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Abstract

This paper investigates the relationship between tariff and growth in the Australian economy over the period from 1871 to 2002. The study is motivated by the debate on the apparent 'tariff-growth paradox', a sign switch in the link between tariff rate and growth between the first and second episodes of globalization in world history, established from cross-country growth regressions. The long annual time series together with the recent developments in time series econometrics allows us to establish an unambiguous and stable negative relationship between tariff rates and economic growth. It is of course not possible to generalize from a single country case, but our results do cast significant doubts on the 'tariff-growth paradox' reported in recent cross-country studies.

Keywords: economic growth, tariff, Australia

JEL Codes: F14, O40, O56,

**Tariff-Growth Nexus in the Australian Economy, 1870-2002:
Is there a Paradox?**[*]

1   Introduction

The purpose of this paper is to examine the relationship between trade protection and growth of output, drawing on annual data for Australia for thirteen decades. The study is motivated by the debate on the apparent 'tariff-growth paradox', a sign switch in the link between tariff rate and growth between the first and second episodes of globalization in world history, established from cross-country growth regressions. We also believe that the study is of direct relevance to the analysis of long-term growth trajectory of the Australian economy, given the prominent position of tariff policy in the national policy debate.

Historians of the 19th Century have canvassed the view that protection, not free trade, was associated with high growth. Perhaps the most forceful voice among them is that of Paul Bairoch who, in a comprehensive survey of the evolution of trade policy during 1892-1914, sums up the tariff-growth correlation in terms of a simple equation: 'protectionism=economic growth and expansion of trade; liberalism=stagnation in both' (Bairoch, 1989, p. 69).   Subsequently, he identified the liberal trade theorist's proposition that protectionism retards growth as a major myth in world history (Bairoch, 1993, Chapter 4). Bairoch's proposition has been given credence by some recent work drawing on cross-country growth regressions that explore the link between protection and growth over a long time period.   For instance, Kevin O'Rouke (2000) examines this relationship by estimating a growth regression with data for over ten countries between 1875 and 1914 and finds that '[t]he Bairoch hypothesis holds up remarkably well' (p.

473). Vamvakidis (2002)[1], using data for the 20th century for a different country sample finds a positive correlation between tariff and growth in the 1930s and a negative relationship between 1970 and 1990. In an analysis covering a sample of thirty-one countries , Michael Clements and Jeffrey Williamson (2001, 2004) confirm O'Rouke's finding for the period between 1870 and 1913 and the sign reversal of the relationship uncovered by Vamvakidis for the post-World War period. They rationalise this sign reversal (which they dub the 'tariff-growth paradox') by linking the relationship to significant shifts in the external economic environment between the two periods. In particular, they claim that the reversal might be related to the average level of protection in the world economy; when a country's trade partners have high tariffs, it can speed up its own growth by adopting high tariff protection.

It is of course possible to build theoretical models in which the relationship between tariff and growth could go either way. But one can also forcefully argue that the pre-war positive correlate between tariff and growth uncovered in the cross national regression analysis simply reflect a failure to appropriately allow for significant structural differences among countries in the post-World War 2 period, and in the late 19th century and the beginning of the twentieth century (Irvin 2001, Helpman 2004, Bhagwati and Srinivasan, 2001). The way trade policy affect growth depends crucially on the economy's characteristics, such as the type of products it trades or the human capital intensity of its import-competing sectors. In particular, in the nineteenth century and early twentieth century, expanding horizons in terms of access to natural resources and labour played a key role (particularly in the western-offshoot countries) in growth of output, with productivity improvement playing a relatively minor role. Cross-country regression analysis, by its very nature, generally fails to capture these details. These regressions, moreover, suffer from problems of specification uncertainty, endogeneity, and measurement errors (Bhagwati and Srinivasan, 2001).

In this context, there is a need for supplementing cross-country evidence with systematic individual country (and industry) studies.   Australia provides an ideal case

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[1] The discussion paper version appeared in 1997.

study of the issue at hand given its rich history of experimentation with trade protection. Australia has gone the full circle from having relatively liberal trade policies at federation in 1901 to being highly protectionist around the middle of the century followed by a rapid progression towards dismantling of trade barriers by the end of the 20th Century. This large variation in the tariff rate permits econometric analysis to decipher the tariff-growth nexus. Moreover, the rich historical economic database of Australia enables us to examine the tariff-growth nexus while controlling for a number of factors impacting on the production frontier such as expansion of land area and endowment of mineral resources on the rate of growth of output.

The rest of the paper is structured as follows. Section 2 provides a brief history of protection within Australia and the motivations for the major changes in the trade stance over the 130-year history. Section 3 presents a short discussion on issues relating to quantification of the restrictiveness of international trade. Section 4 presents the empirics including the econometric analysis. Conclusions bring the paper to a close. Our results reveal a persistent statistically significant negative relationship between the tariff rate and growth in Australia over the 1870-2002 period. It is of course not possible to generalize from the experience of a single country, but our results do point to the need for further systematic analysis of individual country experiences in resolving the existence or otherwise of the claimed 'tariff-growth paradox'.

2.   The Australian Tariff Policy

The usual starting point for studying the evolution of trade policy in Australia is 1850 when the Australian Colonies Government Act laid the foundation for self-government in the colonies. The Act applied to New South Wales (NSW), Van Diemen's Island (subsequently renamed Tasmania), South Australia and Victoria and provided for future application to Western Australia. On the basis of the Act of 1850 the various colonies framed their constitutions and legislated for tariffs in the period 1850-1856. The tariffs that first evolved in the three main colonies (NSW, Tasmania and Victoria) were simply revenue tariffs, with special duties on a limited list of goods such as wine, tobacco, tea,

coffee and sugar and no *ad valorem* duties. South Australia framed a rather more complicated tariff structure with specific duties only on spirits and tobacco and a uniform 5 per cent *ad valorem* rate on other goods not on the free list. Overall, 'the colonies at first were inclined to outdo the mother country in their free trade zeal' (La Nauze 1955).

A significant departure from this common free-trade stance of the colonies took place one-and-a-half decades later. In April 1866, the Victorian Assembly passed a tariff bill enabling the introduction of tariff protection to support local industry. Victoria was the first British colony to introduce trade policy intended to promote industrialization by means of a protectionist tariff (Bairoch, 1989, p 146). The initial Victoria tariff was relatively moderate, but import duties were noticeably increased in 1871 and again in 1877 (Corden 1964). While trade protection soon became the firmly established policy in Victoria, free trade reigned in NSW for the rest of the nineteenth century. The other colonies, although with tariffs primarily designed for revenue, were at the same time by no means such staunch free traders as New South Wales. Queensland, separated from NSW in 1859, started to protect its sugar industry first by bounties and later by duties on refined sugar and syrups. South Australia, mainly dependent on primary production, and strongly in favour of inter-colonial free trade, nevertheless protected its clothing and wool industry. Tasmanian tariffs had been of a retaliatory character. State powers were not granted to Western Australia until 1890. These increasingly divergent policies contributed to inter-colonial debates on customs policies. [2]

The first federal tariff was introduced on 8 October 1901; putting an end to inter-colonial tariff wars. The new tariff, a compromise between the revenue tariff of NSW and protectionist tariffs of Victoria, was 'weakly protective' (with duties ranging from 5 to 25 percent) (Pincus 1995, p 60). However, the truce did not last long. The fear that American industry would 'dump' surplus production at prices that would suppress wages of the Australian workers resulted in a major tariff reform in June 1908. The new tariff

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[2] The causes of the triumph of protectionism in Victoria and the free trade stance of NSW remain a subject of interesting debate among economic historians (Corden 1964, Pincus 1995, Anderson and Garnaut 1987).

(the so-called Lyne-tariff) involved doubling of import duties on most categories of goods, while retaining preferences for British products. The new tariff marked the beginning of linking tariff protection to employment generation. Duties were further increased in 1911 and 1914 but no further revision took place until after the First World War.

After the interruption to international trade caused by the 1914-18 war, Australian trade policy became increasingly protectionist. Defense and national security was prominent in the arguments for protection – much was made of the danger of isolation and instability to get industrial supplies should there by another war. The average tariff rate of the 1921 Greene tariff was twice that of the Lyne Tariff of 1907-08.   There was an extension of the protectionist umbrella to shelter chemical, engineering and electrical industries. Under the tariff reforms introduced in 1921 (Lyne Tariff), in addition to preferential rates and general rates, intermediate rates were introduced (the 'three-decker' tariff) making tariff negotiations possible with foreign countries. There were also provision for 'deferred' duties, which were to operate unless the Minister was satisfied that the goods, at the stipulated future date, could not be produced in Australia. The Customs Tariff (Industrial Preservation) Act was passed in the same year to provide for anti-dumping measures. This was done not only to prevent ordinary price dumping, but also 'exchange dumping', that is low-price competition because of depreciated overseas currencies.

The Tariff Board was set up in 1921 for overall evaluation of tariffs with a view to protecting producer and consumer interests. But in reality, it became 'the institutionalized voice of protection' (Castle 1988, p. 94). As one member of the Board was to put it in 1926, '[w]e are non-patrician because we have been selected by a Government of a country, 95 per cent of those representatives are protectionists' (Foster 1964, p.17).

The 1920s saw extension of protection beyond manufacturing to primary production. Sugar was protected by an embargo on imports. There were high tariffs on

butter and dried fruits, and a great many others received some protection, such as oats, maize, tobacco, hops, tinned meat, fish, bacon, cheese and others. The notion that tariffs could protect jobs, not just in the manufacturing sector but in the broader economy, was symbolized in the term 'all-around protection' (Shann 1930).

In 1929, the Brigden Committee justified the policy of protection of the past on employment grounds, [3] but expressed at the time that the amount of protection had reached its 'safe' limits (Brigden and others 1929). It strongly recommended that further protection should be given only with the greatest care, and particularly when discriminating between industries. The cautious policy conclusion of the 1929 report was, however, made irrelevant by the Great Depression. In order to enhance federal tax collections, as well as to stimulate employment and to improve the balance of payments, emergency tariffs were introduced by the Scullin Government in 1929 and repeatedly raised or extended. Not only were duties greatly increased, but many imports were prohibited.

From 1932 to 1936 there were some attempts by the Tariff Board in pruning excessive protection. First, tariff rates applicable to British goods were reduced by a quarter, in keeping with the fall in the exchange rate in 1931. The Tariff Board also assumed a central role in further amendment of the tariff schedules in order to implement the increased British preferences in the Australian market under the 1932 Ottawa Agreement. The new rates proposed were generally lower than the Scullin rates. However, in a radical departure from this trend, in 1936 the government initiated a policy of 'trade diversion' to 'good customers' (mainly Britain) through import licensing. Rates were increased in 1936, without a prior Tariff Board reference, during the damaging episode of trade diversion against Japanese textiles and American cars. This policy was abandoned in May 1938, but the protective effect of the measure was consolidated by tariff legislation.

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[3] This view, the so-called 'Australian case for protection' subsequently became the subject of international scholarly comment and spawned a vast literature including the famous 1941 paper by W.E. Stolper and P.A. Samuelson.

Protection made a comeback with the slogan 'Populate or Perish' in the period of economic reconstruction after the Second World War. With the displaced persons of Europe as a new source of immigrants, Australian trade protection was broadened and escalated to give immigrants jobs. Balance of payments exigencies also played a role. Thus, in the 1950s quantitative import restrictions temporarily supplanted tariffs. Although import quotas were dismantled in the early 1960s, they were replaced by equally protective tariffs. For the next decade or so, tariff became the chief means of affording import protection. The Tariff Board took the approach that it had used in the pre-war period, setting 'made-to-measure' tariff rates at levels needed to offset the cost disadvantage of Australian industry.

During 1950s and (decreasingly) in the 1960s trade stance was kept away from the international initiatives to reverse the protectionist approach of the inter-war years and to return to the open trading conditions that prevailed before the First World war. For a variety of reasons, Australia's policy choice was to continue with an inward-looking trade and industry policy which had its origin in the very first decade after Federation (Garnaut 2003). The Tariff Board resurrected the protectionist approach that it had pursued in the pre-war period, recommending the tariff rates to offset the cost disadvantage of Australian industry. The official ideology, as expressed by the Vernon report in 1965, was that tariff, apart from providing employment, was 'important in the extension and increased diversity of industry, the development of labour skills, the advance of technology, the ability to absorb a rapid increase in population, involving a high rate of migration, and the steady increase in capital investment essential to all these achievements' (Vernon et al. 1965, p.366, as quoted in Castle 1988, p 144).

In recent decades inward looking trade policy has begun to come under serious doubt. Protectionism fell into disrepute. 'The balance has changed within and between private interests and public interests; elite opinion is now predominantly behind a movement towards a more open, outward looking, internationally competitive Australian economy' (Pincus 1995, Garnaut 2003).

From the late 1960s, the Australian economic profession became increasingly outspoken against protection during the 1960s, and by the early 1970s was advocating trade liberalization with near unanimity. The cost of the inward-looking economic strategy was brought into sharp focus with increased analytical sophistication. The conventional wisdom that protection promotes employment (and thus facilitates immigration) was convincingly demolished through systematic empirical analysis (Anderson and Garnaut 1987, Pincus 1995). These views were also reflected in numerous official reports, and found sympathetic ears among an increasing number of politicians and within the financial press. A similar change occurred within the bureaucracy, especially in the Tariff Board (under the strong leadership of Alf Rattigan).

This palpable ideological shift set the stage for the historic 25% tariff cuts in 1973. From the mid-1970s, Australia reduced some tariffs even further. However, it also increased its protection against imports of textiles, clothing, footwear and motor vehicles substantially through quantitative restrictions (Anderson and Garnaut 1987, p 7-8). The transition to lower rates of protection gathered momentum in the early 1980s as part of a broader economic liberalisation policy package.

In sum, the history of Australia's trade policy over the century to 1950 was one of sporadic increases in trade protection without any notable deviation from the overall, increasing trend. The period from 1973 has however seen notable and persistent dismantling of trade barriers (Figures 1 and 2). By the end of the century Australia's tariff levels were amongst the lowest in the world. The large variability in the rates of protection combined with an equal variability of the rate of growth of output provides the ingredients for exploring the link between the two statistically. Figure 2 provides a scatter plot of the rate of growth of annual GDP against the levels of protection for the 126-year period. As shown on the figure, there is a negative correlation between the two variables but the model explains a mere 5 percent of the variation in the rate of growth of GDP. The next section explores this relationship in more detail employing the conventional growth accounting framework.

3   The model, Econometric Methodology and Data

We employ the conventional growth accounting framework in investigating the tariff-growth nexus in the Australian economy since 1870 (Solow, 1957; Barro, 1999). This is particularly relevant in this context given the expanding frontiers in terms of access to land for agriculture, discovery of mineral deposits for mining, access to immigrants as a source of labour, and global savings for investment. The impact of the two wars and the great depression are (crudely) accounted for by including period dummies.

The level of output (GDP) can be expressed as:

$$Y = F(TR,\ WAP,\ LAND, MNR,\ KAP,\ WW1, DEP, WW2) \qquad (1)$$

where,

Y   Real gross domestic product (GDP)

KAP   Capital stock

LND   Land under cultivation

MNR   Mineral resources under commercial exploitation

TR   Tariff rate (customs duties as a percentage of FOB imports)

WAP   Labour force (working age population)

WW1   Dummy variable to capture the impact of the First World War (1914-18)

DEP   Dummy variable for the years of the Great Depression (1928-1932), and

WW2   Dummy variable to capture the impact of the Second World War (1938-45).

The production function given above is implemented in growth form such that the rate of growth of output is a function of the rates of growth of the four factors of production. There is no capital stock series for the Australian economy covering the entire period under study. We therefore follow the conventional practice in the empirical growth

literature of using the rate of investment (*I/Y*) as a proxy for *KAP* (Barrow 1998, Temple 1999).[4]

The policy environment is assumed to impact on productivity growth (Stern, 1991), thus the levels and rates of change of policy measures are included in the growth from of equation.[5] We consider tariff policy here when the policy vector comprises a host of policy instruments; the reason for doing so is that Australia has experimented with trade protection for over a century. As pointed out in section 2, the principal motivation for protection in Australia was not driven by growth objective and thus the use of TR as an explicator of growth is justified. As Rodrik (2005) has forcefully argued 'regressing economic growth on policies' is uninformative when the observed levels are from an equilibrium relationship.[6] Given the recent literature on the trade-growth nexus surveyed in section 2 above and the market reforms in the last 20 years of the 20th Century, we test for the stability of the tariff-growth link within sub-periods as well as for the whole period by running separate regressions.

Since the model is estimated using a long time series for a single country that has over its entire history had stable institutions, there is no need for using institutional quality as a control variable. The issue of income convergence is also not relevant in modeling growth for a single country case.

In the empirical implementation of the model it is important to take into account the lags involved in the postulated relationships between the explanatory variables and the dependent variable, while guarding against the possibility of uncovering spurious

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[4] Let K denote the capital stock such that investment (I) is the change in the stock of capital. Then,

$$\frac{I}{Y} = \frac{\Delta K}{K} \frac{K}{Y}$$

This states that the investment rate, I/Y, equals the rate of growth of capital multiplied by the capital-output ratio. One of the stylized facts of growth is that the ratio of physical capital to output is nearly constant over the long run (Kaldor 1963)..

[5] The channels via which policy has impacts on growth is being investigated as part of our ongoing research.

[6] Regressing the rate of immigration or population growth in Australia on the level of protection will be prone to Rodrik's critique.

relations. The general to specific methodology (also know as the Hendry methodology or the London School of Economics method) has been employed to allow the data to determine the model dynamics. The essence of GSM is to embed the relationship being investigated within a dynamic specification, including lagged dependent and independent variables so that a parsimonious specification of the model can be uncovered. The estimation technique employed aims to minimize the possibility of estimating spurious relations whilst retaining long-run information. A major advantage of this method is that it yields an equation with first-differenced (and hence stationary) dependent variable, which, unlike a simple first-differenced equation, also appropriately retains long-run information embodied in the data (Hendry 1996).

Under this procedure, estimation starts with an over-parameterized autoregressive distributed lag (ADL) specification of an appropriate lag order. The ADL specification is then re-parameterized in terms of differences and levels to obtain the error correction mechanism (ECM) representation of the model, which is the 'maintained hypothesis' of the specification search. The estimation procedure involves estimating this progressively, simplifying it by restricting statistically insignificant coefficients to zero and reformulating the lag patterns to achieve orthogonally. The final model, to be acceptable for drawing inferences, must satisfy a battery of diagnostic tests. In applying this estimation procedure, we set the initial lag length on all variables in the unrestricted equation at four periods. This is the established practice in modeling with annual data.

The ECM representation of Equation 1 which constitutes our maintained hypothesis is:

$$\Delta y_t = \lambda_0(L)\Delta y_{t-1} + \lambda_1(L)invr_t + \lambda_2(L)\Delta wap + \lambda_3(L)\Delta mnr + \lambda_4(L)\Delta land$$

$$+ \lambda_5(L)y_{t-1} + \lambda_6(L)tr + \delta_i D_i + \varepsilon_t$$

(2)

where the notations are the same as used for equation (1), the lower case represents the natural logarithms of the respective variables, y_{t-1} is the lagged (log) GDP, and D denotes

a set of dummy variables that capture the effects of the two world wars and the great depression.

Most of the previous studies in this area have used data series in the form of period averages (mostly over five-year non-overlapping periods) to wash out the cyclical component of output. This approach has two major weaknesses, however (Hendry and Erricsson 1991). First, the aggregation of annual data results in the loss of information. Second, averaging involves the arbitrary use of data-based filters without explicitly accounting for their impact on the estimated parameters. Because of these reasons we model with annual observations. The investment series instead of the capital stock series has been used here for the same reason; the latter is constructed from the former using the perpetual inventory method.

Re-parameterization of the original equation in ECM form (Equation 2) has three distinct advantages. First, the parameters of (2) can be estimated using OLS so long as ε_t is normally distributed, an issue that can be tested following model estimation. Second, the formulation in (2) allows for the use of the general to specific model selection procedure; a significant advantage when there is uncertainty regarding the explanatory variables to be included in the model (see Harvey, 1990: chapters 7 and 8).[7] Third, re-parameterization in terms of differences and lagged levels permit us to separate the short-run and long-run multipliers of the system. For instance, the short-run (impact) elasticity of output-growth to the level of tariffs is given by λ_6, while the long-run (steady-state) elasticity is given by $-\lambda_6/\lambda_5$.

The lag structure employed here enables us to decipher both the short and long run impacts of tariffs on growth. One may expect, as an example, for trade protection to lead to higher growth during the 'import-led' industrialisation phase.[8] The longer-run elasticity may have the opposite sign, but could just as well be positive as in the case of

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[7] The instrumental variables approach yields consistent parameter estimates in the presence of serial correlation. In the latter case, the lagged values of the exogenous variables constitute the 'true' instruments for the lagged dependent variable.

[8] The converse in terms of the static efficiency losses from protection could also hold.

'learning by doing' or 'import protection as export promotion' (Arrow, 1962 and Krugman, 1984). The sign and magnitude of the short- and long-run impact multipliers,[9] thus, can only be established empirically. Such interpretation, however, rest on the critical assumption that the model is correctly specified, an assumption that is tested rigorously in the next section.

Data

We use annual data over the period from 1870 to 2002. The model is estimated for the overall period, and four sub-periods: namely, 1870-1900; 1901-1949; 1950-2002; and, 1901-2002. The sub-periods are chosen carefully with a view to examining possible structural break in the tariff-growth nexus. The data sources are listed and method of variable construction is explained in the Appendix. The data appendix provides the full description and sources of all the data used in this analysis. Note that for the pre-Federation period (1870-1990) we use data aggregated across the states.

The measure of trade policy used in our analysis is the simple tariff rate, customs (tariff) revenue expressed as a percentage of total value of merchandise imports. We are mindful of the limitations of this variable as a measure of the restrictiveness of the trade regime (Andersen and Wincoop, 2004, Pritchett 1996, Rodriguez and Rodrik 2001). However, the purpose of our analysis is to examine whether the 'tariff- growth paradox' holds in a time-series study of Australia. Thus, using the same measure of tariff used in the previous cross-country studies is our natural choice.

In using the tariff rate in time-series analysis, it is important to take into account the possible endogeneity. For instance, there is the possibility that the government resorts to tariff increases in an economic downfall for revenue reasons, generating a spurious negative relationship between tariff and growth. Also, in a recession the average rate of duty is likely to overstate actual level of protection when specific duties

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[9] Given that the model is estimated in the log-log form, these impact multipliers are elasticities.

cover significant part of imports.[10] We incorporate the above possibilities by including dummy intercept terms for the periods of the two world wars and the Great Depression. We also explicitly check for endogeneity (using the Wu-Houseman test) in the estimation process.[11]

4.   Results

The final parsimonious estimates of the model are reported in Table 1 together with diagnostic tests of the underlying assumptions relating to the OLS error process. All equations pass the standard F-test for the overall significance; the models explain at least 60% of the total variation of the dependent variable in terms of the adjusted-R^2. Statistically the equations perform well, passing the test for the functional form (*RESET* test), heteroscadasticity (*BP, ARCH*), and serial correlation (*DW, DH, LM*) at the conventional levels of statistical significance. In all cases, the assumption of exogeneity of the right-had side variables was not rejected in terms of the Wu-Hausman test (*WH*).[12]

The long-run (steady state) elasticity estimates derived from the estimated equations are reported in Table 2. Before proceeding to consider the tariff-elasticity, the variable of principal interest to this paper, we cross checked the estimates of the factor-elasticities with our priors. The labour-elasticity is stable across the three sub-periods and its estimate is not statistically different from unity; the latter suggests that the growth equation could have been expressed in per-capita form. The land-elasticity at approximately 40 percent is stable across the sub-periods and, at least in retrospect, appears reasonable if the figure is interpreted as reflecting the share of total payments accruing to land. The elasticity estimates for mineral and capital, in contrast, varies across the sub-periods. The elasticity of output growth with respect to change in mineral

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[10] Presumably, his is not a significant source of bias in our analysis because, unlike in countries such as the USA, specific duties have never figured prominently in the Australian tariff structure

[11]We experimented, following O'Rouke (2000) with a cyclical variable (which measure percentage deviation of GDP from a quadratic trend) as an additional explanatory variable to allow for possible tariff endogeneity. This variable turned out to be statistically insignificant over and above the dummy variables for the two world wars and the depression.

resource endowment for the second half of the 20th Century is nearly four time the figure for the first half of the Century. This could reflect the contribution of the mineral boom to growth of production in this period. The investment elasticity estimate, 0.25 on average, is broadly consistent with the findings of the recent growth literature (Helpman, 2004).

The long-run elasticity of growth with respect to the tariff rate, the coefficient of principal interest to this paper, is 0.28% for the entire period of 1870-2002. This drops marginally to 0.23% when the pre-Federation years are excluded from the time coverage. A comparison of estimates for the three sub-periods points to a remarkable stability of the elasticity estimate between 1870-1900 and 1901-1949. The estimate for 1950-2002 shows a marked decline in the magnitude of the elasticity coefficient compared to the previous periods.   However, there has not been a sign switch in the tariff-growth relationship for the entire period. As a further test of the stability of the coefficient of the tariff variable, we estimated the model using recursive OLS. The results showed that the coefficient remained within the 95 per cent throughout with the negative sign.[13] In sum, in protection has been unequivocally negatively correlated with growth in Australia throughout the period under study. This finding is in sharp contrast to the findings from cross-country analyses (which include Australia in the sample) of O'Rouke (2002), Vamvakidis (2002), and Clemens and Williamson (2004).

Clemens and Williamson explains the sign switch in the tariff-growth correlate which they find between the pre-First World War period and the Post-Second World War period in terms of the difference in the average global tariff levels between the two periods.   They infer that increase in national tariff is conducive for growth for a given country when partner countries maintain high tariffs. While such an interpretation would hold for a large country which can influence its terms of trade, the same would not be the case for a small open economy such as Australia. The optimal tariff for a small open

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[12] Note that Wu-Hausman test is also asymptotically equivalent to testing the statistical significance of the difference between the OLS and 2SLS estimates of the regression coefficients.
[13] The test results are available from the authors on request.

competitive economy, even when the (given) world prices are distorted, is zero. The optimality of free trade breaks down for a small open economy only in the presence of increasing return to scale.[14]

5.   Conclusion

In this paper we have examined the tariff-growth nexus in the Australian economy using data for thirteen decades by estimating a growth model which explicitly accounts for all of the factors of production.   The econometric methodology used appropriately captures the dynamics involved in the hypothesized economic relations while guarding against the possibility to uncovering spurious relations.

We find no tariff-growth paradox for Australia. Our results provide strong support for a negative association between tariff and growth. This result survives various re-parameterization of the model and for different sub-periods.   In sum, an extremely robust finding from this analysis is that protection within Australia has been unequivocally negatively related with growth; a finding that is in sharp contrast to the findings from cross-country analyses.   Our results, however, are consistent with the consensus view in Australian policy circles that unilateral liberalization is the best policy for the nation (Garnaut, 2003).   It is of course not possible to generalize from the experience of a single country case study, but our results do point to the need for further systematic analysis of individual country experiences in resolving the existence or otherwise of the claimed 'tariff-growth paradox'

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[14] Bhagwati and Srinivasan (1983, chapters 15 and 16) provide a formal proof for the optimality of free trade for a small open competitive economy.

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Data Appendix

Tariff rate (TR): Calculated as the ratio of customs collections, net of excise taxes, to the
value of merchandise imports all in current prices.

Customs duties: 1870-1900: Vamplew (1987: 283-84) (); 1901-1972: Mitchell
(2003); 1973-2002: ABS, catalogue number 5206.0 table 37 (quarterly data were
aggregated into an annual series).

Merchandise Imports (FOB) 1870-1982: Vamplew (1987, pp. 282 - 4); 1983-
2002: ABS catalogue number 5439.0, table 1.

Gross Domestic Product (GDP at 1966/7 prices): 1870-1900: Haig (2001); 1901-1981:
Maddock and McLean (1987), table 4; 1982- 2004: ABS catalogue number
5204.0, Table 1.

Gross capital formation (Investment): 1870-1900; 1901-1959: Maddock and McLean
(1987), table 3; 1960- 2002: ABS catalogue number 5204.0 Table 8. The
Maddock series for 1960 to 1981, the period of overlap with the data from ABS,
has investments as a ratio of GDP is 5.6 percent lower than the ABS figures. The
series from 1901 to 1959 has been adjusted by this percentage.

Land (in hectares): Arable land in use, defined by the FAO as "as land under temporary
crops (double-cropped areas are counted once), temporary meadows for mowing
or for pasture, land under market or kitchen gardens, and land temporarily
fallow". The for 1870- 1981: Vamplew (1987), page 74; 1981- 2002: FAO
database (accessed via the World Development Indicators).

Working Age Population. 1871-1900: Vamplew (1987); 1901-1981: Maddock and
McLean (1987); 1982-2002: ABS Catalogue number 6202.0 table 1. Data from
1871 to 1900 generated by multiplying the share of population in workforce to
total Population.

Mineral resources under commercial exploitation (proxied by the index of mineral
production lagged by one year).   The mineral production index for 1984-2002
(1997 = 100) is from the Bureau of Agricultural and Resource Economics,
Agriculture Resource Quarterly (1989-93) and *Australian Commodities:
Forecasts and Issues* (1994-2002).   The index was linked to a production index

constructed for the earlier period using mineral production and value data obtained from Vamplew (1987).

Table 1: Tariff -Growth Nexus in the Australian Economy: Regression Results

(a)   1870 – 1900

$$\Delta_2 GDP_t = -0.410 \quad -0.107\Delta_2 TR_t \quad -0.152 TR_{t-2} \quad +0.957\Delta WAP_{t-1} \quad +0.645 WAP_{t-1}$$
$$(1.971)** \quad (1.684)** \quad (1.955)** \quad (1.366)*** \quad (2.798)***$$

$$-0.475 GDP_{t-2} \quad +0.394\Delta_2 GDP_{t-1}$$
$$(2.303)** \quad (2.475)**$$

$\bar{R}^2 = 0.740 \quad SE = 0.023 \quad F = 13.340$

$DH = 1.364 \quad LM, F(1, 19) = 0.745 \quad ARCH, F(1, 19) = 0.85 \quad BP, \chi^2(7) = 0.951$

$JB, \chi^2(2) = 0.963 \quad RESET, F(1, 19) = 0.334 \quad WH, F(2, 17) = 0.147$

(b)   1901-1949

$$\Delta_2 GDP = -1.742 \quad -0.178\Delta_2 TR_t \quad -0.143 TR_{t-2} \quad +0.896\Delta WAP_{t-1} \quad +0.3615 WAP_{t-1}$$
$$(1.943)** \quad (5.330)*** \quad (2.720)*** \quad (2.650)*** \quad (2.207)**$$

$$+0.204 LAND_{t-1} \quad +0.037(\Delta MNR_t + MNR_{t-1}) \quad -0.086 WW1 \quad -0.019 DEP_2 GDP_{t-1}$$
$$(2.258)** \quad (1.310)* \quad (2.932)*** \quad (0.565)$$

$$+0.026 WW2 \quad -0.439 GDP_{t-2}$$
$$(0.783) \quad (2.932)***$$

$\bar{R}^2 = 0.653 \quad SE = 0.046 \quad F(10, 38) = 10.018$

$DW = 1.915 \quad LM, F(1, 37) = 0.074 \quad ARCH, F(1, 37) = 0.074$

$BP, \chi^2(12) = 3.972 \quad JB, \chi^2(2) = 0.405 \quad RESET, F(1, 37) = 2.274 \quad WH, F(3, 35) = 2.425$

(C)   1950-2002

$$\Delta_2 GDP = -0.059 \quad -0.018\Delta_2 TR_t \quad -0.024 TR_{t-2} \quad +0.970\Delta WAP_t \quad +0.247 WAP_{t-1}$$
$$\qquad\quad (0.086) \qquad (1.218)* \qquad (2.398)** \qquad (4.521)*** \qquad (1.665)**$$

$$\qquad\qquad +0.010\Delta INVR_t \quad +0.096 INVR_{t-1} \quad +0.070\Delta MNR_t \quad +0.864 MNR_{t-1} \quad -0.248 GDP_{t-2}$$
$$\qquad\qquad (3.514)*** \qquad (2.441)** \qquad\quad (1.604)** \qquad (3.307)*** \qquad (3.481)***$$

$\overline{R}^2 = 0.723 \qquad SE = 0.017 \qquad F(9, 43) = 16.058$

$DW = 1.931 \quad LM, F(1, 42) = 0.034 \quad ARCH, F(1, 42) = 0.017$

$BP, \chi^2(10) = 2.467 \quad JB, \chi^2(2) = 0.876 \quad RESET, F(1, 47) = 1.794 \quad WH, F(4, 39) = 2.941$

(D)   1901-2002

$$\Delta_2 GDP = -1.151 \quad -0.114\Delta_2 TR_t \quad -0.054 TR_{t-2} \quad +0.608\Delta WAP_{t-1} \quad +0.238\ WAP_{t-1}$$
$$\qquad\quad (3.023)*** \ (5.863)*** \qquad (3.355)*** \quad (2.949)*** \qquad (2.253)**$$

$$\qquad\qquad +0.044\ INVR_{t-2} \quad +0.094\ LAND_{t-1} \quad +0.069\ \Delta MNR_t \quad +0.028\ MNR_{t-1}$$
$$\qquad\qquad (1.830)** \qquad\quad (2.631)** \qquad\quad (1.475)* \qquad\quad (2.736)***$$

$$\qquad\qquad -0.065\ WW1 \quad +0.017\ WW2 \quad -0.037\ DEP \quad -0.243\ GDP_{t-2} \quad +0.166\ \Delta_2 GDP_{t-1}$$
$$\qquad\qquad (2.993)*** \quad (0.868) \qquad\quad (1.481)* \qquad (3.798)*** \qquad (2.280)**$$

$\overline{R}^2 = 0.619 \qquad SE = 0.037 \qquad F(13, 88) = 13.67$

$DH = 1.547 \quad LM, F(1, 87) = 2.207 \quad ARCH, F(1, 87) = 1.884$

$BP, \chi^2(14) = 1.314 \quad JB, \chi^2(2) = 3.589 \quad RESET, F(1, 87) = 0.456 \quad WH, F(3, 85) = 0.496$

(E)   1870-2002

$$\Delta_2 GDP_t \quad = -0.957 \qquad -0.113\,\Delta_2 TR_t \quad -0.054\,TR_{t-2} \quad +0.645\,\Delta WAP_{t-1} \quad +0.163\,WAP_{t-1}$$
$$\qquad\qquad (4.893)*** \quad (7.142)* \qquad (3.763)*** \quad (3.446)*** \qquad (2.138)**$$

$$\qquad\qquad +0.050\,INVR_{t-2} \qquad +0.090\,LAND \qquad +0.023\left(\Delta MNR_t + MNR_{t-1}\right) \qquad -0.069\,WW1$$
$$\qquad\qquad (3.015)*** \qquad (3.907)*** \qquad (2.724)*** \qquad\qquad (3.510)***$$

$$\qquad\qquad +0.011\,WW2 \qquad -0.037\,DEP \qquad -0.195\,GDP_{t-2} \quad +0.214\,\Delta_2 GDP_{t-1}$$
$$\qquad\qquad (0.597) \qquad (1.615)* \qquad (4.267)*** \qquad (3.334)***$$

$\overline{R}^2 = 0.615 \qquad SE = 0.036 \qquad F\,(12, 116) = 18.083$

$DH = 1.624 \quad LM\,, F(1, 115) = 2.452 \quad ARCH\,, F(1, 115) = 2.263$

$BP\,, \chi^2(12) = 0.923 \quad JB\,, \chi^2(2) = 3.894 \quad RESET\,, F(1, 115) = 0.294 \quad WH\,, F(3, 112) = 1.401$

Notes:

a. All variables are in natural logarithms. The t-ratios of regression coefficients are given in brackets., with statistical significance denoted as, 10 percent = *; 5 percent = **; and 1 percent ***.

c. The test statistics are **:**
LM   Lagrange multiplier test of residual serial correlation;
ARCH Engle's autoregressive conditional heteroscedasticity test.
BP   Breusch-Pagan test for hetoroscadasticity
JBN   Jarque-Bera test for the normality of residuals.
*RESET* Ramsey test for functional form misspecification
WH   Wu-Hausman T_2 statistic for testing erogeneity of regressors.

Table 2: Long-Run (Steady State) Growth Elasticities

|	1870-1990	1901-1949	1950-2002	1901-2002	1870-2002
TR	-0.320 (1.550)**	-0.325 (3.078)***	-0.101 (1.770)**	-0.225 (2.958)***	-0.277 (3.635)***
INVR			+0.384 (2.342)**	+0.179 (2.489)**	+0.257 (2.479)**
WAP	+1.358 (9.789)***	+0.823 (3.454)***	+0.989 (2.739)**	+0.979 (4.371)***	+0.837 (3.640)***
LAND		+0.464 (2.271)**		+0.385 (2.395)**	+0.463 (3.007)***
MNR		+ 0.085 (1.300)*	+0.346 (2.638)***	+0.115 (2.395)**	+0.116 (2.9204)***

Note: t-ratios derived from asymptotic standards errors given by the long-run (steady-state) solution to the model are given in brackets, with statistical significance denoted as, 10 percent = *; 5 percent = **; and 1 percent ***

Source: Computed using the regression results reported in Table 1.

Figure 1: Average duty rate, Australia 1871 to 2002
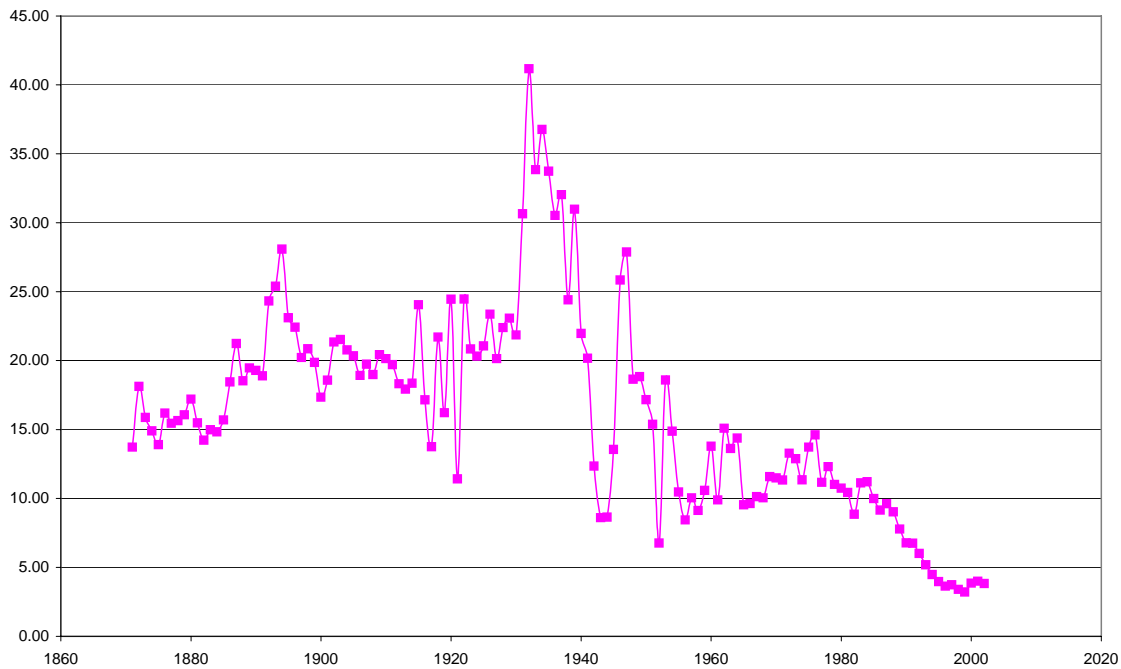
Source: Based on data compiled from sources listed in the Appendix

Figure 2: Scatter plot of growth of GDP against tariff rate, 1872 to 2002.
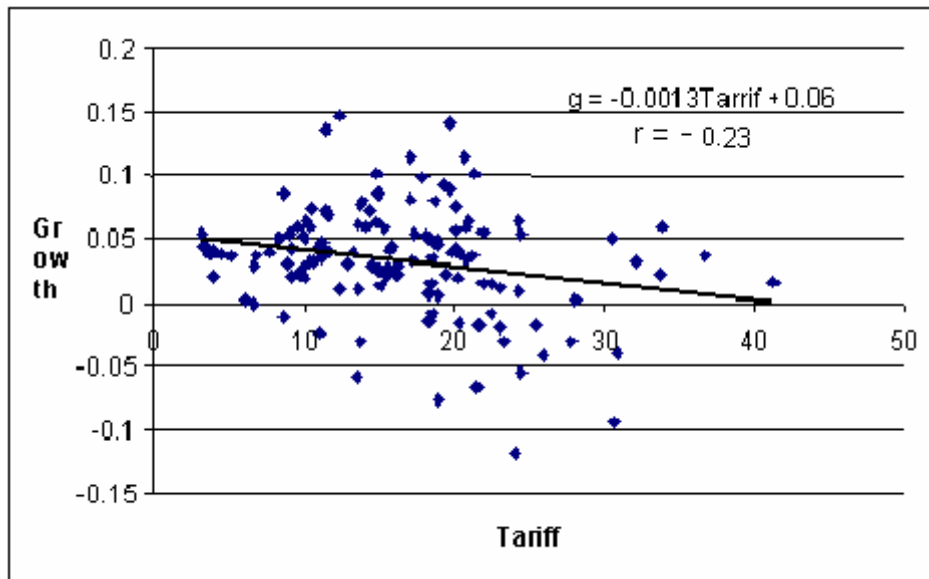
Source: Based on data compiled from data sources listed in the Appendix