EXPLAINING THE RECENT PERFORMANCE OF AUSTRALIA'S MANUFACTURED EXPORTS

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Research Discussion Paper
9310

August 1993

Economic Group

Reserve Bank of Australia

We are grateful to Adrian Blundell-Wignall for suggesting this topic. Jacqui Dwyer provided invaluable suggestions, as did Philip Lowe, Michele Bullock and David Gruen. The econometric analysis in this paper was aided by conversations with Alexandra Heath and Andy Tremayne. We also thank the survey respondents for taking the time to tell us about their firm's exports. Any errors are ours alone. The views expressed herein are those of the authors and do not necessarily reflect the views of the Reserve Bank of Australia.

ABSTRACT

Australia's manufactured exports have grown rapidly since the mid-1980s. The growth of Australia's trading partners and the overall depreciation of the exchange rate, while important, do not fully explain this growth. This paper seeks to explain the remaining growth in reference to firms' cost structures, in particular their sunk cost structures. A model is developed. It shows how, in the presence of sunk costs, a shock to the economy can cause a permanent increase in the level of exports. This model is applied to Australia's manufactured exports. The results suggest that their recent growth may not be undone, even if the recent economic shocks faced by exporters are reversed.

TABLE OF CONTENTS

1. INTRODUCTION 1

2. MANUFACTURED EXPORTS: THE STYLIZED FACTS 3

3. A SUNK COST MODEL 7

- 3.1 External Shocks: The Exchange Rate and World Demand 11
- 3.2 Internal Shocks: Domestic Demand 13
- 3.3 The Vanguard Effect 15
- 3.4 Tariff Reductions 16

4. EVIDENCE OF HYSTERESIS 18

- 4.1 History in Terms of the Model 18
- 4.2 Methodology 19
- 4.3 A Sample Survey of Manufacturing Exporters 20
- 4.4 An Export Supply Equation 24

5. CONCLUSION 28

APPENDIX A: MODEL ASSUMPTIONS 31

APPENDIX B: SAMPLE SURVEY RESULTS 33

APPENDIX C: REGRESSION RESULTS 35

APPENDIX D: DATA SOURCES AND DEFINITIONS 40

REFERENCES 42

EXPLAINING THE RECENT PERFORMANCE OF AUSTRALIA'S MANUFACTURED EXPORTS

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1. INTRODUCTION

The process of international integration has been accompanied by important changes in Australia's balance of payments. One such change is the marked increase in the nation's export orientation, parallelling an increase in import penetration. Another is the diversification of the type of goods that are exported. Historically, Australia has exported mainly primary commodities. Although such commodities continue to account for the majority of Australia's merchandise exports, manufactured export volumes have grown strongly in recent years. In fact, since the mid-1980s, they have grown at twice the rate of traditional exports. How can the performance of manufactured exports be explained?

In popular discussion it has been argued that Australian exporters of manufactures have established so-called "beachheads" in foreign markets.[1] If so, it can be expected that sales to these markets will not be abandoned readily even when economic conditions faced by exporters change. Thus the pattern of export growth that has emerged since the mid-1980s may persist for some time, contributing to a structural change in the nation's merchandise trade.

There is a growing body of literature that seeks to explain structural changes in patterns of trade in the context of hysteresis.[2] It is argued that, following a shock to an economic system, there is a change in the pattern of trade that fails to be reversed when the shock is reversed (Baldwin 1988; Baldwin and Krugman 1989). Failure to revert to the initial equilibrium arises because agents incur sunk costs when entering a market (Dixit 1989).

The existing literature arose to explain the apparently hysteretic effects of the prolonged swing in the value of the US dollar during the 1980s.[3] It tends to focus

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1 The landing of the Allies at Normandy in World War II established a "beachhead".

2 Hysteresis is the failure of a shocked variable to return to its original state when the cause of the shock is fully reversed.

3 For example, Baldwin (1988) found evidence for an altered pass-through of import prices.

on exchange rate movements as the potential source of a permanent change in trade volumes. However, it is plausible that other shocks may also be important. The decision of firms to export will be influenced by the profitability of selling output locally compared with selling to foreign markets. Therefore, changes in world and domestic demand could, in principle, be as important as changes in the exchange rate.

In this paper, a standard export model is altered by allowing for the existence of sunk costs. In the world of the sunk-cost model, agents do not necessarily respond in the standard way to economic forces. Sunk costs effectively create a hurdle that any would-be exporter must surmount. Exporters may not appear to respond to changed incentives (such as tariff reductions) until a threshold value is reached. Furthermore, even if the shock is reversed (as exchange rate and demand shocks can be) they may not abandon their markets, having paid their sunk costs.

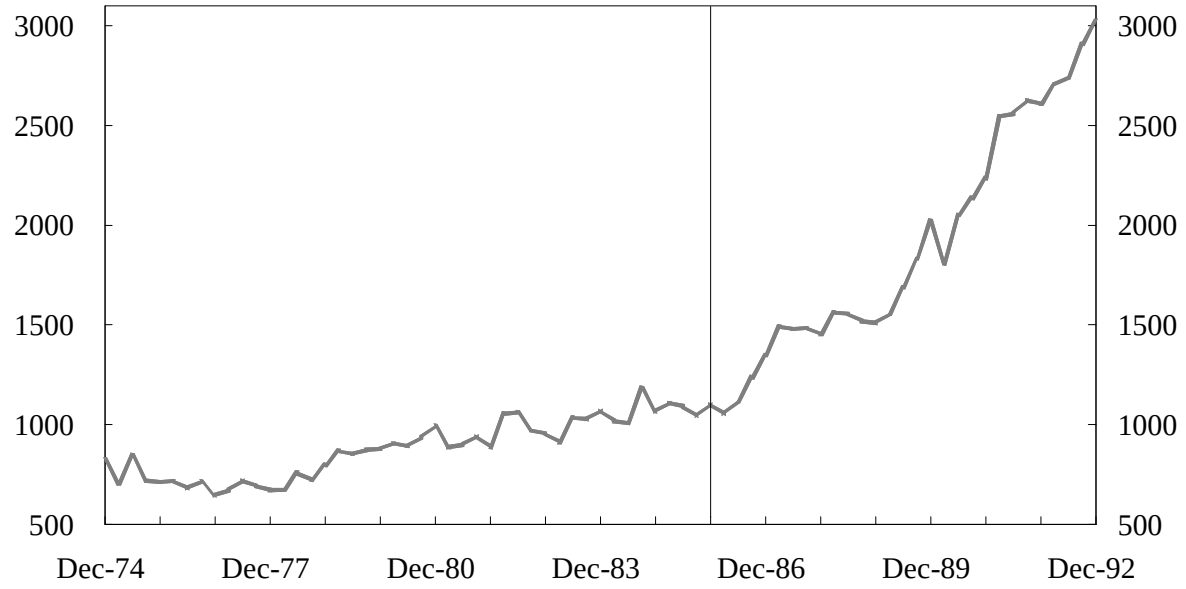
The main theoretical result of the model is that both demand and exchange rate shocks to the economic system can generate hysteresis. Another result is that tariff reductions may appear to have no effect on exports until a threshold is reached. An attempt is made to relate this theoretical model to the actual performance of manufactured exports. Econometric and survey data support a structural break in the mid-1980s. A case for hysteresis is developed where the catalysts for change are the historic mid-1980s exchange rate depreciation, the most recent recession and the process of internationalisation begun in the early 1970s (embodied in tariff reductions). It is also suggested that the existence of positive externalities has enabled and will continue to enable new exporters to benefit from the presence of Australian firms already established in overseas markets.

The paper is organised as follows. In Section 2, stylised facts are presented. In Section 3, a sunk cost model is developed. In Section 4, some evidence of hysteresis in Australia's manufactured exports is considered, along with evidence relating to other explanations. Finally, implications and conclusions are drawn.

2. MANUFACTURED EXPORTS: THE STYLIZED FACTS

Figure 1 shows real manufactured exports over the past two decades.[4] Since 1985/86 manufactured export volumes have grown by 16 per cent per annum. In fact, they now account for more than 20 per cent of total merchandise exports, compared with under 11 per cent in 1985/86. Reflecting increased international integration, imports have likewise trended upward over the period (Reserve Bank 1992).

Figure 1: Manufactured Exports
(1989/90 prices, $million)



The timing of major movements in the growth rates of manufactured exports suggests some responsiveness to macroeconomic shocks. For instance, in recent years, there have been substantial swings in Australia's real exchange rate, fluctuations in economic activity and the continued dismantling of trade restrictions. Each of these factors is expected to have impacted on manufactured export growth.

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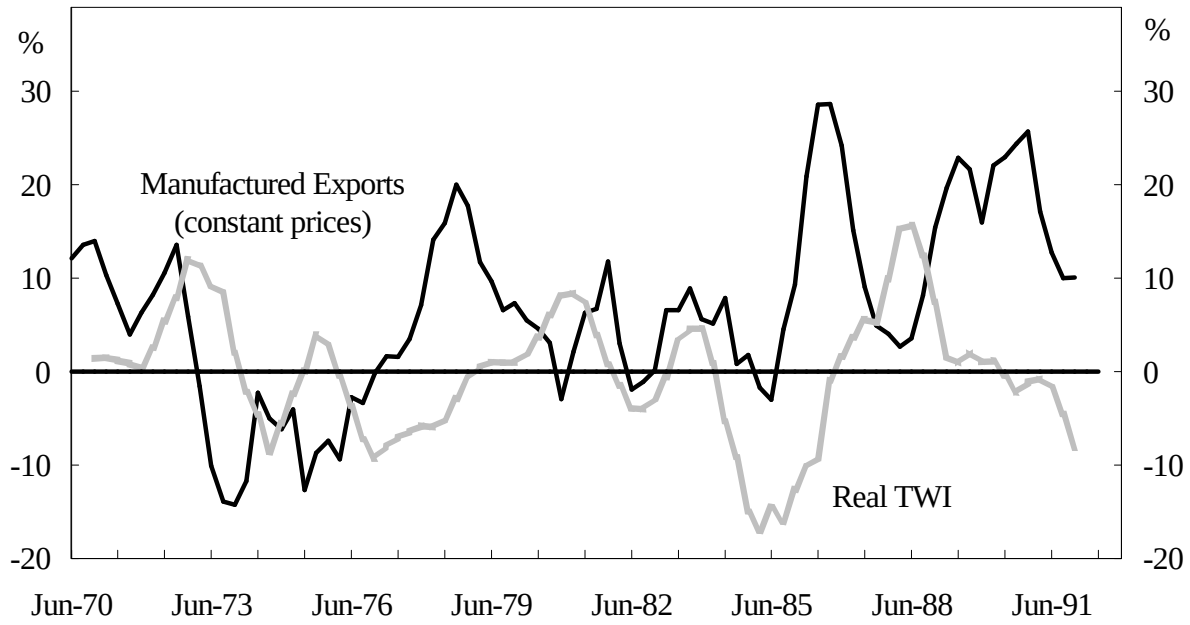
[4] The definition of manufactures used in this paper excludes some simply transformed manufactures, such as iron and steel and non-ferrous metals. It also excludes processed food and beverages. Further details are provided in Appendix D.

Figure 2 shows the relationship between the real trade-weighted exchange rate and the growth of manufactured exports.[5] To varying degrees each of the periods of appreciation correspond to a decline in manufactured export growth. Similarly, episodes of depreciation tend to be associated with accelerations in the growth rate of manufactured exports (albeit lagged). Thus real exchange rate movements appear, in general, to be negatively correlated with the growth in manufactured exports. However, since 1986/87, a situation has emerged where export growth has been sustained *despite* episodes of real appreciation. One possible explanation is that the sharp depreciation of the mid-1980s may have had an hysteretic effect.

Figure 2: Manufactured Exports and the Exchange Rate
(annual per cent change[6])

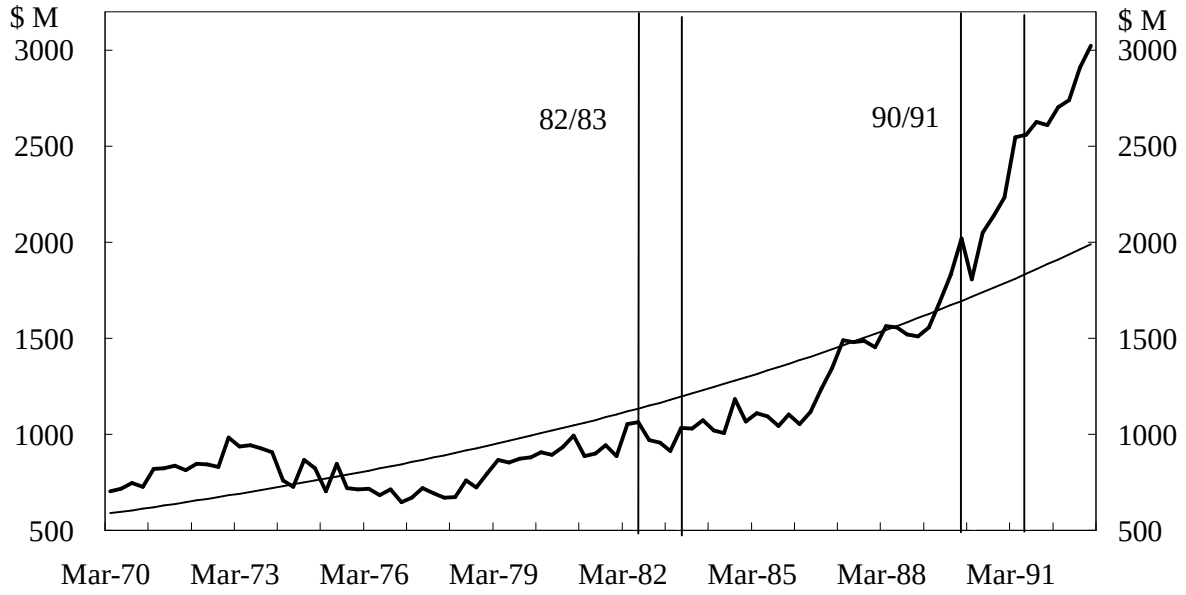


[5] Pitchford (1993) alludes to the controversy surrounding the correct measure of the real exchange rate. This may influence its perceived impact on exports. However, for the sake of simplicity, the measure used in this paper is the real TWI calculated in Jones and Wilkinson (1990).

[6] In this section, all series graphed on an annual growth basis are shifted left by one year to compensate for the phase shift introduced by the transformation from levels to annual growth rates. That is, a growth rate attributed to December 1985 on the graph refers to the year-on-year growth between 1985 and 1986.

Similarly, it has been suggested that the recent recession has been a factor contributing to the surge in export growth; the fall in domestic demand may have caused manufacturers to direct production to overseas markets. However, as shown in Figure 3, no such relationship between exports and domestic demand was evident in the 1982/83 recession.

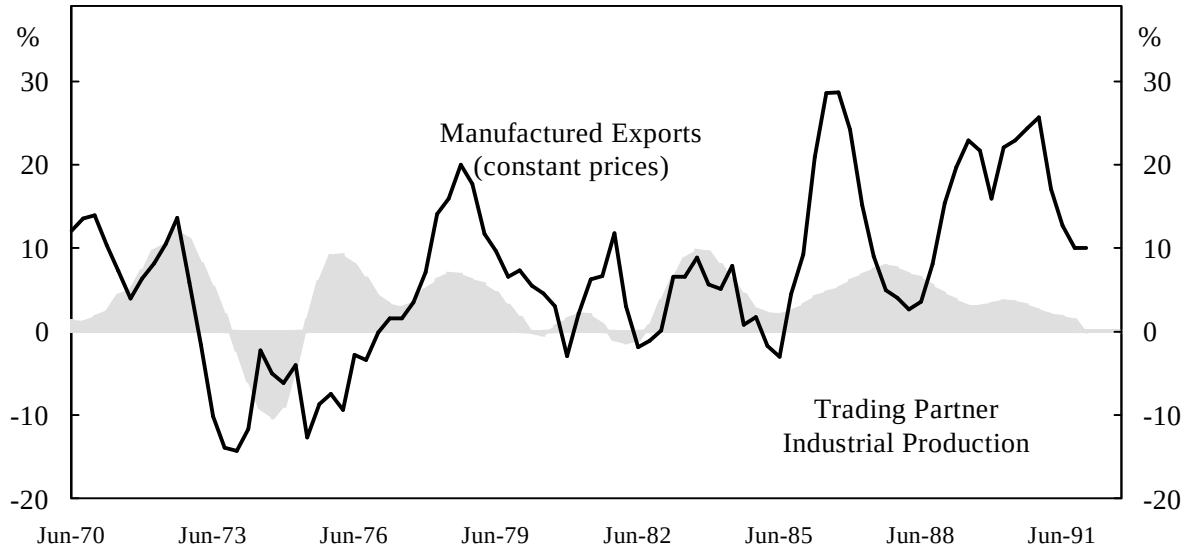
Figure 3: Manufactured Exports and Recessions
(1989/90 prices, exponential trend line)



It might also be expected that export growth would be directly related to economic activity in the markets in which they are sold. Much attention has been paid to the growth in Asia and the attendant expansion of potential export markets in that region. Certainly, as shown in Figure 4, there is a broad positive correlation between the industrial production of Australia's trading partners and export growth. However, recent growth in overseas demand has been associated with higher-than-expected rates of export growth.[7] Growth in overseas demand, particularly Asian demand, does not appear to fully explain the growth in manufactured exports since the mid-1980s.

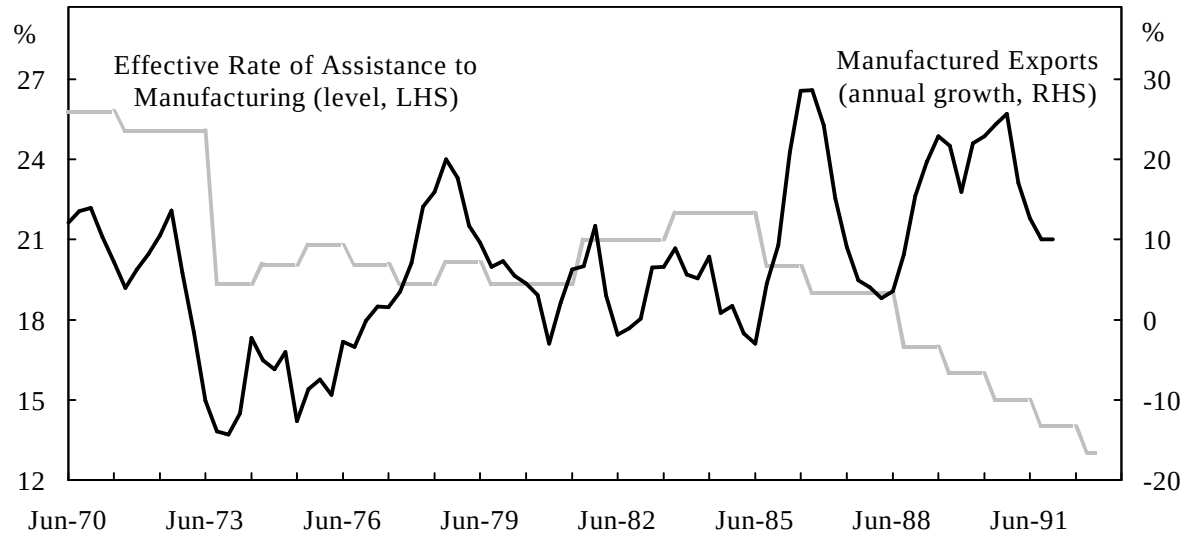
[7] The co-movements observed in the series up until the mid-1980s suggest lower elasticities.

Figure 4: Manufactured Exports and Overseas Demand
(annual per cent change)



Finally, increased export orientation may also be a response to the dismantling of trade restrictions. A measure of the effective rate of assistance for manufacturing (based on Plunkett et al. (1992)) is illustrated in Figure 5. The sharp cut in tariffs in 1973 coincided with a fall in exports, whereas the gradual lowering of assistance in the second half of the 1980s was associated with strong export growth.

Figure 5: Manufactured Exports and Protection



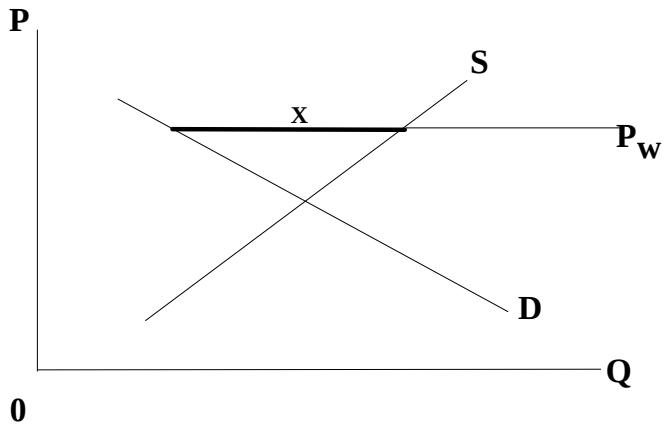
It is clear that the growth of manufactured exports in the late 1980s is not easily explained by a *single* cause. However, the graphs have suggested an interesting puzzle. The surge in exports following the mid-1980s depreciation has continued in spite of subsequent episodes of appreciation. Furthermore, the apparent strength of the link between the recent recession and export growth stands in stark contrast to the lack of effect of the 1982/83 recession.

The following sections of the paper explore some potential explanations for these anomalies. Central to the analysis will be a model which allows exporting firms to have sunk costs. That model is now examined.

3. A SUNK COST MODEL

Consider first the properties of the standard export model. In this model, domestic firms compete in perfectly competitive markets. Entry into the world market is assumed to be costless and there are no transportation costs. Firms are price takers in the world market for traded goods and hence, the local price (P_L) and the world price (P_W) are the same when expressed in a common currency. The quantity of goods exported equals the excess of domestic supply over domestic demand, as shown in Figure 6.

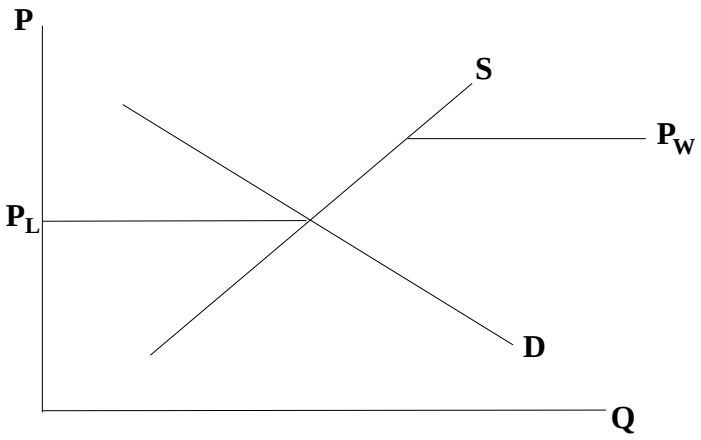
Figure 6: The Standard Model



What will be referred to as the "sunk cost model" is the standard model with an additional assumption; firms must pay a once-off sunk cost (C) when they first export. Exporting will only commence if it improves the expected present value of

profits by at least *C*. In general, the presence of *C* drives a wedge between the local price and the world price. There is no automatic tendency for P_L to equal P_W, because there is no profitable way for firms to exploit the difference in prices.

Figure 7: The Sunk Cost Model



In general, models that incorporate sunk costs are characterised by a "band of inaction" where movements of a causal variable within some band fail to have an effect. For example, an exchange rate band of inaction in an export model refers to a range of values for the exchange rate (the causal variable) that will not motivate firms to commence or cease exporting. The so called "lower bound" of the band of inaction is the value of the exchange rate that will make local firms export for the first time, while the "upper bound" is the value of the exchange rate that will make hitherto exporting firms cease exporting.[8]

In the sunk cost model of this paper, the causal variable is the price differential P_W-P_L. A high value of the differential (the upper bound) will motivate firms to commence exporting, while a low value (the lower bound) will motivate exporting firms to cease exporting and instead sell their output on the domestic market. Movements of the price differential within the band of inaction (i.e. between the upper and lower bounds) will not change the number of exporting firms. For simplicity, the upper bound will be referred to as *d*, while the lower bound will be

[8] The exchange rate in this example is expressed as the foreign currency price of the local currency.

assumed to be zero.[9] Subsequently, a change in the number of firms involved in exporting will be referred to as a "change in market structure".

Dixit (1989) discusses the factors that influence the width of a band of inaction. In his model, the degree of variation in the causal variable is shown to be a surprisingly important determinant of the width of the band; the greater the variation the wider the band. Using numerical examples, he also argues that variability in a causal variable can create a wide band of inaction *even if the sunk costs are quite small*.[10] This insight becomes important when evidence is presented for the existence of sunk costs.

To see how variability can influence the band of inaction, imagine that P_W-P_L is a random walk. For expository ease, assume that a firm faces this choice in each period: it can pay the sunk cost and then export forever or it can sell domestically and put off till the next period the decision about when to enter the export market. Further assume that, for the first time, P_W-P_L has risen to a level high enough for potential exporters to just cover the sunk cost C. That is, the expected present value of exporting now is zero.[11] The current price differential would be the top of the band of inaction (i.e. exports would commence) if the future value of P_W-P_L was not expected to vary. However, in the presence of future variability it is *not* optimal to export immediately. Since it is possible that P_W-P_L will rise further, a rational firm can do even better by remaining uncommitted for one period. If the price differential does rise, the firm can pay the sunk cost then and get a positive expected present value. If P_W-P_L falls next period, it can decide not to pay the sunk cost, and wait a further period. Viewed from the original period, the expected present value of waiting is positive, while the expected present value of exporting immediately is zero.

Nevertheless, this does not imply that there is no upper bound. If P_W-P_L in the current period is high enough for exporters to cover sunk costs *and earn a return in*

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[9] In other words, when the local price exceeds the world price a representative firm will cease exporting and instead sell on the domestic market. This is consistent with the simple model in Appendix A, but not with the more sophisticated analysis of Dixit (1989) subsequently discussed in the text.

[10] However, sunk costs must be non-zero for there to be a band of inaction.

[11] Here and subsequently, the "present value of exporting" refers to the value of the *extra* profits attainable compared to selling locally.

the current period, there is an opportunity cost of waiting. There is, therefore, a value of P_W-P_L which is so high that the foregone revenue associated with waiting equals the benefit of waiting. A value of P_W-P_L higher than this motivates exports *immediately*. This is the true upper bound (*d*). The band of inaction is, therefore, *wider* because of the variation in the causal variable.[12]

Earlier literature has tended to focus on the exchange rate as the sole source of movements in P_W-P_L. However, changes in world demand or domestic demand will also alter this price differential. Therefore shocks to exports via these causal variables will now be examined.[13] The hysteretic effect on exports of a subsequently reversed shock will be shown diagrammatically. The shocks considered will be classified as *external* (changes in world demand or the exchange rate) and *internal* (changes in domestic demand). Some other market-altering shocks will also be considered.

A simple three-period model consistent with the following diagrammatic exposition is described in Appendix A. Firms sell all their output overseas or domestically; they do not sell some in each market. Shifts in market structure are equivalent to shifts in a local supply curve. This curve is the horizontal summation of the marginal cost curves of those firms supplying the local market at a point in time.

Firms make their export decisions sequentially according to the following rules:

export for the first time if	$(P_W\text{-}P_L)$	$>$	d
cease exporting if	$(P_W\text{-}P_L)$	$<$	0

In addition, local and exporting firms choose output so that marginal cost is equated to the relevant output price: P_L and P_W respectively.

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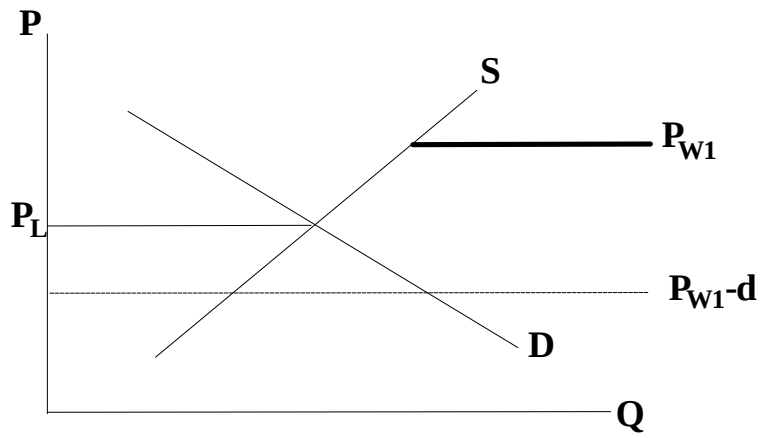
[12] Dixit (1989) also shows how the lower bound falls with increased uncertainty in the causal variable.

[13] The issue of how the future variances and covariances of the causal variables effect the width of the band of inaction is sidelined. A formal extension of Dixit (1989) which allows for these variances and covariances is not attempted. The model in Appendix A assumes that firms export as soon as sunk costs can be covered.

3.1 External Shocks: The Exchange Rate and World Demand

Exchange rate depreciation or an increase in world demand should, other things being constant, be reflected in a rise in the world price of exports, when measured in local currency.[14] The hysteretic effects of such an external shock, and its subsequent reversal, are now shown. Figure 8 shows the situation in period one, before the shock.[15]

Figure 8: External Shock, Period One

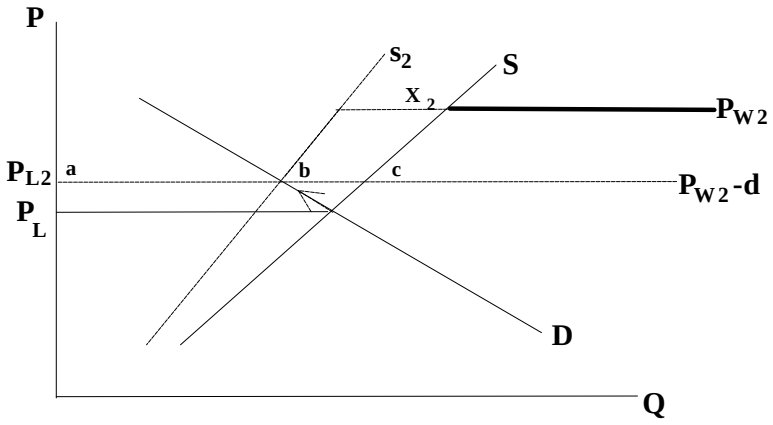


Local supply and demand are equated at P_L, and P_W-P_L is in the band of inaction. There are no exports: the higher price for exports will not compensate a firm adequately over the three periods for its entry cost. In Figure 9, the world price rises due to an external shock.

[14] This abstracts from productivity shocks which would effect both the exchange rate and the total supply curve. See Appendix C for a discussion of the associated empirical difficulties.

[15] In subsequent diagrams, numerical subscripts denote the time period.

Figure 9: External Shock, Period Two



The new world price exceeds P_L (the local equilibrium) by more than *d*; firms will want to export. As firms leave the domestic market one-by-one, domestic supply[16] contracts toward s_2, putting upward pressure on the local price. This process continues until the marginal firm no longer faces a local price that differs from the world price by more than *d*. The new equilibrium has a proportion, *bc/ac*, of exporting firms. However, the level of exports is not *bc*. As exporting firms are producing up to the point where marginal cost equals world price, the level of exports is shown by the segment x_2 between the two supply curves at that price. Now consider the reversal of the shock so that P_W returns to its initial level (see Figure 10).

As P_W falls, the differential between P_W and the new P_L falls into the band of inaction. It will not be optimal for any *new* firms to export. As P_W falls each exporting firm will produce less output. Aggregate exports will fall to x_3 as a result. However, *firms that have already paid their sunk costs will continue to export*, so long as the world price is higher than the local one.[17] Thus, despite a reversal of the shock, some exports continue to occur. *There is hysteresis*.

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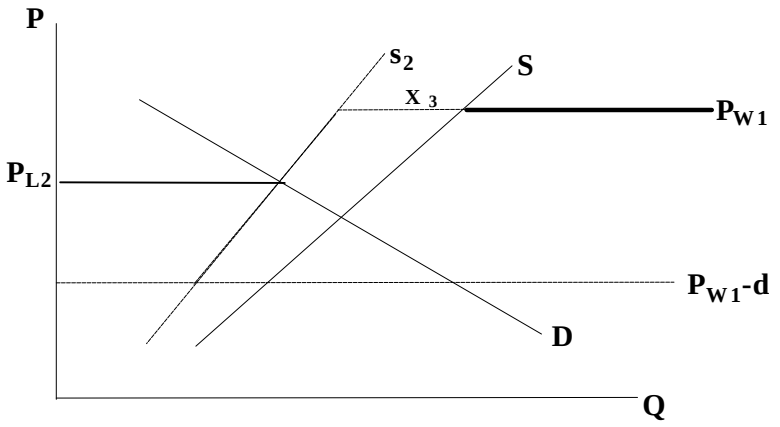
[16] If the local price rises above P_w or falls below P_W-d, the number of firms supplying the domestic market changes. This is shown graphically by dashing the s line outside these limits.

[17] That is, while P_W-P_L exceeds the lower bound of the band of inaction.

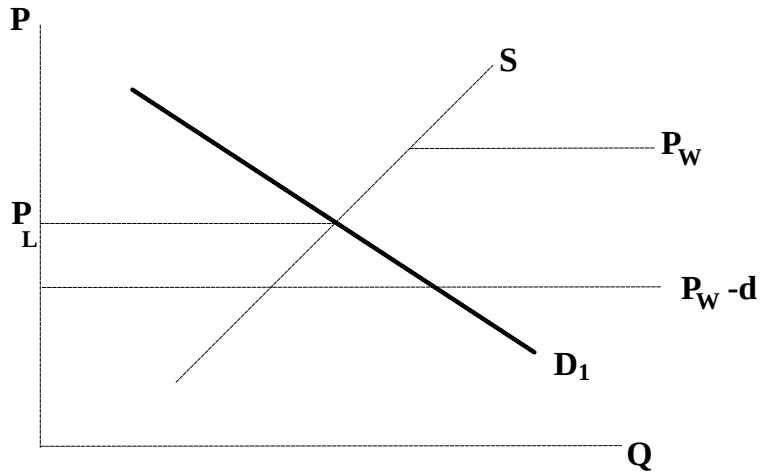
Figure 10: External Shock, Period Three



3.2 Internal Shocks: Domestic Demand

In this section the hysteretic effects of a large decline in domestic demand, and its subsequent reversals, are shown. Figure 11 shows the situation in period one, before the shock. Again, no firm is initially exporting.

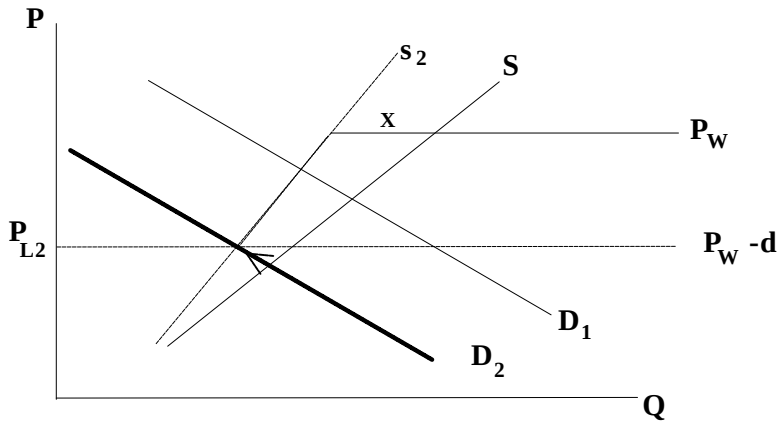
Figure 11: Internal Shocks, Period One



In the second period there is a fall in domestic demand so that D_1 shifts to D_2.[18]

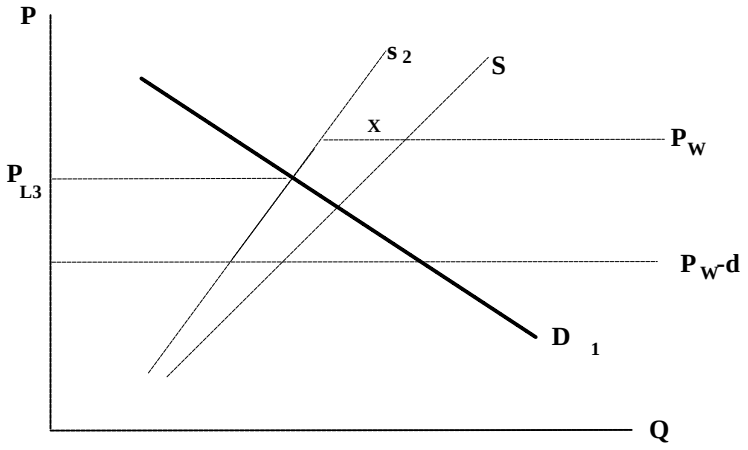
[18] The local demand for the exportable good shifts in response to GNE.

Figure 12: Internal Shocks, Period Two



The decline in demand initially results in a local price which differs from the world price by more than *d*. Local supply will therefore fall to s_2 and exporting will occur. When the shock is reversed (and demand shifts back to D_1) what will happen to exports?

Figure 13: Internal Shocks, Period Three



As local supply has contracted, the new local price will be higher than it was in period one. The price differs from P_W by less than *d*, stopping entry of *new* firms into the export market. However, *firms that have paid their entry costs will continue to export.* There is no change in aggregate exports because the output price for these exporting firms has not changed. This is in spite of the shock being reversed. *There is hysteresis.*

The differences between the sunk cost model and the standard model are most apparent in the face of an internal shock. Unlike the standard model, shocks to domestic demand which leave P_W-P_L in the band of inaction have *no effect* on aggregate exports. However, external shocks alter output for every exporting firm by changing P_W (the output price). Provided that some firms are exporting, *any external shock* will affect the aggregate (as in the standard model), even if there is no change in market structure.

3.3 The Vanguard Effect

It has been shown that firms that have already paid their sunk costs will continue to export, so long as the world price is higher than the local one. In the popular vernacular, each firm has established a "beachhead" so that export sales are not given up when market conditions change. In fact, "beachhead" is often used as a metaphor for hysteresis in exports. However, the beachhead notion may be applied to a group of firms, as well as an individual firm. A military beachhead enables later forces to enter the battle more easily. With regard to exports, initial entrants may form a "vanguard" which reduces the sunk cost for subsequent entrants.[19]

In terms of the model, a fall in C makes it optimal for firms to leave the local market in response to a smaller price differential. Consider the extreme case where one firm paying C means that other firms do not have to pay C. The final period solution of the model for all three shocks is shown in the following diagram.

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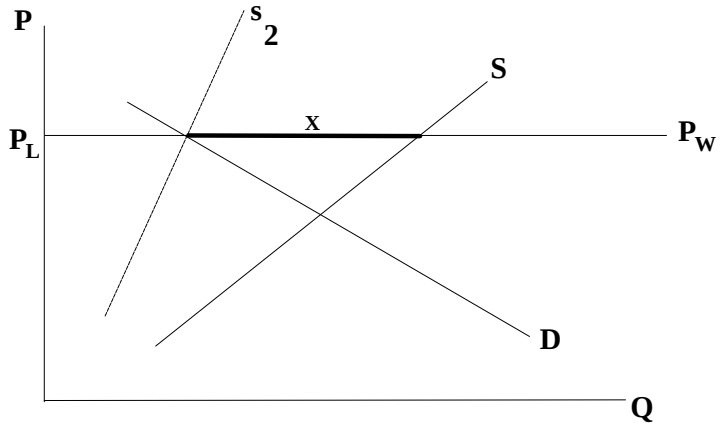
[19] A vanguard is the "foremost part of an army or fleet" (Oxford Dictionary). Its existence creates a free-rider problem. It also may help explain the existence of industry organisations the role of which is to facilitate entry of firms to foreign markets. If it is a policy objective to increase exports, the government can subsidize the vanguard. As well as encouraging outward focus, organisations such as AUSTRADE already fulfil this purpose. For example, Export Marketing Development Grants cover marketing expenditures of firms which export less than $25 million worth of merchandise.

Figure 14: Zero Sunk Costs in the Final Period



This can be recognised as the standard model. A comparison with the final equilibria for both the internal and external shocks shows that hysteresis can be *magnified* by the effects of a vanguard.[20]

3.4 Tariff Reductions

The discussion thus far has been restricted to movements in world price, domestic demand and sunk costs. This restriction has facilitated the discussion of *hysteresis* using the sunk cost model. However, an important class of shocks can be represented by a shift in the *supply* curve.[21] If declines in protection result in cheaper imported inputs, the cost curves for Australian manufacturing will shift down. This is equivalent to an outward shift in the supply curve. In the following diagram, imported inputs are an argument of supply.

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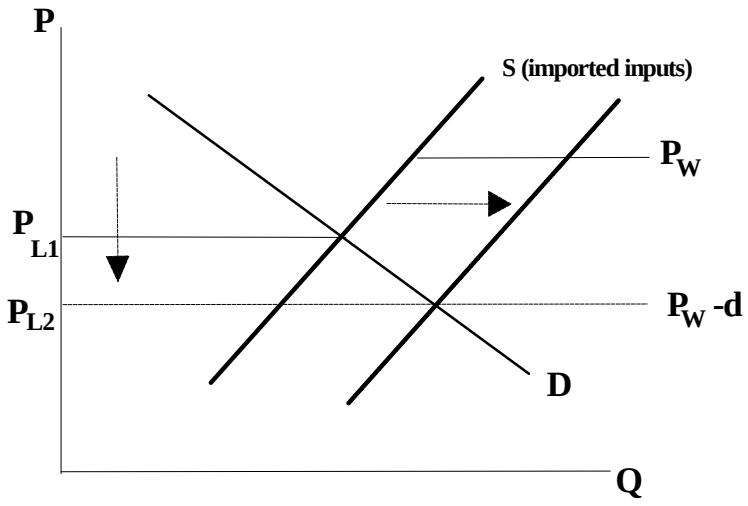
[20] An interesting corollary to the vanguard effect is that *future* hysteretic effects will be less pronounced if the sunk costs are made smaller by the vanguard.

[21] Some of these shocks, such as microeconomic reform and tariff reductions, are not expected to be reversed and therefore cannot be "hysteretic" in the strict sense of the word. They are, nevertheless, interesting.

Figure 15: Tariff Reduction Supply Shock



While P_W-P_L remains in the band of inaction, no new firms will export. However, exports will increase if P_W-P_L exceeds *d*. Therefore efficiency gains from cheaper imported inputs (or microeconomic reform) could induce an apparently "sudden" rise in exports.

It has been established that the presence of sunk costs brings with it the possibility of hysteresis. The source of hysteresis may be world demand or domestic demand, in addition to the more conventional exchange rate channel highlighted in earlier models. Furthermore, the sunk cost model describes two facets of international integration. Export vanguards reduce sunk costs for subsequent entrants, thereby accelerating the momentum of an export surge. Tariff reductions (or microeconomic reform) may proceed for some considerable time, apparently without effect. In reality, the outward shift in the supply curve places downward pressure on local prices without effecting exports, until a threshold is reached where new exporters can cover their sunk costs. The resultant growth in exports may appear to be sudden, and unrelated to its true explanators. In what remains of the paper, an attempt is made to relate the experience of the 1980s to the analytical framework that has been developed.

4. EVIDENCE OF HYSTERESIS

The shocks examined in the theoretical framework were chosen because they occurred in the 1980s. In this section, it is asserted that the sunk cost model adds to the understanding of the recent growth in exports. Then evidence is brought to bear on that assertion.

4.1 History in Terms of the Model

The *1982/83 recession* had little effect on exports. The model suggests a possible explanation for this; exporters faced a price differential in the band of inaction. Though the recession would have tended to reduce profits from domestic sales, the exchange rate may not have been low enough to generate export profits sufficient to cover sunk costs.

The historic *depreciation in the mid-1980s* was a catalytic event for would-be exporters. In the sunk cost model, the world price (in local currency) rose to an extent that encouraged firms to pay their sunk costs and export for the first time.[22] Even though the exchange rate movement was partly reversed in the latter half of the decade, the model predicts that firms that had paid their sunk costs would tend to remain in their established markets. The strength of this alleged hysteretic effect depends on the exchange rate expectations of the individual firms at that time. Optimistic firms may have believed that the favourable shock would persist. These firms would have had a narrower band of inaction because the expected present value of exporting would have been unrealistically high. Note the following statement made at that time by Senator Button:

"Manufacturers should be making their investment plans on the basis that the dollar will remain very close to its current levels and that the Government will successfully influence the course of wage and price growth to preserve gains we have made in international competitiveness" (quoted in Dunkerly 1986, p.80).

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[22] Dwyer, Kent and Pease (1993) argue that export price pass-through is not as rapid for manufactures as it is for commodities. Nevertheless, to whatever extent an exchange rate depreciation causes a decline in the foreign currency price of Australian manufactures, the demand for exports should increase. In this case hysteresis may occur because the increased demand enables sunk costs to be covered.

However, other commentators, such as Dr. E. Shann, were more cautious:

"... eventually our real exchange rate will rise. There is thus a window of opportunity for manufacturers with short lead times to earn profits. However, for projects with longer lead times there is a risk of the real exchange rate rising before they have recouped their costs, or paid off the overheads involved in establishing markets overseas" (Shann 1986, p.15).

In the sunk cost model, the *recent recession* could have had a different effect on aggregate exports than the 1982/83 recession. This is because the exchange rate was lower, overall, than it was in the early 1980s. All other things held constant, P_W-P_L was closer to the upper bound of the band of inaction. Slack domestic demand could have put downward pressure on prices in both recessions, but expected export profits in the early 1990s may have been relatively greater by virtue of the lower exchange rate.

The model can explain some of the surge in exporting since the mid-1980s by the *vanguard effect*. Responding to the depreciation and the recession, pathbreaking firms established themselves in overseas markets. Their presence reduced entry costs for subsequent firms. Furthermore, the influence of the *tariff reductions*, begun in the early 1970s, at some point began to have an influence. The efficiency gains from using imported inputs steadily improved the competitiveness of exporters. However, in the sunk cost model, the effect on exports could have been sudden, as the threshold was reached, rather than steady.[23]

4.2 Methodology

Empirical analysis of sunk cost models is difficult. A comprehensive analysis would seem to require (unavailable) cost data for firms over a wide range of industries. There is the added difficulty of modelling export equations, which has traditionally met with little success.[24] As a result, the literature tends to focus on hysteresis in

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[23] Sunk costs issues aside, gradual tariff reductions could also exhibit a sudden effect if, at some indefinable point, they came to be regarded as permanent.

[24] Consequently, the most established body of empirical literature on trade flows is that relating to single equation models of import demand. In contrast, modelling of exports is less established, Key examples of the literature on export models are Leamer and Stern (1970), Goldstein and Khan (1978) and, with respect to Australia, Ryder and Upcher (1990).

imports. Econometric validation of various models, if it exists, rests on limited evidence, such as the significance of structural breaks.[25]

The approach adopted in this paper is to have a simple model which is open to the scrutiny of testable implications. Many of the implications of the sunk cost model, including the existence of a structural break, are observed in the data. With this a case is built for the sunk cost model and hysteresis. The difficulties experienced in modelling exports motivate a sample survey. The results of the survey are consistent with the econometric results.

At the outset, a distinction is made between building a case for the sunk cost model, on the one hand, and building a case for hysteresis on the other. These beliefs are discussed separately for both the survey and the econometric evidence. First, evidence is presented in support of the sunk cost model. However, even if sunk costs can be shown to have been important, the economy may not have received the sequence of shocks necessary to change the local supply curve. That is, evidence in favour of the sunk cost model is necessary but not sufficient to establish hysteresis. The second step, therefore, involves examining export growth since the mid-1980s in light of the sunk cost model. Armed with a prior about the correct model, statistical evidence builds a case for hysteretic effects.

4.3 A Sample Survey of Manufacturing Exporters

A small scale survey was carried out to establish the importance of sunk costs. AUSTRADE provided the first 100 exporters from an alphabetical listing of its database. The listing was confined to companies in NSW with annual export revenue of between $2 million and $50 million.[26] These firms were contacted in alphabetical order until 30 successful interviews occurred.[27] This procedure

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[25] Baldwin (1988) infers hysteresis from a structural break in an import equation, while Dixit (1989) discusses hysteresis using a model with imposed parameter values.

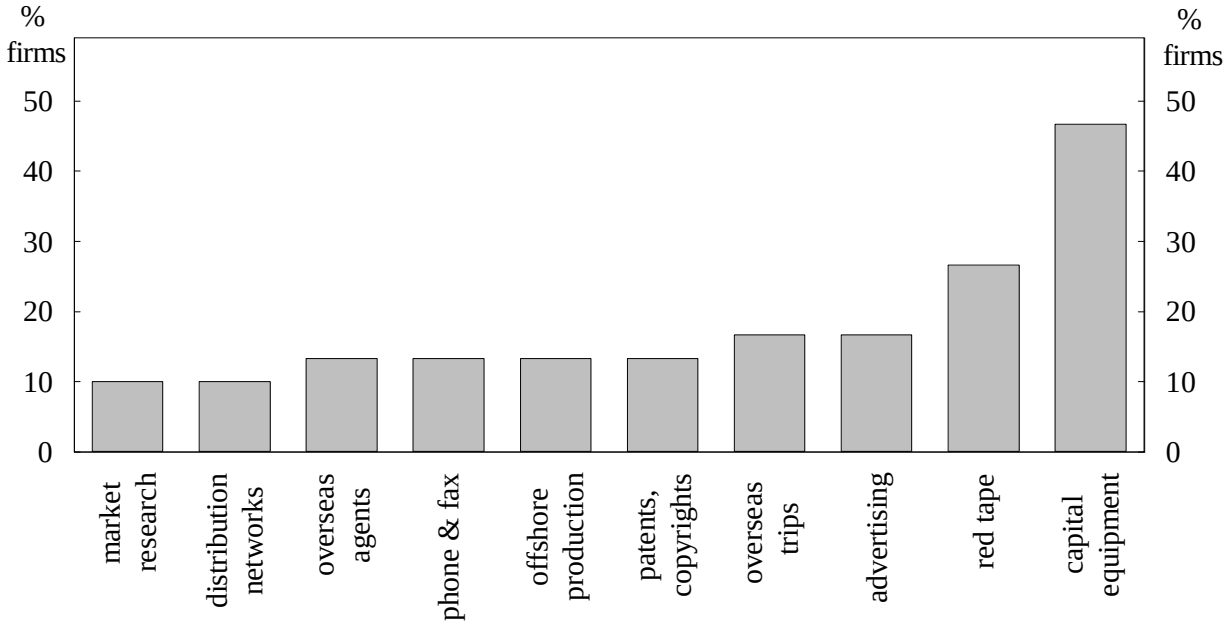
[26] The export revenue range was chosen to be comparable with the McKinsey and Co. (1992) study. See Appendix B.

[27] Some of the firms on the database did not export manufactured goods and some had ceased exporting. A preliminary screening question enabled those firms to be excluded from the sample. Furthermore, firms were also excluded when the first word of their name described their business (e.g. "Agribusiness") and therefore determined their alphabetical order.

approximates a random sample of Australian exporters that export between $2 million and $50 million.[28]

The survey supported the existence of a vanguard, where pathbreaking exporters reduce sunk costs for subsequent entrants. For example, some respondents argued that the profile of Australian goods established by the vanguard made subsequent entry easier. Other respondents indicated that the vanguard helped new firms by passing on information at industry forums or in networks.[29]

Figure 16: Significant Sunk Costs



[28] It is reasonable to assume that companies' costs are totally unrelated to their order in the alphabetical listing. Also, it has also been argued that the characteristics of NSW exporting firms can be generalized to Australian firms (Daly et al. 1992). Companies consent to being on the AUSTRADE database because they have asked for assistance, to be informed of seminars or to be matched with buyers in overseas markets. A self selection problem may arise if only those companies with large sunk costs approach AUSTRADE. On the other hand, the fact that AUSTRADE has paid some of their sunk costs may mean that they do not realize the magnitude of them. It was usually necessary to contact Managing Directors or Financial Controllers and this meant that many of the interviews were conducted under time constraints. Anticipating this problem, an abbreviated version of the survey was offered to executives if they were too busy (questions 3 to 12 inclusive). This proved effective in raising the response rate.

[29] Of the 25 firms answering the relevant question, 2 stated that other firms had made their entry easier and 2 claimed to have made subsequent entry by their competitors easier.

The survey respondents indicated that there were large one-off fixed costs. At the 5 per cent level, it was established that *more than half* the firms had at least one significant sunk cost.[30] The most significant individual sunk costs were in the area of export-related plant and equipment.[31] Even if the size of these costs are exaggerated, the analysis of Dixit (1989) has an important point to make. The combination of sunk costs and uncertainty means that *large economic shocks may be necessary to change market structure*. This implies that the sunk cost model is more realistic than the standard model. Armed with this prior, the late-1980s export surge is now given a sunk cost interpretation.

The exchange rate was nominated by 60 per cent of firms as being an important factor in their initial export decision.[32] Furthermore, the survey shows that one quarter of firms currently exporting began in 1986, the year of an historic $A depreciation.[33] If the sunk cost model is correct, this could signify that the depreciation enabled a large number of firms to cover their sunk costs and establish beachheads.

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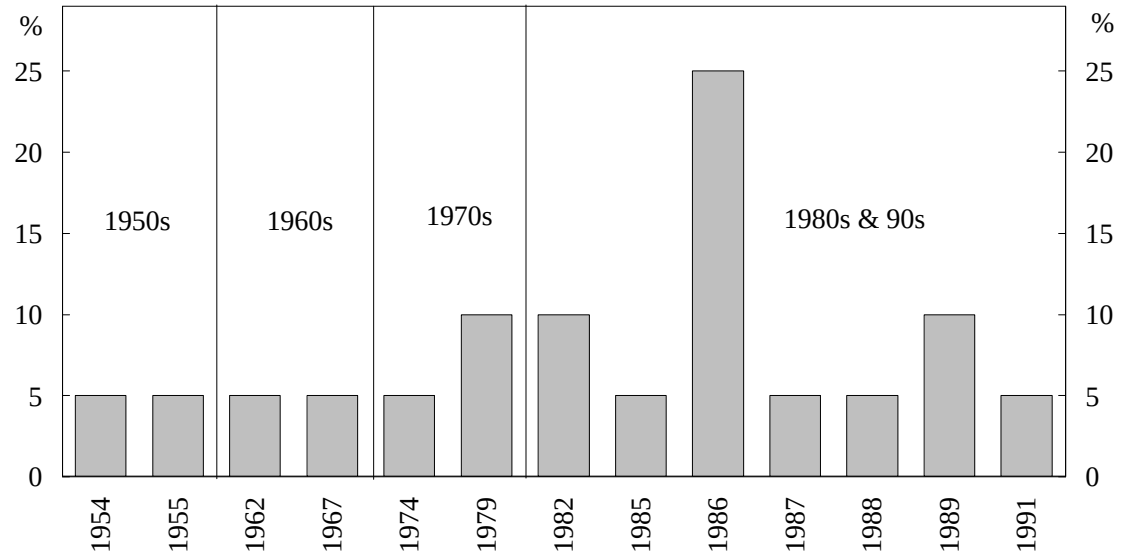
[30] "Significant" means that the cost was taken note of when firms were considering an export venture. In describing the costs as sunk, it is implicitly assumed that they cannot be recouped if the firm exits the market.

[31] If capital is rented, then the costs are fixed rather than sunk. However, survey respondents indicated that their spending on these items declined once they had established themselves in a foreign market. The survey did not explore the issue of how saleable capital was in the event of exit.

[32] 12 respondents indicated this out of 20 who answered the relevant question.

[33] Firms indicated the year in which they exported more than 10 per cent of their output. In a study by McKinsey and Co. (1992), 1986 was also highlighted as a significant entry year.

Figure 17: First Year Exports Exceed 10 per cent of Production[34]
(20 firms from survey)



The survey also indicated that the most recent recession has had a greater impact on exports than any other recession. Of the respondents, 40 per cent indicated that they had significantly increased their exports in response to it. (Only one firm indicated that a previous recession had caused a significant increase in exports.[35])

The importance of the last recession is consistent with the description of hysteresis in the late 1980s. The combination of slack domestic demand and a (generally) lower exchange rate pushed P_W-P_L above d, increasing the discounted future stream of export profits to the point where paying sunk costs was optimal.

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[34] It was confirmed that the 1986 observation did, in fact, reflect an increase in export *volumes*. All firms which nominated that year were contacted again to make sure that the increased share represented an increase in actual merchandise.

[35] 25 exporters answered the question about the effects of the "recent recession" and 20 answered the question about the effects of "any other recession". With regard to the 1982/83 recession, 9 firms first exported more than 10 per cent of their production prior to 1983. Of these, 2 increased their exports in response to the recent recession and 1 of those 2 increased its exports in response to "another recession" (probably 1982/83). Of the firms which indicated that they were exporting less than 10 per cent of sales in 1982/83, 2 said that the incentive to export was greater in the recent recession than it was in 1982/83.

4.4 An Export Supply Equation

In an attempt to gather evidence for sunk costs and hysteresis, the following model of manufactured exports was estimated using quarterly data from March 1970 to December 1992:

$$\begin{aligned} x_t \;=\; & \lambda_1 + \lambda_2 t + \lambda_3 (t-64)D + \sum_{i=1}^{4} \alpha_i x_{t-i} + \\ & \sum_{j=0}^{4} \beta_j twi_{t-j} + \sum_{k=0}^{2} \gamma_k protect_{t-k} + \\ & \sum_{l=0}^{2} \delta_l tp_{t-l} + \sum_{m=0}^{4} \phi_m gne_{t-m} + \varepsilon_t \end{aligned} \qquad (1)$$

The following notation applies:

t	-	a time trend
D	-	a dummy variable which takes the value unity on and after March 1986 (the 65th observation)
protect	-	the effective rate of assistance to manufacturers[36]
x	-	real manufactured exports (logarithm)
twi	-	the real trade-weighted exchange rate (logarithm)
tp	-	trading partner's industrial production index weighted by exports (logarithm). (Moving weights capture the recent switch to Asia[37])
gne	-	real GNE (logarithm)

A full list of estimates is provided in Appendix C.[38] The variable *gne* was found to be insignificant (p-value = 0.14). The following long-run estimates from a reparameterisation (a Bewley transformation) were obtained after *gne* was excluded:

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[36] The construction and interpretation of this series is described in Appendix D. It is measured as a proportion; that is, 20 per cent is 0.2.

[37] This is because their share of Australia's exports has been rising recently.

Table 1: Long-run Elasticities
(Estimation: March 1971 - December 1992)

Variable	Elasticity	t-Statistic
twi	-0.6701	-1.7
tp	1.6896	2.0
protect[39]	4.8034	3.8

As expected, exchange rate depreciations and world growth increase export volumes. The perverse sign of the coefficient measuring the effective rate of assistance results largely from an inexplicably strong decline in exports in the early 1970s, coincident with the large tariff reductions. To remove the effect of this episode, the model was re-estimated from December 1974 and the following estimated long-run coefficients were obtained:

Table 2: Long-run Elasticities
(Estimation: December 1974 - December 1992)

Variable	Elasticity	t-Statistic
twi	-0.2048	-0.9
tp	0.2335	0.3
protect	-3.6640	-1.3

This table illustrates the difficulties involved in modelling exports that were alluded to earlier. Though the significance of the parameters suffers substantially from the shorter estimation period, the main point to be made is that the declines in protection explain most of the growth in exports in this regression. The surprisingly

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[38] The estimation technique was OLS with a Newey-West correction for a nonscalar identity covariance matrix. Serial correlation was present, which implies inconsistent estimates, given the lagged dependent variable. The equation was estimated using IV with the broken trend as an instrument for *x*. The main result, namely that *gne* was insignificant and the broken trend was significant, was verified. A cointegrating relationship was found between exports and its explanators (excluding *gne).* Nevertheless, in order to verify the main result, the model was run in a difference form. Again *gne* was insignificant while the dummy was significant.

[39] This elasticity is defined as the per cent increase in exports resulting from a one percentage *point* increase in the effective rate of assistance to manufacturers.

low elasticities for the exchange rate and the growth of our trading partners may be the result of the timing of the late 1980s tariff cuts, which mirrored the export surge.[40] The true values of the elasticities probably lie somewhere between the sets of estimates generated over the different sample periods. Having examined the properties of the export equation, it is now shown that it provides some evidence for the importance of sunk costs and the existence of hysteretic episodes in the late 1980s.

Econometric validation of sunk costs requires testing for a "hurdle" that exporters must surmount. Krugman (1989) argues that sunk costs should make trade flows "rather unresponsive" to the exchange rate. Developing this idea further, if the situation arose where exports were *totally* unresponsive to some range of changes in exchange rates, world demand and domestic demand, it might seem plausible that there was a "hurdle" for exporters in the form of sunk costs. This would contrast with the standard model where any shock to these explanators should cause exports to change.

However, this "hurdle test" is too broad. The sunk cost model has shown that external shocks change the world price in domestic currency. This induces a change in the output of every *exporting* firm. Therefore, changes in world demand or the exchange rate will alter aggregate exports *as in the standard model*: neither model predicts that exports will be totally unresponsive to changes in the exchange rate or world demand.[41] As seen above, our export model estimated over the full sample period showed that both the real exchange rate and a measure of world demand designed to capture the increased trade with Asia were significant, and took the correct signs.

However, the hurdle test works for domestic demand shocks since the output price for exporting firms, P_W, does not change. Therefore, a testable implication of the sunk cost model which clearly discriminates it from the standard model is that domestic demand shocks will not effect aggregate exports if P_W-P_L is in a band of inaction. This differs from the standard model where any decline in domestic

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[40] An alternative is that tariffs really do explain all the growth in the late 1980s. If this is so, then a strong tariff effect on imports should also be observable.

[41] This is true if exports are already occurring.

demand will cause exports to increase.[42] If the standard model is correct, the effect of domestic demand movements on manufactured exports should be detectable, given the large proportion of manufactured output that is sold domestically.[43] The estimated export model failed to find a significant relationship between real manufactured exports and GNE. This can be thought of as a failure to reject a joint null hypothesis that the sunk cost model is correct and that P_W-P_L was in a band of inaction due to sunk costs. Naturally this result has to be seen in the light of the econometric difficulties encountered. As with earlier studies, the identification of a well-specified export equation has proved difficult. However, *the insignificance of the domestic demand variable fails to support the standard model and is consistent with the sunk cost model.* Armed with this prior, the late 1980s export surge is given an hysteretic interpretation.

The structural break term in the export equation was significant when the model was estimated over the full sample (l_2 = 0.01, p-value = 0.00).[44] This is consistent with the result that real manufactured exports have a unit root around a broken trend, with the break in 1986.[45] The conventional explanators in the preferred version of the model did not remove the need for the break; it remained significant and accounted for 4 percentage points of the 16 per cent average annual growth in real manufactured exports since 1986. This surge in exports is interpreted as arising partly from an hysteretic shock to local supply caused by the exchange rate depreciation.[46] This empirical observation of a structural break forms *part* of a body

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[42] Despite this, bands of inaction do not always imply the possibility of hysteresis. A band of inaction may exist if *C* is incurred each period. The survey is relied upon to establish that some costs are sunk. Given this, bands of inaction do imply the possibility of hysteresis.

[43] If a small proportion of manufactured output was sold domestically, it could be empirically difficult to find a significant relationship between exports and domestic demand. As it is, 70 per cent of manufactured output is sold domestically.

[44] In part, models with significant structural breaks were preferred to other models in the estimation process. The late 1980s surge in exports resulted in the estimated equations having either a significant structural break or, in a few versions of the model, very high exchange rate elasticities. Believing the latter result implied that exports were "explosive". See Appendix C.

[45] There is very strong evidence that the series is "explosive" unless there is a structural break. That is, the effects of an innovation to exports will magnify through time rather than die down. As this is highly implausible for an economic time series, the few versions of the model which did not have a significant structural break were abandoned. See Appendix C.

[46] While the late 1980s surge is modelled as a broken trend, it is not anticipated that recent rates of growth will continue indefinitely after the effects of hysteretic shocks, tariff reductions and vanguards have run their course.

of evidence which suggests hysteresis. Though other explanations for the structural break could conceivably be given, the econometric validation of the sunk cost model, together with the survey evidence, lends substantial weight to this interpretation.

It will be recalled that the sunk cost model offers an explanation for the belief (backed up by the survey evidence) that the most recent recession seems to have affected exports, in contrast to earlier recessions. This assertion is supported by the econometric model. In order to demonstrate this, the following term was added to the original regression:

$$\sum_{m=0}^{4} q_m (D^* gne)_{t-m} \tag{2}$$

The dummy variable, D^*, took the value unity during the period March 1990 until September 1991. The inclusion of these terms had little impact on the other estimates. Nevertheless, these slope dummies were jointly significant (p-value = 0.00), and the p-value for the test of significance of the original *gne* terms rose from 0.13 to 0.75. In other words, almost all of the explanatory power of *gne* comes from the recent recession.

This suggests that the shock in 1986 set the stage for the subsequent recession having an impact on exports. Up until that time, P_W-P_L was in a band of inaction. Nevertheless, in the sunk cost model, the subsequent recovery need not act to reduce exports.

5. CONCLUSION

This paper has attempted to explain recent manufactured export growth by a simple addition to the so-called standard model. The sunk-cost model explains firms' export success in terms of their cost structures, in particular their *sunk* cost structures. This consideration of sunk costs has been a fruitful exercise, both from a theoretical and empirical point of view.

Theoretically, the net of possible causes of hysteresis has been cast further to include world demand and domestic demand. Changes in these determinants of exports, or in the exchange rate, can permanently alter market structure. These hysteretic effects can be magnified if the initial entry into a market is made by an export vanguard that reduces sunk costs for subsequent entrants. The existence of these positive externalities is a theoretical aspect of the oft-cited "internationalisation" of Australia's manufacturing sector. Another aspect is the access to cheaper imported inputs which, to the extent that sunk costs are important, could help explain the discrete surge in exports.

Empirically, the sunk cost model has received some support on a macroeconomic level by the existence of bands of inaction and on a microeconomic level by the testimony of individual firms. It appears that the historic depreciation in the mid-1980s enabled many firms to cover their sunk costs and export for the first time. The claim that the most recent recession, in contrast to the 1982/83 recession, has encouraged export growth makes sense in the hysteretic framework. Even though the 1982/83 recession was of a comparable magnitude, the higher value of the exchange rate at that time meant that there was insufficient incentive to pay the sunk costs. The tariff reductions in the early 1970s, as well as being somewhat sudden, may not have induced a supply shock large enough to force firms to incur the sunk costs necessary for exporting. The gulf of opportunities between selling domestically and selling abroad did not widen until later.

The catalytic role of the exchange rate in the process of structural change cannot be overstated. As well as causing an increase in the number of exporting firms in the mid-1980s *directly*, the other macroeconomic shocks became effective in changing market structure in the late-1980s because the exchange rate had depreciated. Furthermore, the increased volatility in the exchange rate observed since the float is seen to be of less consequence when sunk costs are important. Small fluctuations in the exchange rate will not motivate firms to *become* exporters, even if they do motivate existing exporters to change the level or destination of their output. Nevertheless, the model does not support the view that exchange rate depreciations or recessions are *necessary* to motivate firms to pay sunk costs. If increasing exports were a policy objective, further tariff reductions, or government assistance to cover firm's sunk costs, would accomplish the same thing.

Whatever the nature of the shock, the assertion that hysteresis occurred in the late-1980s is equivalent to the assertion that a structural change occurred to Australia's

balance of payments. Hysteresis, like structural change, implies a measure of *resilience* in the face of adverse shocks. If the late-1980s saw exporters establish beachheads around the world for Australia's manufactured exports, and, if this was aided by tariff reductions which will not be undone, it is to be expected that neither ebb nor flow of internal and external shocks will easily uproot them.

APPENDIX A: MODEL ASSUMPTIONS

A three-period model is used to illustrate the effect of a shock that is subsequently reversed. The initial period is one in which there are no exports because of the presence of sunk costs. In the second period, a shock occurs that makes exports profitable; firms make the decision to export sequentially (one by one), changing the number of firms that export and, thereby, the market structure. In the final period, the shock is reversed but the changed market structure ensures that output continues to be sold overseas. In each period, a representative firm must decide how much to produce[47] and whether it should export. Exporting output involves paying a sunk cost, C. There is an order of magnitude more firms in the world market than in the domestic market. Switching output between the two markets therefore changes P_L but not P_W. For simplicity, it is assumed that an individual firm ignores its own effect on P_L when it maximizes profits. However, the next firm in the sequential decision making process makes its decisions using the altered P_L.

In the standard model, the gap between supply and demand at P_W is exported. However, in the presence of a sunk cost, if a firm is to export it must make extra profits (compared to selling domestically), the discounted sum of which is at least enough to cover the sunk costs. For the sake of simplicity, it is assumed that exports will occur *as soon as this is the case*. (This is contrary to Dixit (1989) where it is shown how it can be optimal to wait.)

In the presence of C it will be optimal for a risk-neutral firm to export all its output, if it exports any.[48] Hereafter, an "exporting firm" is one that exports all its output. For a given number of exporting firms, local and total supply may then be defined.[49]

It is assumed that a firm will export as soon as the sum of the present value of profits from exporting exceeds the sum of the present value of profits from selling

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[47] It is assumed that there is no production smoothing and that firms maximise profits over the whole three periods.

[48] Given P_W is higher than P_L, once the sunk cost is paid it makes sense to sell all the output at the higher price. A proof is available from the authors.

[49] Total supply (S) is the output of all firms for each price level. It is obtained by the horizontal summation of all firms' marginal cost curves. Local supply (s) is the sum of the marginal cost curves for the firms that sell all their output domestically.

locally. This requires that firms ignore the variance of prices. Given an assumption that all shocks are thought to be permanent, entry will occur in, say, the second period if:

$$\left(\sum_{t=2}^{3} \left(P_w n_w - TC(n_w) \right) d^{\,t-2} \right) - C > \sum_{t=2}^{3} (P_L n_L - TC(n_L)) d^{\,t-2} \qquad (3)$$

where

	n_L	output sold locally by a representative firm
	n_W	output exported by a representative firm
	$TC(n_L+n_W)$	total cost function
	d	1 - the discount rate

If d is close to unity, this yields an expositionally useful approximation:

$$\left[P_w n_w - TC(n_w) \right] - \left[P_L n_L - TC(n_L) \right] > \frac{C}{2d} \qquad (4)$$

Ignoring discounting (d = 1), this approximation states that the decision to export will be made if, in each of the two remaining periods, at least one-half of the sunk cost can be recouped. The presence of discounting merely says that a firm needs to expect to do a little better than this before it will export, to cover the opportunity cost of spending C.

If the TC function were known, it would be possible to solve the above inequality for P_W-P_L (d hereafter) , at least numerically.[50] The "export premium", d, is clearly an increasing function of C.[51] The top of the band of inaction is d. That is, P_W must exceed P_L by at least d before it will be profitable to export. The bottom of the band of inaction is zero because a local price above P_W will immediately result in a representative firm ceasing to export.

The diagrams in the text are consistent with this simple model.

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[50] Experimentation with simple TC functional forms often produced analytically intractable results because n_L is functionally related to P_L.

[51] Furthermore, in this three period model d will actually change size each period because there are fewer periods in which to cover the sunk cost. This is ignored as it does not change the sense of the results.

APPENDIX B: SAMPLE SURVEY RESULTS

Table B1: Survey Questions

Q1: Approximately what percentage of your produce do you export?	**mean = 30.9 s= 31.6**	
Q2 : Name the first year in which you exported more than 10% of your produce (those who answered 1986 meant volumes: see text)		
I am now going to read out some costs relating to exports . When I say "cost" it can mean money , time, or inconvenience. For each type of cost I'm going to ask: (a) Is it a significant cost? (b) Does your spending on it fall after you have established your presence in an overseas market.	**% answering " Yes"**	
Q3 : Overseas trips	**(a)%**	**(b) %**
(a) & (b)	**53**	**17**
Q4 : Maintaining overseas reps.		
(a) & (b)	**43**	**13**
Q5 : market research		
(a) & (b)	**20**	**10**
Q6 : Long-distance communication		
(a) & (b)	**60**	**13**
Q7 : Trade Fairs and establishing brand awareness		
(a) & (b)	**30**	**17**
Q8 : Red tape		
(a) & (b)	**57**	**27**
Q9 : Offshore production to get a foot in the door.		
(a) & (b)	**13**	**13**
Q10 : Protecting patents and copyrights		
(a) & (b)	**37**	**13**
Q11 : Running a distribution network		
(a) & (b)	**23**	**10**
Q12 : Purchases of plant or machinery specifically related to exports (a) & (b)	**47**	**47**
Q13 : Why did you commence exporting?		
Q14 : Has the recent recession (since 1990) caused your firm to significantly increase its exports?	**40**	
Q15 : Has any other recession in the past caused your firm to significantly increase its exports?	**14**	
Q16 : Do you think that when Australian import tariffs are cut further your business will export more produce? Why?	**9**	
Q17 : Has the reduction in tariffs on imported inputs significantly reduced your firm's costs?	**20**	
Q18 : Was the exchange rate an important factor when you first decided to export?	**60**	
Q19 : What region do you export the most produce to? Has this region become easier to sell to since 1985?	**48**	
Q20 : Have other Australian firms paved the way for your exports? If so, how?	**2 yes, 2 firms helped others**	

Questions 3 to 12 aim to establish whether a group of fixed costs are sunk and significant. If respondents questioned what a "significant" cost was, they were asked if they considered it when evaluating an export project. Out of a total of 59 appropriate firms contacted[52], there were 30 useable responses.[53] This was sufficient to invoke the Central Limit Theorem. A 95 per cent confidence interval for the proportion of firms with a certain characteristic can be no wider than:[54]

$$\hat{p} \pm 1.96\sqrt{\frac{.5(1-.5)}{n}} \qquad (5)$$

For a sample size of 30 the confidence interval for the proportion of firms with at least one significant sunk cost is [0.9122 0.5544]. Therefore, more than half of manufacturing exporters have at least one significant sunk cost. The confidence interval for the proportion of firms with significant sunk costs in the area of export-related plant and equipment is [0.6456 0.2878].

These results are in no way overturned by the small sample size. Examining equation (5), there is no need to make any allowances for the small sample size beyond those already made. The calculation of the standard error factors in the small sample size and widens the interval.

The really crucial issue for the robustness of the results is the random sampling assumption.[55] In this regard, the survey uncovered a similar pattern of initial exporting as did the McKinsey and Co. report. The latter used more than ten times as many respondents (310) and had an Australia-wide focus. Yet both samples indicate that a large number of firms commenced exporting for the first time in 1986.

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[52] Of the 100 names provided, 3 were excluded because their line of business determined their order on the alphabetical listing, and a further 5 were excluded because they appeared on the database more than once. Firms were then contacted in alphabetical order from the remaining list of 92. When the goal of 30 successful interviews had been reached 12 firms had not been contacted at all. Of the 80 firms contacted, 21 indicated that they were not exporters of manufactured output.

[53] 30 executives agreed to the telephone interviews, 2 declined and 27 could not be contacted.

[54] The width is conservatively large because it uses the maximum possible value of the variance of $\hat{p}$, rather than the estimated variance ($\hat{p}(1-\hat{p})/n$).

[55] Selecting 30 respondents by a process that has been randomised is arguably better than, say, citing the views of 30 conference participants (a non-random sample) as "anecdotal evidence".

APPENDIX C: REGRESSION RESULTS

Table C1: Estimates of the Auto-Regressive Distributed-Lag (ADL) Model
($R^2_{adj.}$ = .98, DW = 2.05, p-value for χ^2 test of all regressors = 0.0000)

Variable	Lag	Coefficient	t-statistic	H_0:explanators jointly zero
constant		2.9424	0.8	
t		-0.0009	-0.3	
(t - 64)D		0.0111	3.6	
x	t-1	0.4117	4.3	
x	t-2	0.0649	0.7	
x	t-3	0.2601	2.7	
x	t-4	-0.0685	-0.9	
twi	t	-0.0253	-0.2	
twi	t-1	-0.1236	-0.6	twi
twi	t-2	-0.4487	-1.6	χ^2_{calc} =16.92
twi	t-3	0.8388	2.7	p-value=0.0047
twi	t-4	-0.3994	-2.3	
protect	t	1.6900	2.3	protect
protect	t-1	1.7362	2.3	χ^2_{calc} =24.53
protect	t-2	-1.9943	-2.8	p-value=0.0000
tp	t	0.3461	0.9	tp
tp	t-1	-0.1495	-0.3	χ^2_{calc} =31.81
tp	t-2	0.5512	1.4	p-value=0.0000
Variable	Lag	Coefficient	t-statistic	H_0:explanators jointly zero
gne	t	-0.2826	-0.9	
gne	t-1	-0.1958	-0.5	gne
gne	t-2	-0.0260	-0.1	χ^2_{calc} =8.37
gne	t-3	-0.2530	-0.5	p-value=0.14
gne	t-4	0.4425	1.3	

GNE was excluded on the basis of these tests (with α=.05). A Bewley Transformation of the ADL was then estimated using x_{t-1} as an instrument for Dx_t. The long-run coefficients cited in the text were then obtained. Even in the presence of a cointegrating relationship, the calculated test statistics in the Bewley transformation are not necessarily t-distributed. However, in small samples they may outperform the Phillips-Hansen fully modified estimator as Inder (1991) has shown. In any case, the model was also run in difference form. Both the insignificance of *gne* and the significance of the broken trend were verified.

A test for cointegration due to Kremers et al. (1992) rejects the null hypothesis of no cointegration at the 5 per cent level (test statistic, -5.3). The sum of the coefficients on *t* and *(t - 64)D* is approximately 0.01, implying that the broken trend after March 1986 adds 1 per cent per quarter (around 4 per cent per annum) onto export growth. That is, the conventional explanators explain roughly three quarters of the 16 per cent per annum average growth in manufactured exports since 1986.

An examination of the time series properties of exports indicates that the series is explosive[56]. The Phillips-Peron Z_t test, with a constant and no trend, rejects the null of a unit root in favour of the alternative that the series is explosive at the 5 per cent level (test statistic, 2.7190). Four lags are sufficient to eliminate autocorrelation for the Augmented Dickey-Fuller test. The null is rejected in favour of an explosive series at the 5 per cent level (test statistic, 1.98).

The conclusion that exports are explosive is highly suggestive of a structural break. Therefore, Peron's test for stationarity around a broken trend is an appropriate diagnostic procedure. The test requires that a structural break be imposed *a priori*. The first quarter of 1986 is used because both the McKinsey report and the sample survey in this paper indicate that many firms commenced exporting around then. The null that the series has a unit root around a broken trend is not rejected at the 5 per cent level (test statistic, -0.1627). Given this result, it became a prior that the final model should have a significant structural break. There were versions of the model where the structural break was insignificant and the exchange rate had a very

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[56] That is, a time series model of *x* has the lagged-dependent variable coefficient significantly greater than unity.

high exchange rate elasticity, but these were abandoned because the time series properties of the model became very unclear.[57]

Heteroskedasticity and autocorrelation were often problems in the various versions of the ADL. Increasing the lag lengths[58] fails to remedy autocorrelation and the resultant loss of degrees of freedom creates other problems.[59] Therefore, the preferred version of the model is estimated using a Newey-West correction for serial correlation and heteroskedasticity[60]. The presence of serial correlation in the estimated model implies inconsistent estimates because of the presence of a lagged dependent variable. Therefore the model was estimated using instrumental variables. The somewhat unorthodox instrument used for exports was the broken trend. The significance of the broken trend was established as was the insignificance of *gne*.

The real exchange rate is used to capture changes in P_W relative to P_L in the model. Conventional measures of relative prices exhibit a perverse negative correlation with the broken trend.[61] Including one of them in the regression introduces multicollinearity and implies a significant role for relative prices, but of the wrong sign. This is mistaken both from a theoretical and practical point of view. Some

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[57] With a structural break on the RHS of the equation, premultiplication by the orthogonal projection matrix M (with X being the broken trend) collapses the problem into modelling an I(1) series. Without the structural break, an explosive series is being modelled. Inference is therefore unclear.

[58] The variables *gne* and *twi* appear in the model with four lags, indicating that adjustments to shocks takes considerable time. Somewhat arbitrarily, the variables *tp* and *protect* appear with two lags because it is judged that they are easier to adjust to. It is assumed that they can be foreseen to a greater degree.

[59] In some estimated versions increasing the lag length appeared to make autocorrelation worse, and, reduces the significance of other estimated parameters.

[60] In RATS, the command is (robusterrors,lags=8,damp=1). Eight lags are used because it is judged that this is a reasonable time for dynamic adjustments to occur. LM tests indicate that serial correlation of this order was a problem in some cases.

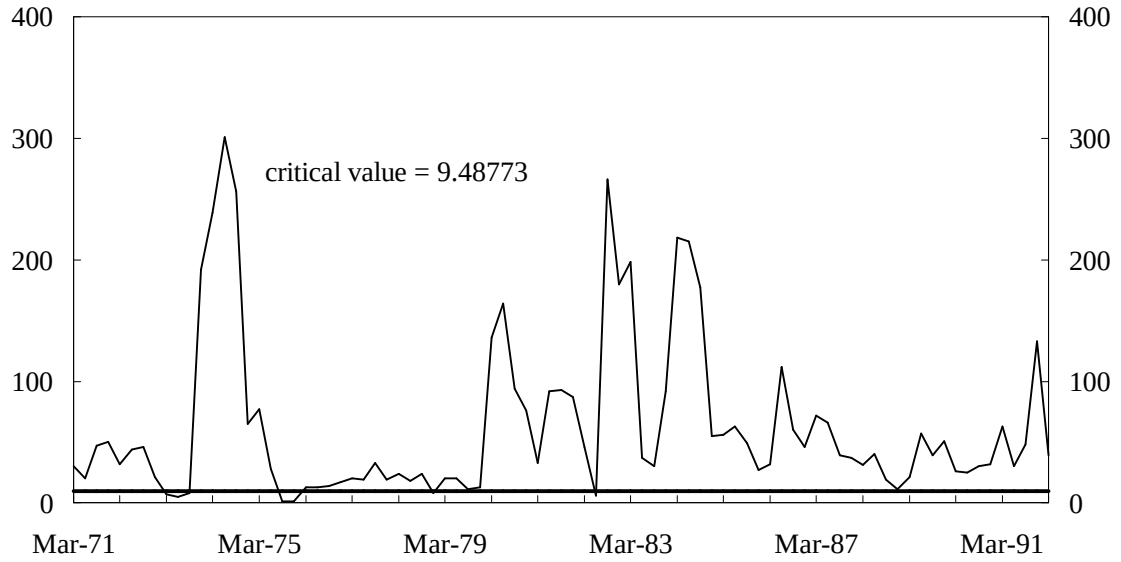
[61] p_x/p_{gne} is a proxy for the ratio of the domestic price of manufactured exports to the domestic price of non-traded manufactures. If p_{man} is the local price of manufactured goods, p_x/p_{man} measures the incentive for a firm to export its output rather than sell it locally. Both relative prices trended down over the sample period with a pronounced downturn since the mid-1980s, coinciding with the export boom.

exporters contacted in the survey clearly stated that relative prices were instrumental in their decision to export.[62]

A modified version of the Chow predictive failure test is useful for ascertaining the extent to which a model explains groups of observations. Several dummy variables are used to entirely explain a group of observations. The joint significance of the dummies is then tested. A model which fits the data well is not improved greatly by the inclusion of the dummies. Conversely, significant dummies indicate that a model does not easily explain the observations in question.

For this particular model, successive regressions are run starting at the beginning of the data set. In each regression four consecutive observations are "soaked up" by four dummies. After testing their joint significance, the same procedure is repeated with four new dummies advanced one time period. The results from these "rolling dummies" regressions are summarized in the following figure.

Figure 18 : Significance of Rolling Dummies
(dummies "soak up" four quarters from date)



[62] It may be that the relative price movement reflects declining Australian productivity *vis a vis* the rest of the world. However, the puzzle remains as to why some survey respondents indicated that they exported because of relative price differentials. (A case in point was a capital goods firm which started to export because the local price of its output fell considerably more than the export price). In the end it was decided to use the real exchange rate because its movements accorded with the survey evidence suggesting that export profitability must have recently improved.

These results imply that estimating the model over sub-periods could generate different coefficient estimates. This suspicion is borne out when the above model is estimated over the sub-period December 1974 to December 1992. This period is chosen because it excludes the effects of the massive 6 percentage point reduction in the effective rate of assistance to manufacturers in December 1973. Estimating the model over this period gives the long run coefficients in the text.

Given this feature of the model, the temptation is to estimate over the period that gives the best results. Therefore a discipline imposed on the procedure is that the preferred model uses the maximum amount of data available. Otherwise the exercise takes on an entirely *ad hoc* character.

Given the problems of serial correlation and parameter instability, the estimated model cannot claim to be a full representation of export supply. However, the most important results are robust to different specifications. A break occurred in 1986 and *gne* does not, in general, explain manufactured exports.

APPENDIX D: DATA SOURCES AND DEFINITIONS

Manufactured Exports

In this paper Australian manufactured exports are defined to be the categories "Machinery", "Transport equipment" and "Other manufactures" as used in the ABS Catalogue No. 5302.0. This definition coincides with Standard International Trade Classification (SITC) sections 5-8, less divisions 67 and 68, and so excludes some Simply Transformed Manufactures (STMs) such as iron and steel.

Current price seasonally adjusted estimates of these series were available from the ABS from September quarter 1969. Constant price estimates, however, were only available from the same source from the September quarter of 1974. This series was extended back to September quarter 1969 by splicing the percentage changes of the implicit price deflator for the category "Metals, metal manufactures, machinery and transport equipment" as used in the ABS Catalogue no. 5421.0.

The Real Exchange Rate

The measure of the real exchange rate used in this paper was first calculated by Jones and Wilkinson (1990). It is the geometric weighted average of the bilateral real exchange rates for 22 of Australia's major trading partners. The bilateral real exchange rates are estimated using each country's consumer price index as the price deflator. The weights are based on annual shares of merchandise trade, interpolated on a quarterly basis.

Overseas Demand

The series for overseas demand is a geometric weighted average of changes in industrial production of 19 of Australia's major trading partners. The weights are based on three-year moving averages of merchandise export shares for those countries.

Domestic Demand

The measure of domestic demand used in this paper is Gross National Expenditure in constant price terms, seasonally adjusted, as published by the ABS Catalogue No. 5206.0.

Effective Rate of Assistance

The Industry Commission has published estimates the average effective rate of assistance for manufacturing on an annual basis since 1968-69 (Plunkett et al. 1992). The effective rate of assistance is a broader concept than the effective rate of protection. It includes non-border interventions that differentially influence the returns to value-adding factors in an industry. The estimates comprise four overlapping series compiled on different base years. Ideally, the series should be calculated with moving weights to reflect the changing patterns of manufacturing production. Therefore, " ...the estimates for all years other than the base year in each series should be regarded as only general indicators of the assistance levels received by the manufacturing sector." (Plunkett et al. 1992 p.49). These four overlapping series were spliced together and then converted to a quarterly series by assuming that changes in assistance only occurred at the start of the September quarter of each year, that is, the effective rate of assistance remained constant within each financial year.

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