteristics.

3.2 Possible non-linear relationships between firm size and exporting

The theoretical literature suggests, among other things, that the presence of fixed costs associated with exporting may mean that export performance could improve with firm size up to some point, but thereafter remain stable or decline — that is, the relationship between export performance and firm size could be non-linear. While most empirical studies reviewed do not examine this issue, some support for the presence of a non-linear relationship is provided by Schlegelmilch and Crook (1988) and Wagner (1995) in studies of British mechanical engineering firms and 700 German manufacturing firms, respectively. Essentially, these studies found hyperbolic non-linear relationships between export intensity and firm size (as measured by sales or employment, respectively).

Table 3.1 **Summary of the empirical studies**
Number of studies

	Relationship between firm size and export performance			
	Positive	None	Negative	Total
1. Reviews identifying measure of export performance:				
Aaby and Slater (1988)				
Probability of exporting	3	na	0	3
Value of exports (level)	1	na	1	2
Export intensity	6	na	1	7
Export growth	1	na	1	2
Total	*11*	*na*	*3*	*14*
Zou and Stan (1998)				
Export sales (financial)[a]	2	8	2	12
Export profit (financial)	0	2	3	5
Export growth (financial)	1	5	0	6
Success (non-financial)	0	1	0	1
Satisfaction (non-financial)	1	1	0	2
Goals achieved (non-financial)	1	3	0	4
Composite	4	3	0	7
Total	*9*	*23*	*5*	*37*
2. Reviews identifying measures of firm size:				
Miesenbock (1988)				
Employment	19	2	0	21
Total sales	9	4	1	14
Total	*28*	*6*	*1*	*35*

a Includes studies using the value of exports or export intensity as the measure of export performance.

Sources: Assessments based on Aaby and Slater (1988, pp. 10–5), Miesenbock (1988, p. 46), and Zou and Stan (1998, p. 347).

3.3 Summing up

Overall, a substantial literature has emerged on the relationship between firm size and export performance. This literature has focused on various measures of the 'absolute size of firms' measured in terms of factors such as firm employment and sales.

However, we are not aware of *any* study that addresses explicitly the relationship between a firm's sales to the domestic market and its export performance, an issue underlying the proposition being examined in this study that '… to succeed internationally an Australian firm will generally need a large domestic base'.

4   Size in the domestic market, firm size and export performance

This chapter uses information from the Business Longitudinal Survey (BLS) to assess the relationship between the size of firms' domestic base, overall firm size, and exporting by manufacturing firms.[1] Domestic-market sales is used as the indicator of firms' domestic base, while total sales, employment and total assets variously indicate overall firm size. Regression analysis is used to separate the possible influence of size from that of other factors (box 4.1).

4.1   Export participation

The BLS Main Unit Record File (MURF) adopted for this study provides details for a sample of over 1500 manufacturing firms that individually operated in Australia over the four survey years from 1994-95 to 1997-98.[2] Of these firms, over 460 exported in each of the four years (regular exporters) and an additional 320 firms exported in at least one year (other exporters).

After weighting to represent the population as a whole, data from the BLS sample show that the proportion of manufacturers that undertook some exporting increased with the size of firms' domestic-market sales (figure 4.1). For example, in the highest domestic sales decile, over 60 per cent of firms were exporters compared to around 5 per cent of firms in the lowest decile. Furthermore, in all domestic sales deciles, a significant proportion of exporters did so in every year. Even for lower-size deciles, for which the proportion of manufacturers exporting is significantly

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[1] The BLS provides information about firm performance, as well as information about firm age, organisational characteristics, product innovation, business conduct and changing business practices. It also provides information on the value of goods and services exported directly, total business capital and employment.

[2] The MURF contains all unit record data collected in the BLS. The file is not available publicly and the results presented in this study are based on analyses undertaken by the ABS using specifications provided. The MURF is complemented by a Confidentialised Unit Record File (CURF), which is a public release unit record file (ABS 2000). The CURF contains confidentialised data on firms employing 200 persons or less.

lower than for other deciles, a significant proportion of exporting firms exported regularly.

Box 4.1   Framework for the regression analysis

Factors influencing the decision to export vary between firms and from year to year for individual firms. To capture the effects of both influences, it is desirable to cover a cross-section of firms and to observe the activity of individual firms over a number of years.

By covering the four-year period, 1994-95 to 1997-98, the BLS lends itself to analyses that take into account both variability between firms and variability of individual firms between years. The comprehensive coverage of financial performance, operating and organisational features of firms reinforces the usefulness of this data source.

Data for a sample of manufacturing firms drawn from the BLS and operating for the four years were used to support two types of regression analysis. First, the information was 'pooled' to support a binary choice analysis which looked at the influence of firm size on the likelihood of firms exporting, the likelihood of firms being regular exporters and the likelihood of exporting firms being regular exporters. This analysis uses a regression technique known as logit analysis.

Secondly, the information was used to support a 'panel' analysis of the relationship between firm size and the level and intensity of exporting. The panel analysis provided a means for controlling for firm-specific effects (box 4.2), that is, unobservable omitted variables and possible biases arising from any correlation between observed explanatory variables and unobservable firm-specific effects. A choice between alternate panel estimators, which reflect different assumptions about the nature of these effects, was made on the basis of formal statistical tests (see appendix C).

A variety of approaches are suggested by the relevant literature concerning the choice of control variables for inclusion in the analysis. For example, some studies look at the relationship between firm size and export performance after controlling for firm characteristics (eg firm age), while others control for financial characteristics (such as financial or operating ratios). After experimentation, a combination of the two approaches was used for this study, with individual control variables being selected on the basis that: (a) data were available for each of the four years; and (b) that the coefficient on the variable was statistically significant. An important outcome of this process was that the sign and significance of coefficients on firm size were not sensitive to the selection of control variables.

Details of the control variables considered and final variables included in the models presented in this chapter are provided in appendixes B and C.

Figure 4.1   Incidence of manufacturing exporters by domestic sales decile, 1997-98[a][b]

Per cent of firms in each decile
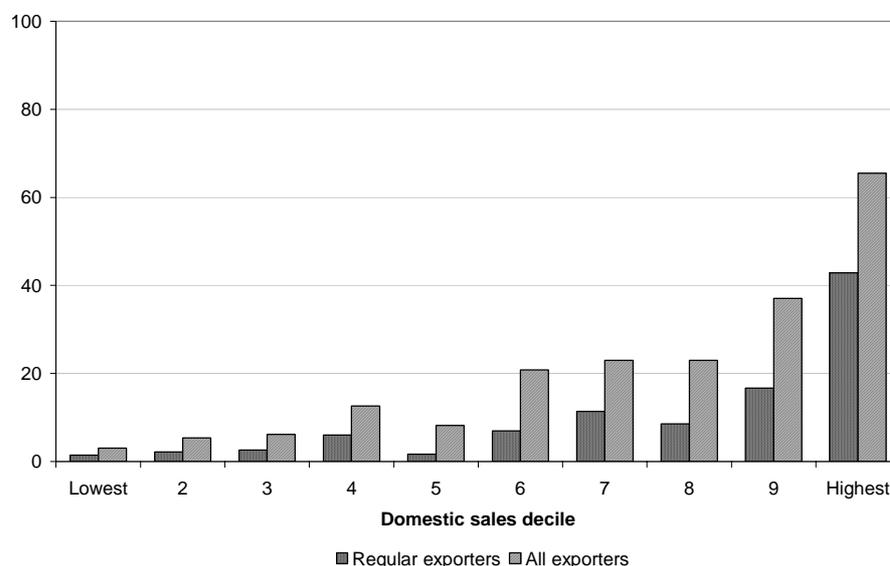
[a] Regular exporters: firms that exported in each year over the period 1994-95 to 1997-98. All exporters: firms that exported in at least one year (including regular exporters). [b] Firms' contributions weighted by their BLS sample weight.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

However, this analysis does not take into account the effect of the wide range of factors beyond the firm's domestic market base that may have had a bearing on the threshold question of whether or not the firm participated in exporting. To control for these factors, the analysis was extended to formally examine the importance of size in influencing the likelihood (or probability) of:

- *a firm* exporting against not exporting;

- *a firm* exporting in *each* year against not exporting in each BLS year (including firms that did not export in any BLS year); and

- *an exporter* exporting in *each* year against being a less frequent exporter.

To do this, binary choice regression analysis was used in which the dependent variable is an indicator of whether a firm participated in exporting or not. The independent variables upon which export participation was considered conditional included the size of a firm's domestic-sales base (or a measure of absolute firm size) and a range of other firm-specific factors suggested by the literature as increasing the likelihood of export participation. The characteristics and rationale for their inclusion are outlined in appendix B.

After controlling for the influence of relevant factors, the likelihood of a firm exporting and of a firm being a regular exporter increased with *domestic sales* (table 4.1). In addition, the likelihood of an exporter being a regular exporter also increased with *domestic sales*.

Separate regression analyses also indicated that the *likelihood* of exporting generally increased with overall firm size for all three measures of firm size considered (table 4.1) — a finding similar to other overseas studies (see chapter 3).

There may be considerable uncertainty about which non-size characteristics may be relevant to identifying firms that export, distinguishing between regular and other exporters, and identifying the direction of causality between such factors and exporting. While not the focus of this study, the analysis of the BLS provides some insights into these issues (appendix C). For example, in the context of export participation, of the range of non-size factors considered in the regression analysis, two items — whether the firm received government export assistance and the extent of foreign ownership — stood out as having a positive and significant association with export participation in all regressions.[3]

Table 4.1   **Responsiveness of manufacturing firms' export participation to firm size, 1994-95 to 1997-98**
Four-year pooled logit regressions

		All firms		Exporters
Specif-ication [a]	Size variable	Likelihood of exporting against not exporting	Likelihood of exporting regularly against not exporting regularly	Likelihood of exporting regularly against other exporting[b]
	Domestic base			
1	Domestic sales	+	+	+
	Firm size			
2	Total sales	+	+	+
3	Employment	+	+	+
4	Total assets	nss	+	+

+ a positive relationship between export participation and firm size that is statistically significant at a 10 per cent level. **nss** not statistically significant.

a Each model includes only one size variable plus selected non-firm size explanatory variables. For the model outline and detailed results, see appendix C. **b** Other exporting: exporting firms that did not export in all years.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

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[3] Revesz and Lattimore (2001) also found a positive association between participation in selected government export assistance programs and total exports using BLS data. In analysing this result, the authors suggested, among other things, that there may be a 'selection bias' problem to the extent that program selection procedures may favour firms that would succeed in exporting independently of the programs.

4.2 Extent of export involvement

The extent of firms' involvement in exporting can be evaluated in terms of the *level* of their export sales. BLS data indicate that the average value of exports by regular exporters and all exporters generally increased with sales to the domestic market (figure 4.2). That is, manufacturing exporters with a larger domestic base also tended to export more. Nevertheless, there was a significant number of manufacturing firms with a small domestic base that also had substantial exports not evident in this aggregate analysis (see appendix C).

The extent of firms' involvement in exporting can also be evaluated in terms of export *intensity*, which is a measure of export sales relative to total sales. BLS data indicate that the export intensity of regular exporters was greater than the average of all exporters for each domestic sales categories (figure 4.3). These data also indicate export *intensity* had a tendency to decline as the *level* of domestic sales increased. This suggests that, although the scale of their overall operations was clearly bigger, some larger firms that exported tended to export a smaller proportion of their overall output than did smaller firms that exported. One possible explanation is that, given the presence of non-trivial fixed costs associated with exporting, smaller firms face a greater imperative than do larger firms to focus on either supplying the

Figure 4.2 **Average value of manufacturing exports by domestic sales decile, 1997-98[a][b][c]**

$ million
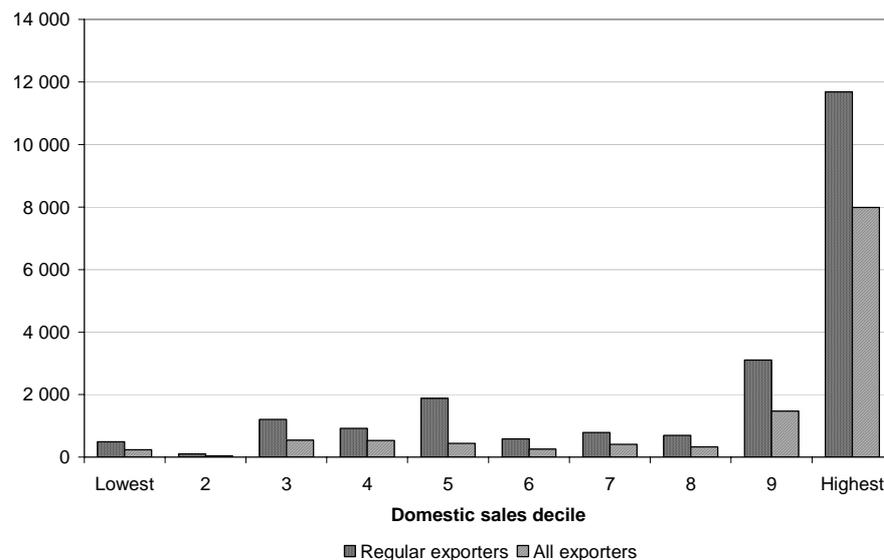
[a] Average value of exports per exporting firm in each decile. [b] Regular exporters: firms that exported in each year over the period 1994-95 to 1997-98. All exporters: firms that exported in at least one year (including regular exporters). [c] Firms' contributions weighted by their BLS sample weight.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

Figure 4.3   **Average export intensity of manufacturing exporters by domestic sales decile, 1997-98[a][b][c]**
Per cent

Domestic sales decile

■ Regular exporters ■ All exporters
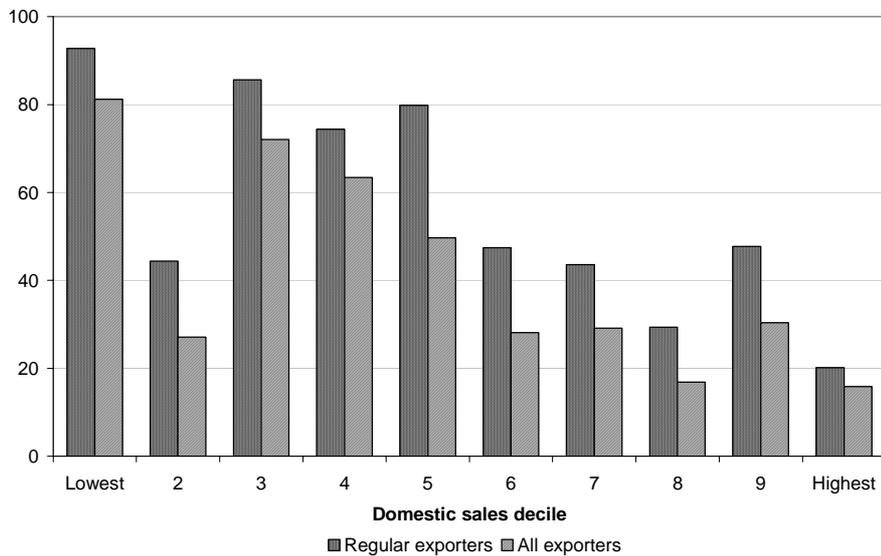
a The value of exports divided by value of sales in each decile for regular and all exporters, respectively. **b** Regular exporters: firms that exported in each year over the period 1994-95 to 1997-98. All exporters: firms that exported in at least one year (including regular exporters). **c** Firms' contributions weighted by their BLS sample weight.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

domestic or export market. If they decide to export, smaller firms must then make a greater relative commitment to exporting than larger firms. On the other hand, larger firms may find sufficient demand for their product lines in domestic and export markets to cover the fixed costs associated with each market segment. Furthermore, by virtue of their size, larger firms may be better placed to diversify their country-specific risk by supplying both the domestic and export markets.

Another factor contributing to the very high export intensity of firms in the lower domestic-sales deciles was the incidence of firms that were large in an overall sense, but, as they specialised in exporting, they made minimal sales to the domestic market.

However, factors other than the domestic base also affect the extent of exporting. The above simple correlations risk attributing effects to firm size that should be attributed to other factors. To control for these factors, the analysis is extended to formally examine the importance of size in influencing:

- the *value* of exports (exporting scale); and

- the *share* of total sales accounted for by exports (export intensity).

Panel data methods were used to estimate both regressions. The panel ('fixed effects') estimator adopted took into account both observed firm-specific characteristics and 'unobserved' characteristics (box C.2).[4] The regression analysis focused on regular exporters because of their predominance in manufacturing exporting.

After controlling for the effect of other factors and unobserved firm-specific and, where appropriate, time-specific effects influencing export performance, the regression analysis indicates:

- no statistically significant relation between domestic sales size and the *value* of exports of regular manufacturing exporters; and

- a *negative* and significant relationship between the domestic sales of regular manufacturing exporters and the *intensity* of exporting (table 4.2).

Box 4.2   **Gauging the effect of unobservable firm-specific factors**

Potentially, there are many factors affecting a firm's export performance that are not recorded in the statistical series used in this analysis. A failure to recognise these factors in any analysis reduces the overall usefulness of that analysis and may, under certain circumstances, lead to biased results. In order to control for the possible influence of these 'unobserved' firm-specific factors and to estimate their effect in aggregate, panel data techniques are used.

The panel data techniques outlined in box 4.1 used in this study (known as fixed effects) add a 'dummy variable' for each firm to the regression model. This firm-specific dummy variable takes on a value of 1 for a particular firm in each year and 0 for all other firms. Each firm-specific dummy variable picks up the combined effect of all of the unspecified factors affecting that firm that are constant across each time period.

Additional time-specific dummy variables for each year were also tested in each model. This time-specific dummy variable takes on a value of 1 in a particular year and 0 for all other years. Each time-specific dummy variable picks up the combined effects of all of the unspecified factors in that year that are constant across all firms.

Formal statistical tests were used to select whether the regression models presented in this study contain firm-specific and/or time-specific dummy variables.

These techniques assume that the unobserved firm-specific and time-specific effects are uncorrelated with the error of the estimates and with each other. These techniques and their application in this study are discussed in more detail in appendix C.

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[4] The estimator used for the export intensity models also took into account time-specific factors (see appendix C).

These results are consistent with those presented in figure 4.3 for export intensity, but appear at variance with those relating to sector averages in figure 4.2. However, the regression analysis indicates that the domestic sales variable in figure 4.2 is picking up the positive effect that should be attributed to the firm-specific factors controlled for in the regression analysis.

The regression analysis also indicates that the value of exports increases with *total sales size*, although the estimated (positive) relationship between the value of exports and employment or asset size is not statistically significant at conventional levels (table 4.2, appendix C). These results do not conflict with the majority of the available overseas studies identified in the reviews of the literature discussed in chapter 3 that found a positive (and, in their case, generally significant) relation between *overall* firm size and exporting. However, the regressions do not find any evidence of export intensity increasing with *total firm size* for the three measures of absolute size considered (table 4.2, appendix C).

Table 4.2 **Responsiveness of manufacturing firms' export involvement to firm size, 1994-95 to 1997-98**

Regular exporters, four-year panel regressions, fixed effects

Model[a]	Size variable	Value of exports	Export intensity
	Domestic base		
1	Domestic sales	nss	-
	Firm size		
2	Total sales	+	nss
3	Employment	nss	nss
4	Total assets	nss	nss

+/- a positive (negative) relationship between export involvement and firm size that is statistically significant at a 10 per cent level or above. **nss** not statistically significant.

a Each model includes only one size variable plus selected non-size explanatory variables. For model outline and detailed results, see appendix C.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

4.3　The relative importance of firm size

The possible importance of domestic sales size relative to other factors was gauged using sensitivity tests in which different assumptions were made about the importance of individual variables. Two sensitivity tests were undertaken:

- the first assumed all unobserved firm-specific characteristics correlated with domestic sales size were dependent on size alone. This scenario provided a measure of the maximum impact of size on the value of exports; and

- the second assumed all unobserved firm-specific characteristics were independent of size (although domestic size may depend on those factors). This scenario provided a measure of the minimum impact of size on the value of exports and aligns closely with the fact that domestic sales was found to be statistically insignificant after controlling for other factors.

Analysis based on these sensitivity tests indicates that, at best, domestic sales size explains only about one third of the variability in the value of exports by regular Australian manufacturing exporters (figure 4.4, bar 2).[5] This scenario could suffer from the limitation that it attributes effects to firm size that rightly should be attributed to other factors, and that the relative importance of firm size might have been lower. The second test suggests that domestic sales explained very little of the variability in export values after controlling for all other factors.

On the other hand, like some of the other studies referred to in chapter 3, this study found that other firm-specific factors are important determinants of the likelihood of a firm exporting and the degree of export involvement. More particularly, it suggests that export performance is primarily explained by unmeasured firm-level characteristics (col. 1), which might include the quality of firm-specific assets and management, rather than the more easily measured characteristics of the firm such as firm size and the size of its sales to the domestic market.

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[5] The analysis is based on model 1 for the value of exports (table 4.2) augmented by a general measure of overall firm size (ie total employment). The formulation adopted investigates the possibility that either domestic size and/or overall size brings intrinsic advantages that enable firms to sell on export markets (chapter 1). It takes advantage of the fact that measures of size are not perfectly correlated and assumes that, if the intrinsic advantages they confer are significant, they would be reflected through the contribution of each measure of size to between-firm variability in export sales.

Figure 4.4
Estimated contributions to the *variation* in exports between manufacturing firms, 1994-95 to 1997-98[a][b]

Regular exporters, per cent
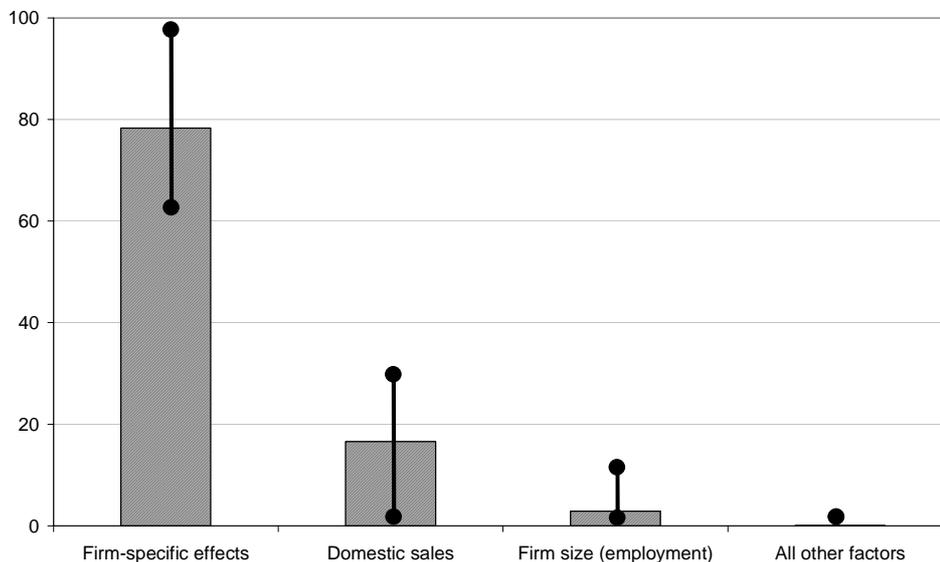
●――――● Estimated maximum and minimum values. See note b.

a Analysis based on model 1 (table 4.2) augmented by a general measure of overall firm size (ie total employment). **b** It is not possible to directly observe the contribution of each factor listed to export involvement. The values reported are the arithmetic average of results from two scenarios — one that assigned the highest possible weight to unobserved firm-specific characteristics and one that assigned the highest possible weight to domestic sales size. The values reported reflect the change in the coefficient of multiple determination (R^2) from the respective scenarios obtained by progressively adding the firm-specific dummies (domestic sales), employment, all other statistically significant explanatory variables and domestic sales (firm-specific dummies) to the value of the exports equation for regular manufacturing exporters.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

4.4 Summing up

Around half of the over 1500 manufacturing firms investigated in this study undertook some exporting over the four year period to 1997-98. Some 460 of these firms exported in each year.

Overall, firms with a larger domestic base also tended to be more involved in exporting. Exporters also tended to have a larger overall size, as indicated by the value of their total sales, employment and/or business assets.

However, further analysis that takes account of a range of factors that may influence export performance suggests that, while overall size generally is positively related to exporting for the sampled firms, other firm-specific factors are likely to be much more important. Once these broader influences are taken into account, the analysis

suggests that the scale of a firm's domestic base is not significantly related to the level of exporting and is negatively related to the intensity of exporting.

These results provide support for the view that, to be successful internationally, firms must develop specialist skills and possess some competitive advantage that makes it feasible for them to overcome the inherent advantages enjoyed by rival firms located overseas.

The results do not appear to support the general proposition that, to succeed internationally, a firm first needs to secure a large domestic base. Potentially, concentration on securing a domestic base, while possibly best suited to a firm's skill level and product range, may not help exporting.

Further research is needed to assess the nature and extent of simultaneous relationships between export performance, firm size and other firm-specific factors that provide a competitive advantage for exporting. Such information would help in identifying the direction of causality between firm size and export performance. It would also help in developing better theoretical models that can be tested empirically.

A   Firm-level data source

This appendix provides an overview of the BLS and data screening undertaken to prepare the BLS firm-level data for analysis.

A.1   Business Longitudinal Survey

The BLS was conducted by the ABS to establish a data set for the analysis of the growth and performance of small to medium-size enterprises in Australia. A primary aim of the BLS was to gather detailed firm-level information on growing businesses with an innovation and export focus. The BLS was conducted over the financial years 1994-95 to 1997-98. In the 1994-95 phase of the survey, around 9 000 live responses were collected. In later phases and after further stratification of firms, between 5 000 and 6 000 live responses were collected. A panel of over 4 000 firms operated for all four years of the survey.

The BLS:

- provides a comprehensive range of information across all survey years on firm performance, involvement in exporting, product innovation, business practices, business restructuring and reorganisation, and training;

- provides information on employment in firms, industrial relations and manager qualifications;

- provides information on total business capital;

- provides information on firm entry and exit; and

- covers firms in 11 industry sectors (table A.1). It excludes all government business enterprises, non-employing businesses, and businesses in the Agriculture, Electricity, gas and water supply, Communication services, Education, and Health and community services industries. Nevertheless, exports originating from these industries undertaken by businesses in other industries may be recorded in the BLS (eg agricultural product exports undertaken by businesses in the Wholesale trade industry).

Table A.1   **Industry coverage of the BLS**

Industries covered by the BLS	Industries/activities not covered by the BLS
Mining	Agriculture, forestry, fishing & hunting
Manufacturing	Electricity, gas & water supply
Construction	Communication services
Wholesale trade	Government administration & defence
Retail trade	Education
Accommodation, cafes & restaurants	Health & community services
Transport & storage	Libraries, museums & parks and gardens (ANZSIC groups 921, 922, 923 from division P)
Finance & insurance	
Property & business services	Other services and Private households employing staff (ANZSIC subdivisions 96, 97 from division Q)
Cultural & recreational services	
Personal & other services	*plus*
	'Non-employing' businesses
	Units classified to the general government institutional sector (although Public Trading Enterprises of in-scope sectors were included)

Source: ABS (2000).

Details of information provided in the BLS are published in ABS Cat. no. 8141.0.30.001 (ABS 2000).[1] A detailed description of aspects of the BLS is provided in Will and Wilson (2001).

The information on firm-level exports and performances makes the BLS particularly suited to the current study.[2]

All activities covered in the BLS were used to provide the broad analyses reported in chapter 2. The more detailed analyses reported in chapter 4 focused on manufacturing exporters. As it primarily focuses on manufacturing firms, the current study is concerned with exports of goods and, in so doing, avoids the problem that the BLS significantly understates exports of services (eg sales of services to overseas visitors and the limited industry coverage) (Pink and Jamieson 2000, p. ix).

BLS unit record data is arranged in two data bases. One data set contains all unit record information collected in the BLS. This file is referred to as the Main Unit Record File (MURF) and contains data on small and larger firms. It is not available publicly to preserve the confidentiality of data provided by individual firms and is

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[1] This publication applies to the CURF. Nevertheless, many of the details are also (but not entirely) applicable to the MURF. The ABS advised of the responses taken by the relevant variables only on the MURF.

[2] The BLS contains firm performance and firm size information not available from alternative firm-level data sets, such as the Australian Workplace Industrial Relations Survey.

held only by the ABS. The MURF is complemented by the Confidentialised Unit Record File (CURF), which is available from the ABS (2000). The 'confidentialised' file removes or alters selected data from the MURF to protect the identity of the respondents. As a result, the data on the CURF is restricted to management units (firms) employing 200 people or less and perturbed (rather than actual) financial data. It also excludes some of the classificatory and other information contained on the MURF (eg foreign ownership characteristics).

This study used the CURF to develop and refine analytical tables and regression analyses. The ABS then ran these models on the MURF to obtain the final results included in this study (see appendix C).

Screening of the BLS unit record data

The data set used for the regression analysis focused on manufacturing firms that were surveyed for all four years.

Despite the substantial review and editing of the BLS data set, the current study encountered data at the unit record level that did not satisfy the study's requirements. Accordingly, manufacturing firms were screened for:

- firms with negative or zero sales;
- firms with negative or zero total employment;
- firms with negative or zero total assets;
- firms with negative or zero wages;
- firms with negative exports; and/or
- firms with exports greater than their total sales (ie the firm had an export intensity greater than one).

In addition, a small number of outliers found only on the MURF with purchases over twice total sales (ie _puratio > 2) and that were older than 2 years of age were excluded from the analysis.

When a firm was identified as having inconsistent data in a particular year, *all* data for that firm in *that* year were removed from the sample (but not for other years).

Overall, the selection and screening process yielded a data set used for the regression analysis that contained in excess of 1500 manufacturing firms that operated for all four years of the survey (providing over 6000 observations available

for analysis).[3] The number of firms, exports and total sales of firms included in the analytical sample, on an unweighted and weighted basis, are reported in table A.2 by survey year.

Table A.2   **Coverage of screened data set, 1994-95 to 1997-98**

	1994-95	*1995-96*	*1996-97*	*1997-98*
Number of firms				
Unweighted	1 520	1 520	1 513	1 514
Weighted	17 691	28 604	28 189	28 749
Exports ($ million)				
Unweighted	5 522	5 957	5 521	5 710
Weighted	17 711	17 462	16 649	17 682
Total sales ($ million)				
Unweighted	37 245	38 784	38 678	40 165
Weighted	125 786	135 985	137 116	141 576

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

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[3] As part of the regression analysis, this sample was further screened for observations with missing data. The number of observations in the final regressions were, therefore, lower than 6000 observations.

B   Variables from the Business Longitudinal Survey

Table B.1 of this appendix lists the items measured in the BLS (or derived from BLS data) used in the regression analyses of this study. Data for these items are available for the four BLS years. Table B.2 lists BLS items potentially relevant to evaluating the export performance of firms that were not included in the regression analyses. These variables were excluded because the BLS does not contain information for all four years or because the item values were effectively constant over the survey period.

B.1   Variables used in regression analyses

The variables in table B.1 are divided into two groups:

- dependent variables, which reflect firms' export participation or the extent of their export involvement; and

- independent variables, which represent identifiable firm-specific characteristics pertinent to export performance.

Dependent variables

The choice of dependent variable in each regression was defined by the analytical question being asked. For example, the question: 'is a firm's domestic base important to whether or not it exports?' suggested a dummy variable indicating whether the firm exported or not (*_xexist*) as the dependent variable. The dependent variables used are either:

- binary (whether a firm exported or not (*_xexist*), or whether a firm exported regularly or not (*regular*)); or

- continuous (the value of exports (*_exports*), or export intensity (*_expint*)).

Independent variables

The independent variables considered are those suggested by the literature for which data items (or proxy items) are available for each BLS data year. However, as the literature on firm involvement in exporting does not provide a single unified and empirically testable theory on factors influencing export participation or the extent of export involvement, specifications for the regression models used in this study were derived empirically, bearing in mind the objectives of the study. Under this approach, the variables were selected from the list of possible items provided in table B.1. The aim of the selection process was to include items that were statistically significant.[1]

The selection procedures were applied to the BLS Confidentialised Unit Record File (CURF) made available by the ABS to the Commission for model development and preliminary analysis (appendix A). The models developed on the CURF were then provided to the ABS for estimation using the BLS Main Unit Record File (MURF), which also contains firm-level records not included in the CURF for confidentiality reasons. The models estimated on the MURF also include some additional variables that were not on the CURF (eg foreign ownership) to see if they were significant. The transfer of the analysis from the CURF to the MURF potentially could lead to changes in the statistical significance of items considered for inclusion in the regression analysis as independent variables. It was not practicable to investigate the extent of this possibility. Any substantial changes in the significance of specified items are noted in the detailed results reported in appendix C.

The analysis involved the application of cross-section binary choice and panel data estimators. The selection procedures applied in the respective models are:

- the firm-size variable of interest was included in the specification of each regression by definition. Domestic sales was used as the measure of firms' domestic base. Total sales, employment (measured in full time equivalent units) and total assets were used as indicators of overall firm size;

- the binary choice models were specified using a general-to-specific approach on the CURF, by which items that were not statistically significant at conventional levels were progressively dropped to leave only explanatory variables that were individually significant. Consideration was given to the inclusion of eight industry-subdivision dummy variables to represent unobserved (in the BLS) industry-specific fixed effects (ie factors external to the firm, such as sectoral

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[1] Because the analysis does not invoke a formal theory and the models derived by the procedures outlined are reduced form, it is possible that there may be simultaneous relations between variables that are not reflected in the empirical analysis. This potential problem also applies to other studies investigating the relation between firm size and export performance.

export orientation due to availability of raw materials or other specialised inputs). However, the final specification did not include subdivision dummies because the broadly defined subdivision classification (eg food, beverages and tobacco products, and machinery products) did not provide a clear basis for distinguishing between groups of firms characterised by such effects or unobserved firm-specific factors; and

- the panel data estimator with fixed effects was applied to the continuous variable models. Independent variables were then selected using a general-to-specific approach on the CURF, by which items that were not statistically significant at conventional levels (based on their t-statistic) were progressively dropped to leave only explanatory variables that were individually significant.

As the explanatory variables measure characteristics pertaining to firms in each BLS year, the models estimated in this study do not explicitly take into account lagged or dynamic effects on export performance (ie additional to effects coincidently covered by contemporaneous variables and fixed effects, or included in the estimator error term). The final models and detailed results are reported in appendix C.

B.2   Additional analysis

As mentioned, table B.2 lists variables that may be of interest in analysing export performance that were not included in the panel data regression analyses for technical reasons (because they were correlated with firm-specific fixed effects) or data availability reasons (less than four years of data). Correlations between these variables and the estimated firm-specific effects obtained from the value of exports model and key measures of firm size are reported in appendix C.

Some variables appear in both tables B.1 and B.2. These items could not be included in the panel data regressions, as they are correlated with the firm-specific effects, but could be considered for the binary choice analysis (which is not characterised by a fixed effects estimator).

Table B.1 **Variables included in the regression analysis**

Variable	Mnemonic	How measured	Derivation/source	Comment	Expected sign
Dependent variables					
Does the firm export?	_xexist	Dummy variable (1=Yes; 0=No)	I if exports are > 0 in any year; 0 otherwise	Used in estimating the probability of exporting	
Does the firm export regularly?	regular	Dummy variable (1=Yes; 0=No)	I if exports are > 0 in all years; 0 otherwise	Used in estimating the probability of exporting regularly	
Value of exports	_exports	$000	BLS item	Total value of exports of goods and services	
Export intensity	_expint	Ratio	Exports / Total sales	Share of sales sold as exports	
Possible explanatory variables					
Measure of domestic base					
Domestic sales	_domsale	$000	Total sales – Exports	Proxy for domestic economic base	+/-
Measures of firm size					
Employment[a]	_totfte	full-time equivalents	Full-time employment + (0.43 x Part-time employment)	Most common measure of firm size used in empirical studies (although usually expressed as the number of employees)	+
Total assets	_totass	$000	BLS item	Alternative measure of firm size	+
Total sales (turnover)	_sales	$000	BLS item	Alternative measure of firm size	+
Firm characteristics					
Age of business	_age_a	Discrete variable (1=0 to < 2 years; 2=2 to < 4 years; 3=4 to < 6 years; 4=6 to < 8 years; 5=8 to < 10 years; 6=10 to < 12 years; 7=12 to < 14 years; 8=14 to < 16 years; 9=16 to < 18 years; 10=18 to < 20 years; 11=20 to < 22 years; 12=22 to < 24 years; 13=24 to < 26 years; 14=26 to < 28 years; 15=28 to < 30 years; 16=30+ years)	BLS item	Measure of experience and proxy for learning by doing *Hypothesis:* As older firms have greater experience, they are better able to establish themselves in global markets	+

(Continued on next page)

Table B.1   (continued)

Variable	Mnemonic	How measured	Derivation/source	Comment	Expected sign
Average wage rate	wagerate	$ per fte	Wages X 1000 / fte employment	Proxy for human capital, as average wages generally increase with skill *Hypothesis:* Firms with higher human capital are more likely to export	+
New business[b]	newbus	Dummy variable (1=Yes; 0=No)	Active firms that are less than 2 years old	Proxy for experience and freshness of management *Hypothesis:* Unclear. New firms have less experience and are less likely to export. Conversely, management of new firms are more dynamic, innovative and inclined to thinking globally	+/-
No. of business locations[b]	_buslocs	No.	BLS item	Measure of commitment to the domestic market and proxy for organisational economies of scale *Hypothesis:* Unclear. Firms with more domestic locations are less committed to exporting. Conversely, organisational economies of scale enhance export competitiveness by lowering unit costs	+/-
No. of generations that have operated the business[b]	genes	No.	BLS item	Measure of the longevity of management. Proxy for how dynamic the firm is, with longevity implying less dynamic *Hypothesis:* Firms with less dynamic managers are less likely to export	-
Foreign ownership	_foreign	Discrete variable (1=None; 2=Up to 10%; 3=11 to 49%; 4=50 to 100%)	BLS item (MURF only)	*Hypothesis:* Foreign subsidiaries are more likely to supply the domestic market than to export	-
Controlled a franchise system	_contfra	Dummy variable (1=Yes; 0=No)	BLS item (MURF only)	*Hypothesis:* Firms controlling franchises are more likely to supply the domestic market	-
Operated as a franchise	_operfra	Dummy variable (1=Yes; 0=No)	BLS item (MURF only)	*Hypothesis:* Firms operating franchise are more likely to supply the domestic market	-

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Table B.1 **(continued)**

Variable	Mnemonic	How measured	Derivation/source	Comment	Expected sign
Union membership (Estimated percentage of persons that were union members as at 30 June)	_unionme	Discrete variable (1=None; 2=Up to 10%; 3=11% to 25%; 4=26% to 50%; 5=51 to 75%; and 6=76% 100%)	BLS item	Proxy for degree of import replacement, as union membership historically higher in import replacement industries *Hypothesis:* Firms engaged in import replacement are less likely to export	-
No of unions representing employees at 30 June	_unionno	No.	BLS item (MURF only)	*Hypothesis:* The number of unions is likely to be higher in firms supplying the domestic market	-
Export marketing strategies					
Export markets targeted[c]	_mjcexp	Dummy variable (1=Yes; 0=No)	1 if _mjcexp=3 (increased); 0 otherwise	*Hypothesis:* Export sales increase as export markets targeted	+
Management					
Undertook comparisons with other business	_comperf	Dummy variable (1=Yes; 0=No)	1 if buscomp5=1, bpcom6=1, bpcom7=1 or bpcom8=1; 0 otherwise	Proxy for quality of management and spillovers from other firms *Hypothesis:* Firms with better 'quality' managers are more likely to export	+
Highest education level obtained by major decision maker[b]	educatn	Discrete variable (0=Not applicable/ no response 1=School 2=Trade 3=Tertiary)	BLS item	Proxy for management quality *Hypothesis:* Firms with better quality management are more likely to export	+
Business-related tertiary qualifications of major decision maker[b]	tertqua	Dummy variable (1=Yes; 0=No)	BLS item	Measures of tertiary qualifications of major decision maker are in business management, commerce or administration *Hypothesis:* Unclear. Firms whose major decision maker has business qualifications are financially stronger and more likely to export. Conversely, firms with decision maker with business qualifications are more risk adverse and less likely to export	+/-

(Continued on next page)

Table B.1   (continued)

Variable	Mnemonic	How measured	Derivation/source	Comment	Expected sign
Financial indicators					
Expense ratio	_puratio	%	Purchases / Total sales	Measure of firm value-added and proxy for firm-specific assets *Hypothesis:* Firms with higher value-added (lower purchases) per unit of sales are more likely to export	-
Return on assets	_asratio	%	(Derived profits + Interest expense) / Total assets	Proxy for the financial position of the firm *Hypothesis:* Firms that achieve higher rates of return on assets employed have a higher likelihood of exporting	+
Return on sales[d]	_ebratio	%	(Derived profits + Interest expense) / Total sales	Proxy for the profitability of export markets *Hypothesis:* Firms are more likely to export if export sales are expected to return more per unit of sales than sales to the domestic market	+
Government assistance					
Received export assistance from the government	expndx	Dummy variable (1=Yes; 0=No)	1 if firm receives any export assistance from any government;[e] 0 otherwise (MURF only)	*Hypothesis:* Firms receiving government export assistance are more likely to export	+
Received non-export assistance from the government	govtndx	Dummy variable (1=Yes; 0=No)	1 if firm receives any non-export assistance from any government;[f] 0 otherwise (MURF only)	*Hypothesis:* Firms receiving non-export assistance are more likely to supply the domestic market	-
Technology					
Capital intensity (per unit of labour)	kintens	$000 per fte	Total assets / fte employment	Proxy for economies of scale in production and per unit production *Hypothesis:* Capital intensive firms are more likely to export	+

a Number of part-time employees weighted by 0.43 to represent the average number of hours worked per week by part-time non-managerial employees on a full time basis (Bland and Will 2001, p. 16, based on ABS Cat. no. 6306.0). **b** Variables considered in binary choice regressions only as the absence of a time dimension means that they will be correlated with the firm-specific intercept in the fixed effects panel estimators. **c** Value for 1995 set to 1 if the firm exported in 1995 and undertook a major marketing campaign (*_mjcmark*=1). **d** Total profits and sales used, as the BLS does not contain information on the profitability of exporting. **e** Coverage of export programs varies from year to year, but includes, where recorded, Export finance and insurance corporation facilities, Export access, Export market development grants (EMDG), International trade enhancement scheme, and Other Austrade services. **f** Coverage of other government programs varies from year to year, but includes, where recorded, National Industry Extension Service (NIES), Research and development tax concession, Grants for research and development, New enterprise incentive scheme (NEIS), Best practice demonstration program, and Other Commonwealth and State programs.

Sources: ABS (BLS, Confidentialised Unit Record File, 1994-95 to 1997-98, Cat. no. 8141.0.30.001) and advice from the ABS.

Table B.2 **Other possible explanatory variables**

Variable	Mnemonic	How measured	Derivation/source	Data availability
Firm characteristics				
No. of generations that have operated the business	genes	No.	BLS item	No time dimension
New business	newbus	Dummy variable (1=Yes; 0=No)	Active firms that are less than 2 years old	All years
No. of business locations	_buslocs	No.	BLS item	All years
Controlled a franchise system[a]	_contfra	Dummy variable (1=Yes; 0=No)	BLS item	All years
Operated as a franchise[a]	_operfra	Dummy variable (1=Yes; 0=No)	BLS item	All years
How many unions represent employees at 30 June[a]	_unionno	No.	BLS item	1995-96, 1996-97 & 1997-98
Export marketing strategies				
Targeted export markets	_bpexp	Dummy variable (1=Yes; 0=No)	1 if _bpexp=1; 0 otherwise	1995-96, 1996-97 & 1997-98
Management				
Highest education level obtained by major decision maker	educatn	Discrete variable (0=Not applicable/ no response 1=School 2=Trade 3=Tertiary)	BLS item	No time dimension
Business-related tertiary qualifications of major decision maker	tertqua	Dummy variable (1=Yes; 0=No/not applicable)	BLS item	No time dimension
Undertook major advertising campaign	_mjcadve	Dummy variable (1=Yes; 0=No)	1 if _mjcadve=3; 0 otherwise	All years
Used a formal business plan	_bpfor	Dummy variable (1=Yes; 0=No)	1 if _bpfor=1; 0 otherwise	1995-96, 1996-97 & 1997-98
Used budget forecasting	_bpbud	Dummy variable (1=Yes; 0=No)	1 if _bpbud=1; 0 otherwise	1995-96, 1996-97 & 1997-98
Used regular income/ expenditure reports	_bpreg	Dummy variable (1=Yes; 0=No)	1 if _bpreg=1; 0 otherwise	1995-96, 1996-97 & 1997-98
Formal networking with other businesses	_bpnet	Dummy variable (1=Yes; 0=No)	1 if _bpnet=1; 0 otherwise	1995-96, 1996-97 & 1997-98
Introduced business improvement program	_busimpr	Dummy variable (1=Yes; 0=No)	BLS item	1994-95

(Continued on next page)

Table B.2   (continued)

Variable	Mnemonic	How measured	Derivation/source	Data availability
Innovation				
Introduced new goods or services	_intgood	Dummy variable (1=Yes; 0=No)	BLS item	All years
Expenditure on development of new or changed products or processes (innovation)	_inntot	$000	BLS item	1994-95, 1996-97 & 1997-98
Expenditure on research and development (R&D)	_rdvalue	$000	BLS item	1995-96, 1996-97 & 1997-98
R&D intensity	_rdint	%	Expenditure on R&D / Total sales	1995-96, 1996-97 & 1997-98
Indexes of government assistance				
Received export assistance from the government[a]	expndx	Dummy variable (1=Yes; 0=No)	1 if firm receives any export government assistance; 0 otherwise[b]	All years
Received non-export assistance from the government[a]	govtndx	Dummy variable (1=Yes; 0=No)	1 if firm receives any general government assistance; 0 otherwise[c]	All years
Technology				
Accessed the internet	_netacc	Dummy variable (1=Yes; 0=No)	BLS item	1996-97 & 1997-98
Industry dummy variables				
Food, beverages & tobacco	dumfbt	Dummy variable (1=Yes; 0=No)	I if anzsic8 = 2100–99; 0 otherwise	No time dimension
Textiles, clothing & footwear	dumtcf	Dummy variable (1=Yes; 0=No)	I if anzsic8 = 2200–99; 0 otherwise	No time dimension
Wood & paper	dumwod	Dummy variable (1=Yes; 0=No)	I if anzsic8 = 2300–99; 0 otherwise	No time dimension
Printing & publishing	dumprint	Dummy variable (1=Yes; 0=No)	I if anzsic8 = 2400–99; 0 otherwise	No time dimension
Petroleum & coal products	dumpetrl	Dummy variable (1=Yes; 0=No)	I if anzsic8 = 2500–99; 0 otherwise	No time dimension
Non-metallic minerals	dumnomet	Dummy variable (1=Yes; 0=No)	I if anzsic8 = 2600–99; 0 otherwise	No time dimension
Metal products	dummetal	Dummy variable (1=Yes; 0=No)	I if anzsic8 = 2700–99; 0 otherwise	No time dimension
Machinery	dummach	Dummy variable (1=Yes; 0=No)	I if anzsic8 = 2800–99; 0 otherwise	No time dimension
Other manufacturing	dumother	Dummy variable (1=Yes; 0=No)	I if anzsic8 = 2900–99; 0 otherwise	No time dimension

a Contained on the MURF only. **b** Coverage of export programs varies from year to year, but includes, where recorded, Export finance and insurance corporation facilities, Export access, Export market development grants (EMDG), International trade enhancement scheme, and Other Austrade services. **c** Coverage of other government programs varies from year to year, but includes, where recorded, National Industry Extension Service (NIES), Research and development tax concession, Grants for research and development, New enterprise incentive scheme (NEIS), Best practice demonstration program, and Other Commonwealth and State programs.

Sources: ABS (BLS, Confidentialised Unit Record File, 1994-95 to 1997-98, Cat. no. 8141.0.30.001) and advice from the ABS.

C Model outline and detailed results

This appendix outlines the econometric techniques adopted, choice of estimators used and the results summarised in chapter 4.

Two forms of regression analysis covering different aspects of export performance were used:

- binary choice (logit) analysis of:
  - the likelihood (probability) of *a firm* exporting against not exporting;
  - the likelihood of *a firm* exporting in *each* year against not exporting in each BLS year (including firms that did not export in the BLS years); and
  - the likelihood of *an exporter* exporting in *each* year against being a less frequent exporter;
- panel data analysis of:
  - the *value* of exports (exporting scale); and
  - the *share* of total sales accounted for by exports (export intensity).

C.1 Binary choice analysis

Technical annex 1 provides a technical outline of the binary choice (logit) estimator adopted in this study.

The logit estimator was applied to pooled cross-section data over the BLS years 1994-95 to 1997-98. The pooled regression analysis is based on two important assumptions:

- first, it was assumed that the decision to export in any one year was an independent decision unrelated to firm behaviour in other years; and
- second, it was assumed that any unobserved firm-specific effects were uncorrelated with the error of the estimates.

The approach adopted allows the decision to export or be a regular exporter to be reversible. Explanatory variables were selected for the logit regressions using the general-to-specific method described in appendix B.

Consideration was given to the use of a one-way fixed effects logit panel-data estimator (discussed below in the context of panel data). However, it was not taken up because it did not reliably reach a solution, possibly because of high levels of correlation between some observed firm-specific characteristics. The substantial list of firm-specific items considered should go some of the way towards proxying for the firm-specific factors that otherwise might have been better represented by a fixed effects estimator.

Detailed results

Table C.1 shows the percentage change in the probability of exporting that resulted from a 1 per cent change in the domestic-sales base or firm size (ie elasticity) — evaluated at (unweighted) sample means (see technical annex 1 for details). For example, a 1 per cent increase in domestic sales was associated with a 0.07 per cent increase in the probability that a firm exported (col. 1). A 1 per cent increase in the same variable was associated with a 0.03 per cent increase in the probability of an exporter becoming a regular exporter (col. 3). The table also shows that a 1 per cent increase in full-time equivalent employment was associated with an 0.07 per cent increase in the probability that a firm exported and a 0.03 per cent increase in the probability of an exporter becoming a regular exporter.

The relation between size and export participation was not uniform between measures of size. For example, for three of the four size measures considered — domestic sales, total sales and employment — the results indicate that the impact of a change in size on the probability of exporting (col. 1) was greater than the impact of a change on the probability of an exporter being a regular exporter (col. 3). On the other hand, the estimated association between total assets and export participation (eg cols 1 and 3) did not follow this pattern.

For the 'average' firm, these impact measures suggest that variation in size did not have a large impact on the likelihood that a firm would export or be a regular exporter. Furthermore, the magnitude of the elasticity was not estimated to be very sensitive to substantial changes in the underlying firm size. For example, the estimated elasticity of the probability of an exporter exporting regularly evaluated at one standard deviation above the sample mean was 0.07 compared to 0.03 (col. 3) at the mean. Nevertheless, this does not necessarily mean to say that, for some firms that differed significantly from the average, domestic sales or overall size was not important to their export participation.

Table C.1   **Probability of exporting with respect to firm size**

Measure of firm size	Probability of a firm exporting	Probability of a firm exporting regularly	Probability of an exporter exporting regularly
Probability of exporting	41.8%	31.1%	59.8%
Elasticity of the probability of exporting:[a]			
Domestic sales	+0.07	+0.09	+0.03
Total sales	+0.07	+0.09	+0.03
Employment	+0.07	+0.08	+0.03
Total assets	<+0.01	+0.01	+0.02

a Percentage change in the probability of exporting from a 1 per cent change in firm size evaluated at MURF sample means from the coefficients in the respective logistic regressions.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

The regression coefficients for each item included in the respective regressions on manufacturing firms are presented in tables C.2 to C.4. Table C.2 considers the probability of a manufacturing firm exporting; C.3 the probability of a firm being a regular exporter; and C.4 the probability of an exporter being a regular exporter. Within each table, its export status is regressed on domestic sales size (or a measure of absolute firm size) in conjunction with other explanatory variables.

The tables show:

- the proportion of successful predictions (a measure of model explanatory power) across size measures exceeded the proportion of firms in each export participation category. The regressions are, therefore, generally more effective in identifying exporters and the nature of their export participation than a random search;

- the size variable is positive and statistically significant in 11 out of the 12 regressions — the only exception being total assets in the probability of a firm exporting (see table C.2);

- all but 5 of the 20 non-size explanatory variables considered (appendix B) were statistically significant in at least one regression — indicating that a wide range of factors, besides firm size, are at play in explaining exports. The 5 items are: firm age (*_age_a*), the highest education level obtained by major decision maker (*educatn*), return on sales (*_ebratio*), whether the firm receives non-export assistance (*govtndx*), and the number of trade unions (*_unionno*). (As mentioned, the items included in each regression were selected using a general-to-specific method (appendix B));

- within each table, the magnitude and significance of non-size explanatory variables were generally similar across each of the size measures — indicating

that the selected items have a statistically independent role in explaining export performance;

- two items — the extent of foreign ownership (*_foreign*) and whether the firm received any form of government export assistance (*expndx*) — were statistically significant in each regression, with both being positively related to each measure of export participation.[1]

- although few firms reported such arrangements, franchise arrangements had a significant impact on exporting by some firms:

  – firms that operated as a franchise were less likely to export than other firms (table C.2);

  – while firms that controlled franchises were less likely to be regular exporters than other firms and other exporters (tables C.3 and C.4, respectively);

- the sign of the regression coefficients (ie direction of association) between the selected explanatory variables and the respective dependent variables generally coincided with the expected sign suggested in table B.1. However, there were a couple of instances where this was not the case, namely:

  – the average wage (*wagerate*) was negative rather than the positive expected, suggesting lower average wages within firms were associated with export participation, after controlling for other factors;

  – return on assets (*_asratio*) was negative rather than the positive expected, possibly reflecting that many export markets may be more competitive than their domestic counterparts or, alternatively, that firms may resort to exporting in the presence of weak domestic demand; and

  – the extent of foreign ownership (*_foreign*) was positive rather than the negative expected, suggesting foreign subsidiaries were more likely to export than counterpart local firms, after controlling for other factors.

As indicated, there is no unified theory which nominates explanatory variables that should be included in the model. Nevertheless, the results indicate that firm characteristics associated with firm size (however measured) are important in distinguishing between exporters and non-exporters (tables C.2 and C.3) and between regular and other exporters (tables C.4).

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[1] Data for the items *govtndx* and *_unionno* were only available on the MURF and were included in the regressions by convention, although the coefficients were not statistically relevant at conventional levels.

C.2   Panel data analysis

Technical annex 2 provides a technical outline of panel data analysis.

An important advantage of panel data analysis is that it controls for unobservable or unspecified differences between firms not easily incorporated in practice in binary choice analysis or in ordinary least squares.

Selection of estimator

In the current study, each model was estimated using three different formulations based on:

- the inclusion of a firm-specific dummy variable to capture the unobservable firm-specific effects (a 'one-way fixed effects' estimator);

- the inclusion of both firm-specific (also called group effects) and time-specific dummy variables (also called period effects) to capture the unobservable firm-specific and time-specific effects (a 'two-way fixed effects' estimator); and

- an alternative estimation technique incorporating an independent firm-specific error term (a 'random effects' estimator).

Statistical testing (using the Hausman test) indicated that both fixed effects estimators were preferred to the alternative 'random effects' estimator and, consequently, the results from the random effects models are not presented. Another statistical test (the F-test) was used to choose between the one-way and two-way fixed effect models. As a result, a one-way fixed effects estimator was used for the value of exports regressions and a two-way fixed effects estimator was used for the export intensity regressions, although the inclusion of the time-specific dummy variables in the export intensity regressions did not significantly enhance the explanatory power of the model.

Explanatory variables were selected for the panel regressions using the augmented general-to-specific method described in appendix B. In addition, the adoption of weighted regressions and the possibility of non-linear relationships between the extent of exporting and firm size were canvassed.

Table C.2   Probability of a manufacturer exporting, 1994-95 to 1997-98

Pooled logistic regression, heteroskedasticity corrected standard errors

Explanatory variables[a]	Mnemonic	Measure of firm size used							
		Domestic sales ($ billion)		Total sales ($ billion)		Employment (000 fte)		Total assets ($ billion)	
		Coefficient[b]	b/St. Er.	Coefficient[b]	b/St. Er.	Coefficient[b]	b/St. Er.	Coefficient[b]	b/St. Er.
Firm size		**3.03** ***	**4.54**	**5.10** ***	**5.84**	**1.40** ***	**5.86**	**0.30**	**0.92**
Firm age[e]	_age_a								
Average wage rate[e]	wagerate	-0.15 ***	-7.97	-0.12 ***	-6.56	-0.12 ***	-6.91	-0.14 ***	-7.87
New business	newbus	0.68 *	1.86	0.71 *	1.92	0.69 *	1.86	0.66 *	1.80
No. of business locations[e]	_buslocs			-0.15 *	-1.80	-0.14	-1.60		
No. of generations	genes								
Union membership	_unionme			-0.10 ***	-4.32	-0.11 ***	-4.96		
Export marketing	_mjcexp	1.62 ***	15.58	1.65 ***	15.81	1.64 ***	15.71	1.61 ***	15.48
Business comparisons[e]	_comperf	1.07	1.23	1.56 *	1.76	1.49 *	1.68	1.73 **	2.00
Highest education level[f]	educatn			-3.15	-1.14				
Business qualifications	tertqua	0.29 ***	2.87			0.31 ***	3.10	0.31 ***	3.06
Expense ratio	_puratio	-1.65 ***	-11.62	-1.44 ***	-9.75	-1.50 ***	-10.40	-1.68 ***	-11.85
Return on assets	_asratio	-0.62 ***	-5.47	-0.59 ***	-5.29	-0.59 ***	-5.29	-0.63 ***	-5.56
Return on sales	ebratio								
Capital intensity[f]	kintens	0.11 ***	5.20	0.09 ***	4.26	0.11 ***	5.42	0.12 ***	5.57
Foreign ownership	_foreign	0.27 ***	6.71	0.31 ***	7.57	0.28 ***	6.92	0.29 ***	7.12
Non-export assistance	govtndx	0.05	0.48	0.07	0.67	0.08	0.73	0.06	0.55
Export assistance	expndx	2.22 ***	16.77	2.27 ***	17.13	2.23 ***	16.74	2.22 ***	16.85
Controls a franchise[d]	_contfra	-0.04	-0.76	-0.04	-0.85	-0.04	-0.81	-0.02	-0.51
Operates as a franchise[c]	_operfra	-0.02 **	-2.05	-0.02 **	-1.97	-0.02 **	-2.10	-0.02 **	-2.11
How many unions[f]	_unionno	-1.33	-0.53	-0.51	-0.54	-0.53	-0.67	-0.48	-0.62

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Table C.2   (continued)

	Measure of firm size used			
	Domestic sales ($ billion)	Total sales ($ billion)	Employment (000 fte)	Total assets ($ billion)
Summary statistics:				
No. of observations	4,481	4,481	4,481	4,481
Log likelihood	-2,485.7	-2,465.7	-2,467.8	-2,501.2
Model Chi-squared	1,118.7	1,158.8	1,154.6	1,087.8
Probability value	0.000	0.000	0.000	0.000
Successful predictions	75.9%	76.3%	76.5%	75.5%
Proportion of firms exporting	41.8%	41.8%	41.8%	41.8%

*** Statistically significant at the 1 per cent level (critical value: 2.576). ** Statistically significant at the 5 per cent level (critical value: 1.960). * Statistically significant at the 10 per cent level (critical value: 1.645).

a All variables considered tested. Only results on variables included in the final model reported (see text). **b** Logistic regression coefficient. **c** Coefficient scaled by 0.01. **d** Coefficient scaled by 0.1. **e** Coefficient scaled by 10. **f** Coefficient scaled by 100. **g** Coefficient scaled by 1000. **h** Coefficient scaled by 1 000 000.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

Table C.3   **Probability of a manufacturer being a regular exporter, 1994-95 to 1997-98**

Pooled logistic regression, heteroskedasticity corrected standard errors

Explanatory variables[a]	Mnemonic	Measure of firm size used							
		Domestic sales ($ billion)		Total sales ($ billion)		Employment (000 fte)		Total assets ($ billion)	
		Coefficient[b]	b/St. Er.	Coefficient[b]	b/St. Er.	Coefficient[b]	b/St. Er.	Coefficient[b]	b/St. Er.
Firm size		**3.00 *****	**5.33**	**4.79 *****	**6.76**	**1.20 *****	**6.17**	**0.84 *****	**2.58**
Firm age[e]	_age_a								
Average wage rate[e]	wagerate	-0.16 ***	-7.98	-0.17 ***	-8.27	-0.16 ***	-7.73	-0.15 ***	-7.75
New business	newbus	0.25	0.66	0.28	0.74	0.26	0.69	0.22	0.58
No. of business locations[e]	_buslocs			-0.13 *	-1.67	-0.11	-1.31		
No. of generations	genes	-0.08 **	-2.29			-0.08 **	-2.21	-0.10 ***	-2.84
Union membership	_unionme	-0.11 ***	-4.75	-0.12 ***	-5.33	-0.12 ***	-5.37	-0.09 ***	-4.21
Export marketing	_mjcexp	0.90 ***	9.83	0.90 ***	9.79	0.89 ***	9.74	0.88 ***	9.73
Business comparisons[e]	_comperf	0.85	0.97	0.48	0.54	0.64	0.73	1.36	1.57
Highest education level[f]	educatn								
Business qualifications	tertqua	0.32 ***	3.23	0.33 ***	3.34	0.33 ***	3.31	0.33 ***	3.38
Expense ratio	_puratio	-1.97 ***	-12.92	-2.00 ***	-13.29	-1.95 ***	-12.78	-1.97 ***	-12.95
Return on assets	_asratio	-0.56 ***	-4.89	-0.56 ***	-4.94	-0.55 ***	-4.84	-0.56 ***	-4.94
Return on sales	_ebratio								
Capital intensity[f]	kintens	0.11 ***	5.73	0.10 ***	5.23	0.12 ***	6.07	0.11 ***	5.55
Foreign ownership	_foreign	0.32 ***	8.19	0.32 ***	8.31	0.31 ***	7.89	0.32 ***	8.30
Non-export assistance	govtndx	0.09	0.91	0.09	0.83	0.10	0.93	0.11	1.02
Export assistance	expndx	1.68 ***	16.40	1.69 ***	16.46	1.65 ***	16.13	1.68 ***	16.44
Controls a franchise[d]	_contfra	-0.21 ***	-3.26	-0.21 ***	-3.19	-0.21 ***	-3.22	-0.20 ***	-3.09
Operates as a franchise[c]	_operfra	-0.30	0.00	-0.30	0.00	-0.30	0.00	-0.30	0.00
How many unions[f]	_unionno	-0.20	-0.40	-0.26	-0.46	-0.28	-0.54	-0.11	-0.27

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Table C.3 (continued)

	Measure of firm size used			
	Domestic sales ($ billion)	Total sales ($ billion)	Employment (000 fte)	Total assets ($ billion)
Summary statistics:				
No. of observations	4,481	4,481	4,481	4,481
Log likelihood	-2,467.6	-2,451.4	-2,459.9	-2,484.9
Model Chi-squared	617.8	650.2	633.3	583.2
Probability value	0.000	0.000	0.000	0.000
Successful predictions	75.4%	75.9%	75.6%	75.3%
Proportion of firms exporting	31.1%	31.1%	31.1%	31.1%

*** Statistically significant at the 1 per cent level (critical value: 2.576). ** Statistically significant at the 5 per cent level (critical value: 1.960). * Statistically significant at the 10 per cent level (critical value: 1.645).

a All variables considered tested. Only results on variables included in the final model reported (see text). **b** Logistic regression coefficient. **c** Coefficient scaled by 0.01. **d** Coefficient scaled by 0.1. **e** Coefficient scaled by 10. **f** Coefficient scaled by 100. **g** Coefficient scaled by 1000. **h** Coefficient scaled by 1 000 000.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

Table C.4   **Probability of a manufacturing exporter being a regular exporter, 1994-95 to 1997-98**
Pooled logistic regression, heteroskedasticity corrected standard errors

Measure of firm size used

Explanatory variables[a]	Mnemonic	Domestic sales ($ billion)		Total sales ($ billion)		Employment (000 fte)		Total assets ($ billion)	
		Coefficient[b]	b/St. Er.	Coefficient[b]	b/St. Er.	Coefficient[b]	b/St. Er.	Coefficient[b]	b/St. Er.
Firm size		**1.23 ****	**2.46**	**1.87 *****	**3.46**	**0.48 *****	**3.03**	**1.51 *****	**3.05**
Firm age[e]	_age_a	-0.03	-0.51	-0.04	-0.63	-0.07	-1.09	-0.03	-0.46
Average wage rate[e]	wagerate								
New business	newbus								
No. of business locations[e]	buslocs								
No. of generations	genes								
Union membership	_unionme								
Export marketing	_mjcexp	0.08	0.85	0.10	1.03	0.08	0.80	0.10	0.99
Business comparisons[e]	_comperf	-0.06	-0.06			-0.25	-0.24	-0.13	-0.12
Highest education level[f]	educatn	-3.29	-1.03	-2.64	-0.82			-3.05	-0.96
Business qualifications	tertqua								
Expense ratio	_puratio								
Return on assets	_asratio								
Return on sales	_ebratio								
Capital intensity[f]	kintens	0.02	0.79			0.02	0.91		
Foreign ownership	_foreign	0.22 ***	5.62	0.21 ***	5.62	0.20 ***	5.40	0.22 ***	5.85
Non-export assistance	govtndx	0.00	0.01	-0.01	-0.09	-0.01	-0.05	0.00	-0.03
Export assistance	expndx	0.78 ***	7.18	0.77 ***	7.16	0.75 ***	6.97	0.78 ***	7.23
Controls a franchise[d]	_contfra	-0.25 ***	-3.96	-0.25 ***	-3.98	-0.25 ***	-3.95	-0.25 ***	-3.89
Operates as a franchise[c]	_operfra	-0.29	0.00	-0.29	0.00	-0.29	0.00	-0.29	0.00
How many unions[f]	_unionno	-0.61	-0.89	-0.72	-0.83	-0.72	-0.89	-0.64	-0.86

Table C.4 (continued)

	Measure of firm size used			
	Domestic sales ($ billion)	*Total sales ($ billion)*	*Employment (000 fte)*	*Total assets ($ billion)*
Summary statistics:				
No. of observations	2,329	2,341	2,329	2,341
Log likelihood	-1,469.5	-1,474.6	-1,468.1	-1,476.7
Model Chi-squared	200.3	209.5	202.9	205.2
Probability value	0.000	0.000	0.000	0.000
Successful predictions	60.6%	60.4%	60.6%	60.4%
Proportion of firms exporting	59.8%	59.8%	59.8%	59.8%

*** Statistically significant at the 1 per cent level (critical value: 2.576). ** Statistically significant at the 5 per cent level (critical value: 1.960). * Statistically significant at the 10 per cent level (critical value: 1.645).

a All variables considered tested. Only results on variables included in the final model reported (see text). **b** Logistic regression coefficient. **c** Coefficient scaled by 0.01. **d** Coefficient scaled by 0.1. **e** Coefficient scaled by 10. **f** Coefficient scaled by 100. **g** Coefficient scaled by 1000. **h** Coefficient scaled by 1 000 000.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

Weighted regressions

A sample weight is assigned by the ABS to each BLS firm in accordance with sample design. High sample weights indicate firms in a particular sample strata (eg a firm size category or industry) had a low probability of selection. The sample weight assigned to each sampled firm also indicates the level of non-sampled activity represented by that firm. Data entering panel regressions may either be weighted according to these sample weights or unweighted.

One argument in favour of using weighted regressions suggests that the relationship between the dependent (endogenous) and explanatory (exogenous) variables may vary systematically with the probability of sample selection. When this occurs, the errors in the regression equation would not have a common variance across firms, with different weights possibly making it appropriate to include a heteroskedasticity-type correction in the regression analysis using the sample weight and applying a weighted least squares estimator (as specified in Greene 1998, p. 238).

A second argument in favour of using weighted regressions suggests that missing data arising from unequal probabilities of selection should not be ignored. In considering this issue, Rogers and Tseng (2000) noted that 'if the regressions are to explore association by looking at the mean of one variable conditional on others, in general, weighted least squares with corrected standard errors is preferred'.

On the other hand, arguments against weighting suggest that, if sample variability were truly representative of population variability, as it should be to obtain unbiased parameter estimates, then weighted regressions would be inappropriate. Furthermore, unweighted estimators are the most efficient estimators among all linear unbiased estimators and are, therefore, to be preferred on efficiency grounds.

The first and second concerns address issues of heteroskedasticity and firm bias that may be inherent in sample design.[2] The third concern addresses issues of the representativeness of the sample. For the current study, coefficient estimates for the weighted regressions are reported. In practice, these do not differ materially from coefficients from unweighted regressions (not reported). Sample mean values

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[2] Heteroskedasticity occurs when the performance of the estimated model, as indicated by the variance of its error term (ie the regression residual), is not equal across the values taken on by the explanatory variables. As indicated, weighted regressions adjust for such variation. Standard adjustments are applied to correct for any remaining heteroskedasticity.

underlying the decomposition analysis reported in chapter 4 (eg figure 4.4) are weighted values.

Non-linearities and linear separability

Some studies suggest a possible non-linear relationship between overall firm size and exporting (chapter 3). Testing in this study for possible non-linearities was undertaken in the panel analysis by entering the square of firm size and firm age into the model along with the original variable. However, a high degree of correlation between the original and squared variable made it statistically difficult to isolate the effect of the original variable from that of its square (suggesting multicollinearity problems).[3] In addition, sensitivity tests, where practicable, indicated that the explanatory power of the models did not increase significantly with the inclusion of the non-linear term. Because of that difficulty and the tentative indications that little gain would be available from the inclusion of the non-linear term, the final models only included the original (unsquared) variables.

The impact of the explanatory variables in the equations estimated was assumed to be separable from the impact of other variables. Reflecting this assumption, the panel analyses did not include any interaction terms between explanatory variables. (The same assumption was applied in the binary choice models reported above.)

Results

The full results for the panel data models focusing on the export involvement of regular manufacturing exporters are presented in tables C.5 and C.6. Table C.5 considers factors associated with variation in the *value* of exports, while table C.6 considers factors associated with variation in the export *intensity* of exporters. Within each table, the export involvement characteristic is regressed, using a fixed effects estimator, on domestic sales size (or a measure of absolute firm size) in conjunction with other explanatory variables.

The tables show that for manufacturing firms that exported regularly:

- of the 4 size variables:
  - the coefficient on domestic sales size was either not statistically significant (against the value of exports, table C.5) or significant and negative (against export intensity, table C.6) after controlling for other factors; and

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3 The correlation coefficients for all of the firm size variables and their squared counterpart on the MURF ranged from +0.83 for employment to +0.89 for total assets.

- the coefficient on overall sales size is positively associated with the value of exports (table C.5). However, the coefficients on the overall size measures are not statistically significant in the export intensity model after controlling for other factors.

- as opposed to the 20 non-size explanatory variables considered in the binary choice analysis, 12 non-size variables were considered in the panel data regressions, as some of the variables lacked a time dimension and, hence, were perfectly correlated with the estimated firm-specific fixed effect, and excluded from the selection process. These items include: whether the firm is less than 2 years old (*newbus*), the number of business locations (*_buslocs*), number of generations that have operated a family business (*genes*) and educational level and type of qualification of major decision maker (*educatn* and *tertqua*).

- that 5 of the 12 non-size variables considered were selected for inclusion in at least one of the final fixed-effects regressions. Fewer non-size items were selected as explanatory variables in the table C.5 and C.6 analyses than in the table C.2 to C.4 analyses. This difference reflects that the firm-level fixed effects estimated in the panel regressions proved to be a better proxy for contemporaneous unmeasured firm-specific characteristics than some items measured in the BLS. These items included: average wage rate (*wagerate*), the incidence of union membership (*_unionme*), firms that undertook business comparisons (*_comperf*), firms that undertook a major export marketing campaign (*_mjcexp*) and capital intensity (*kintens*);

- the regressions using the fixed effects estimator explain over 85 per cent of the variability (as measured by the adjusted R^2) in the value of firm exports and export intensity. Without the fixed effects estimator, the explanatory power of the regression is much lower, explaining:

  - less than one-half of the variation in the value of exports for 3 of the 4 size variables (the regression including total sales being the exception (table C.5, col. 2)). For example, in the regression on the value of exports containing domestic sales as an independent variable, variation of the specific items included in the model were associated with around one-third of the variation in export values of regular exporters (table C.5, col. 1); and

  - less than 10 per cent of between-firm variability in export intensity;

- the regression coefficients on non-size items typically have the expected sign suggested in table B.1; and

- higher returns on sales (the BLS-based proxy for profit margins on sales) (*_ebratio*) were associated with higher rates of export intensity for regular exporters, in particular table C.6, whereas, returns on sales was not identified as

a significant factor in the variation of export participation (tables C.2 to C.4) or in the value of exports (table C.5).

While the binary choice analysis suggested domestic sales size and overall firm size were positively associated with export participation, the panel regressions indicated that unobserved firm-specific effects were the dominant influence (figure C.1, left-hand bars). The panel regressions also indicate that the statistical significance of the coefficient on domestic sales size is sensitive to the inclusion (non-inclusion) of firm-specific effects. These factors could indicate omitted variable bias, particularly in the binary choice analysis, which did not control for all unobserved firm-level fixed effects. The analysis may also indicate that the relationship between firm-specific characteristics, firm size and export performance is more complicated than what is reflected in the aggregate analysis.

Furthermore, the statistical importance of the firm-specific fixed effects evident in the panel analyses could also be associated with other BLS items not included in the panel analysis for technical reasons.

These issues are considered below.

Table C.5   **Value of exports by regular manufacturing exporters, 1994-95 to 1997-98**

Four-year panel regressions, weighted least squares with group dummy variables, heteroskedasticity corrected standard errors

Explanatory variables[a]	Mnemonic	Domestic sales ($ million)		Total sales ($ million)		Employment (fte)		Total assets ($ million)	
		Coefficient	b/St. Er.	Coefficient	b/St. Er.	Coefficient	b/St. Er.	Coefficient	b/St. Er.
Firm size		**-96.5**	**-0.26**	**367.2** **	**2.10**	**34.5**	**1.08**	**64.2**	**0.92**
Firm age	_age_a			-141.9	-0.63				
Average wage rate	wagerate			-7.3	-1.36			6.7	0.54
Union membership	_unionme								
Export marketing	_mjcexp								
Business comparisons	_comperf								
Expense ratio	_puratio			66.6	0.04				
Return on assets	_asratio	-309.6 **	-2.33	-256.1 **	-2.00				
Return on sales	_ebratio	2,033.3	0.70					1,003.2	0.39
Capital intensity	kintens							-5.3	-1.05
Foreign ownership	_foreign	51.7	0.30	178.8 *	1.82	-285.7	-0.51	-42.8	-0.22
Non-export assistance	govtndx	305.7	0.41	553.1	0.72	739.0	0.90	444.3	0.57
Export assistance	expndx	-1,423.5 ***	-2.58	-711.4	-1.50	-1,322.2 ***	-2.58	-1,219.6 **	-2.39

Measure of firm size used

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Table C.5   (continued)

| | Measure of firm size used | | | |
	Domestic sales ($ million)	Total sales ($ million)	Employment (fte)	Total assets ($ million)
Summary statistics:				
No. of observations	1,858	1,852	1,858	1,852
Adjusted R²	0.970	0.979	0.971	0.972
Unadjusted R²:				
X variables only	0.334	0.583	0.391	0.468
X and Group effects	0.978	0.985	0.979	0.979
X, Group & Period effects	0.942	0.961	0.944	0.947
Model F statistic	128.76 F[476, 1381]	183.31 F[478, 1373]	134.21 F[474, 1383]	134.49 F[477, 1374]
Probability value	0.000	0.000	0.000	0.000

*** Statistically significant at the 1 per cent level (critical value: 2.576). ** Statistically significant at the 5 per cent level (critical value: 1.960). * Statistically significant at the 10 per cent level (critical value: 1.645).

a All variables considered tested. Only results on variables included in the final model reported (see text).

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

Table C.6   **Export intensity of regular manufacturing exporters, 1994-95 to 1997-98**

Four-year panel regressions, weighted least squares with group and period dummy variables, heteroskedasticity corrected standard errors

| | | Measure of firm size used | | | | | | | |
| | | Domestic sales ($ billion) | | Total sales ($ billion) | | Employment (000 fte) | | Total assets ($ billion) | |
Explanatory variables[a]	Mnemonic	Coefficient	b/St. Er.	Coefficient	b/St. Er.	Coefficient	b/St. Er.	Coefficient	b/St. Er.
Constant		0.35 ***	4.24	0.31 ***	3.70	0.31 ***	3.75	0.32 ***	3.78
Firm size		**-1.39** ***	**-4.85**	**0.14**	**0.56**	**0.02**	**0.31**	**0.03**	**0.36**
Firm age[e]	_age_a	-0.10	-1.57	-0.09	-1.39	-0.09	-1.41	-0.09	-1.42
Average wage rate[e]	wagerate								
Union membership	_unionme								
Export marketing	_mjcexp								
Business comparisons[e]	_comperf								
Expense ratio	_puratio	-0.10 ***	-4.63	-0.11 ***	-4.71	-0.11 ***	-4.71	-0.11 ***	-4.71
Return on assets	_asratio	-0.04 ***	-7.36	-0.04 ***	-7.32	-0.04 ***	-7.33	-0.04 ***	-7.33
Return on sales	_ebratio	0.15 ***	4.58	0.15 ***	4.38	0.15 ***	4.41	0.15 ***	4.40
Capital intensity[f]	kintens								
Foreign ownership	_foreign	0.00	0.14	0.01	0.16	0.01	0.15	0.01	0.15
Non-export assistance	govtndx	0.00	0.17	0.00	0.27	0.00	0.28	0.00	0.27
Export assistance	expndx	-0.00	-0.67	-0.00	-0.56	-0.00	-0.59	-0.00	-0.58

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Table C.6 (continued)

| | Measure of firm size used | | | |
	Domestic sales ($ billion)	Total sales ($ billion)	Employment (000 fte)	Total assets ($ billion)
Summary statistics:				
No. of observations	1,858	1,858	1,858	1,858
Adjusted R^2	0.879	0.876	0.876	0.876
Unadjusted R^2:				
X variables only	0.078	0.077	0.076	0.077
X and Group effects	0.903	0.902	0.902	0.902
X, Group & Period effects	0.910	0.908	0.908	0.908
Model F statistic	28.93 F[482, 1375]	28.18 F[482, 1375]	28.26 F[482, 1375]	28.27 F[482, 1375]
Probability value	0.000	0.000	0.000	0.000

*** Statistically significant at the 1 per cent level (critical value: 2.576). ** Statistically significant at the 5 per cent level (critical value: 1.960). * Statistically significant at the 10 per cent level (critical value: 1.645).

a All variables considered tested. Only results on variables included in the final model reported (see text). **e** Coefficient scaled by 10. **f** Coefficient scaled by 100.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

Figure C.1 **Estimated contributions to the *variation* in exports and export intensity between manufacturing firms[a]**

Regular exporters, per cent

Value of exports   *Export intensity*

Maximum contribution by domestic sales

Minimum contribution by domestic sales

Average contribution[b]
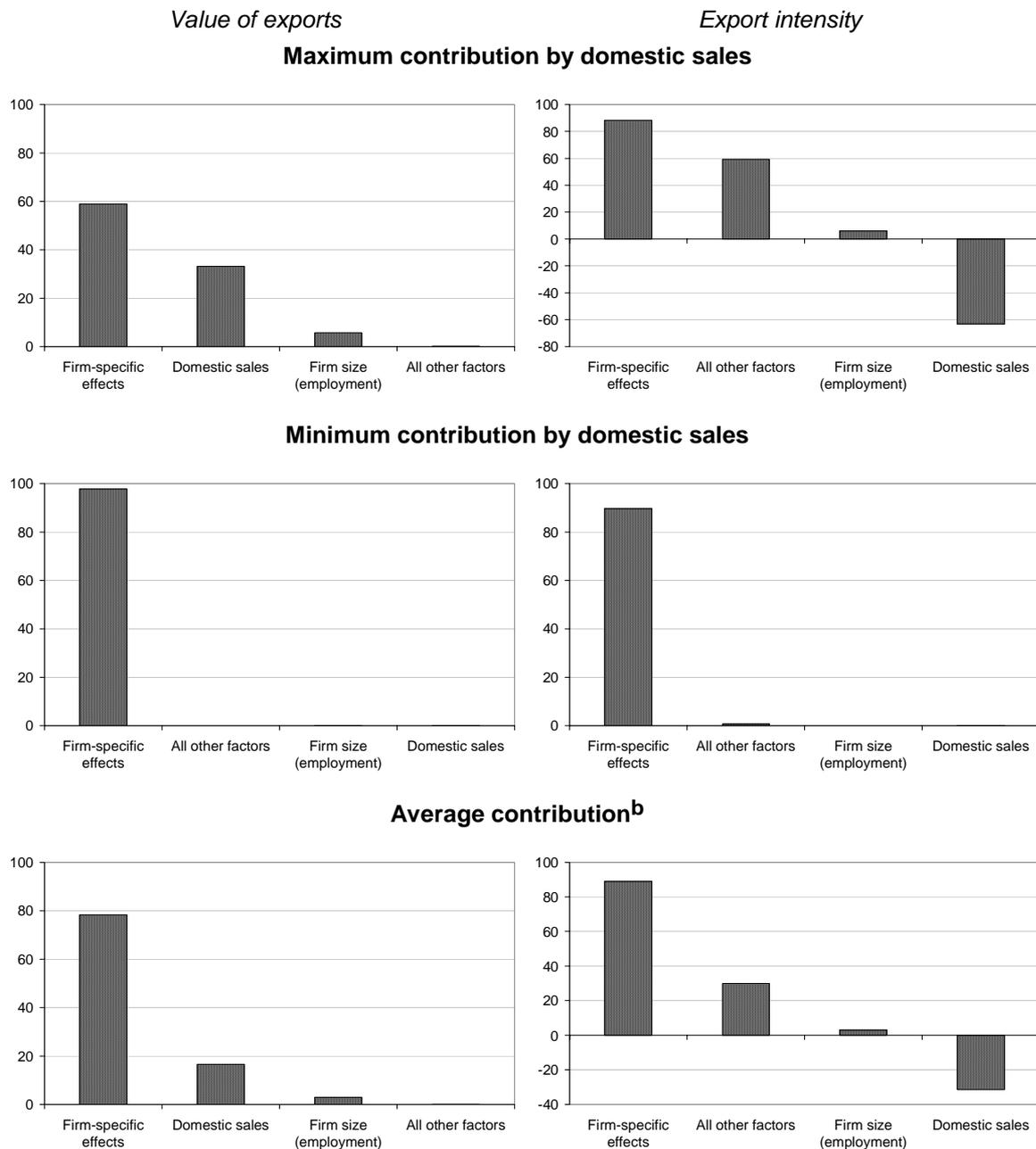
a Analysis based on the domestic sales model in tables C.5 and C.6 augmented by a general measure of firm size (employment). **b** It is not possible to directly observe the contribution of each factor listed to export involvement. The average contributions reported are the arithmetic average of results from two scenarios — one that assigned the highest possible weight to unobserved firm-specific characteristics and one that assigned the highest possible weight to domestic sales size. The values reported reflect the change in the coefficient of multiple determination (R^2) from the respective scenarios obtained by progressively adding the group dummies (domestic sales), employment, all other statistically significant explanatory variables and domestic sales (group dummies) to the value of exports equation for regular manufacturing exporters.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

C.3   Explaining the firm-specific factors

What is the association between firm-specific effects and domestic sales size?

Table C.7 indicates that the firm-specific effects estimated in the regressions on export values (table C.5) were positively correlated with domestic sales size and measures of overall firm size, respectively.

Table C.7   **Correlation between the firm-specific effect from the manufacturing value of exports regression and firm size**
Regular exporters, correlation coefficient[a]

Variable	Mnemonic	Firm-specific fixed effect	Domestic sales	Employment
Firm-specific fixed effect		1.00	0.71	0.74
Domestic sales ($000)	_domsale	0.71	1.00	0.92
Total employment (000)	_totfte	0.74	0.92	1.00
Total sales ($000)	_sales	0.86	0.97	0.92
Total assets ($000)	_totass	0.74	0.90	0.89

a A correlation coefficient of +1 or –1 indicates a perfect positive or negative relationship with the firm-specific intercept (effect), while a value of 0 indicates no statistical relationship.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

These high partial correlations raise the possibility that domestic size may be more important than suggested by the apparently weak regression results reported above (table C.5). On one hand, the firm-specific dummy variables could be simply interpreted as a proxy for domestic sales size, thereby indirectly making domestic size a determinant of the export activity of regular exporters. On the other hand, the firm-specific dummy variables could be interpreted as representing the unobservable firm-specific characteristics that they are supposed to, and that these factors are also related to the firm's size in the domestic market. To investigate this issue, reference was made to details of the firm-level relation between domestic sales and the value of exports of regular manufacturing exporters.

Figure C.1 provides a stylised representation of that relation for manufacturing firms in the BLS identified as regular exporters.[4] The figure indicates that the high correlation between domestic sales and exports was associated with a distribution of firms across three broad groups of regular exporters:

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[4] Data required to report the actual distribution of firms were not available from the ABS for confidentiality reasons.

- the *first* and largest group of firms, is tightly clustered about the lower left-hand corner of the figure. These firms generally had lower levels of exports and/or domestic sales;

- the *second* group of firms is represented by a narrow horizontal array in which exports varied widely — from low to very high values. This group of firms typically had lower levels of domestic sales; and

- the *third* group of firms is represented by a broader, slightly upward sloping array. This group was characterised by firms with higher domestic sales and significant exports.

Figure C.2 **Stylised representation of the distribution of manufacturing firms in the BLS**

Regular exporters
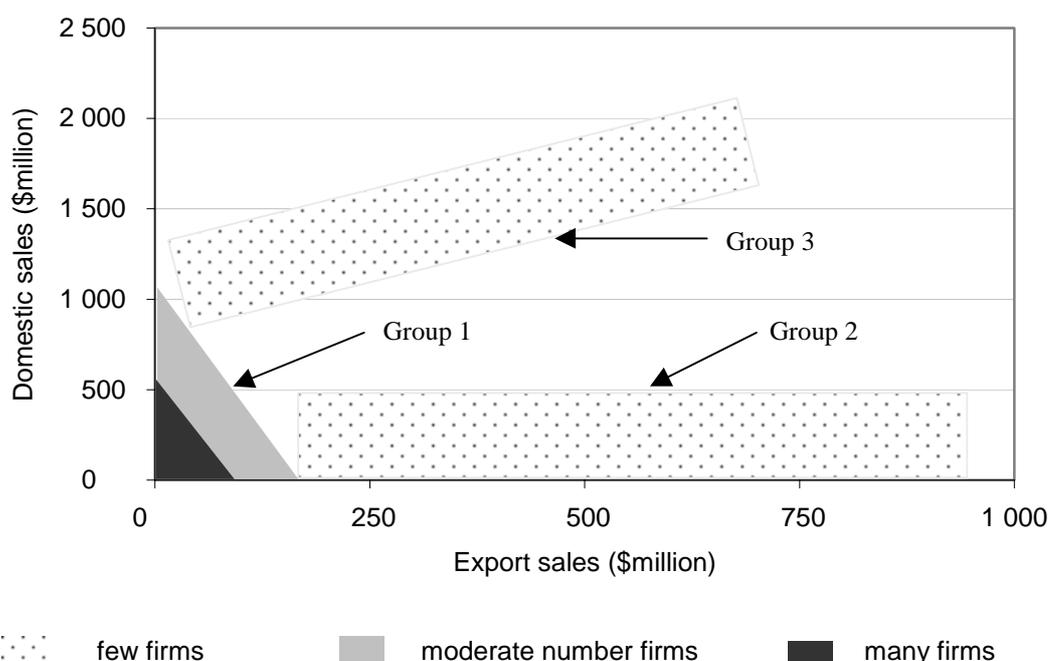
a For confidentiality reasons, firm data cannot be shown. The stylised figure is drawn broadly to the scale of actual data.

Source: ABS advice based on the BLS, Main Unit Record File, 1994-95 to 1997-98.

From the figure, there appears to be no discernible relation between domestic size and the value of exports for the first two groups of regular exporters. Moreover, for the second group, export performance does not depend on (the uniformly low) domestic sales size. Nevertheless, there appears to be a positive relation between domestic size and the value of exports for the third group. The strongly positive partial correlation evident in table C.7 reflects the fact that the third group is typically above the first and second groups and to the right of the first. However, the

partial correlation coefficient ignores factors that may have led firms to their observed domestic sales/export structure.

The substantial diversity of firms within and between groups evident from figure C.1 suggests that there was either no systematic firm-level relationship linking domestic sales size and the value of exports, or that a more complex analysis is necessary to reveal the relationship and its nature.

The estimated firm-specific effects were found to have significantly more explanatory power than domestic sales size and the other observed explanatory variables combined. For example, regressions including only domestic size and the other observed variables explained only about one third of the variation in the value of exports (as indicated by the regression coefficient of multiple determination (ie R^2) for 'X variables only' in table C.5). On the other hand, the regression allowing for unobserved firm-specific characteristics (through the firm-specific dummy variables) accounted for around nine-tenths of the variation (as indicated by the coefficient of multiple determination (ie R^2) for 'X and group effects'). Furthermore, the negative but statistically insignificant coefficient on domestic sales size in table C.5 indicates that, after accounting for unobserved factors, domestic size had little overall influence on variation in the value of exports of firms. [5]

Results reported in table C.6 indicate that, if anything, the value of domestic sales is negatively related to export *intensity*. That is, on average, the larger a firm's presence in the domestic market, the *lower* is its export sales relative to domestic sales, after account is taken of unobserved firm-specific characteristics. Again, the unobserved firm-specific characteristics were estimated to have been the main factors influencing export intensity.

Overall, these findings cast significant doubt on the general applicability of the first interpretation of the high correlation between firm-specific effects and domestic sales size — that is, that the firm-specific effects are a proxy for firm size. The regression results, accordingly, have been interpreted as indicating that it was unobserved firm-specific factors, rather than domestic size as such, that influenced a firm's involvement in exporting. Such an interpretation is consistent with, for example, the findings of McKinney & Company (1993, p. 17), which found that the best practices of successful exporting firms could be distilled into three key non-size-related elements: the leadership and commitment of senior management; being

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[5] Some indication of the impact of inclusion of the third group on the analysis can be gained by reference to CURF results. The CURF data set contained no group 3 firms for confidentiality reasons. The correlation between domestic sales and exports for firms in the CURF was around 0.2, much lower than indicated by the MURF analysis. Furthermore, the regression analysis based on the CURF and using the same model specification found the coefficient on domestic sales size was *negative* and statistically significant.

able to compete on value, particularly in quality, technology and product design; and having a strong customer orientation and tailoring products to meet customer requirements. These results for firm size are also broadly consistent with those of Atuahene-Gima (1995), the only study of Australian firms identified in the reviews of the empirical literature (chapter 3).

Nevertheless, there is always a possibility for individual cases or types of activity where the size of the domestic base was a determining factor in exporting.

Are firm-specific effects associated with other measures?

Table C.8 presents correlations between the regression estimates of firm-specific factors (the coefficients on the group dummies) and a range of BLS items not included in the panel regression analysis for data or technical reasons.[6] The analysis shows:

- very low correlations (ie less than 0.1) between the fixed effects and many of the BLS items not included in the analysis;

- weak (but variable) positive correlations (0.1 or higher) between the fixed effects and variables associated with adoption of advanced business practices or innovation, including [whether the firm]: undertook a major advertising campaign (_bpexp_), used a formal business plan (_bpfor_), undertook formal networking (_bpnet_), undertook expenditure on new or changed products (_innot_), had internet access (_netacc_) and its expenditure on research and development (_rdvalue_). There was also stronger positive correlation between the fixed effects and the number of trade unions representing employees (_unionno_);

- advanced business practice and innovation variables positively related to the estimated fixed effects also tended to be positively correlated with firm size measures; and

- negligible correlations between the fixed effects and the 8 manufacturing industry subdivision indicators — the exception being metal products with a correlation exceeding 0.1.

The low correlations suggest that there is no one factor that stands out as being strongly associated with exporting by manufacturers and that more difficult to measure firm-specific assets are likely to be key factors determining exports.

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[6] Many of these variables could not be included in the fixed effects regressions because there was insufficient variation over time for each firm (and, hence, they would be highly correlated with the firm-specific intercept) or because data were not collected for the four years of the BLS.

Nevertheless, the grouping of low, but positive, correlations around the adoption of advance business practices and innovation point to these factors as being potentially important. Moreover, it is possible that unobserved factors proxied by the BLS measures considered complement each other to influence exporting and that more complex measures of firm characteristics could form appropriate explanatory variables to firm export participation (considered in the binary choice regressions) and involvement (considered in the panel regressions).

Overall, the techniques adopted and the additional correlation analysis in this section attempt to delve into the 'black box' of firms' decision making and operations as they relate to exporting. The findings relating to firm size appear robust. However, the other measures available from the BLS and the way they are defined and modelled only partially shed light on the broader and more complex subject of export performance.

Table C.8 Correlation between the firm-specific effect from the manufacturing value of exports regression and 'other' independent variables

Regular exporters, correlation coefficient[a]

Variable[b]	Mnemonic	Firm-specific fixed effect	Domestic sales	Employment
Foreign ownership	_foreign	0.07	0.06	0.07
No. of generations	genes	-0.03	-0.06	-0.07
New business	newbus	0.00	-0.02	-0.02
No. of business locations	_buslocs	0.16	0.41	0.46
Controls a franchise	_contfra	0.02	0.07	0.10
How many unions	_unionno	0.33	0.33	0.42
Undertook export marketing	_bpexp	0.10	0.11	0.12
Highest education level	educatn	0.01	0.00	0.02
Business qualifications	tertqua	-0.03	0.03	0.03
Undertook a major advertising campaign	_mjcadve	0.00	-0.02	-0.01
Uses a formal business plan	_bpfor	0.12	0.14	0.17
Uses budget forecasting	_bpbud	0.08	0.08	0.09
Uses regular income/expenditure reports	_bpreg	0.05	0.05	0.05
Formal networking with other businesses	_bpnet	0.13	0.14	0.15
Introduced business improvement program	_busimpr	0.09	0.10	0.12
Introduced new goods or services	_intgood	-0.04	0.01	0.00
Expenditure on development of new or changed products or processes (innovation)	_inntot	0.41	0.42	0.47
Expenditure on research and development (R&D)	_rdvalue	0.25	0.39	0.37
R&D intensity	_rdint	-0.03	-0.03	-0.04
Export assistance	expndx	0.01	0.02	0.05
Non-export assistance	govtndx	0.07	0.09	0.09
Internet access	_netacc	0.12	0.12	0.15
Food, beverages & tobacco	dumfbt	-0.02	0.00	-0.02
Textiles, clothing & footwear	dumtcf	0.03	-0.05	-0.03
Wood & paper products	dumwood	0.07	0.21	0.23
Printing & publishing	dumprint	-0.04	-0.02	-0.03
Petroleum & coal products	dumpetrl	-0.04	0.01	-0.01
Non-metallic minerals	dumnomet	-0.02	0.00	0.02
Metal products	dummetal	0.16	0.11	0.11
Machinery	dummach	-0.05	-0.10	-0.09
Other manufacturing	dumother	-0.05	-0.05	-0.04

a A correlation coefficient of +1 or −1 indicates a perfect positive or negative relationship with the firm-specific intercept, while a value of 0 indicates the absence of any relationship. **b** Data for 'other' independent variables cover the years indicated in table B.2.

Source: Estimates based on ABS (BLS, Main Unit Record File, 1994-95 to 1997-98).

Technical annex 1: Binary choice (logistic) regressions

The logit model assumes a regression model:

$$y_i^* = \alpha + \sum_{j=1}^{K} \beta_j X_{ij} + u_i \tag{1}$$

where α is the common intercept across all firms, X_{ij} is a vector of explanatory variables, $i = 1,\ldots,N$ (the number of firms), $j = 1,\ldots,K$ (the number of explanatory variables) and y_i^* is an unobserved variable that can only be observed in a dichotomous state such that:

$$y_i = \begin{cases} 1 & \text{if } y_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

In this study, the underlying variable, y_i^*, could be considered as the likelihood of a firm exporting or exporting regularly. The explanatory variables in equation (1) should then include items that explain whether a firm exports or exports regularly.

From equations (1) and (2):

$$P_i = Prob[y_i = 1] = Prob\left[u_i > -\left(\alpha + \sum_{j=1}^{K} \beta_j X_{ij}\right)\right]$$

$$= 1 - F\left[-\left(\alpha + \sum_{j=1}^{K} \beta_j X_{ij}\right)\right] \tag{3}$$

where P_i is the probability of the particular export state occurring (eg that a firm exports) and F is the cumulative distribution function of u_i.

If the distribution of u_i is symmetric, then:

$$P_i = F\left[\alpha + \sum_{j=1}^{K} \beta_j X_{ij}\right] \tag{4}$$

For the logit model, the cumulative distribution of u_i is assumed to be logistic,[7] in which case:

$$F(Y_i) = \frac{exp(Y_i)}{1 + exp(Y_i)} \quad (5)$$

where $Y_i = \alpha + \sum_{j=1}^{n} \beta_j X_{ij}$.

Therefore,

$$ln\left[\frac{F(Y_i)}{1 - F(Y_i)}\right] = Y_i$$

For the logit model,

$$L_i = ln\left[\frac{P_i}{(1 - P_i)}\right] = \alpha + \sum_{j=1}^{K} \beta_j X_{ij} \quad (6)$$

L_i (the log-odds ratio) is now a linear function of the explanatory variables.

The logistic regressions undertaken in this study estimate equation (6), where the explanatory variables are those selected from table B.1. In respective simulations, each model was estimated with either the size of the domestic base (domestic sales) or one of the measures of firm size (total sales, employment or total assets) as one of the explanatory variables.

Some care needs to be taken in interpreting the coefficients estimated from logistic regressions (ie those presented in tables C.2 to C.4), as they represent the marginal effects of a change in each explanatory variable on the log-odds ratio (L_i), and not the marginal effects on the probability of the export state occurring (P_i). The following expression for the marginal effects on P_i can be derived by transforming and totally differentiating equation (6):

$$\frac{\partial P_i}{\partial X_j} = \beta_j \hat{P}_i(1 - \hat{P}_i) \quad (7)$$

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[7] A logistic regression assumes that the error term associated with the estimated model is distributed according to a logistic distribution, which is similar to a standard normal distribution used by probit regressions, although with slightly 'fatter' tails. The coefficients estimated in logit and probit regressions need to be transformed to enable comparisons to be made between the two regressions. However, both regression results are similar, especially with regard to statistical significance.

where:

$$\hat{P}_i = \frac{exp(\hat{Y}_i)}{1 + exp(\hat{Y}_i)} \text{ and } \hat{Y}_i = \alpha + \sum_{j=1}^{K} \beta_j \overline{X}_j .$$

Equation (7) demonstrates that these effects are determined by both the value of the coefficient (β_j) and the level of the probability at which the change is measured (P_i). The results reported in table C.1 are elasticities obtained from tables C.2 to C.4 evaluated at sample means ($\overline{X}_j$), where the elasticity of the probability P_i with respect to the characteristic of X_j is equal to:

$$Elasticity = \frac{\partial P_i}{\partial X_j} \frac{\overline{X}_j}{\overline{P}_i} \tag{8}$$

Technical Annex 2: Panel data regressions

Panel data regression techniques take into account various biases and other disturbances in the regression analysis that ordinary least squares (OLS) does not. These biases may arise from systematic variation between firms and/or across all firms over time.

A panel model can be represented as:

$$Y_{it} = \alpha + \beta_i X_{ijt} + \mu_i + \lambda_t + v_{it} \tag{9}$$

where α is the common intercept across all firms, X_{ijt} are the explanatory variables, $i = 1, \dots, N$ (the number of firms), $j = 1, \dots, K$ (the number of explanatory variables), and $t = 1, \dots, T$ (the number of time periods).

The last three terms of equation (9) are related to the components of the error term in the regression. The assumptions of correlation between the errors and the explanatory variables determine the appropriate estimator for panel regressions. The first term (μ_i) represents firm-specific effects. For example, the firm-specific effect represents efficiencies or comparative advantages known to the firm, but not otherwise specified, that affect the export performance of the firm. The second term (λ_t) represents time-specific effects, such as business cycles and trend growth, that affect all firms in the sample. The final term (v_{it}) represents pure random error and does not systematically affect export performance.

The means of controlling for unobservable omitted variables depend upon whether a fixed or random effects model is used. A fixed effects (within-firm) estimator is

typically chosen when unobservable firm-specific and/or time-specific effects (indicated, respectively, by μ_i and λ_t in equation 9) are assumed to be *correlated* with the observed explanatory variables. The within-firm transformation of the fixed effects estimator (applied by including firm-specific and/or time-specific dummy variables) eliminates such effects, thereby lessening the possibility of simultaneity bias in the coefficients (β_j) on the observed variables (X_{ijt}). The estimated coefficients on the dummy variables included in the fixed-effects estimator provide a measure of the importance of unobserved factors in explaining export performance. A random-effects estimator is typically chosen when unobservable firm-specific effects are assumed to be *uncorrelated* with the observed explanatory variables.

Two types of fixed-effects estimators were considered in this study. A 'one-way' fixed-effects estimator that includes firm-specific dummy variables was used to control for unobserved firm-specific factors affecting export performance. An alternative 'two-way' fixed-effects estimator that also includes time-specific dummy variables was used to control for unobserved time-specific factors affecting export performance. An *F test* was used to choose between the one-way and two-way fixed-effect estimators.[8] As a result of the application of these tests, a one-way fixed-effects estimator was used to estimate the regression model for the value of exports, whereas a two-way fixed-effects estimator was used to estimate the export intensity model.

However, there could remain residual specification problems, arising from simultaneity, mis-specified dynamics and/or measurement error. Typically, this would be represented by correlation of the error term v_{it} over time. Techniques are being developed to correct for this source of bias (eg Generalised Method of Moments (GMM) estimation methods, Bond 2002). However, the application of such methods is problematic on short time series (eg Greene 2002, p. E8-30), such as the BLS, and was not attempted in this study.

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[8] An *F test* statistically assesses whether these firm-specific and time-specific dummy variables are collectively equal to zero and, hence, add no additional explanatory power to the estimated model.

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