THE UNIVERSITY OF WARWICK

Library Declaration and Deposit Agreement

1. STUDENT DETAILS

Please complete the following:

Full name: …………………………………………………………………………………………….

University ID number: ………………………………………………………………………………

2. THESIS DEPOSIT

2.1 I understand that under my registration at the University, I am required to deposit my thesis with the University in BOTH hard copy and in digital format. The digital version should normally be saved as a single pdf file.

2.2 The hard copy will be housed in the University Library. The digital version will be deposited in the University's Institutional Repository (WRAP). Unless otherwise indicated (see 2.3 below) this will be made openly accessible on the Internet and will be supplied to the British Library to be made available online via its Electronic Theses Online Service (EThOS) service.
[At present, theses submitted for a Master's degree by Research (MA, MSc, LLM, MS or MMedSci) are not being deposited in WRAP and not being made available via EthOS. This may change in future.]

2.3 In exceptional circumstances, the Chair of the Board of Graduate Studies may grant permission for an embargo to be placed on public access to the hard copy thesis for a limited period. It is also possible to apply separately for an embargo on the digital version. (Further information is available in the *Guide to Examinations for Higher Degrees by Research*.)

2.4 *If you are depositing a thesis for a Master's degree by Research, please complete section (a) below. For all other research degrees, please complete both sections (a) and (b) below:*

(a) Hard Copy

I hereby deposit a hard copy of my thesis in the University Library to be made publicly available to readers (please delete as appropriate) EITHER immediately OR after an embargo period of ……….................... months/years as agreed by the Chair of the Board of Graduate Studies.

I agree that my thesis may be photocopied. YES / NO (*Please delete as appropriate*)

(b) Digital Copy

I hereby deposit a digital copy of my thesis to be held in WRAP and made available via EThOS.

Please choose one of the following options:

EITHER My thesis can be made publicly available online. YES / NO (*Please delete as appropriate*)

OR My thesis can be made publicly available only after…..[date] (Please give date)
YES / NO (*Please delete as appropriate*)

OR My full thesis cannot be made publicly available online but I am submitting a separately identified additional, abridged version that can be made available online.
YES / NO (*Please delete as appropriate*)

OR My thesis cannot be made publicly available online. YES / NO (*Please delete as appropriate*)

3. GRANTING OF NON-EXCLUSIVE RIGHTS

Whether I deposit my Work personally or through an assistant or other agent, I agree to the following:

Rights granted to the University of Warwick and the British Library and the user of the thesis through this agreement are non-exclusive. I retain all rights in the thesis in its present version or future versions. I agree that the institutional repository administrators and the British Library or their agents may, without changing content, digitise and migrate the thesis to any medium or format for the purpose of future preservation and accessibility.

4. DECLARATIONS

(a) I DECLARE THAT:

- I am the author and owner of the copyright in the thesis and/or I have the authority of the authors and owners of the copyright in the thesis to make this agreement. Reproduction of any part of this thesis for teaching or in academic or other forms of publication is subject to the normal limitations on the use of copyrighted materials and to the proper and full acknowledgement of its source.

- The digital version of the thesis I am supplying is the same version as the final, hard-bound copy submitted in completion of my degree, once any minor corrections have been completed.

- I have exercised reasonable care to ensure that the thesis is original, and does not to the best of my knowledge break any UK law or other Intellectual Property Right, or contain any confidential material.

- I understand that, through the medium of the Internet, files will be available to automated agents, and may be searched and copied by, for example, text mining and plagiarism detection software.

(b) IF I HAVE AGREED (in Section 2 above) TO MAKE MY THESIS PUBLICLY AVAILABLE DIGITALLY, I ALSO DECLARE THAT:

- I grant the University of Warwick and the British Library a licence to make available on the Internet the thesis in digitised format through the Institutional Repository and through the British Library via the EThOS service.

- If my thesis does include any substantial subsidiary material owned by third-party copyright holders, I have sought and obtained permission to include it in any version of my thesis available in digital format and that this permission encompasses the rights that I have granted to the University of Warwick and to the British Library.

5. LEGAL INFRINGEMENTS

I understand that neither the University of Warwick nor the British Library have any obligation to take legal action on behalf of myself, or other rights holders, in the event of infringement of intellectual property rights, breach of contract or of any other right, in the thesis.

Please sign this agreement and return it to the Graduate School Office when you submit your thesis.

Student's signature: ....[redacted]..…… Date: ....

Three Essays on the Comparative Growth of Settler Economies

by

Nicholas Joseph Zammit

Thesis

Submitted to the University of Warwick

for the degree of

Doctor of Philosophy

Department of Economics

October 2013

THE UNIVERSITY OF WARWICK

Contents

List of Tables iii

List of Figures v

Acknowledgments vi

Declarations vii

Abstract viii

Abbreviations ix

Chapter 1 Introduction to Thesis 1

I Settler Economies - An Overview 1
II Contribution of this Thesis 4

Chapter 2 Expectations Reconsidered: A Sectoral Comparison Of Canadian-Australian Productivity, 1871-2007 6

I Introduction to Chapter 2 6
II Data and Methods 8
III Relative Pattern of Economic Progress 12
IV A Benchmark for 1936/37 15
V PPP Adjusted Real Output Per Capita and Labour Productivity Comparisons 18
VI Explaining Divergent Outcomes 21
VII Conclusion 36
VIII Tables & Figures - Chapter 2 37

Chapter 3 Manufacturing Success in the Nineteenth Century: An Application of Data Envelopment Analysis 55

I Introduction to Chapter 3 55
II Overview on Manufacturing 57
III Data: Characteristics and Limitations 59
IV Cross-Country Comparisons of Manufacturing 67
V Growth Accounting 71
VI Data Envelopment Analysis 72
VII A Case Study: Agricultural Implements 79
VIII Conclusion 81
IX Tables & Figures - Chapter 3 82

Chapter 4 Death by Distance: Market Potential of Australian States before World War One 92

I Introduction to Chapter 4 92
II A Model for Market Potential 97
III Empirical Approach 99
IV Results and Analysis 109
V Sensitivity to Distance 113
VI Decomposition of Market Potential 114
VII Counterfactuals 115
VIII Geography Rules 116
IX Conclusion 117
X Tables & Figures - Chapter 4 120

Chapter 5 Bibliography 137

Appendices I

Appendix Chapter A I

Appendix Chapter B XII

Appendix Chapter C XXV

List of Tables

2.1 Real GDP, Employment & Labour Productivity (1871=100) 38
2.2 Real GDP & Employment Shares (% of Total) 39
2.3 1936/37 PPP Manufacturing 40
2.4 1936/37 PPP Agriculture, Industry & Services 41
2.5 Aggregate PPPs 42
2.6 Correlation Coefficients 43
2.7 Granger Causality Wald Tests 43
2.8 Regression Results 44

3.1 Share of Value Added in Manufacturing 83
3.2 Relative Capital Intensity 84
3.3 Horse Power Used 85
3.4 Relative Resource Intensity 86
3.5 Relative Output Generated 87
3.6 Annual Growth Rates in Manufacturing (%) 88
3.7 1890 DEA Results 89
3.8 1900 DEA Results 90
3.9 1910 DEA Results 91

4.1 Real PPP Adj. $1990 GDP (W.Europe = 100) 121
4.2 Share of State Trade by Principal Destination (%) 122
4.3 Preferred Nominal ER Adjusted GDP Estimates (£mn) 123
4.4 Australian GDP Estimates by State 123
4.5 Shipping Rates per Ton on Grain & Coal (Shillings) 124
4.6 Estimated/Actual Freight to London on Grains (£ per ton) 124
4.7 Foreign Effective Tariff Rates (Import Duties/Imports) 125
4.8 Inter-State Effective Tariff Rates (Customs/Imports) 125
4.9 Comparative Rail Freight Receipts (*d.* per ton mile) 126
4.10 Market Potential (£mn) 126

4.11 Comparative Indexes (NSW=100) 127
4.12 Annual Growth Rates (%) 128
4.13 Australian Potential Over Time 129
4.14 Exports vs. Market Potential by Destination for Each State (%) . . 130
4.15 Inter-State Exports vs. Market Potential by State (%) 131
4.16 Alternative Effects on Market Potential 132
4.17 Counterfactuals 132

List of Figures

2.1 Real GDP Per Capita Relative to the USA (1990 $GK) 45
2.2 Consistency of the Relative Real GDP Indices 46
2.3 CAN/AUS PPP Adjusted Aggregate Real GDP Per Capita 47
2.4 CAN/AUS PPP Adjusted Real GDP Per Capita in Agriculture . . . 47
2.5 CAN/AUS PPP Adjusted Real GDP Per Capita in Industry 48
2.6 CAN/AUS PPP Adjusted Real GDP Per Capita in Services 48
2.7 CAN/AUS PPP Adjusted Aggregate Labour Productivity 49
2.8 CAN/AUS PPP Adjusted Labour Productivity in Agriculture 49
2.9 CAN/AUS PPP Adjusted Labour Productivity in Industry 50
2.10 CAN/AUS PPP Adjusted Labour Productivity in Services 50
2.11 Share of CAN Imports from and Exports to the USA and GBR . . . 51
2.12 Relative USA and GBR Shares of Canadian Manufactured Exports . 51
2.13 Manufactured Share of Total Canadian Exports 52
2.14 Canadian & Australian Relative Duties on Imports 52
2.15 Share of Canadian Patents Issued to Foreign Residents 53
2.16 Real Value of Principal Canadian Staple Exports (1911 Prices) . . . 53
2.17 Real Value of Principal Australian Staple Exports (1911 Prices) . . . 54
2.18 Real Value of CAN/AUS Staple Exports in a Base Year (1871=100) 54

4.1 Australian Shipping Routes from 1870 to World War One 133
4.2 Grain Freight Rates to Britain (£ per ton) 134
4.3 Length of Railway Miles Open by Country (m. per 10,000 sq. m.) . 134
4.4 Length of Railway Miles Open by State (m. per 10,000 sq. m.) . . . 135
4.5 Overland Trade Share in Inter-State Trade (%) 135
4.6 River Murray Trade Share in Inter-State Trade (%) 136
4.7 Counterfactual Australian GDP 136

Acknowledgments

I would like to thank my supervisors Steve Broadberry and Nick Crafts as outstanding mentors and for providing a great deal of support and guidance in the completion of this work. Both Steve and Nick have given me an invaluable education in economic history. They have supplied insightful critiques on how to improve my research. Steve has devoted a considerable amount of his time to reading numerous editions of each chapter, always offering thoughtful criticisms on key elements that had been overlooked. I should acknowledge very useful advice from Mark Thomas who attended an early presentation of my work at the University of Warwick. I would also like to thank attendees of the Economic History Association Annual Meeting 2012, the Asia-Pacific Economics and Business History Conference 2013, and the Economic History Society Conference 2013 who provided comments on my work, specifically Ian Keay, Kris Inwood, Almos Tassonyi, Marvin McInnis, Martin Shanahan, John Wilson, Rajabrata Banerjee, Les Oxley and Knick Harley. In particular I should thank Ian Keay, who served as the lecturer for graduate level economic history at Queen's University during my studies there. Ian gave me both a foundation and interest in Canadian economic history. Financial support through the University of Warwick Postgraduate Research Scholarship (WPRS) program has been vital to my studies and was much appreciated. My parents have always encouraged my dreams at great personal expense and they deserve my thanks. Finally I must thank my wife Natalie for her support and dedication in our shared goals and achievements. Any errors in this thesis are my own.

Declarations

This thesis is an account of research undertaken between January 2010 and September 2013 at The Department of Economics, The University of Warwick, Coventry, United Kingdom.

Except where acknowledged in the customary manner, the material presented in this thesis is, to the best of my knowledge, original and has not been submitted in whole or part for a degree in any university.

Nicholas J. Zammit

October, 2013

Abstract

The traditional view of the Canadian economy from the late nineteenth century onward has been one of failure relative to the United States. This thesis examines the Canadian experience from the late nineteenth century in relation to other 'settler economies'. Similarities between these countries include their resource abundance, low population density and European institutions. In the first essay, creation of long-run, sectorally disaggregated, Purchasing Power Parity (PPP) adjusted Canadian/Australian data reveals that the Canadian economy was characterised by relatively strong and sustained growth in real output per capita and labour productivity. This paper takes a first step in estimating the importance of many potentially relevant factors. Results indicate that acceptance of foreign technology from abroad was a significant determinant of success.

From 1870 to World War One, Canada performed particularly well against settler economies like Australia and New Zealand in terms of output and productivity in manufacturing. The second essay looks more deeply at the question of manufacturing success. A novel approach is taken by applying non-parametric frontier analysis to manufacturing census data in order to make cross-country efficiency comparisons. Measures of Total Factor Productivity indicate that nineteenth century Canadian manufacturing was surprisingly efficient relative to Australia, New Zealand and South Africa.

The third essay takes a comparative approach in analysing market potential. Historically there has been a predisposition to view settler economies like Canada and Australia as part of a homogeneous 'periphery' relative to a British 'metropole'. This concept serves to mask important differences in the 'peripherality' of each country. This study suggests the key geographical factor in explaining relative success amongst settler economies was access to markets. Peripherality is observed by estimating an aggregate measure of distance including adjustments for falling transport costs, tariff barriers and border effects. This aggregate distance estimate is used to form a measure of market potential that can be compared with observed trade behaviour. Focus is on the Australian colonies given their acute isolation. Counterfactuals are then generated to quantify the effects of distance on long-run growth during the period from 1870 to World War One.

Abbreviations

ABS	Australian Bureau of Statistics
ARTC	Annual Report of the Department of Trade and Commerce
ASASCA	A Statistical Account of the Seven Colonies of Australasia
ASTA	Annual Statement of the Trade of the Commonwealth of Australia
AYB	Australian Year Book
CANSIM	Canadian Socio-Economic Information Management System
CBCS	Commonwealth Bureau of Census and Statistics
CEO	Canadian Economic Observer
CIPO	Canadian Intellectual Property Office
COC	Census of Canada
CYB	Canada Year Book
DBS	Dominion Bureau of Statistics
KLEMS	Capital (K), Labour (L), Energy (E), Materials (M) and Services (S)
NZLYB	New Zealand Official Year Book
SABE	Statistical Abstract for the British Empire
SABI	Statistical Abstract Relating to British India
SAPOFC	Statistical Abstract for the Principal and Other Foreign Countries
SASCOPUK	Statistical Abstract for Several Colonial and Other U.K. Possessions
SAUS	Statistical Abstract of the United States
SCTAS	Statistics of the Colony of Tasmania
SCQLD	Statistics of the Colony of Queensland

SRNSW	Statistical Register for New South Wales
SRSAU	Statistical Register for South Australia
SRWAU	Statistical Register for Western Australia
SRVIC	Statistical Register for Victoria
TTNC	Tables of Trade and Navigation of Canada
VYB	Victorian Year Book
YBWAU	Year Book of Western Australia

Chapter 1

Introduction to Thesis

I Settler Economies - An Overview

The grouping together of 'regions of recent settlement' for comparative analysis has long been recognised to hold untaped potential.[1] Recently there has been a renewed interest in the comparative economic history of these so called 'settler economies'.[2] The existing literature suggests the most useful settler countries for comparative analysis with Canada are: Australia, Argentina, New Zealand and South Africa.[3] Similarities between these countries include their land and resource abundance, staples-based export-oriented development, small domestic markets with low potential for economies of scale, relatively high real income per capita and inherited European institutions. Despite these similarities only a small number of detailed comparative studies exist. Often studies that do attempt a comparative approach take on too much by spreading focus over time and space, serving little purpose given the comparative benchmarks desired. Fogarty (1981)[29] raised some doubts on the blanket comparison of settler economies. According to Fogarty (1981)[29], comparative studies must clearly define the conditions such that countries can claim to be settler economies, which is subject both to regional considerations and the time frame of analysis undertaken. For example, any argument that property rights were a major cause for divergence between settler societies seems to void one of the key conditions on which their comparison is based. Studies that do not suffer from these

[1] According to Fogarty (1981)[29] the term 'regions of recent settlement' was first coined in Nurkse (1961)[68].

[2] Here I am referring to a growing number of journal publications from authors like Ian McLean, Les Oxley, David Greasley, John Fogarty, Warwick Armstrong, Roberto Cortes Conde, Tim Rooth and Boris Schedvin; several unpublished studies and graduate thesis work should also be noted. Regions of recent settlement are now commonly referred to as settler economies.

[3] Some studies have also suggested Brazil, Uruguay, Chile and the American South.

issues cover only a small subset of numerous interacting factors.

Literature on settler economies typically views divergent growth as the result of differences in trade policies (tariffs), land policies (property rights) or geography (staple resources and market access). Good examples are Schedvin (1990)[100], Greasley and Oxley (1998)[32] and Sanz–Villaroya (2005)[99]. However, some key problems arise in most analysis on settler economies. Firstly, there seems to be too much ex-ante acceptance of one 'smoking gun' in explaining why some settler societies succeeded and others failed, leaving many hypotheses untested. For example, emphasis is often placed on Canada's trade with the United States during the interwar period or after World War Two. While this approach might highlight one key factor that occurred during one particular episode it ignores a great deal of the changes in trade policy over the entire pre- and post-war period.

Secondly, not enough relevant quantitative evidence supports the claims made in most studies. While there are lots of qualitatively reasonable explanations for differing comparative outcomes there is little quantitative evidence in most cases. If any quantitative approach is undertaken then it is done in isolation by assuming away too many factors. Moreover, one policy or institutional factor is often considered but no attempt is made to determine its relative significance. For example, trade policy is important in explaining growth but it may be the case that technology transfer embodied in imports played a bigger role than access to United States consumers. Another common mistake is to ignore the basic implications of neoclassical growth models, especially with respect to convergence. Although institutions show some variance amongst settler economies they were generally good and relative growth stories may have been influenced heavily by 'catch-up' growth.

It should be noted that most studies are limited in the extensiveness with which their data can meaningfully comment on comparative growth. Most studies use only data on aggregate output that does not isolate any sectoral fluctuations in output or productivity. At the national level, there is no way to discern if aggregate patterns were directly attributable to an increased resource intensity, residual productivity in manufacturing or other sector specific explanations. The question of why different countries were successful is also difficult to disentangle. Relevant explanatory variables are often assembled only for a limited number of years due to the difficulty of sourcing annual data and many studies must isolate analysis to a very narrow period (typically only a few observations). Given the amount of variation over long periods this may be a significant issue.

National accounting estimates were unavailable until the interwar period for most settler economies. The first estimates by R.A. Lehfeldt for the Union of South

Africa were in 1925. The Dominion Bureau of Statistics officially organised the first Canadian estimates in 1925. New Zealand's first set of estimates were officially organised in 1931 by the Census and Statistics Department. The Australian Government Statistician provided some of the earliest official estimates in 1886, many decades before there were official estimates on the Netherlands, Italy, Spain, Belgium and Switzerland. Since the first official estimates were produced, pioneering authors have collected and organised a great deal of data at the national level for settler economies. Key contributors are far too numerous to list but they include individuals such as Charles Feinstein, Colin Clark, Noel Butlin, J.T. Sutcliffe, S.H. Frankel, R.H. Coats, F.B. Stephens, M.C. Urquhart, Alan Green and Marvin McInnis.

Recently there has been a tendency in economic history to move away from narrow intranational studies and turn towards international comparative studies with the goal of answering long and broad questions on growth. The ongoing work of researchers such as Angus Maddison, Steve Broadberry, Prados de la Escosera, Luiten Van Zanden, Marcel Timmer, Les Oxley, David Greasley, Ian Mclean and research groups such as the Maddison Project, the UN International Comparisons Project (ICP), the International Comparisons of Output and Productivity (ICOP) project and the World Level Analysis of Capital, Labour, Energy, Materials, and Service Inputs (KLEMS) project have advanced the relative narrative on settler economies in their work.[4]

Although good national accounting data are now available for many settler economies there has been little attempt to draw existing data together in one unified study. This has left gaps over the long-run and in a comparative context. In order to conduct detailed cross country comparisons, a substantial amount of data must be organised and analysed. Important questions cannot be answered by observing aggregate output patterns without considering changing patterns of employment, resource extraction, trade, etc. Moreover, Purchasing Power Parities (PPPs) have been estimated only for modern points of reference and used in conjuction with procedures pioneered by Bairoch and Maddison to generate the long-run aggregate GDP estimates presently available. Despite the introduction of distortions in inter-temporal comparisons, this method has served as the basis for virtually all quantitative comparative work on settler economies.

Long-run regional and sectoral decompositions of output, employment and productivity are in very short supply. Where they do exist, other problems are common

[4]Examples of work by these authors are too numerous to list and many can be found in the bibliography to this thesis.

in comparative studies of settler economies. For example, gaps still exist in sectoral GDP at constant prices for Canada, and no attempt has been made to regionally decompose Canadian output by province before World War Two. This is a problem in comparative studies on Canadian manufacturing where virtually all manufacturing activity was being undertaken in Ontario and Quebec. Another issue has been the limited scope of studies. Canada has received focus in a number of cross-country comparisons with the United States, whilst other settler economies such as the Cape Colony and New Zealand have been virtually ignored in comparative studies. Australia has garnered its share of comparative studies but they have suffered from the same short comings present in the Canadian literature. This thesis takes an important first step in addressing many of these issues.

II Contribution of this Thesis

This thesis is in the spirit of recent comparative trends with a direct focus on settler economies during the 'long' nineteenth century.[5] Chapter two compares long-run trends in GDP, employment and labour productivity between two of the wealthiest settler economies, Canada and Australia. This chapter develops the only consistent long-run sectorally disaggregated annual data sets on output and labour productivity available for Canada and Australia. These data have been carefully assembled and checked for consistency and should serve as the most comprehensive set of data available. Chapter two also presents a newly estimated set of Purchasing Power Parity (PPP) values by sector for Canada and Australia. These 1936 bilateral PPPs are highly detailed and push back the date on PPP estimates for Canada and Australia by approximately fifty years.

Furthermore, chapter two makes an important contribution to the literature on settler economies by analysing several of the most popular claims for relative success in a more rigorous quantitative framework. Previous work has discussed claims on the success of each country in isolation and these have been incorporated into chapter two. For example, the role of technology transfer from the United States has been an active area of research in the Canadian literature but may also have been important for other settler economies. Another key topic has been the trade policy of both Canada and Australia. Access to export markets and changes in tariff policies have featured prominently in the literature on all settler economies. In summary, this

[5]The term 'long' is now commonly applied to the nineteenth century in order to refer to the period running from approximately the late eighteenth century to World War One.

chapter combines many of the standard topics for discussion on settler economies into a unified and quantitative approach.

Chapter three focuses on the comparative development of manufacturing amongst settler economies whilst addressing the traditional criticisms placed on this sector in the Canadian literature. Chapter three represents the first study where manufacturing data from Canadian censuses have been organised into categories at the provincial level that are consistent with national data. Chapter three further organises data for Ontario and Quebec, Victoria, New South Wales, New Zealand and the Cape Colony into universal categories that are consistent for cross-country comparisons. In the spirit of recent studies on Canadian manufacturing, chapter three relies on estimates of total, rather than partial, factor productivity to determine relative efficiency. A non-parametric frontier approach adapted from operations research is applied to historic manufacturing data as an alternative to more restrictive parametric approaches. The result is a study of manufacturing for the long nineteenth century that is unique, not only in the work on settler economies but in economic history more generally.

Chapter four completes the study by addressing the most important deep determinant of growth performance amongst settler economies before World War One, geography. Focus is on a comparison of the Australasian colonies, as they represent the most distant and geographically constrained of the settler economies. A model for market potential from the economic geography literature is adapted to a mass of data from statistical registers and statistical abstracts. Chapter four represents one of the most detailed studies on the role of distance in the nineteenth century, offering several counterfactuals to highlight the significant effect that location and distance to markets have played on the development of settler economies.

Beyond the economic history of settler economies I believe this thesis has broad implications for long-run growth and development. Many modern developing economies face similar growth issues as settler economies faced in the nineteenth century. Issues of capital accumulation, foreign investment and involvement, structural change, tariff protection for industry, resource use and exploitation, technology transfer and geographical determinism are all important topics for modern development. Settler economies offer a nineteenth century laboratory to study the interaction of these factors. This thesis applies novel techniques to the comparative study of growth and development.

Chapter 2

Expectations Reconsidered: A Sectoral Comparison Of Canadian-Australian Productivity, 1871-2007

I Introduction to Chapter 2

A long running debate (often termed the 'British Failure Hypothesis') has surrounded the failure of Britain to stay ahead of early challengers like the United States and Germany. British failure (as argued by McCloskey) centred on 3 factors: a lack of demand, a failure to invest domestically and an entrepreneurial failure.[1] This perceived failure was often based on Britain's declining position in industry and exhibited in statistics on output and labour productivity. In hindsight, the United States' large homogeneous market and potential for structural and technological change made its early twentieth century rise as industrial leader a likely outcome.

Unsurprisingly, the nineteenth century Canadian economy is also argued to have under-performed relative to the United States. Observers have pointed fingers at Canadian entrepreneurs, particularly in manufacturing, who they felt lacked innovative effort and/or ability. This entrepreneurial failure (which I refer to as the 'Canadian Failure Hypothesis') was advocated by various authors and focused on the lack of responsiveness amongst Canadian manufacturers in adapting production decisions to domestic market conditions.[2] Namely, Canadian entrepreneurs failed

[1] See McCloskey (1971)[58].

[2] Examples include Naylor (1975)[65], Levitt (1970)[51] and Watkins (2007)[115].

to act in a manner consistent with theories of cost minimisation and induced innovation.

A great deal of recent literature has successfully attempted to restore the reputation of Canadian relative to American entrepreneurs, by challenging the claims of inefficient input responses in Canadian manufacturing.[3] However, Canadian failure relative to the United States is still clearly visible in comparisons of real output per capita and labour productivity. The calculation of Total Factor Productivity (TFP) and the use of advanced econometric techniques still leaves the casual observer asking questions of Canadian entrepreneurs.[4]

Although some studies have exonerated Canadian entrepreneurs using more comprehensive measurement techniques this paper is a shift in the comparative framework. Various endowments provided the United States with the perfect conditions for an early and rapid industrialisation along with substantial labour and TFP growth. In terms of invention, innovation or expanding production through economies of scale, other settler economies such as Canada, Australia and Argentina seemed to lack the dynamism that the large domestic markets of the United States provided. Even the more established European industrialisers failed to match the success of the United States in the early twentieth century. Hence, It is unrealistic that Canadian manufacturers could have kept pace with their American counterparts in terms of output, productivity or technological change.

Figure 2.1 displays real GDP per capita for several countries relative to the United States.[5] In 1870 there was a great disparity in relative output per capita. Canada progressed rapidly, virtually eliminating this gap by World War One. After World War Two, Canada was able to overtake Australia in terms of aggregate real output per capita, something that was not accomplished relative to the United States. This comparison highlights the problem in focussing studies of Canada on the United States. When compared with Australia there is little evidence suggestive of a productivity shortfall attributable to Canadian manufacturers and entrepreneurs. The first goal of this paper is to challenge the legitimacy of a 'Canadian Failure Hypothesis' by drawing on the literature on settler economies and shifting comparison of Canada towards Australia.

The second goal is to explain relative Canadian success by unifying various narratives on Canadian growth in the existing literature. Typical explanations surround

[3]Key examples include Wylie (1986; 1989; 1990)[117][118][119], Keay (2000)[48][47], Inwood and Keay (2005)[41], as well as various other publications by these authors.

[4]Broadberry et. al. (2012)[11] have noted that any cross-country comparison involving the United States will be impacted by the 'unusually dynamic performance of the United States economy'.

[5]See appendix figure A.1 for a comparison relative to Canada.

the proximity to the United States, quality of institutions, openness to trade, adoption of new technology and importance of staple exports. An attempt will be made to quantify these potential explanations for Canadian success relative to Australia.

II Data and Methods

II.1 Canadian Time Series

Analysing productivity trends in the Canadian economy back to the nineteenth century requires a time series on output and employment by sector. Obtaining this is not a trivial task as there is no long run output series connecting the pre- and post-war data. Moreover, sectoral data on real output prior to the Second World War are only available after 1935 in Urquhart and Buckley (1965)[112]. Nominal output data are available by sector from Urquhart (1986)[111] but must be deflated. Hence, the first task was to extend the nominal output series from 1870 to 1935. This was relatively straight forward using nominal GDP by sector from Urquhart and Buckley (1965)[112] covering the period 1926 to 1976. The second, less straight forward task, was to deflate output by sector.

Urquhart does not make any attempt to deflate his sectoral data. Instead, the fixed capital component of his aggregate series has been deflated using a cost of capital index and the remaining component of the aggregate series was deflated using the Consumer Price Index. These two real components are then combined to form aggregate real output. Ideally, one could create a series of real output for each sector from 1870 to 1935 by deflating both the intermediate inputs and gross outputs through a method of double deflation. Realistically, I have opted to follow Altman (1992)[2] in deflating value added in each sector separately using the most appropriate wholesale price index. The deflated real GDP series by sector are then combined to get aggregate real output. Altman perceives this method as an improvement on Urquhart (1986)[111] and uses it for the purpose of analysing patterns in aggregate GDP. Unlike Altman I attach no significance to differences in the aggregate series and utilise this technique in the absence of an alternative, with the goal of analysing the sectoral series. The aggregate series created from Altman's deflated sectoral data is a close enough approximation to Urquhart's deflated aggregate series, providing support for the validity of Altman's sectoral series.

Thus, the next step was to create various price series by sector that could be used to generate a real GDP series up to 1935 where it could be linked with the real GDP series found in Urquhart and Buckley (1965)[112]. Fortunately, many of the original sources used by Altman to construct the wholesale price series up to 1926 actually cover a longer period and can be used to extend many of the sectors beyond 1926.[6] I will skip the detailed description of each series and how it was deflated as this is explained in length in Altman (1992)[2]. Where it was impossible to extend Altman's data directly I have chosen the most appropriate wholesale price series available.[7]

The final step was to bring the sectoral real GDP series up to the present period. This was done using several editions of the Canadian Economic Observer. The data on real GDP have been organised into a series for the aggregate economy and for the three main sectors of agriculture, industry and services. The data are also available at a more disaggregated level but have been organised for ease of international comparisons. Agriculture includes arable, pastoral, forestry and fisheries; Industry includes mining, manufacturing and construction; Services acts as a residual including all remaining categories, and includes house rents.[8] The most contentious aspect of this aggregation is the inclusion of mining in the industrial category. The decision to proceed this way follows Broadberry and Irwin (2007)[12] and makes for an easier comparison with existing long-run data that may be used in future studies. For many reasons, such as capital intensity and minimum efficient scale, mining is more akin to other secondary areas of production. When comparing Canada and Australia, the inclusion of mining as an industrial pursuit will result in Australia having a much larger share of output and employment in industry than if mining were included as a primary activity. Mining in Australia was a positive contributor to average labour productivity and will bias my results towards a more impressive secondary sector in Australia, strengthening my conclusions on Canadian manufacturing.

Sectoral employment is available only for decennial census years in the pre-war period. I have followed Urquhart (1986)[111] in using Firestone (1958)[28] and Urquhart and Buckley (1965)[112] for employment by sector.[9] The number of individuals gainfully occupied by sector is available annually after 1946 from Buckley et. al. (1983)[110]. The output and employment data are used to calculate productivity per worker by major sector.

[6]For example, see McInnis (1986)[59] for the series on an agriculture price deflator, Green (1986)[33] for the series on transportation prices, etc...

[7]See Buckley et. al. (1983)[110] section K for various wholesale price series.

[8]Examples of services include distributive trades, communication, transportation, gas, water and electricity, professional services, etc...

[9]There are large criticisms surrounding data found in Firestone (1958)[28] due to a lack of supporting evidence. I have very limited use of Firestone (1958)[28] and have followed Urquhart (1986)[111] in accepting this data as the best estimates available.

II.2 Australian Time Series

Australian data on real GDP by sector are, somewhat, more conveniently provided in the widely used series by Butlin (1962)[13]. Although no data on real output exist from 1939 to 1949, post-war data on real output are available from the Commonwealth Bureau of Census and Statistics (later the Australian Bureau of Statistics) up to the present period.[10] The difficulty in creating a long-run series of real output by sector for the Australian economy is primarily in linking pre- and post-war data. Haig (2001)[35] provides a link but this raises questions over the use of Butlin's data rather than Haig's data for the pre-war period. Given the lack of options I have followed Broadberry and Irwin (2007)[12] by linking pre- and post-war data using Haig's alternative series.

Haig (2001)[35] provides two sets of data, one for the period up to 1911 and the other for the period from 1911 to 1949. Broadberry and Irwin (2007)[12] suggest Haig's data prior to World War One does not demonstrate consistent correct-cross country comparisons. As a result, I have utilised Butlin (1962)[13] for pre-1911 data and spliced this to Haig's second data set after 1911. Thus, my series relies on patterns in Butlin's data before World War One and those in Haig's data from World War One until World War Two. This approach produces a series that is extremely consistent with successive versions of Maddison data based on backward projection from a present benchmark.

Annual employment at the sectoral level after 1891 is available from Butlin and Dowie (1969)[14] and before 1891 from Haig (1989)[34].[11] Data on the total workforce (gainfully occupied) are available only in decennial format after 1891. As a result I have chosen to use average annual employment. This differs from Canadian employment data on the number of individuals gainfully occupied. Hence, Australian data will understate employment relative to Canadian data. This is acceptable as any bias appears small and will be in favour of Australian labour productivity.

One issue that exists in both the Australian output and employment data is the shift from calendar years up to 1900 to fiscal years starting in July from 1900/1901. Since Canadian data are given either for calendar years or for fiscal years ending in March (which provides a closer approximation to calendar years), I have averaged the con-

[10]See Australian National Accounts[76] for detailed national accounting data.

[11]I have used Broadberry and Irwin (2007)[12] which summarises the employment data from these two sources.

necting fiscal year data for Australia to represent calendar years. For example, the data for 1910/1911 and 1911/1912 are averaged together to represent calendar year 1911. Previous analysis has treated fiscal year 1910/1911 as though it was calendar year 1911 for means of cross-country comparison.[12] In Canadian-Australian comparisons, this method produces more extreme swings in relative output and employment, notably surrounding the Great Depression. The approach I have taken produces a greater consistency with data provided by Maddison (2010)[73].

II.3 Data Accuracy

In my data, evaluation is about confirming that methods of deflating, aggregating and linking such a long-run series have not inappropriately altered the data. As the method I have employed to get aggregate data is to combine deflated sectoral data, rather than deflating an aggregated nominal series, the aggregate data on real GDP per capita for Canada and Australia can be checked by comparing each series to those provided by Maddison (2010)[73]. Hence, to check the accuracy of my sectoral data, each aggregate series has been converted to an index with the same 1990 base year as Maddison's data. My relative Canadian/Australian output per capita series has been benchmarked using Maddison's Canadian/Australian 1990 PPP observation as well as the 1990 exchange rate. Figure 2.2 compares the relative Canadian/Australian aggregate real GDP per capita series generated from my sectoral data and Maddison's 1990 PPP (as well as the 1990 exchange rate) with the original Maddison series.[13] This is not an attempt to demonstrate the finer quality of Maddison's data but rather to establish the general validity of my sectoral series. It should be apparent that although the aggregate real GDP series for Canada and Australia have been created as sums of real sectoral data they are very close to Maddison's corresponding data. The only discrepancy of note occurs during the interwar period, directly surrounding the Great Depression. This discrepancy is likely related to the difference in deflation methods previously discussed. While my sectoral series are deflated using wholesale prices (producer prices), the aggregate real GDP series provided by Urquhart (utilised by Maddison) relies on consumer prices to deflate the majority of the series. Since producer prices lead consumer prices, and there is a more dramatic fall in producer prices at the onset of the depression, this reduces the initial collapse in real output in Canada. This results in a relative real GDP

[12] See Wray (1987)[113] as an example.

[13] ICP 1990 PPPs used to convert Canadian and Australian nominal GDP from KLEMS in 1990 into GK$s. The exchange rates are 1.15 CAN$/GK$ and 1.22 AUS$/GK$.

series that does not produce as dramatic a collapse in Canadian/Australian real GDP per capita. Overall the two relative real GDP per capita series are extremely close providing me with confidence in the accuracy of my sectoral series.

III Relative Pattern of Economic Progress

Table 2.1 displays Canadian and Australian real output by sector relative to 1871. Casual observations can be drawn from the data while keeping in mind that comparative output growth is not always a good predictor of relative success given that growth often appears quickest in areas or sectors that are relatively behind. Firstly, Australian agricultural output grew much more rapidly and consistently over several periods. Even during the draught and depression of the 1890s, Australian real output had increased significantly relative to its 1871 level. Canadian agricultural growth in real output outpaced Australian growth during the wheat boom and World War One but this proved to be a short lived phenomenon in the history of the two countries. Shocks to agriculture in the interwar period were particularly hard felt in Canada. Agricultural output relative to 1871 was substantial for Australia when compared with Canada during the 1920-21 recession and the Great Depression. After the 1930s, agricultural output in Canada recovered very slowly, in contrast to Australia.

The situation was rather different in both industry and services. Both the Barings Crisis of 1890-91, the 1893 Australian banking crisis and subsequent lack of investment had a persistent impact on Australian industrial output. Canada also suffered some fluctuations over this period that may be unsurprising given the large share of foreign investment in Canada coming from the United Kingdom[14] and a similar banking crisis in 1893 impacting the United States. However, an apparent breakthrough occurred in Canadian industry with the onset of the wheat boom. It was during the period after 1896 that Canada began to display rapid growth relative to its 1871 level. Hence, it is probable that linkages into industry and investment in infrastructure needed to support agriculture generated large real output gains in other sectors. Following the wheat boom period, the 1920s also stand out as a period of Canadian success in industry with strong relative growth in real output. During the 1920s agricultural output growth looked unspectacular in Canada, hence the success of Canadian industry was not dependant solely on linkages from agriculture.

[14]United Kingdom foreign investment in Canada was still 85% of total foreign investment by 1900.

The most significant sector for Canada in terms of real output relative to 1871 was the service sector. It was in services, both during the wheat boom and the 1920s, where Canadian real output growth was exceptional. The timing of this result does seem to have been related to linkages from other sectors (agriculture before World War One and industry in the 1920s), changes in trade policy and Canada's increasing dependence on United States capital and technology. Interestingly, due to the difficulty in measurement, this is the sector least discussed in Canadian economic history. If organised efficiently, this sector appears to be highly responsive to linkages, foreign investment opportunities and the benefits of an export oriented growth strategy.

Real output shares by sector are displayed in table 2.2. The Canadian share of real GDP in agriculture steadily declined throughout the period (From approx. 40% in the 1870s to approx. 2% in 2007). Although the share of real output in agriculture also declined in Australia, this decline was more rapid in Canada. By the 1920s Canada had a smaller share of real output in agriculture than Australia despite having double the share of real output in agriculture in 1871. The share of real output going to the Canadian industrial sector remained fairly constant throughout. The story looked very similar in the Australian industrial sector with only a marginal difference in the two countries after the 1930s.

Meanwhile the share of real output in Canadian services increased very rapidly (from approx. 30% in the 1870s to approx. 70% by 2007). As early as the 1890s Canada had overtaken Australia in the share of output going to services. In terms of real output, the 1920s represented a clear break for the two countries with Canada becoming more industry and service based and less agricultural.

Tables 2.1 and 2.2 provide indexes and shares of Canadian employment by sector. It is sometimes forgotten that Canada suffered from net emigration in the late nineteenth century as workers pursued opportunities in a rapidly industrialising United States economy. As a result employment growth in Canada was unexceptional. However, with the expansion of the prairie wheat frontier in the early twentieth century, disaggregated data show that all sectors of the Canadian economy exhibited strong growth of employment. The service sector was the most striking in this respect. Before World War One Canada had grown far more in service sector employment than Australia had over the same period. Increased Canadian employment in services outstripped Australia throughout the twentieth century. Growth in industrial employment was also relatively strong for Canada after World War One.

Relative to Canada, Australian employment shares in agriculture and services were more characteristic of a developed economy in the late nineteenth century. However, there were clear changes taking place with a growing relative share of Canadian employment in industry and services. By the 1930s Canada employed a comparable share of its workforce in industry. From the 1950s onward Canada employed a larger share of its workforce in services. Hence, from 1870 to World War One, Canada took major steps in transitioning from a primarily agricultural economy.

Labour productivity indexes are displayed in table 2.1. Aside from the recession and drought of the 1890s, Australia consistently maintained extremely high aggregate labour productivity growth. Labour productivity growth in Canadian agriculture looks less spectacular. The 1920/1921 recession (following the wheat boom and World War One) had left Canadian agricultural labour productivity relatively unchanged compared with its 1871 level. In contrast, Canadian labour productivity growth in industry and services after 1871 was impressive. Industrial productivity grew particularly rapidly in Canada, doubling in the last 30 years of the nineteenth century. Australian growth after 1891 stagnated and grew little until the 1970s. As a result, while Canadian productivity in industry had increased over nine times its 1871 level a century later, Australian productivity had only advanced three times its 1871 level.

A similar pattern is revealed in terms of relative service sector productivity. Growth in Canadian service sector labour productivity relative to 1871, unlike real output, was significant. In contrast, by 1901 Australian labour productivity in services had declined relative to 1871. Hence, while the wheat boom contributed a great deal to agricultural output this was extensive growth, marked by increased capital flows and immigration. The productivity effects seem to have been felt more in the service sector where linkages generated pure efficiency gains. These results seem to indicate a very productive service sector in Canada, even during the later period of the twentieth century when services came to dominate output shares and the size of the service sector was extremely large in both countries.

In terms of consistent growth in labour productivity over the period, industry was also a clear winner for Canada. With the exception of the period around World War One, growth rates in Canadian industrial labour productivity growth rates were exceptionally strong, placing doubt on the traditional argument that Canadian industry was unresponsive, myopic or sluggish in adopting new capital and technology. The industrial sector of Canada comes across as having impressive growth rates in labour productivity, contributing an increasing share to aggregate labour productivity throughout much of the twentieth century.

IV A Benchmark for 1936/37

Comparison of Canadian and Australian sectoral indexes of real output and labour productivity in levels requires both a comparative time series and comparative estimates in a common currency for a benchmark year. To pin down the comparative long run time series on real output I have constructed a benchmark for 1936/37 where sectoral output has been adjusted for purchasing power parity (PPP). Broadberry and Irwin (2007)[12] have argued that this is necessary given the failings of the exchange rate as a guide for price differences between countries, especially at the sectoral level where PPPs will vary across sector according to comparative advantage. The 1936/37 benchmark was chosen as this was the earliest date the Australian Bureau of Statistics published a detailed account of primary and secondary industries that covers quantities and values of manufactured goods produced.[15]

Tables 2.3 - 2.5 elaborate on the calculation of sectoral PPPs.[16] For all sectors the PPPs were based on relative unit values of goods and services derived from quantities and values of gross output. Data on Canadian unit values for 1936 are contained in the Historical Statistics of Canada and the 1937 edition of the Canada Year Book. Data on Australian unit values for 1936/37 are from the 1938 Australian Production Bulletin, the 1938 Australian Year Book and Butlin (1962)[13]. Relative unit values were combined into PPPs for disaggregated sectors using either gross output weights or value added weights.[17] For manufacturing relative unit values were first formed into sub sectors based on the category of manufacturing using gross output weights and then aggregated using value added weights. Value added weights in agriculture, forestry and fisheries could only be meaningfully applied to Australian data. Agricultural sub sectors have been combined based on gross output weights. The geometric mean of these sub sectors has been taken to form an overall PPP for agriculture in each country and another geometric mean was taken to arrive at an aggregate PPP. The disaggregated sectors were then combined into the 3 aggregate sectors (Agriculture, Industry and Services) using Australian and Canadian value added weights. PPPs using Australian and Canadian value added weights for each sector were averaged into one PPP per sector by taking the geometric mean. Finally these were combined to form an aggregate PPP using value added weights.

[15]Gross and net values of output for manufacturing are available for much earlier years but quantities are available only for a limited spread of manufactures.

[16]A more detailed set of tables is shown in the appendix. See appendix tables A.1 - A.5. Even these detailed tables have been condensed for a more practical presentation in this thesis by combining sub-categories of manufacturing production and recalculating PPPs for combined sub-categories.

[17]Disaggregate sectors include: Agriculture, Fishing, Mining, Manufacturing, Construction, Personal and Professional Services, Transport, House Rents.

Since the exchange rate in 1936 was \$3.95 CAN / £1 AUS, the PPP for agriculture, forestry and fisheries of 2.99 indicates a significant cost advantage in this area for Canada. Agriculture, forestry and fisheries were disaggregated into sub sectors for arable, fisheries and dairy, and pastoral and wool. As expected, Canada had comparative advantages in arable, forestry, fisheries and dairy while Australia had a comparative advantage in pastoral and wool. The most significant agricultural good was wheat which makes up more than one third of both Australian and Canadian gross agricultural output. Unsurprisingly, Canada had a comparative advantage in wheat with a PPP of 3.5. Hay and clover were also significant agricultural products for both Canada and Australia making up approximately one fifth of gross agricultural output in each country. Canada had a comparative advantage in hay and clover with a PPP of 2.16.

Fruit made up very little of gross agricultural output for either country. Canada had a slight comparative advantage in fruit production. Fishing was of much greater significance to Canada than to Australia, representing less than 1% of Australian gross output in agriculture, forestry and fisheries and over 6% for Canada. Forestry made up approximately 19% of gross output in agriculture, forestry and fisheries in Canada but only 4% for Australia. Canada was significantly more competitive in both forestry and fishing. Expectantly, Australia had a substantial comparative advantage in meat and wool. Wool was the most significant good in Australia making up approximately 40% of gross output but was insignificant in Canada. All the PPPs fit with the history of each country and their expected relative comparative advantage in staple goods for export.

The PPP of 4.30 for manufacturing indicates that Australian goods were cheaper than Canadian goods in 1936. I believe the explanation for this is related to a shift in Canadian industry towards more valuable secondary manufacturing. Fully manufactured Canadian goods such as iron and steel products, agricultural implements and chemicals were competing in world export markets by 1936. Generally, the share of manufactured goods in total exports rose significantly after World War One. In this case Canada was likely manufacturing much higher quality goods with higher costs of production. This could be explored by deflating both the intermediate inputs and the gross outputs from manufacturing by sub-sector. A complete study would require both input and output prices and allow for a comparison of value added in each sub-sector. Here it is adequate to note that the PPP calculations are fit for the purpose of comparison undertaken in this study.

Another explanation for this might be related to the importance of staple linkages in supporting a manufacturing sector aimed both at the domestic market and one that might produce goods for the export market. A deeper look into the manufacturing sector PPP indicates the importance of linkages. Based on PPPs Australia had a comparative advantage in animal related products, textiles and textile products, non-metallic minerals, iron products and rubber products. For Australia, only its advantage in iron products seems consistent with advances outside staples led development and on closer inspection its advantage in iron was principally from pig iron and direct castings while Canada had an advantage in automobiles, automobile components and agricultural implements. Canada had a comparative advantage in chemical products, non-ferrous metals, wood and paper products and some miscellaneous industries. Of these industries wood and paper products seem to speak most heavily to Canada's natural resource advantages. If both Canada and Australia had been equally successful in developing manufacturing linkages that stretched beyond the processing of staples then there should have been a less resource-oriented pattern in Australian manufacturing. It appears here that Canada was able to develop its secondary manufacturing a greater diversity than Australia. My theory is that Canada's success lay partly in its ability to transition its staples export sector towards a more advanced industrial (and service) led-growth than in other resource based economies like Australia. This implied manufactured goods were produced for the domestic market and for exporting abroad. In a sense, Australia was not fully exploiting linkages from staple resources because it was not developing a diverse manufacturing sector that could sustain long-run growth. The results here provide some evidence of this.

The service sector PPP of 3.45 indicates a comparative advantage for Canadian services. Data are very limited in services and these results are based on cost advantages in Canadian railroad transportation and in personal, professional and domestic services. Canada transitioned much later out of agriculture and into services but already had a comparative advantage in services, driven mainly by relative wage costs and low transport rates, as early as 1936. Again these results seem to indicate the success of Canada in converting its early staples led growth of the late nineteenth century into transportation infrastructure and final demand linkages in the service sector.

IV.1 1997 Benchmark Crosscheck

As a final check on the validity of the 1936/37 benchmark I have followed Broadberry and Burhop (2007)[10] with the use of additional benchmarks to provide cross-checks on my time series projections. The 1997 benchmark has been created using data for both value added and sectoral PPPs from the World KLEMS database. Table 2.5 gives the summary of the 1997 PPPs. For the aggregate economy, Canadian real GDP per capita was 118% of Australian real GDP per capita in 1997 using the 1936/37 benchmark compared with 117% using the 1997 cross check. According to Maddison's data, Canadian real GDP per capita was 104% of Australian GDP in 1997, hence my data provide estimates very close to both the Maddison data and the KLEMS data. In either case there is a very small discrepancy between my data based on the 1936/37 benchmark and alternative data at the 1997 benchmark (or Maddison's data).

The 1936/37 benchmark is also satisfactory at the sectoral level. In industry, Canadian real GDP per capita was 128% of Australian real GDP in 1997 using the 1936/37 benchmark. According to KLEMS data, Canadian real GDP per capita in industry was 146% of Australian real GDP. This is a discrepancy of approximately 15%, which seems acceptable given the greater inaccuracy of sectoral data. For services, Canadian real GDP per capita was 119% of Australian real GDP in 1997 using the 1936/37 benchmark. Canadian real GDP per capita in services was 117% of Australian real GDP per capita according to KLEMS data. This implies a discrepancy of about 2% between the two figures. Lastly, real agricultural output per capita for Canada in 1997 was 53% of Australian real output per capita using the 1936/37 benchmark. KLEMS data indicates Canadian agricultural output was 65% of Australian output in 1997. This represents a discrepancy of approximately 20%. It is likely given the discrepancy in manufacturing and agriculture, forestry and fisheries that either the 1936 PPP overestimates the cost advantages for Canadian manufacturing and underestimates the cost advantages for Canadian primary production or that the 1997 PPP does the reverse. This makes my results using the 1936 benchmark an upper bound on Australian agricultural productivity and an upper bound on Canadian industrial productivity. The results using the 1997 benchmark are a lower bound for Australian agricultural productivity and a lower bound for Canadian industrial productivity.

V PPP Adjusted Real Output Per Capita and Labour Productivity Comparisons

Figures 2.3 to 2.6 display the relative PPP adjusted Canadian/Australian real GDP per capita series based on the 1936/37 benchmark (The 1997 boundary based on the KLEMS PPP has also been included to set out the confidence interval suggested in the previous section). Canadian aggregate real GDP per capita was significantly lower than that of Australia in 1871. Throughout most of the 1870s real output per capita in Canada fell relative to Australia, reaching a low of approximately 40%. The period directly following the Canadian National Policy (1879) saw Canada begin to catch-up on Australia in real GDP per capita. Some combination of economic events and policy responses in the 1890s initiated a period of even more rapid Canadian catch-up in relative GDP per capita. Impressively, Canada was able to improve its output per person from less than half of the Australian level to parity by World War One.

Following the war, real output per capita in Canada collapsed relative to Australia, reaching a trough in 1921. The post 1920/21 recession saw a revitalised Canadian economy, with Canada making further ground on Australia until the Great Depression where relative output per capita in Canada had risen well above the Australian level. The 1930s depression hit Canada much harder than Australia and relative real output fell back to pre-World War One levels. World War Two sparked a relative revival in Canada in terms of real GDP per capita. From the 1950s onwards there was a gradual slowdown of relative Canadian output growth but a persistent dominance over the Australian level. Australian catch-up of output per capita did not begin to occur until the 1980s, likely due to changes in Australian trade policy and greater openness initiated in the 1970s.

The agricultural sector was a consistently productive sector for Australia in the long-run. The 1890s depression and/or Canadian wheat boom were significant in boosting Canadian real agricultural output per capita to between 1.5 to 2.5 times the Australian level. The increased volatility in agricultural output of economies dominated by wheat production is evident from the early twentieth century. The effect of the Great Depression on Canadian agricultural output was also substantial, pushing Canadian real agricultural output per capita from its peak to well below that of Australia in only a few years. However, this event looks like a rapid return to the trend of relative decline in Canadian agriculture that began in the nineteenth century and was interrupted by the wheat boom years.

Canadian real industry output per capita was approximately half of the Australian level in 1871. The 1870s saw Canadian industry output per capita fall well below half of the Australian level. From the 1880s Canada started its upward climb in terms of relative industrial output. Although Canada took a large dip in relative industrial output per capita both around World War One and the Great Depression, it maintained a significant advantage over Australia throughout most of the twentieth century. Real industrial output per capita in Canada fluctuated around

40-50% above Australia in the post-war period.

Before the 1880s, real output per capita in Canadian services was only one third of the Australian level. By the end of World War Two Canadian service sector output per capita was close to one and a half times Australian output per capita. Overall there was a clear upward trend in relative service sector output per capita for Canada starting in the 1880s, with an interruption around World War One and the Great Depression, levelling off in the post-war period. The significant pattern in the sectoral data appears to have been the success of Canadian industry and services during the late nineteenth and early twentieth centuries, reaching peak output levels by World War Two.

Although both countries are often argued to have lived and died by their agricultural success, this could not have occurred literally through relative gains in agricultural output but rather through the gains translated via linkages to the manufacturing and service sectors. Hence, Canadian staple resources, more so than Australian staples, must have been underwriting future gains in manufacturing and services and not just a high, but transitory, standard of living. Australian catch-up in aggregate output per capita did not begin until the 1990s when production shifted away from the traditional resource base.[18]

There are several important features of the PPP adjusted relative labour productivity series that stand out. Firstly, Canadian aggregate labour productivity from 1871 to 1891 was very low and did not increase at all relative to Australia. Sectoral analysis reveals that relative Canadian labour productivity was constant in industry and rising marginally in services but falling in agriculture. One possibility could have been due to the relative protectionist stance of the 1880s and its effect on productivity. Dismantling of the National Policy Tariffs and increased union with the United States under the Liberals in the 1890s likely increased competition in manufacturing. Services also benefitted from the spillover effects of the growing domestic manufacturing sector and its agglomeration forming in Ontario and Quebec. Another potential explanation could be related to foreign technology transfer through growing capital and labour flows.

Secondly, the 1890s also provided several dramatic economic shocks. Australian productivity suffered from the depression and subsequent lack of investment, as well as a serious drought while Canada entered a period of booming agricultural expansion. Between 1891 and 1901 Canadian aggregate labour productivity had risen

[18]Relative Canadian labour force participation was increasing from the 1970s to 1990s. This was the reason for the delay in Australian catch-up of aggregate relative real output per capita until the 1990s. Hence, this result fits with the theory that a push towards Australian openness to trade in the 1970s was a key event.

from 60% to 100% of the Australian level. It is hard to ignore the relationship between timing of this observation and the expansion of the Western Frontier and the rising importance of prairie wheat in the global market. However, my theory is that Canadian productivity benefitted substantially because of an emphasis on establishing long-run growth potential in the industrial and service sectors. As a result, all sectors of Canadian production saw large relative gains in labour productivity over this period. For whatever reason, the 1890s reflected a structural break in terms of labour productivity for Canada relative to Australia, supporting literature in both countries which suggests a permanent and opposite shock from trend growth during this period.

The period from 1901 to World War One saw Canadian aggregate labour productivity growth slowdown relative to Australia. Both the agricultural and service sectors had bounced back for Australia. Only Canadian industry had continued its relative productivity growth over the period and was at a local maximum just before World War One. This is further evidence that Canadian industry before World War One could not have been as inefficient as has been suggested by some authors. In fact, the Canadian industrial sector after 1891 was always a positive contributor to relative aggregate labour productivity when compared with Australia.

During the period after World War Two until the 1970s Canadian labour productivity remained well above the Australian level. After the 1970s relative aggregate labour productivity declined but remained in Canada's favour. Sectoral analysis reveals that relative labour productivity had peaked in services directly following World War Two and had been on the decline throughout this period. It was industry that had sustained the large Canadian advantage over Australia in aggregate productivity from World War Two until the 1970s. Relative labour productivity in industry began to decline in the 1970s and with it the aggregate series followed. Hence, Canadian productivity after World War Two was maintained by the impressive growth in Canadian industry relative to Australia during this period.

VI Explaining Divergent Outcomes

VI.1 Determinants of Growth

Since 1776 there has been some understanding of the deep determinants of long-run growth. Adam Smith recognised the role of good institutions, and beneficial geography. In other words, extensive growth resulting from capital accumulation, immigration or the acquisition of new land could not fully explain differing growth outcomes in the long-run. Endogenous growth theory developed by authors like Romer (1986)[98] and Lucas (1988)[52] have refined this understanding. Modern development economics is now awash with studies proposing to have discovered the next big thing in explaining long-run growth. In a sense, macroeconomic studies have reached a critical mass of correlates explaining the rate of growth in per capita income across countries and over time. Examples include measures of property rights, rule of law, democracy, language, religion, corruption, colonial heritage, access to the sea, trade openness, climate, and many others. There is no consensus on which of these sources of growth might be most significant or even if these explanatory variables have any real explanatory power.[19]

Fortunately, attempting to isolate causes of relative growth amongst settler economies is aided by the nature of their commonalities. Canada and Australia share many similarities that rule out most measures of growth as being able to explain differing performance. Considering first the 'proximate' sources of growth (physical and human capital accumulation, exploitation of scale economies, other productivity improvements), both Canada and Australia share broadly similar experiences. Both countries enjoyed periods of rapid capital accumulation during the late nineteenth century. In both cases these substantial capital inflows came from the same source, Britain. According to Magee and Thompson (2010)[56] Canada received £43,446,000 of investment from Britain between 1870 and 1909 while Australia received £56,911,000. Of course this flow of investment followed different patterns with each receiving similar amounts of investment in 1870, Australia receiving more from 1880 to 1900 and Canada receiving substantially more investment after 1900. Both the interwar period and postwar period were marked by an overall reduction in international capital flows as a result of the depression and the Bretton Woods agreement.

Labour flows were not drastically different either. Canada received 1,379,200 immigrants from Britain over the period from 1870 to 1910, while Australia and New Zealand received 893,900.[20] Immigration from the United States to Canada was also substantial in the late nineteenth century but net migration in that direction was typically negative. As a result, it should be assumed that the larger British immigration figures to Canada, when compared with Australia, were overstated by migrants moving on to the United States. As with investment, Australia received significantly more migrants from Britain before 1890 and Canada received more from 1890 to World War One. Comparative studies of human capital accumulation have

[19]Much of this summary of growth theory was discussed in McLean (2004)[60].

[20]Magee and Thompson (2010)[56], pg. 69.

shown that high school participation rates were much slower to rise in Australia than in the United States.[21] The consensus, however, is that other advanced economies like Canada similarly lagged the United States in educational attainments, leaving little explanatory power for human capital differences amongst settler economies.
Scale economies may have influenced relative performance in manufacturing but it seems unlikely that the scale of agricultural production differed markedly between the two countries. The settlement of land and the distribution of land grants was not dissimilar enough to warrant the belief that large scale commercial agriculture took root more deeply in one country, in contrast to the Argentinian Pampas where property rights for tenant farmers implied significant differences in the scale of agricultural production.[22]
Other differences that generated productivity gaps in the two countries cannot be ruled out. The most likely proximate source of growth to play a significant role in differing growth performance was technological change. McLean (2004)[60] highlighted the view that Australia remained dependent on factor accumulation with low levels of TFP growth well into the twentieth century. Although this observation on Australia may have been in marked contrast with the United States it fits into the common framework of growth amongst settler economies. Certainly it seems unlikely that TFP in Canadian agriculture was significantly higher than in Australia before World War One. More likely is the argument that Canadian manufacturing and services benefitted from spill-over investment in agriculture during the wheat boom and this generated relatively high levels of productivity growth.
Another set of potential determinants of growth are the so called deep determinants of growth, namely formal institutions, informal institutions and geographic features. Measures of institutional quality such as property rights, rule of law, democracy, language, religion, corruption and colonial heritage were too similar in Canada and Australia to adequately explain differing growth experiences. By contrast the other major deep determinant of growth, geography, requires its own detailed and dedicated study reserved for later work. Here I will simply note that the effect of geography on growth is unclear in the context of settler economies. One might predict that location and access to markets gave Canada a significant advantage over Australia but there were other geographical factors at play. Australia had better access to the sea with almost no economic activity being conducted deep in the interior of the country. Australia's population was farther removed from markets resulting in a greater degree of urbanisation and potential for gains from increased

[21] See MacKinnon (1989)[53] for a detailed discussion.
[22] See Solberg (1987)[103] for a detailed comparison of land tenure in settler economies.

economic density and agglomeration economies. Australia's climate was also quite different from Canada's but both managed to produce a similar set of staple products for export such as grain, timber and meat.

The final source of growth is policy. Within the limitations of this paper there are two reasons to focus on policy as the primary source of differences in growth performance. Firstly, as discussed above, both the proximate and deep determinants of growth emphasised in most comparative studies will not have serious explanatory power in the context of settler economies. This was especially true as significant differences in growth performance occurred during the long nineteenth century (particularly in a comparison of Canada and Australia). Secondly, the benefits of understanding the role of policy on growth in the context of settler economies is arguably more important because it provides a laboratory for developing countries and can offer suggestions for decision makers. Although generally considered short-run determinants of growth, policy can be either growth-enhancing or growth-inhibiting and in some cases the impacts of policy decisions can have consequences for long-run growth. These 'deep policy' sources of growth for settler economies relate to the long term stance on tariff policy (general openness to trade), the direction of trade (dependency relationships and taste), policy on resource extraction (link to proximate sources of growth through scale economies), and policy on the adoption of foreign technology (openness to technology transfer directly or indirectly). The following sections set out the process of creating measures of these 'deep-policy' sources of growth and applying them to regression analysis in order to determine their relative significance.

VI.2 Creation of Explanatory Variables

A significant contribution of this paper is to quantitatively approach the question of why Canada caught up and overtook Australia in output per capita. This required creation of several relevant explanatory variables. The literature on settler economies has suggested that proximity to the United States may have been a key factor in Canadian success amongst it settler peers. The advantage of proximity to the United States is argued to have been in access to its markets through trade. According to the conventional wisdom on settler economies, variables measuring the degree of openness, the development of a secondary manufacturing sector, the quality of labour markets and the performance of staple exports should all hold explanatory power. Although not a common suggestion in the literature, I believe the willingness and ability to adapt foreign technology may have been an important determinant of growth performance amongst settler economies as well. As mentioned in the previous section, I have decided to focus on the 'deep-policy' determinants of growth that are most likely to show variation between settler economies with reasonably similar characteristics such as inherited European institutions. The variables chosen relate broadly to changes in the size, direction, and nature of trade, the transfer and adoption of foreign technology, the share of the export sector devoted to manufacturing and the price fluctuations in low value added staple exports. Ideally, I would also like to address the potential variance in policy related to labour markets that created differences in labour market rigidity, however this has proven more difficult empirically.

Canadian trade and customs data has been collected and organised from the Tables of Trade and Navigation of the Dominion of Canada and from the Annual Report of the Department of Trade and Commerce. The trade and navigation volumes separate exports and imports into categories for the produce of: mines, fishing, forestry, animal products, arable, miscellaneous, and manufactures. Annual reports provide the data in categories for products of: vegetable, animal, textile, wood and paper, iron, metals, chemicals and miscellaneous. Linking the categories is time consuming and impractical over long periods. However, I have focused only on the rising importance of manufactured goods as a share of exports. Manufacturing remains fairly consistent, Annual Reports provide the share of fully and partially manufactured goods in exports. The produce of manufactures from the trade and navigation volumes is equivalent to fully manufactured goods from the Annual Reports providing a link. Trade data are available showing the destination country, allowing creation of a series for exports to the United States and the United Kingdom by degree of manufacture. In order to calculate the real value of staple exports I have observed quantities and values of the most significant low-value added staple resources exported from Canada and Australia. This allowed the conversion of nominal export values into real values for each staple export without relying on a broad deflator. Exports of the staples chosen represent between 50% to 90% of the share of total exports for either country in most years. A weighted staples export price series for Canada and Australia has been created to highlight the relative effect of price shocks. The index for Canada is based on the weighted price series for wheat, lumber and dairy exports. The Australian index is based on the weighted price series for wheat, wool and dairy.

Australian trade and customs data is slightly more complicated due to idiosyncrasies in the individual colonies before federation. Detailed data from 1899 onward are available for the entire Australian Commonwealth from Australian Bureau of

Statistics publications on the Annual Statement of the Commonwealth of Australia. Moreover, colonies were treated as foreign countries for purposes of data collection before federation. Hence, summary statistics on foreign trade make an inappropriate comparison with Canadian data unless adjusted for inter-colonial trade. For data before 1899 I have had to rely on data from the Statistical Register for New South Wales and Statistical Register for Victoria in each individual year in order to make the appropriate adjustment for inter-colonial trade. Data for New South Wales and Victoria have been spliced in 1899 with the data from the Australian Bureau of Statistics so that the data before 1899 reflects the entire Australian Commonwealth. This gives me limited concern since New South Wales and Victoria were the largest and most important of the colonies, representing the dominant share of Commonwealth trade.

Other important data collected relate to patenting in Canada and Australia. Canadian patent data indicating the country of inventor are available for limited years in copies of the Canada Year Book. These data are based on Annual Patent Reports published by the Canadian Intellectual Property Office (CIPO). Unfortunately the annual reports are difficult to obtain for the nineteenth century. I have filled gaps in the patent data using the online Canadian Patent Database provided by the CIPO. Unfortunately the database does not contain strings allowing inventors country to be isolated when searching through data before the late twentieth century. Hence, I have painstakingly recorded detailed information on each patent for the missing years between 1871 and 1891. Australian patent data differentiated by country of inventor is only available for New South Wales and Victoria before federation. As with trade data, I have used data for New South Wales and Victoria as representative of patterns in the entire Australian Commonwealth. In the case of patenting, it was necessary for an inventor to apply for a patent in each colony separately before the patent act of 1904. As suggested in Magee (1999)[55], this implies that it might be appropriate to focus on patenting in either Victoria or New South Wales but not both. I have spliced patent data for Victoria with post-federation data for the entire Australian Commonwealth to form one continuous series.

As mentioned, data on labour market quality were difficult to collect in a meaningful series. Several measures of labour disputes are available from Mitchell (2013)[64]. Appendix figure A.2 shows the number of workers involved in strikes and lockouts in Canada relative to Australia. Unfortunately data on strikes and lockouts for Canada are available only after 1900 and for Australia only after 1913. Lastly one might consider policy on immigration or foreign investment by source country. This may have been a significant factor for Canada given its proximity to the United States.

Appendix figures A.3 and A.4 display the relative importance of the United States to the United Kingdom as a source of labour and capital for Canada. As with data on the incidence of strikes, data on immigration and foreign investment do not cover the entire period of this study and have been excluded from the analysis in the next section.

VI.3 Trade Flows

The most common debate on the importance of proximity to the United States surrounds growing Canada-United States trade. Much emphasis has been placed on the significant opportunities afforded Canada by its access to American markets. While Canada sought a re-orientation in trade from Britain to the United States, Australia focused on British trade well into the twentieth century. Pomfret (2000)[89] has suggested Canada's most important locational advantages over Australia were exploited when partially or fully manufactured goods such as newsprint and consumer durables (especially automobiles) were being exported to the United States. Figures 2.11 and 2.12 provide information on the direction of Canadian trade with the United States and the United Kingdom. It is clear that the share of total exports to the United States did not come to dominate those going to the United Kingdom until the post-World War Two period, well after Canada's initial catch-up in GDP per capita with Australia (and others). However, evidence does seem to suggest some importance in the timing of a shift in manufactured exports to the United States. Raw material exports show no real re-orientation towards the United States until World War Two and even then the process was more gradual than in manufactured goods. The re-orientation of manufactured exports to the United States does appear to correlate with earlier periods of exceptional Canadian performance relative to Australia.

Interestingly, the share of total imports from the United States began to dominate those from the UK as early as the 1880s. After the 1880s, Canadian trade policy placed more emphasis on bringing in low cost intermediate goods and raw materials from the United States and blocking the import of fully manufactured goods. As a result, Canadian entrepreneurs were successful in obtaining imports from the United States during the critical period of the 'second industrial revolution'. Imports from the United States may have represented not only cheap access to intermediate goods and raw materials needed in manufacturing but may have also transferred embodied technology.

'Gradualist' literature in Canadian economic history has placed significant weight on the early development of a strong domestic manufacturing sector in Canada to explain previously unappreciated periods of growth. Figure 2.13 shows the breakdown of total exports by degree of manufacture. Although there was a gradual rise in the export of manufactured goods in the late nineteenth century, this rise was unspectacular until World War One. However, it is interesting to note that the share of manufactured goods was rising gradually even during the Canadian Wheat Boom. In other words, despite the presumption that wheat came to typify the staples story for many authors, the share of non-manufactured exports was on the decline from the 1880s onward. One should be careful drawing conclusions here since this does not imply that staple exports played a diminishing role as there are important indirect linkages into other sectors of production such as manufacturing.

VI.4 Tariff Policy

In the late nineteenth century Canada moved decidedly towards a more protectionist trade regime based on tariffs in manufacturing designed to promote industrialisation. The Cayley-Galt Tariff of 1858, the failure to renegotiate reciprocity with the United States after 1866 and the National Policy Tariffs of 1879 typify the nineteenth century period of Canadian protectionism. The first movement towards openness occurred when the Liberals took power in the 1890s with their eyes on dismantling the National Policy Tariffs. After World War One Canada again looked towards a low tariff policy regime, most notably with relatively low barriers to U.S. imports. The Great Depression interrupted this process. However, beginning in the early 1930s with Imperial Preference (1932) and United States Reciprocity (1934) tariff barriers began to fall and declined below the prevailing National Policy period.

Before the 1890s Australian tariff policy was diverse across its colonies but comparatively open, with the free traders of New South Wales and moderate Victorians representing the bulk of Australiasian imports. The downturn of the 1890s led to a strong protectionist backlash and a large increase in duty on imports across all of the colonies. This protectionism persisted after federation and did not really begin to decline until the 1970s. Figure 2.14 displays relative Canadian/Australian average effective tariffs (measured as customs collected over imports). From the implementation of National Policy Tariffs (1879) in Canada until the 1890s depression in Australia, Canada did have comparatively high tariffs. Average duties were generally lower in Canada from the 1890s until the 1920s but not drastically. From the 1920s onward there was a significant decline in relative duties in Canada until World War Two. Broadberry and Irwin (2007)[12] have identified that, after 1920, the abrupt relative decline of Australian labour productivity in manufacturing correlates with Australia's sharp rise in import tariffs. My data confirm this, however in the Canadian comparison the 1920s indicate an abrupt relative decline in Australian labour productivity in services rather than manufacturing, which faced a more continuous relative decline beginning in the 1890s.

VI.5 Technological Openness

Economic historians have long appreciated that growth is heavily influenced by the adoption of new technologies. Many authors have debated, with no clear answer, the validity in using patents as a measure of innovation or technological change across countries and over time.[23] Setting this debate aside, I pursue an approach similar to Magee (1999)[55] by suggesting that patent data can reveal some information on the diffusion and/or adoption of foreign technology. Figure 2.15 displays the total Canadian patents issued to foreigners relative to Canadians.[24] The first patent issued in Canada to a foreign resident was not until 1872. After 1872 the share of patents taken out in Canada by Americans increased dramatically. From the 1880s to World War One approximately 70% of patents issued in Canada went to Americans. By contrast, the share of American inventors taking out patents in New South Wales was approximately 10% over this period.

It is unlikely that American inventors would have applied for patent protection in Canada or Australia without expecting a return on their investment in intellectual property rights. Moreover, Magee (1999)[55] has noted that the Australian colonies had relatively strong patent rights in the late nineteenth century, which provided a good return on investment due to the long period of protection for a comparatively low cost in the context of other developed countries. Hence, we should assume that much of the increasing influence of foreign patenting was indicative of actual technology transfer.

Previous research on technological adaptation in Canadian manufacturing has assumed that technology transfer from the United States was significant but that the technology needed to be altered to make it cost effective in Canada.[25] Analysis on comparative adaptation of United States technology is reserved for further study. It may be significant enough to note here that the United States was pushing the technology frontier and Canada was clearly impacted by this process. Even casual

[23] Good examples are various publications by Jacob Schmookler, Ken Sokoloff, Zorina Khan, Naomi Lamoreaux, Petra Moser and Josh Lerner.

[24] For a more detailed breakdown in Canada see appendix figure A.5.

[25] The classic example is Wylie (1989)[118].

observation of the patent data makes a convincing case for technology transfer from the United States playing a substantial role in Canadian growth.

VI.6 Staple Resources

The 'Staples Thesis' as originally espoused by Harold Innis and extended by Watkins (1963;2007)[114][115], Mackintosh (1964)[54], Caves (1965)[17] and others, is well known amongst many economic historians and I will overlook the elaboration it deserves. Debate in this literature has been over the importance of staples in the growth of settler economies. Staple resources are argued to have been key either directly as resources entering the production function or indirectly through linkages into manufacturing and services, influencing the proximate measures of growth. It is instructive to put the significance of staples growth in perspective by comparing two staple exporting economies. The issue of resource advantages as the primary contributor to output growth and productivity has been looked at in the case of Australia by McCarty (1964)[57], Schedvin (1990)[100], McLean (2004)[60] and Broadberry and Irwin (2007)[12]. One key observation in this area of research is that Australia's early success in the nineteenth century was due to large deposits of resources which were unable to sustain exceptionally high rates of long-run growth. The question of why resources contributed to sustainable long-run growth in Canada but not Australia or how Canada was able to transition away from extensive growth to intensive growth in resource extraction has not fully been answered. The most common assessment assumes that each staple is inherently different in the degree that it demands capital and labour, thus promoting linkages.[26] If a particular staple can be extracted and exported without economies of scale or without advancements in technology then there may be limited spill-over effects that generate increased productivity.

Figures 2.16 and 2.17 display the real value of principal staple exports in each country. Two significant patterns are evident. Firstly, Canada had a much greater diversity in staple exports before World War One than Australia, which was almost singularly focussed on wool. As pointed out in Caves (1965)[17], the central limit theorem suggests that variance in output will decrease as the number of staples exported increases. This is an interesting observation since the significance of comparative diversity in staples production has not been explored in empirical work. It

[26]Fogarty has suggested that Canadian wheat was a 'super-staple' that demanded much more investment and promoted greater forward and backward linkages than Australian wool or Argentinian beef.

may be that a diversity of staples is needed to sustain long-run growth. Secondly, after World War One staples extraction and export in both Canada and Australia became polarised in a limited number of staples. Wheat and lumber were extremely dominant staples in Canada after World War One while wool and wheat were dominant in Australia (butter and cheese or meat were occasionally a close third for each country). The implications of these observations are still to be explored.
Figure 2.18 gives the staples significance index. The staples significance index measures the weighted relative real value of the principal staples for Canada and Australia with a base year of 1871. Increases in the index imply the real value of exports in Canadian over Australian staples is increasing relative to its position in 1871. The index highlights the fact that in 1871 the Canadian over Australian real value of staples was very high and not reached again until World War One. Analysis here must be conditioned on the fact that the relative value of staples in 1871 could have favoured either Canada or Australia dramatically or only slightly and the index says nothing about this. Still the general story is one of declining significance of staple exports for Canada relative to Australia from a historically high level in the nineteenth century. This conforms well with the fact that Canadian literature has been much less confident regarding the importance of staple exports relative to manufactured exports than the Australian literature.

VI.7 Results

Establishing the significance of various explanations for the relative success of settler economies is difficult. Correlations between variables measuring the competing explanations for relative performance are shown in table 2.6.[27] The strongest correlation with Canadian/Australian relative GDP per capita comes from the share of Canadian patents issued to foreigners. The share of exports in manufacturing and the share of Canadian imports from the United States are also highly correlated with relative GDP per capita. The share of Canadian exports going to the United States is moderately correlated with relative GDP performance. The two variables measuring the significance of staple exports are weakly correlated with relative GDP. An increased relative price in the staples index has a positive relationship with relative GDP. An increase in the relative real export value of staples also has a positive connection with relative GDP. Finally the measure of relative tariffs is moderately

[27]GDP data are for 1875-1970 due to missing observations in some of the variables during the early 1870s and difficulty in gathering trade data by degree of manufacture for Canada after the 1970s.

negatively correlated with relative GDP.
These correlations imply that manufacturing exports rather than raw material or staples exports are connected with relative GDP performance. They also imply that proximity to the United States had a stronger connection with growth through increased imports than exports. Manufacturing activity was also highly correlated with the share of Canadian imports coming from the United States. This fits the story that United States imports were used as intermediate goods in a developing manufacturing sector. The degree of foreign patenting in Canada also looks to have had an important impact on Canadian performance. Foreign patenting was highly correlated with imports from the United States, as one might expect since both serve as channels for technology transfer. Foreign patenting was also highly positively correlated with manufacturing indicating that American patenting in Canada was expanding with the domestic manufacturing sector.
In all of this analysis it is important not to assume causation. A simple example is illustrative. While it may be tempting to assume that an increased focus on manufacturing impacts growth positively, it could also be that increased growth promotes a structural change and the development of a stronger manufacturing sector capable of exporting goods abroad. In order to comment on causation it is necessary to apply more complex methods. The approach taken to solve this issue was to run a series of Vector Autoregression (VAR) models and test for Granger Causality. Table 2.7 shows the results of these tests where the null hypothesis in each case was that the 'excluded' variable does not granger cause the 'equation' variable.[28] The results indicate that in three of the cases (tests on the share of exports to the United States, relative tariffs and the relative price of staples exports) it is not possible to reject the null hypothesis that the excluded variable does not granger cause relative GDP per capita. In all of these three cases it is uncertain whether relative GDP per capita granger causes these variables. The most conceivable explanation based on empirical and theoretical grounds is that an increase in Canadian GDP per capita led to a Canadian policy response to lower tariffs. It seems unlikely that relatively strong GDP per capita in Canada resulted in an increase in Canadian exports going to the United States as a share of total exports. It also seems unlikely that better relative output performance in Canada should have influenced the relative price of staple exports.
The share of Canadian imports coming from the United States does granger cause relative GDP as the test rejects the null hypothesis at the 15% level of significance. It does not appear that relative GDP performance granger causes an increased share

[28]One VAR model was run with 2 lags of each variable included in the model.

of imports from the United States at any reasonable level of significance. This is suggestive evidence that United States imports to Canada influenced relative Canadian success. Similarly manufacturing granger causes relative GDP at the 15% level of significance while relative GDP does not granger cause changes in the share of manufactured exports at standard significance levels. Since the correlation is positive this implies that an increased focus on producing manufactured exports in Canada relative to Australia resulted in an improved relative performance for Canada.

The relative real value of staple exports and foreign patenting are slightly unclear. Both the relative real value of staple exports and the share of Canadian patents issued to foreigners granger cause relative GDP but relative GDP also granger causes these variables. In other words, it is uncertain whether the dominant channel is from the relative real value of staple exports and foreign patenting to GDP performance or visa versa. It is entirely possible that a feedback loop exists in either case. For example, an increased real value of staple exports could influence relative output performance and relative output performance could then impact development of the staple export sector. In the case of patenting, an increase in relative output could encourage foreign inventors who then transfer technology and increase output performance further.

The final goal was to determine the relative importance of each explanatory variable in combination. As with all broad macroeconomic studies issues of endogeneity and other complications in modelling a statistical relationship exist. I have deliberately made no attempt to account for all of these issues. This was based on the assumption that when looking at comparative growth over such a long period, any attempt to add complexity to the modelling process would likely do more harm than good in confounding the results. Relative GDP per capita has been regressed on all potentially relevant variables discussed above. The regression is improved on by removing all of the variables that are statistically insignificant or highly correlated with another explanatory variable. Independent variables that are highly correlated with other more relevant variables are removed. The final regression discards the lag dependent variable in order to prove the results are not dependent on the annual fluctuations not specifically identified in the theory. Table 2.8 gives the results of these regressions.

Several observations can be drawn from the results. Only the price of staple exports are completely insignificant in the first regression which includes all explanatory variables. The share of imports coming from the United States, the share of exports going to the United States, the relative tariff rate, the share of manufactured exports, and the share of foreign patents issued are all statistically significant at the 1% level of significance. The relative real value of staple exports is statistically significant only at the 15% level. All of the coefficients are what might be expected a priori except for the measure of manufactured exports which has a negative sign. Given the strong positive correlation between the share of exports in manufacturing, the share of imports from the United States and the share of patents issued to foreigners this was an expected problem. Dropping the United States imports measure, the relative tariff measure, and the relative staples price measure produces the correct sign in the manufacturing share coefficient. The third regression assumes that the explanatory variables have an effect on relative GDP per capita only after a lag. Both theoretically and statistically this specification is more relevant and I prefer this to the other specifications. This is confirmed by the p-values given from RESET tests for correct specification of the model which do not reject the null hypothesis of no omitted variable bias in the third regression.

The preferred regression highlights the fact that an increased share of imports from the United States had a statistically significant impact on Canadian growth. Although the share of exports going to the United States was also statistically significant and positive the coefficient was almost one third as large.[29] The share of patents issued to foreign residents in Canada was both positive and statistically significant at the 1% level. The coefficient on the foreign patent share measure was double the size of the coefficient on imports from the United States. Both are measured in terms of percentages indicating that relative output growth was more heavily influenced by a one percentage increase in foreign patents as a share of total than by imports from the United States as a share of total. This result may also be unsurprising since foreign patents represent a direct technology transfer that are expected to hold productive potential whilst imports transfer technology indirectly and may be impossible to reproduce through domestic production. The prospect that technological transfer was the most significant factor in Canadian proximity to the United States has received little attention. More work here is needed and a detailed look at Canadian patenting appears worthwhile.

Relative tariffs were included in the original regression with the assumption they might capture a measure of competitiveness in markets that is not picked up by the trade variables. The threat of entry is impacted by the level of protection and this might have been measured by relative tariffs. Relative tariffs can also represent a policy push towards openness that has a long-run effect on growth. The relative tariff variable was excluded from later regressions as it was insignificant once issues

[29]Since both the share of imports from the United States and the share of exports to the United States are measured in percentage terms it is possible to compare these directly.

of multicolinearity were reduced. Finally, it should be noted that because there are no institutional variables or geography variables there is no way to discern if the deep determinants of growth played a larger or smaller role relative to policy in comparative long-run growth.
Although there is no theoretical reason why the relative GDP per capita between the two countries would trend in either direction in the long-run, an augmented dickey-fuller regression does not result in a rejection of the null hypothesis of non-stationarity. Caves (1965)[17] has suggested that growth in settler economies is made up of a stable neoclassical component and a cyclical export-oriented component that fluctuates with expansion and contraction of resource exploitation. This view of the growth process implies the appropriateness of difference stationarity, rather than trend stationarity, representations of the Canadian and Australian real GDP time series. In order to support the results, I have created a series of relative GDP per capita growth rates to act as the dependent variable in alternate specifications. Converting the dependent variable into a growth rate allows the inclusion of the lag of relative GDP per capita to measure catch-up growth. In other words, this specification controls for the standard neoclassical catch-up growth that occurs when countries have matched some growth supporting conditions related to the proximate and deep determinants of growth.
The alternative set of growth regressions have been included in table 2.8. As anticipated, the high R^2 has fallen as growth rates are more difficult to predict. Forcing the dependent variable and all independent variables to be stationary has altered the statistical significance of all the explanatory variables except the share of patents issued to foreign residents, which remains statistically significant. The lag of the relative GDP per capita variable has the correct negative sign and is statistically significant, indicating that catch-up growth does explain some of the rapid Canadian growth from the 1870s to World War One relative to Australia. Conclusions on the importance of technology transfer is clearly robust. However, the interesting story is really in explaining the trend of a non-stationary variable that should be stationary in theory. Over the period from 1875 to 1970 we would expect Canadian GDP per capita relative to Australian GDP per capita to be stationary. Persistence of Canadian growth relative to Australian growth over such a long period is perplexing.

VII Conclusion

When compared with Australia, instead of the United States, Canadian industry and services appear to have performed extremely well in statistics on real output and labour productivity. Growing in size and importance these two sectors were relatively efficient in Canada. In contrast, growth in the agricultural sector seems to have been less significant in the Canadian success story when compared with other resource rich countries like Australia, at least directly. Indirectly, agriculture likely provided a boom in the early twentieth century that generated efficiency gains and spill-over effects for the development of industry and services. Manufacturing did grow in importance and there was an eventual boom in manufactured exports, especially those going to the United States. This can be seen in the change in the composition of exports towards higher value intermediate and final goods. Much of this shift was related to the proximity and role of the United States since it was during this period that the United States overtook the United Kingdom as the principal export market for Canada.

Arguably proximity to the United States played a bigger role through the increased share of imports made available to Canada. This work has shown that the share of imports from the United States was strongly positively correlated with relative Canadian performance and with both the increase in manufactured exports and technology transfer from abroad. The causality appears to run from increased United States imports to increased relative growth. Increased imports coming from the United States may have influenced growth in Canada by making cheap intermediate goods available for manufacturing or by transferring embodied United States technology to Canada.

The results also show that staples remained a factor in Canadian export-led growth, but this should not be over exaggerated. While regression analysis supports the significance of, and casual link between increasing staple exports and growth there is a weak correlation describing their relationship. However, exports of the staple resource may show up not only in the sector where they are produced but also in other sectors through linkages. The effect of staples may show up in fully manufactured goods through their conversion as intermediate inputs. In this case, Australia could be argued not to have maximised its comparative advantage or was not as successful in generating comparable productivity gains in industry and services by exploiting linkages. Although Australia focused its trade policy on the protection of domestic manufacturing there is little statistical evidence to argue that relative tariffs had a marked impact on performance amongst settler economies.

The most significant finding in this research appears to be that the strongest candidate in explaining relative Canadian success was the measure foreign technology transfer. Canada issued a significantly higher level of patents to foreigners (mainly Americans). This should not be viewed as a lack of innovativeness on the part of Canadians as Canada was not on the technology frontier. It made sense to maximise the use of cost-efficient foreign technology, pushing Canadian firms closer to the efficiency frontier. It is likely that large levels of R&D spending in the United States during this period generated high levels of innovation that had spillover benefits for Canada. Even if technology adopted was not originally designed to suit Canadian factor prices, it must have been cost-effective to use this technology and/or adapt it in Canada given the substantial investment of American inventors on Canadian patent rights. In economic theory, technological change is the one of most important factors in explaining sustained long-run growth and its significance in differentiating Canadian success from other settler economies is supported empirically in my results.

Table 2.1: Real GDP, Employment & Labour Productivity (1871=100)

Real GDP

	Canada				Australia			
Year	Agriculture	Industry	Services	Total	Agriculture	Industry	Services	Total
1871	100	100	100	100	100	100	100	100
1881	156	144	156	153	211	186	160	178
1891	152	217	243	198	305	277	237	263
1901	217	285	401	294	226	255	278	260
1911	299	585	827	542	447	371	413	405
1921	215	529	982	542	437	415	514	465
1931	304	920	1775	935	579	376	544	492
1941/38	303	1633	2633	1391	634	674	756	705
1950	330	2272	3487	1839	948	1001	1026	1003
1960	398	3717	5463	2870	692	1729	1824	1581
1970	486	6435	9276	4822	901	2953	3185	2680
1980	535	8864	15010	7309	1144	3762	4866	3791
1990	679	10842	19709	9387	1475	4849	6845	5154
2000	728	13770	25762	12102	2014	6356	9760	7139
2007	733	14867	31970	14390	1780	7867	12351	8829

Employment

	Canada				Australia			
Year	Agriculture	Industry	Services	Total	Agriculture	Industry	Services	Total
1871	100	100	100	100	100	100	100	100
1881	116	112	139	119	–	–	–	–
1891	129	119	203	138	168	158	232	185
1901	126	143	258	152	200	174	297	222
1911	168	217	475	232	246	236	365	282
1921	186	227	623	269	266	251	436	317
1931	204	288	826	329	288	212	465	317
1941/38	204	438	838	372	299	347	541	398
1950	176	554	1144	439	270	511	746	523
1960	122	607	1723	517	252	595	947	618
1970	92	720	2573	671	229	792	1375	831
1980	89	836	3644	876	223	737	1802	951
1990	92	866	4668	1053	228	703	2437	1150
2000	79	923	5448	1190	233	703	2928	1315
2007	83	959	6411	1359	192	819	3502	1541

Labour Productivity

	Canada				Australia			
Year	Agriculture	Industry	Services	Total	Agriculture	Industry	Services	Total
1871	100	100	100	100	100	100	100	100
1881	134	129	112	129	–	–	–	–
1891	118	182	120	143	182	175	102	142
1901	172	200	155	193	113	146	94	117
1911	178	269	174	234	181	157	113	144
1921	116	233	158	202	165	165	118	147
1931	149	319	215	284	201	177	117	155
1941/38	148	373	314	374	212	194	140	177
1950	187	410	305	419	351	196	138	192
1960	326	612	317	555	275	291	193	256
1970	525	894	361	719	393	373	232	322
1980	599	1060	412	834	513	510	270	399
1990	740	1252	422	891	648	690	281	448
2000	916	1492	473	1017	864	904	333	543
2007	884	1551	499	1059	927	960	353	573

Canadian Sources: Altman (1992)[2], Urquhart & Buckley (1965)[112], Urquhart (1986)[111], Buckley et al. (1983)[110], CEO (Various)[15], COC (Various)[83], Firestone (1958)[28], KLEMS (2008)[74], CANSIM (Various)[26]
Australian Sources: Butlin (1962)[13], Haig (2001)[35], CBCS/ABS (Various)[76], AYB (Various)[75], Broadberry (2005)[9], Butlin & Dowie (1969)[14]

Table 2.2: Real GDP & Employment Shares (% of Total)

Real GDP						
	Canada			Australia		
Year	Agriculture	Industry	Services	Agriculture	Industry	Services
1871	43	25	32	19	35	47
1881	43	24	33	22	36	42
1891	33	27	40	22	37	42
1901	31	24	44	16	34	50
1911	24	27	49	20	32	48
1921	17	24	59	17	31	52
1931	14	25	62	22	27	52
1941/38	9	29	61	17	33	50
1950	8	31	61	18	35	48
1960	6	32	62	8	38	54
1970	4	33	62	6	38	55
1980	3	30	67	6	34	60
1990	3	29	68	5	33	62
2000	3	28	69	5	31	64
2007	2	26	72	4	31	65
Employment						
	Canada			Australia		
Year	Agriculture	Industry	Services	Agriculture	Industry	Services
1871	56	28	16	28	39	33
1881	55	26	19	–	–	–
1891	52	24	24	25	33	42
1901	47	26	28	25	31	45
1911	41	26	34	24	33	43
1921	39	23	38	23	31	46
1931	35	24	41	25	26	49
1941/38	31	32	37	21	34	45
1950	23	35	43	14	38	48
1960	13	32	54	11	38	51
1970	8	30	63	8	37	55
1980	6	26	68	6	30	63
1990	5	23	72	5	24	71
2000	4	21	75	5	21	74
2007	3	19	77	3	21	76

Canadian Sources: Altman (1992)[2], Urquhart & Buckley (1965)[112], Urquhart (1986)[111], COC (Various)[83],Firestone (1958)[28], Buckley et al. (1983)[110], KLEMS (2008)[74], CANSIM (Various)[26]
Australian Sources: Butlin (1962)[13], Haig (2001)[35], CBCS/ABS (Various)[76], AYB (Various),[75], Broadberry (2005)[9], Butlin & Dowie (1969)[14]

Table 2.3: 1936/37 PPP Manufacturing

Sector	PPP	Value Added (%)
Australia		
Sector	PPP	Value Added (%)
Food, Drink & Tobacco	4.60	24
Rubber Products	5.08	1
Skins & Leather	2.96	2
Textile & Textile Goods	6.02	6
Clothing	4.81	9
Woodworking, Furniture & Other	3.61	8
Industrial Metals, Implements & Other	4.31	34
Precious Metals, Jewellery & Plate	3.67	1
Non-metalliferous Mine Products	4.10	6
Chemicals, Paint, & Oils	3.46	7
Miscellaneous Products	3.32	1
AUS Manufacturing PPP	4.37	
Canada		
Sector	PPP	Value Added (%)
Vegetable Products	5.13	19
Animal Products	5.33	9
Textiles & Textile Products	5.23	14
Wood & Paper Products	2.50	21
Iron & Its Products	4.38	15
Non-Ferrous Metals	3.67	9
Non-Metallic Mineral Products	4.58	6
Chemicals & Chemical Products	3.53	6
Miscellaneous Industries	4.37	2
CAN Manufacturing PPP	4.23	
Manufacturing PPP		4.30

Sources: See section IV

Notes: Manufacturing PPP is a geometric mean of AUS & CAN PPPs

Table 2.4: 1936/37 PPP Agriculture, Industry & Services

Agriculture, Forestry & Fishing				
	Australia		Canada	
Sector	PPP	Value Added (%)	PPP	Value Added (%)
Arable	3.51	32	3.38	–
Dairying, Forestry & Fishing	1.88	19	1.41	–
Pastoral	4.47	49	5.04	–
AUS Agriculture PPP	3.09			
CAN Agriculture PPP	2.89			
Agriculture, Forestry & Fishing PPP				2.99
Industry				
	Australia		Canada	
Sector	PPP	Value Added (%)	PPP	Value Added (%)
Mining	4.93	12	4.93	20
Manufacturing	4.30	65	4.30	72
Construction	4.21	23	4.21	9
AUS Industry PPP	4.35			
CAN Industry PPP	4.42			
Industry PPP				4.39
Services				
	Australia		Canada	
Sector	PPP	Value Added (%)	PPP	Value Added (%)
Transport & Communications	2.05	11	2.05	36
Property & Finance	6.48	18	6.48	29
Personal, Professional & Domestic	2.71	71	2.71	34
AUS Services PPP	3.31			
CAN Services PPP	3.58			
Services PPP				3.45

Sources: See section IV

Notes: AUS & CAN PPPs for Agriculture, Forestry & Fishing are based on the geometric mean of sub categories. Sectoral PPPs are a geometric mean of AUS & CAN Sectoral PPPs. Categories have been organised to match data in Butlin (1962)[13].

Table 2.5: Aggregate PPPs

1936/37 PPP			
		Australia	Canada
Sector	PPP	Value Added (%)	Value Added (%)
Agriculture	2.99	24	12
Industry	4.39	25	33
Services	3.45	51	55
AUS Aggregate PPP	3.57		
CAN Aggregate PPP	3.71		
Aggregate PPP			3.64
1997 PPP			
		Australia	Canada
Sector	PPP	Value Added (%)	Value Added (%)
Agriculture	1.06	3	2
Industry	0.84	25	28
Services	0.82	72	70
AUS Aggregate PPP	0.83		
CAN Aggregate PPP	0.83		
Aggregate PPP			0.83

Sources: See table 2.4 & KLEMS (2008)[74]

Notes: Aggregate PPPs are a geometric mean of AUS & CAN Aggregate PPPs

Table 2.6: Correlation Coefficients

	REL-GDP	EXP-US	IMP-US	MNFG	REL-TAR	FOR-PAT	STA-P	STA-O
REL-GDP	1.00	–	–	–	–	–	–	–
EXP-US	0.40	1.00	–	–	–	–	–	–
IMP-US	0.87	0.25	1.00	–	–	–	–	–
MNFG	0.75	0.39	0.81	1.00	–	–	–	–
REL-TAR	-0.34	0.11	-0.27	-0.48	1.00	–	–	–
FOR-PAT	0.88	0.37	0.76	0.77	-0.43	1.00	–	–
STA-P	0.07	0.34	0.01	0.14	0.05	0.16	1.00	–
STA-O	0.20	-0.20	0.37	0.23	0.06	0.01	-0.33	1.00

Notes: REL-GDP is relative Canadian over Australian GDP per Capita, EXP-US is the share of Canadian exports going to the United States, IMP-US is the share of Canadian imports coming from the United States, MNFG is the manufactured share of Canadian exports, REL-TAR is the effective tariff rate in Canada relative to Australia, FOR-PAT is the share of Canadian patents issued to foreign residents, STA-P is the relative price index of staple exports in Canada with Australia, STA-O is the relative real output index of Canada with Australia. Complete data are for 1875-1970.

Table 2.7: Granger Causality Wald Tests

Equation	Excluded	Chi^2	DF	P Value
REL-GDP	EXP-US	2.703	2	0.259
EXP-US	REL-GDP	1.7457	2	0.418
REL-GDP	IMP-US	4.2442	2	0.120
IMP-US	REL-GDP	1.6769	2	0.432
REL-GDP	MNFG	4.497	2	0.106
MNFG	REL-GDP	0.39092	2	0.822
REL-GDP	REL-TAR	0.98176	2	0.612
REL-TAR	REL-GDP	4.0464	2	0.132
REL-GDP	FOR-PAT	11.67	2	0.003
FOR-PAT	REL-GDP	15.391	2	0.000
REL-GDP	STA-P	1.3819	2	0.501
STA-P	REL-GDP	3.9476	2	0.139
REL-GDP	STA-O	7.0557	2	0.029
STA-O	REL-GDP	5.6711	2	0.059

Sources: See section III.1

Notes: Variables as defined in table 2.6. Complete data are for 1875-1970.

Table 2.8: Regression Results

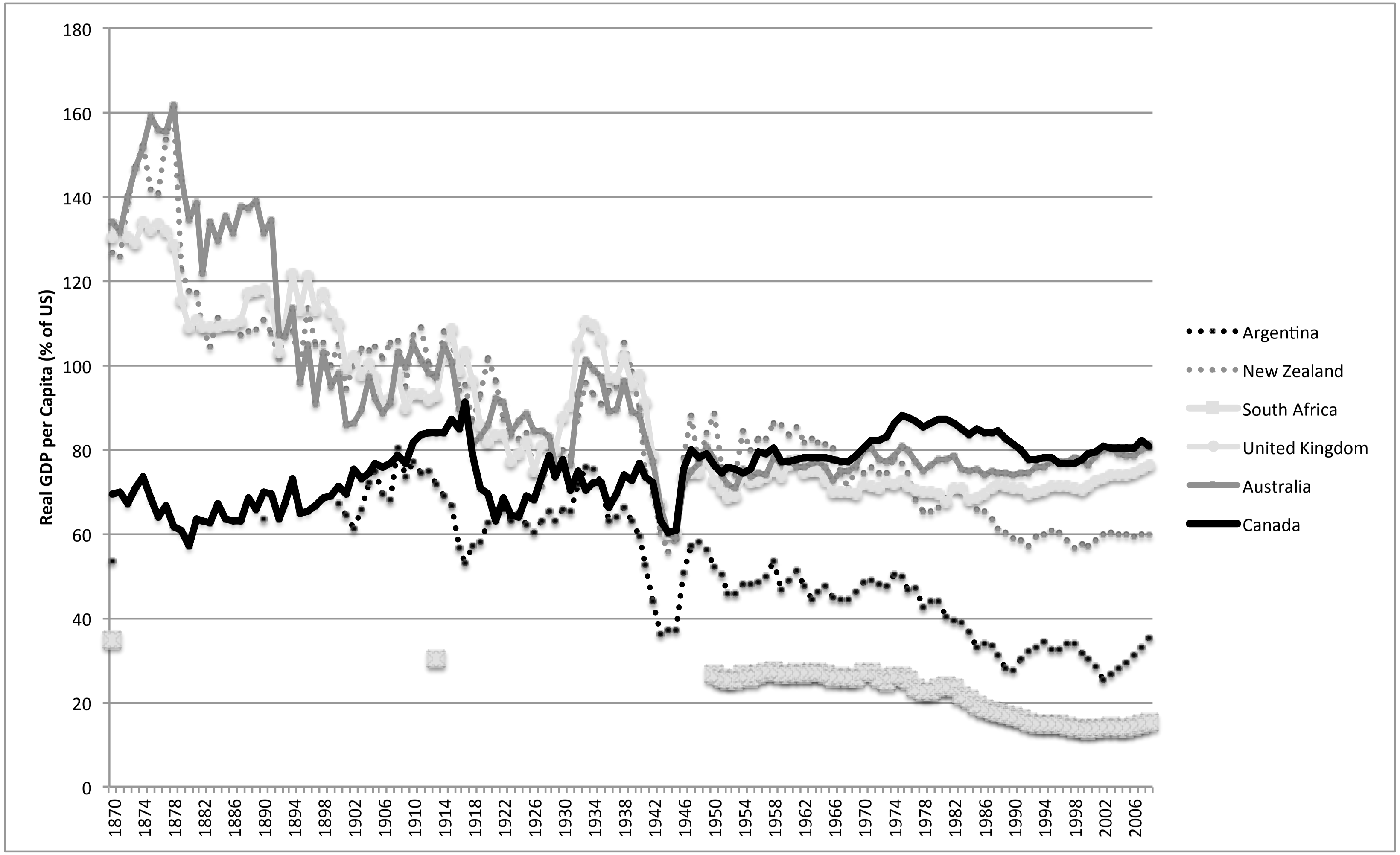
VARIABLES	(1) REL-GDP	(2) REL-GDP	(3) REL-GDP	(4) GRO-GDP	(5) GRO-GDP	(6) GRO-GDP
EXP-US	0.431***	0.261**		0.106	0.0716	
	(0.0681)	(0.101)		(0.0922)	(0.0771)	
IMP-US	1.121***			0.116		
	(0.141)			(0.204)		
MNFG	-0.300***	0.0399		-0.102	-0.0505	
	(0.0630)	(0.0730)		(0.0890)	(0.0574)	
REL-TAR	-0.115***			-0.0338		
	(0.0408)			(0.0497)		
FOR-PAT	1.203***	1.851***		0.403*	0.416**	
	(0.163)	(0.169)		(0.207)	(0.201)	
STA-P	-2.440			3.441		
	(4.401)			(4.115)		
STA-O	0.0245*	0.0605***		0.0163	0.0140	
	(0.0130)	(0.0145)		(0.0137)	(0.0111)	
EXP-US$_{-1}$			0.259***			0.0548
			(0.0653)			(0.0698)
IMP-US$_{-1}$			0.652***			-0.0447
			(0.156)			(0.173)
FOR-PAT$_{-1}$			1.261***			0.337*
			(0.155)			(0.203)
STA-O$_{-1}$			0.0333**			0.0128
			(0.0142)			(0.0120)
REL-GDP$_{-1}$				-0.240**	-0.207**	-0.196*
				(0.107)	(0.0792)	(0.109)
Constant	-94.17***	-99.42***	-83.31***	-23.83	-21.66	-13.51
	(11.39)	(14.15)	(8.246)	(15.89)	(14.23)	(12.95)
RESET	0.001	0.0094	0.1672	0.0013	0.0295	0.0286
Observations	96	96	96	96	96	96
R^2	0.901	0.823	0.869	0.114	0.101	0.085

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Sources: See section III.1 for a description of variables.

Notes: Most variables as defined in table 2.6 GRO-GDP is the growth rate of GDP in Canada minus Australia (or the growth rate of Canadian over Australian GDP). Variables with a −1 subscript have been lagged by one year. Complete data are for 1875-1970.

Figure 2.1: Real GDP Per Capita Relative to the USA (1990 $GK)

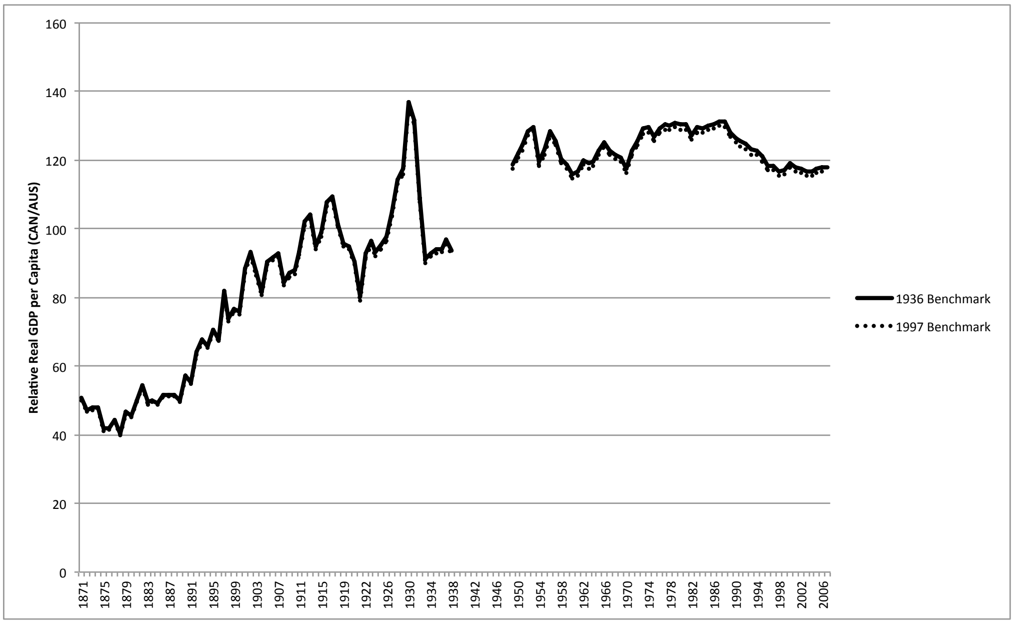


Sources: Maddison (2010)[73]

Figure 2.2: Consistency of the Relative Real GDP Indices

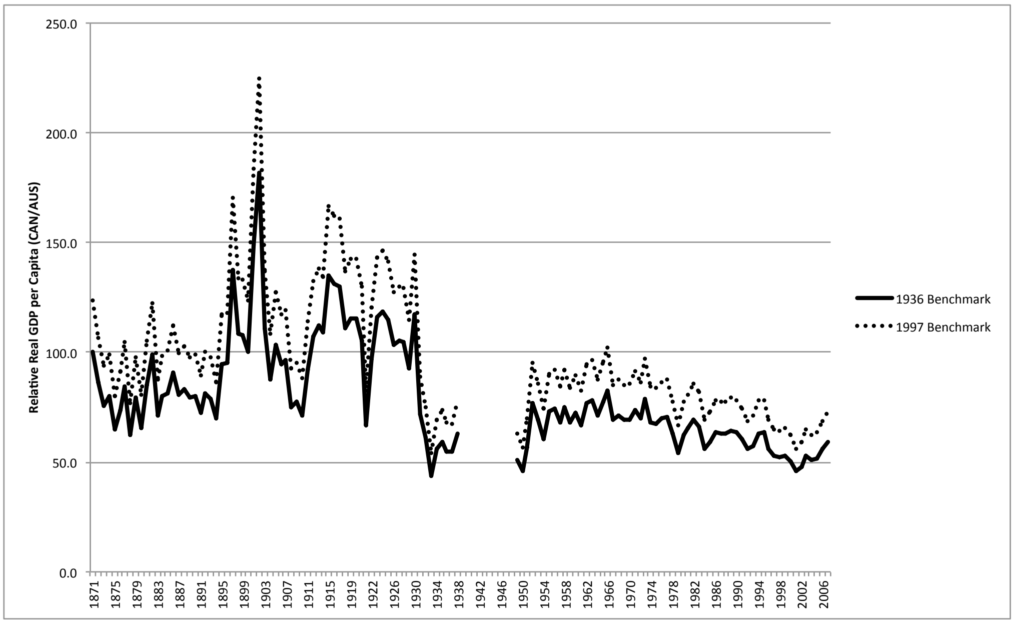
Sources: See Table 2.1 & Maddison (2010)[73]

Figure 2.3: CAN/AUS PPP Adjusted Aggregate Real GDP Per Capita



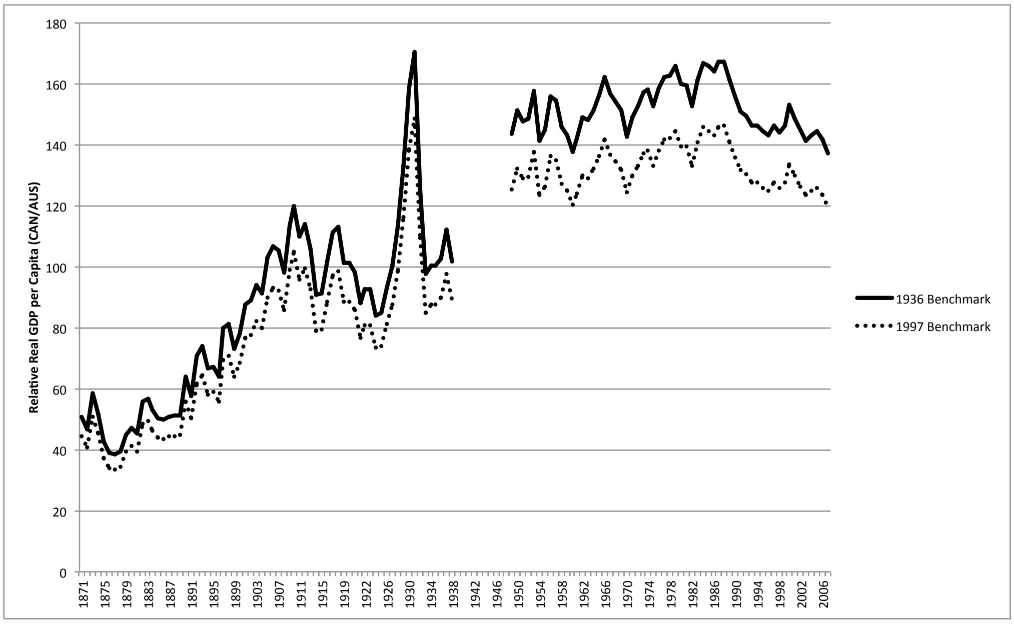
Sources: See Table 2.1 & Tables 2.4-2.5

Figure 2.4: CAN/AUS PPP Adjusted Real GDP Per Capita in Agriculture



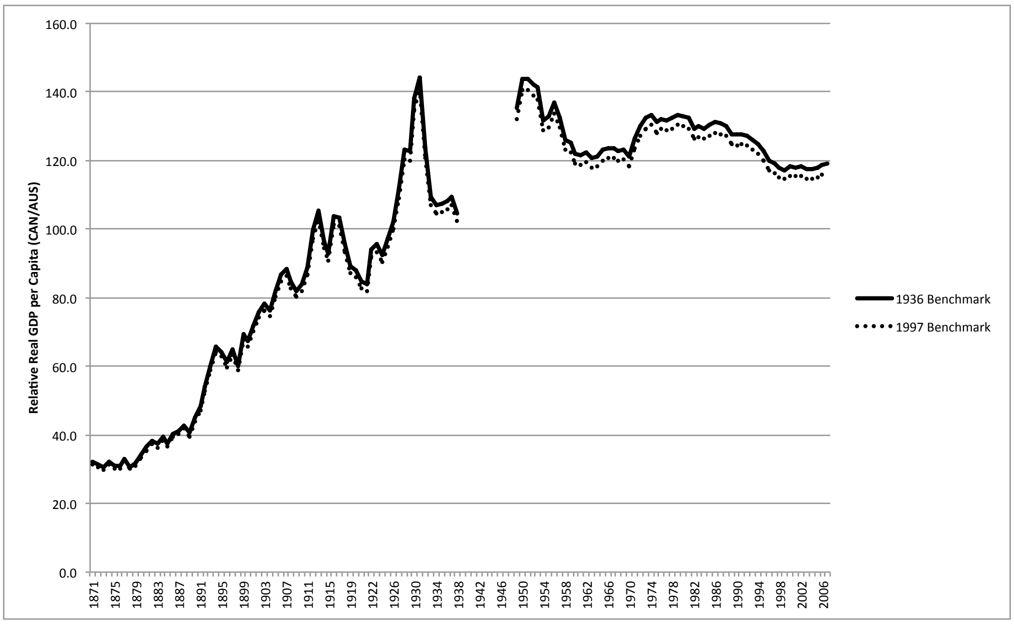
Sources: See Table 2.1 & Tables 2.4-2.5

Figure 2.5: CAN/AUS PPP Adjusted Real GDP Per Capita in Industry



Sources: See Table 2.1 & Tables 2.4-2.5

Figure 2.6: CAN/AUS PPP Adjusted Real GDP Per Capita in Services

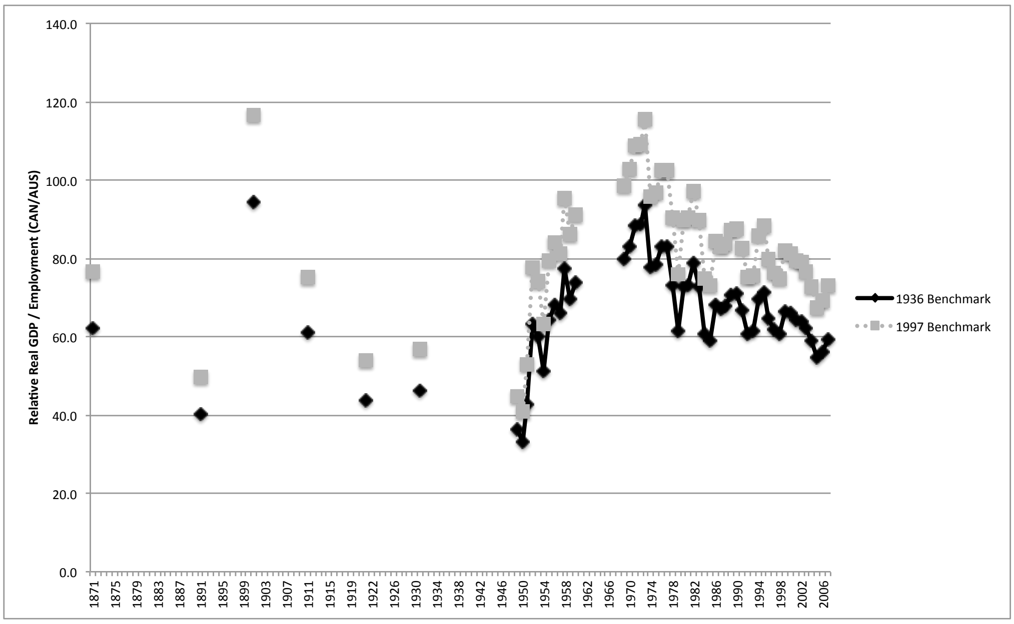


Sources: See Table 2.1 & Tables 2.4-2.5

Figure 2.7: CAN/AUS PPP Adjusted Aggregate Labour Productivity

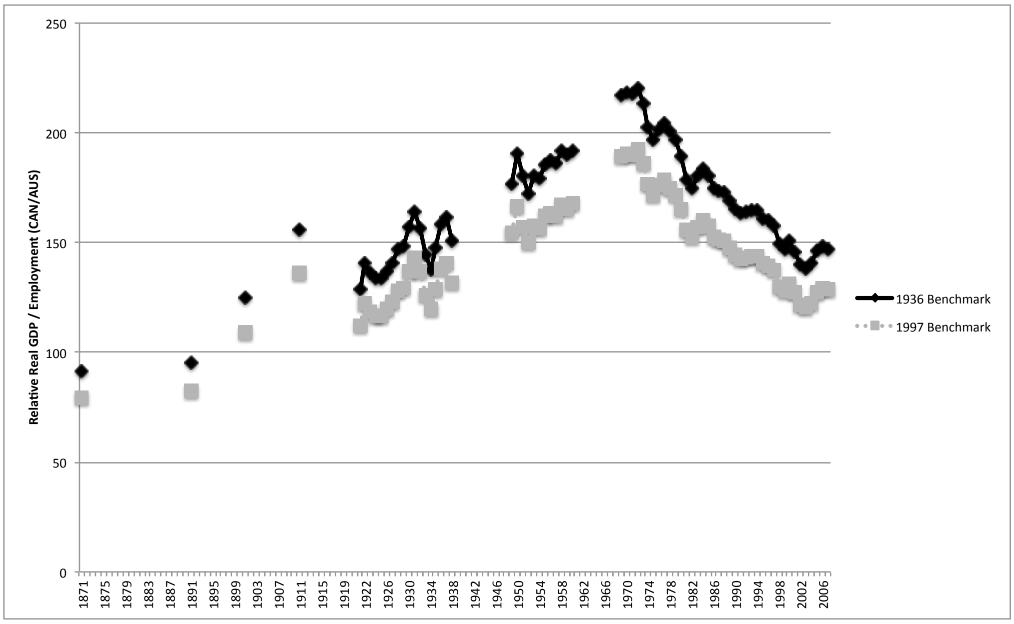
Sources: See Table 2.1 & Tables 2.4-2.5

Figure 2.8: CAN/AUS PPP Adjusted Labour Productivity in Agriculture



Sources: See Table 2.1 & Tables 2.4-2.5

Figure 2.9: CAN/AUS PPP Adjusted Labour Productivity in Industry

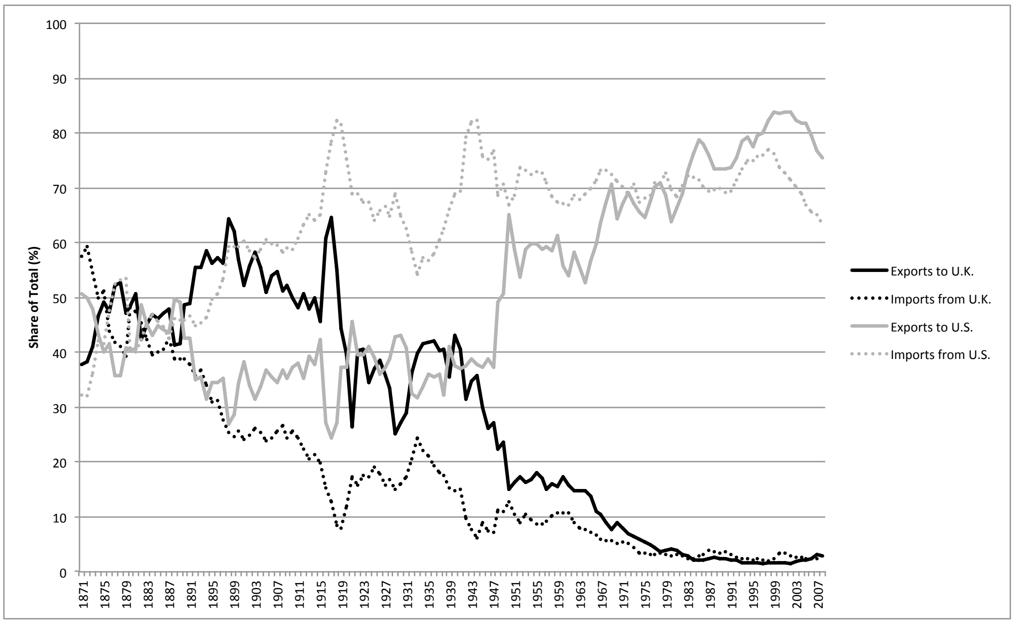


Sources: See Table 2.1 & Tables 2.4-2.5

Figure 2.10: CAN/AUS PPP Adjusted Labour Productivity in Services

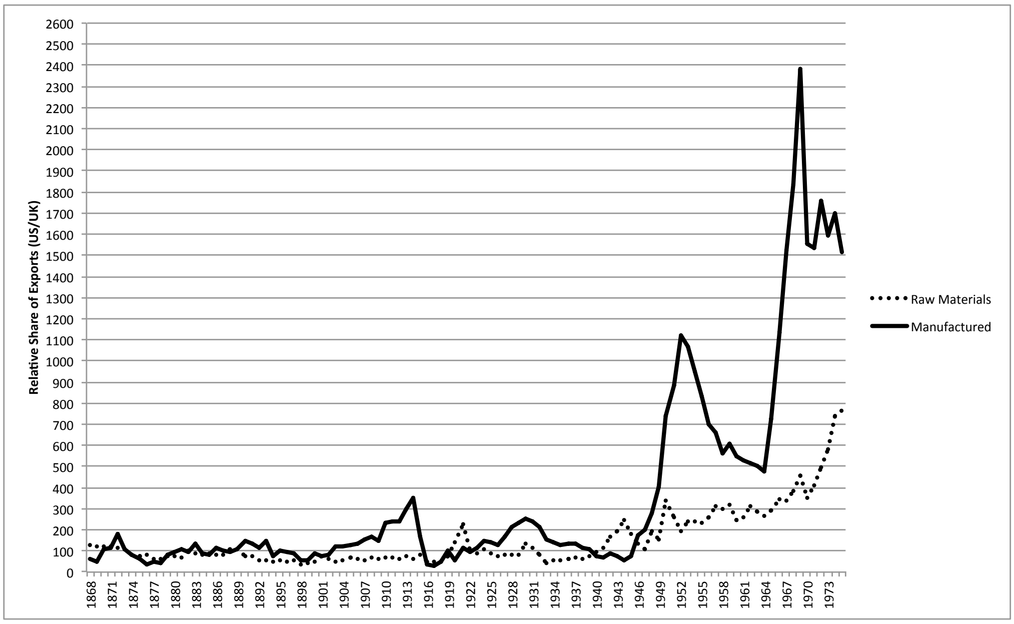
Sources: See Table 2.1 & Tables 2.4-2.5

Figure 2.11: Share of CAN Imports from and Exports to the USA and GBR



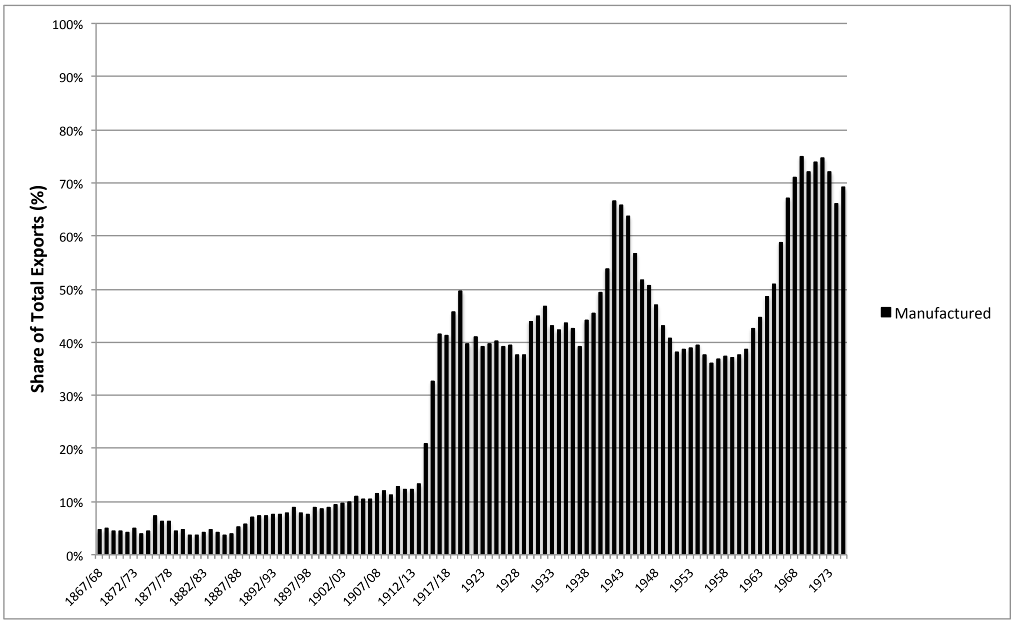
Sources: CYB (Various)[18], Buckley et. al. (1983)[110]

Figure 2.12: Relative USA and GBR Shares of Canadian Manufactured Exports



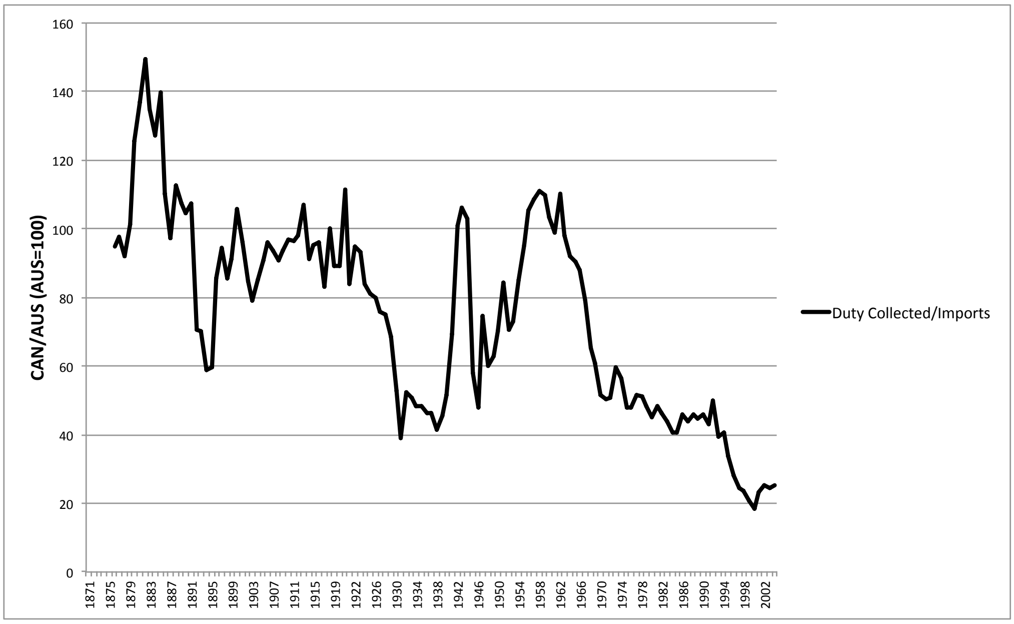
Sources: TTNC (1869-1908)[71], ARTC (1909-1982)[81]

Figure 2.13: Manufactured Share of Total Canadian Exports



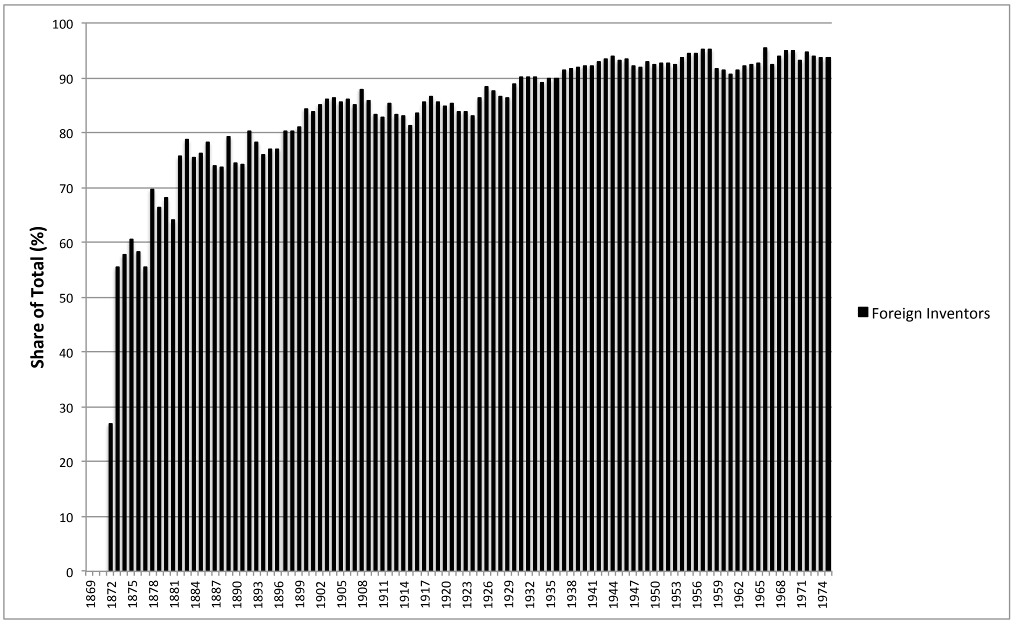
Sources: TTNC (1869-1908)[71], ARTC (1909-1982)[81]

Figure 2.14: Canadian & Australian Relative Duties on Imports



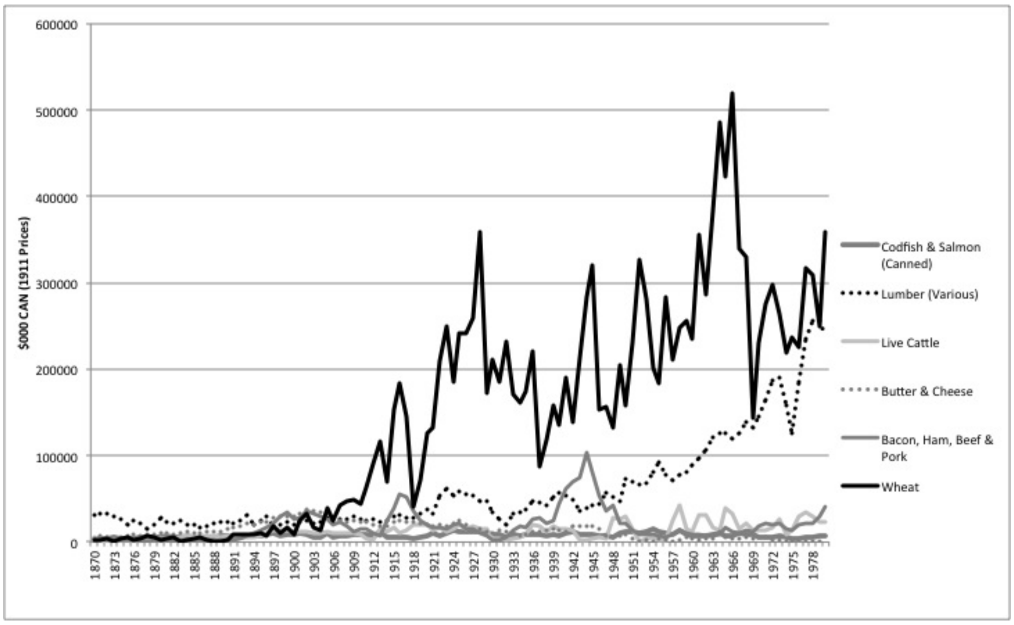
Sources: TTNC (Various)[71], Buckley et. al. (1983)[110], CBCS/ASTA (Various)[76][80], SRNSW (Various)[78], VYB (Various)[69], YBWAU (Various)[88]

Figure 2.15: Share of Canadian Patents Issued to Foreign Residents



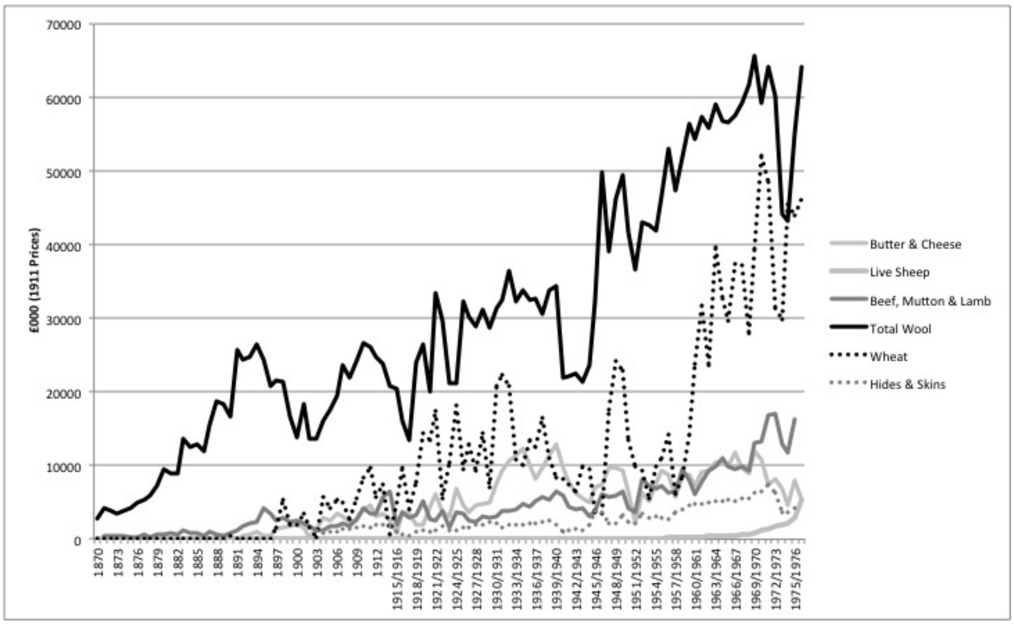
Sources: CYB (Various)[18], CIPO (Online)[84]

Figure 2.16: Real Value of Principal Canadian Staple Exports (1911 Prices)



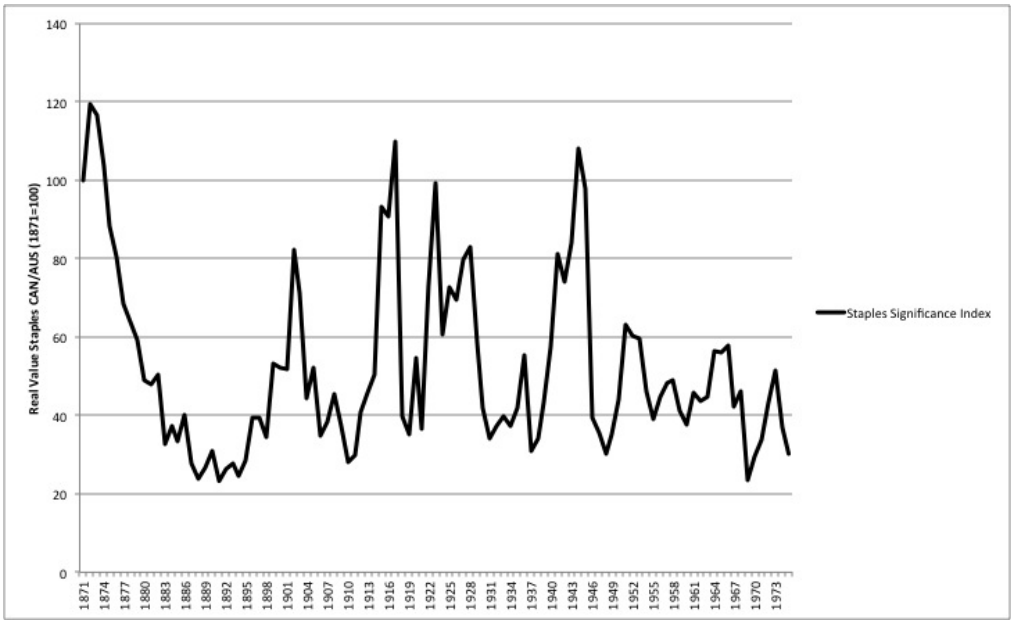
Sources: TTNC (1869-1908)[71], ARTC (1909-1982)[81]

Figure 2.17: Real Value of Principal Australian Staple Exports (1911 Prices)



Sources: SRNSW (1871-1899)[78], ASTA (1899-1976)[80]

Figure 2.18: Real Value of CAN/AUS Staple Exports in a Base Year (1871=100)



Sources: TTNC (1869-1908)[71], ARTC (1909-1982)[81], SRNSW (1871-1899)[78], SRVIC (1871-1899)[87], ASTA (1899-1976)[80]

Chapter 3

Manufacturing Success in the Nineteenth Century: An Application of Data Envelopment Analysis

I Introduction to Chapter 3

On the 4th of May 1886 the Indian and Colonial Exhibition was opened in South Kensington. The Canadian display at this exhibit had been much more important than at the 1876 Centennial Exhibit, both in the quantity and quality of its contributions. According to contemporary British accounts,

> this progress (since 1876) does not confine itself to machinery, agriculture and forestry but is especially noticeable in manufactures of all kinds, showing, not only an increase of intelligence and industry, but also of population and wealth. In point of fact, in many ways Canada now compares well with the United States, and even with this country (Britain), for the bulk of the manufactured goods shown, if they lack artistic finish of design, are certainly equal to anything we can produce in quality.[1]

Canada received the largest exhibit space of any Dominion, 73,830 square feet. *The London Times* remarked how Canada was spread 'almost all over the building, from the gateways of British Guiana and the West Indies on the one side

[1] *The Morning Post*, June 2nd 1886.

to the frontiers of Natal and the Cape on the other.'[2] While the Australasian and South African colonies chose to focus on the more 'un-English' artefacts and raw materials of their lands, Canada presented a homely and familiar court where English industries appeared to have been duplicated and made identical to those in Britain.[3] This is not to suggest that no showing was made of Canadian resources or agriculture (there was a large display on salmon breeding, examples of arable marvels, an authentic fur trader and a large display on Canadian forestry, to name a few). However, the most striking aspect of the Canadian exhibit was the advancement of its industrial abilities since the 1870s. A full account of the machinery in the Canadian exhibit would require significant digression and so the discussion here must be limited. Of particular importance were advances in iron and steel that permitted the manufacture of numerous agricultural implements; self-binders, reapers, mowers, horse-rakes, seeders, harrows, ploughs, scrapers, rollers, cultivators, fanning mills, threshing machines, and general harvesting machinery. These were exhibited by Canadian industrialists who could rival many in the United States and Britain; Masey Manufacturing Company of Toronto, the Watson Manufacturing Company of Ayr, the Cockshutt Plough Company and Elliott and Sons of Ontario. Many other categories of Canadian manufacturing were particularly surprising to British and Colonial visitors to the exhibition such as textiles, furniture and musical instruments.

Given these contemporary accounts from the 1880s it seems odd to approach the study of Canadian manufacturing with condemnation. Yet the traditional argument claims that Canadian manufacturing suffered from relatively low labour productivity and income per capita. As Keay puts it, 'in much of this work (traditional literature on Canadian manufacturing) the Canadians' performance has been found to be lacking relative to some international, usually American, standard.'[4] Should we accept the traditional United States centric view that Canada was an industrial laggard with a poorly developed manufacturing sector before 1900? If not then how can we reconcile the two opposing views on Canadian manufacturing? Was the fanfare at the Colonial and Indian Exhibit justified or were the toasts of rival Dominions cheap talk? This paper seeks to address the question of Canadian success by placing Canadian manufacturing into the context of other 'settler economies'. Focus is on a comparison of Ontario and Quebec with Victoria, New South Wales, New

[2] *The London Times*, 6th of August.

[3] Tellingly the Cape Colony chose not exhibit any manufactured implements at the 1886 exhibit and there is no record of agricultural implement factories in the Cape Colony in the 1891, 1904 or 1911 censuses.

[4] Keay (1999)[46], pg. 5.

Zealand and the Cape Colony, rather than country wide comparisons. This regional approach seems more appropriate as it isolates the study to the most advanced centres of manufacturing in each country.[5] Data on several aspects of manufacturing are used to shed light on the relative development and efficiency of manufacturing in settler economies. In response to recent studies that suggest partial factor productivity is insufficient to gauge the comparative success of manufacturing I employ two theoretical approaches, Growth Accounting and Data Envelopment Analysis (DEA). These approaches are utilised to obtain overall measures of efficiency that combine all available information on manufacturing inputs and outputs.

II Overview on Manufacturing

Since World War Two there has been significant debate on the development of Canadian manufacturing following confederation. Traditionally, Canadian manufacturing is argued to have been sluggish in the period before 1900 with relatively low output growth in manufacturing corresponding with a collapse in the export of established staples such as fish, furs and timber. Traditionalists argue that manufacturing output grew rapidly after 1900 with the onset of booms in both wheat and minerals. Traditionalists also typically contend that manufacturing was encouraged by various trade and tariff policies intended to support import substitution. Authors such as Gordon Bertram challenged a traditional view of rapid manufacturing growth after 1900, claiming a more gradual process occurred from 1870 onward.[6] According to the gradualist view secondary manufacturing developed relatively independently of the traditional staples to satisfy growing domestic (and later international) demand. More recent work by Mac Urquhart and Morris Altman has criticised the gradualist view and supported the traditionalists, arguing that manufacturing growth was extremely rapid after 1900 and fairly dismal before 1900.[7] Consensus has yet to be reached, however most agree that manufacturing growth was strong in the period from 1900 to 1910 and weak in the recession period of the early 1890s before the onset of the wheat boom.

Shifting away from the overall growth story there were some interesting developments from 1870 to 1910 in terms of the structure of manufacturing in Canada. According to Norrie and Owram, the distribution of gross domestic product revealed

[5] In much of the analysis the mention of Canada will imply Ontario and Quebec more precisely.

[6] See Bertram (1964)[7] for the original source or Norrie and Owram (1991)[66] for a summary.

[7] See Urquhart, M.C. (1986)[111] and Altman, M. (1987) for the original source or Norrie and Owram (1991)[66] for a summary.

a clear hierarchy of manufacturing activity in 1870. Wood products (principally planks and boards) were at the top of the hierarchy; iron and steel products (including agricultural implements, foundry and machine shop products, boilers and engines, cutting and edging tools, pumps and windmills, sewing machines and wire), leather products and food and beverage products were second in importance; transportation and clothing came third; textiles (excluding clothing), nonmetallic minerals and printing and publishing were the least significant categories. This hierarchy had broken down by 1900 with wood products giving way to food and beverages and iron and steel products. The rest of the hierarchy had dissolved into a continuous step pattern of importance.[8]

Substantial growth in manufacturing from 1870 to 1900 occurred either in fields related to new resource products (Nonferrous metals, paper, chemicals, hydro-electricity and electrical apparatus and nonmetallic minerals) or to import competing industries selling finished goods to the domestic market (Rubber, textiles, printing and publishing, tobacco, clothing, miscellaneous industries and food and beverages). Growth in manufacturing from 1900 to 1910 was influenced heavily by the opening of the prairies and westward expansion. The classic example is the iron and steel industry which was spurred to rapid growth by increased demand and technological change promoting lower input costs in production.

Table 3.1 compares the share of value added in manufacturing for Canada, Victoria and New Zealand in 1890, 1900 and 1910 based on census data. Manufacturing in Canada appears to have been more diverse than in New Zealand and possibly even more so than in Victoria. Metal works, food and beverages and clothing and textiles made up the lions share of value added in Victoria's manufacturing from 1890 to 1910. Wood products were highly significant in both Victoria and New Zealand. In Victoria they had diminished in importance by 1900 but they were still significant relative to most other categories. In New Zealand wood products were a very important manufacturing category before World War One.

All of the settler economies were heavily orientated towards the manufacture of food and beverage products before World War One. For Victoria food and beverages made up 24.9%, slightly more than metal products at 19.5%. For New Zealand food and beverage products held the largest share by some margin making up 42.2% of value added. Both Victoria and New Zealand's share of value added in food and beverage products peaked in 1900 at 36.5% and 48.3% respectively. In Canada, food and beverage manufacturing made up a slightly smaller figure between 16-18% of value added. Food and beverage manufacturing was of course related to agriculture

[8]Norrie and Owram (1991)[66].

since many agricultural materials such as milk were used as inputs in production. It stands to reason that Canada's smaller share of value added in food and beverages indicates it had further developed its secondary manufacturing sector. This is evident given the significant share of value added in iron, steel and other metals. Since year book data organised agricultural implements and other machinery into the miscellaneous category the figures actually understate the level of secondary manufacturing in Canada relative to other settler economies. If issues of data organisation were taken into account then Canada would have a comparable share of manufacturing in metal products and machinery.

Unlike Canada and Victoria, metal manufacturing was not an important category for New Zealand making up between 6 to 10% of total value added. Clothing and textiles were also less important in New Zealand than in Canada where they made up approximately 15% of value added. Printing and bookbinding were significant in both Victoria and Canada in 1890 but did not become relatively important in New Zealand until much later. Clearly manufacturing in Victoria and Canada was based more on the production of metal products, machinery and textiles (likely for the domestic market) while New Zealand was heavily dependent on converting its arable, pastoral and forest products into goods that could be exported. The next section describes the availability of data and its comparability over time. Later sections deal with the issues inherent in cross country comparisons using manufacturing data and present a compromise categorisation of data on consistent basis.

III Data: Characteristics and Limitations

III.1 Raw Manufacturing Data

Manufacturing data on the number of establishments, hands employed, wages paid, capital owned, materials used and gross output generated are available at a fairly desegregated level for the Canadian provinces, Victoria, New South Wales, New Zealand and the Cape Colony. Canadian factories were enumerated in census years and published in the Canadian Year Book in 15 categories including food products, textiles, iron and steel products, timber and lumber manufactures, leather products, paper and printing, liquors and beverages, chemicals and allied products, clay and glass products, metal products (other than iron and steel), tobacco manufactures, vehicles for land, vehicles for water, miscellaneous industries and hand trades. This organisation of the data was based on the 1901 census where these categories first appeared. Although earlier censuses organised data on manufactories into several alternative categories, the year books reorganised previously categorised data in order to analyse changes over time.

Unfortunately, only the data for Canada as a whole, rather than the individual provinces, was published in the Year Books and no record was left on how the subcategories of manufactories were organised into major categories. This implies that one must make an educated guess on how industrial subcategories should be organised and adjust this organisation until the correct totals for major categories are obtained. The 1871 census enumerated 140 distinct factory subcategories while the 1881 census enumerated 176 subcategories. After carefully applying this approach I have successfully determined the correct organisation of industry types into the year book categories by province for 1870 and 1880. In 1890 there were several subcategories that could not be perfectly matched since the year books have inexplicably excluded some of the manufactories from the original census.[9] The 330 distinct industry subcategories have been organised into the most appropriate major categories with very little discrepancy relative to the Year Book totals. Another issue in organising manufactories according to the Year Books was the inconsistency over time for which the Year Books were responsible. For example, carpentry and joinery were included as hand trades in 1871 but were moved to the miscellaneous category in 1891.

Furthermore, it is impossible to organise the manufactories from the 1901 and 1911 censuses into the corresponding Year Book categories at the provincial level since they were not reported adequately. Both the 1901 and the 1911 censuses do not provide the same level of detail on minor categories of manufactories at the provincial level, as at the federal level, rendering the same organisation of data impossible. Appendix tables B.1 and B.2 display manufactories for Ontario and Quebec in 1870 and 1880 using the Year Book categories. The Year Book data for 1890, 1900 and 1910 are presented in appendix table B.3.

Manufacturing activity in Victoria was being enumerated yearly by 1870. Data on the number of establishments, hands employed, the value of land, building and machinery and the horsepower used in each factory type are contained in the annual volumes of the Statistical Registers for the Colony of Victoria. However, the value of materials used and output generated in each factory were only enumerated in census years and are available in Victorian Year Books.[10] The first census where

[9] Most categories have been perfectly determined in 1891, any categories that could not be perfectly determined had only a very minor discrepancy with the year book totals.

[10] Paradoxically the data enumerated during census years for Victoria and New South Wales were not published with other census data, as in Canada, New Zealand and the Cape Colony, but were made available in government Gazette's and Year Books.

materials used and output generated were enumerated was in 1880. Victoria's factories were organised into approximately 19 major categories, depending on the census year, that were then subdivided into minor classes. Major categories in the 1911 census for Victoria were: treating raw materials, oils and fats, processes relating to stone, clay and glass, working in wood, metal works and machinery, food and drink, clothing, textiles, and fibrous materials, books, paper, printing and engraving, musical instruments, arms and explosives, vehicles and fittings (including saddlery and harness), shipbuilding, furniture and bedding, drugs, chemicals and by-products, surgical and scientific appliances, timepieces, jewellery and platedware, heat, light and energy, leatherware and miscellaneous. I have organised the 125 (105) subcategories of manufacturing in 1890 (1900) into the major categories set out in the 1911 census. The results are displayed in appendix table B.4.

Data on manufacturing for New South Wales was organised under the same categorisation as Victoria after 1896 and published in fragments amongst the Statistical Registers and Year Books. However, data availability for New South Wales before 1896 was less robust than for Victoria. For completeness I have included New South Wales data for 1890 despite the inability to organise sub categories of manufactories. The data for 1890, 1900 and 1910 are provided in appendix table B.5.

Excellent manufacturing data exist for New Zealand beginning in 1886. Although factories were enumerated in New Zealand back to the 1871 census there was no attempt to estimate the value of materials used or output generated for each category of manufacturing before 1886. The 1911 census organised 97 subcategories of factory type into 27 major categories. These categories were: animal food, vegetable food, drinks, narcotics and stimulants, animal matters, working in wood, fodder, paper, gasworks, electric light and supply, electric tramways, stone, clay and glass, metals (other than gold and silver), publications, musical instruments, ornaments and other small wares, equipment for sports and games, designs, medals, type and dies, ammunition, machines, tools and implements, carriages and vehicles, harness and saddlery, ships and boats, furniture, chemicals and allied, textile fabrics, dress and fibrous materials. I have taken the 86 (110) subcategories from the 1891 (1901) census and organised these into the major categories from the 1911 census. Appendix table B.6 displays the results.

Cape Colony manufactories were enumerated in the censuses of 1891, 1904 and 1911. The 1904 census organised the specific classes of manufactories into 24 broad categories: animal foods, vegetable foods, drinks, narcotics and stimulants, animal matters (not otherwise classed), vegetable matters (not otherwise classed), wood products, houses and buildings, furniture, carriages and vehicles, harness and saddlery, ships and boats, printers and bookbinders, designs and type, lighting, dress, textile fabrics, dye and cleaning works, fibrous materials, metals (other than gold and silver), processes relating to stone, clay and glass, chemicals, production of salt, arms and explosives, gold, silver and precious stones, small wares (not otherwise classed). The 1911 census continued to organise manufacturing around the 1904 categories. For comparison over time I have organised data on manufactories in the 1891 census in terms of the 1904 census.[11] Table B.7 displays Cape Colony manufacturing according to the 1904 categories.

No equivalent to the SIC in manufacturing existed in censuses before World War One. Cross-country comparisons by category of manufacturing require some reorganisation in order to standardise the various divisions. It would be inappropriate to use raw data on manufacturing organised into each country's census or year book categories for cross-country comparisons. One must understand both the limitations of this data for comparison and undertake the task of organising the data into consistent cross-country categories.

III.2 Technicalities of Enumerations

Of course one problem that exists in cross-country comparisons of manufacturing is the incompatibility of estimates based on differences in data collection. In Australia each colony imposed its own definition of factories and persons employed.[12] Before 1896, establishments in New South Wales were enumerated if they were engaged in manufacturing activity using machinery or where no machinery was used if at least five or more hands were employed. The definition of a factory before 1896 was more complex in Victoria. Enumerators were instructed to return all manufacturing establishments where steam, gas or water-power was used but not to return retail clothing establishments employing less than ten, nor retail boot factories employing less than five hands, and to exclude all persons connected with the commercial branch of a business. In 1896, Victoria and New South Wales agreed to adopt a common system of the term factory. According to the 1896 agreement a factory was any, 'factory, workshop, or mill where four or more persons are employed or power is used'. This change implied that for both New South Wales and Victoria four em-

[11] In a few cases it was impossible to separate data on some classes of manufacturing to conform to the exact categories from 1904. As a result I have combined data on carriage and vehicle manufactories with harness and saddlery, printers and bookbinders have been combined with design and type works and textiles, fabrics, dye and cleaning works have been combined with chemicals and salt production.

[12] Australian statisticians have suggested this was due to the relatively minor place that manufacturing held in relation to total economic activity.

ployees were necessary for enumeration after 1896. Enumerators were instructed to record all manufacturing with less four hands only if steam, gas, electric, water, wind or horse power was employed. However, a final stipulation allowed for the inclusion of all industries of 'unusual or interesting character'. The remaining Australian States accepted the Victorian definition at the Conference of State Statisticians in 1902.

New Zealand adopted the same enumeration definitions as Victoria and New South Wales after 1896. The 1896 census provides an adjustment for the 1891 and 1886 census' of industries to bring their summary data in line with the 1896 definition. Another issue was the inclusion of tailoring, dressmaking and millinery (shirt-making), stone-quarrying, monumental masonry, tramways, engineering, wire working, asphalting, jewellery manufacture and fencing-standard making in the 1901 census but not in earlier enumerations. The 1901 and 1911 censuses include an adjusted series that removes these industries in order to keep the sample consistent over time. I have chosen to remove stone-quarrying but keep all remaining data in order to maintain consistency with data for other colonies. A further issue with New Zealand data was the number of industries that were recorded both within their appropriate subcategory in terms of hands employed and horse power used but in an undisclosed category in terms of materials used and the value of output. Since it would be impossible to disaggregate the undisclosed data, I have considered all data from these partially undisclosed firms as being undisclosed.

Censuses enumerated for the Cape Colony included all establishments with an annual amount of goods produced in excess of £100. One of the biggest issues in using data on the Cape Colony to make comparisons is in the treatment of mines and quarries. Diamond mining became a major industry of the Cape Colony after diamonds were discovered in the 1860s. Estimates of capital intensity are heavily influenced by the inclusion of diamond mining in summary statistics for industry but much of this is due to the perceived value of land rather than plant and machinery. The most straight forward way to deal with this issue is exclude quarrying and mining from data on industries. Another approach is to drop any data from Kimberley out of the sample. Since quarrying has been removed from the industry data in the other colonies I have chosen this approach.

The 1901 Canadian census defined a factory as

> any premises, building, room or place where steam, water or other power is used to move or work machinery employed in preparing, manufacturing or finishing any article, substance, material, fabric or compound, or to aid the manufacturing process carried on there, or any premises, build-

> ing, room or place wherein the employer of the persons working there has the right of access and control, and in which any manual labour is exercised by way of trade or for purposes of gain, in making, altering, repairing, ornamenting or finishing any article or part of article to adapt it for sale.[13]

Essentially the Canadian enumerators were concerned with distinguishing between domestic or hand labour and factory labour. The Factory Act in Ontario only applied if more than five persons were employed in any appropriately defined establishment. None of the five could be children unless steam, water or other motive power was used in the aid of manufacturing. This was the basis for the enumerators of the Canadian census who took the term 'manufacturing establishment or factory' to imply 'no manufacturing establishment or factory will be so recognised for census purposes which does not employ at least five persons, either in the establishment itself or as piece-workers employed out of it.'[14] As in the case of Victoria certain concessions were made for 'special industries'. Butter and cheese factories and brick and tile works were enumerated even if they contained fewer than five employees since they were often large scale capital intensive operations that required few hands. This became true of many industries as capital intensity increased. The 1906 and 1911 censuses extended this exemption on the number of employees to flour mills, gristing mills and electric light plants. The 1911 census also exempted saw mills, shingle mills, fish curing plants and lime kilns.

Prior to 1901, Canadian censuses attempted to enumerate all factories regardless of the number of hands employed. This basis for enumeration generates the most serious issues for cross-country comparisons and comparisons over time. The change in definition had a significant impact on the number of factories enumerated. The 1901 census estimates that the number of factories enumerated in 1891 under the 1901 definitions would have been 14,065 rather than 75,964. This implies there were 61,899 factories with less than five hands. Wages and salaries paid would have fallen from $100,415,350 to $79,234,311. The value of output produced would have declined from $469,907,886 to $368,696723. Although it is important to remember that the enumerators in 1891 may have included some of these smaller factories even under the 1901 definitions given the 'special character' or power employed.[15]

Practically, all of these cross-country differences imply that small factories were ignored when there were tighter definitions of what constitutes a 'factory' or where a

[13] Census of Canada (1901)[83], Section III Manufactures, pg. vi.
[14] Census of Canada (1901)[83], Section III Manufactures, pg. vi.
[15] Census of Canada (1901)[83], Section III Manufactures, pg. lxv.

larger number of employees were required for enumeration. Presumably this would tend to remove the less efficient small scale factories and increase estimates of capital per worker and output per worker. For some industries it is impossible to predict how cross-country comparisons would be biased since enumerators included all establishments for some industries based on the use of motive power or based on the high capital intensity of firms in that industry.
However, some perspective is necessary in order to understand the magnitude of the problem. Consider the adjustment needed in 1896 to bring the definition of a factory for Victoria and New South Wales together. The adjustment required Victoria to add 51 dressmaking and millinery factories, 68 tailoring factories, 4 boot factories and 8 railway workshops to the its original 1896 enumeration. It also had to subtract 210 factories, in which the hands fell below four, that would have been included before the 1896 definition. The overall result of this was an increase of 2742 hands employed, £40,020 of machinery and plant, £66,700 of land and £86,970 of buildings. These adjustments represent about 1% of the capital stock and 3% of labour employed.[16] It seems highly unlikely that this bias would be so great as to influence cross-state or cross-country comparisons to the point where broad generalisations would be considered inaccurate.
Consider a second example for Canada. Exceptions for special industries with fewer than five hands added to the 1906 and 1911 censuses resulted in an increase of $8,886,303 to the value of capital in 1905 and $14,658,010 in 1910, $8,901,486 to the value of products in 1905 and $17,753,848 in 1910. These changes represented approximately 1% of the value of capital in 1905 and 1910, 1.25% of the value of products in 1905 and 1.5% in 1910. Similar figures could be furnished for the adjustments in the enumeration for New Zealand or the Cape Colony.

III.3 A Time Consistent Cross-Country Organisation

In order to accurately compare the characteristics of manufacturing over time and across countries it is necessary to match disaggregated data into consistent international subcategories of manufacturing. To this end, I have created a set of universal categories for manufacturing activity by observing the limitations of cross-country data and reorganising appropriately. The universal subcategories are then aggregated into broad but consistent major categories. There are 16 major categories of well matched data. The universal major categories are as follows: food products which contains the subcategories dairy produce (principally butter and cheese), meat and fish (slaughtering, preserving and packing), bread, biscuits and confectionary

[16] Adjustments calculated from information in the 1895 Year Book for Victoria.

(including sugars), flouring and grist mills, fruit and vegetable preserving and canning, coffee, chicory, cocoa, and spices, salt works and starches, ice and cold storage, baking powder and flavouring; textiles which contains the subcategories wollen goods, hats, caps and furs, awnings, tents and sails (including oilskin and waterproof materials), men's clothing (tailoring), women's clothing (dressmaking and millinery), cordage, rope and twine, dressed flax and seeds, hosiery and knits; iron and steel which contains the subcategories wire working, engineering and foundaries, cutlery, edge tools, nails, lead, and machinery; timber and lumber which contains the subcategories saw milling, moulding and joinery, furniture, upholstered goods and billiard tables, basket making, picture frames, woodcarving and turnery, cooperage, boxes and cases; leather products which contains the subcategories boots and shoes, tanneries, fellmongeries and wool-washing, harness and saddlery (including whips); paper and printing which contains the subcategories paper boxes, ink, printing, bookbinding, publishing, engraving, stereotyping and electrotyping, stationary goods, account-books, paper, cardboard and strawboard, rubber stamps (including other rubber goods); liquors and drinks which contains the subcategories liquor, malt, wine, distilleries and breweries, aerated and mineral waters; chemicals and drugs (including allied products) which contains the subcategories chemicals, drugs and medicines, paints, varnishes, fertilizers and tallow (including bone milling and boiling down); clay, glass and stone which contains the subcategories cement, lime and plaster, brick, tile, pottery and glass, stone and marble sawing, monumental stone; metal manufactures which contains the subcategories smelting, goldsmithing, jewellery and electroplating, plumbing and tinsmithing (including sheet iron and japanning); tobacco has no standard subcategories but contains all manufacturing related to smoking, chewing and snuff, cigars and cigarettes; vehicles for land contains the subcategories carriages, waggons, railway coaches, cars and bicycles, vehicles for water contains no standard subcategories but includes all manufacturing of boats and ships (including building and repairs), docks, and patent slips; miscellaneous which contains the subcategories umbrellas, brooms and brushes, blacking and washing compounds, soap and candles, agricultural implements, musical, scientific and surgical instruments, mattress and spring beds; power and light which contains the subcategories gasworks, electric light and power, other light and power (including electric apparatus, matches, lamps, charcoal dust and hydraulic power); hand trades which contains the subcategories dyeing, cleaning and scouring, blacksmithing.

All of the remaining types of factories listed for each country have been organised into an unmatched and undisclosed category. If the type of factory fit the description of one of the major categories but was missing from all other countries then it was included in the unmatched category. For the purpose of cross country comparison I have chosen to combine the data for Ontario and Quebec. Although it was impossible to disaggregate the provincial data according to Canada Year Book categories, it was possible to disaggregate provincial data according to my universal categories. This was due to the fact that the most important subcategories of manufacturing were available and could be matched while all others were placed in an unmatched category.

IV Cross-Country Comparisons of Manufacturing

IV.1 Relative Value Added

Although Canadian firms have often been shown to have been less productive than American firms in the long nineteenth century, very little work has been done to determine if this relationship holds relative to other countries. The primary goal of this paper is to determine Canadian performance relative to other settler economies. Table 3.5 shows net output per establishment and net output per worker for Victoria, New South Wales, New Zealand and the Cape Colony relative to Canada (Ontario and Quebec). Before 1890 Canadian firms were at a disadvantage in terms of net output generated. The Australasian colonies had approximately four times the net output per establishment and higher levels of net output per worker. In 1890 the Cape Colony was ahead in terms of net output per establishment but had slightly less net output per worker. By 1900 the situation had changed dramatically. Canadian manufacturers generated a higher net output per establishment than all other settler economies. Although New Zealand and New South Wales still had higher levels of net output per worker, Canada had overtaken Victoria. By 1910 Canada dominated all other settler economies in terms of net output in manufacturing both on a per firm or per worker basis. For example, Victoria and the Cape Colony were generating only half of Canadian net output per worker in 1910.

This was a dramatic turn of events, Canada moved from having the lowest value added in its manufacturing sector, on either a per establishment or per worker basis, to having the highest in under thirty years. Even at an early stage Canadian iron and steel manufactures performed well, as did chemical products, metal manufactures and the production of some miscellaneous goods. Food products remained an area of relatively low net output per establishment and per worker. Hence cross-country data on net output seems to support the view that Canadian manufacturing generated low levels of labour productivity before 1890 and that something changed before, rather than after the turn of the century. It is apparent that manufacturing in Canada did advance rapidly after 1900 to the point where it was a comparatively productive sector by 1910. The connection between Canada's economic boom around 1900 with increased manufacturing activity is clear. This is highly suggestive evidence that manufacturing played a key part in Canada catching-up on other settler economies before World War One. The following several sections of this paper attempt to address the role of extensive and intensive growth in relative manufacturing success.

IV.2 Capital Intensity

Why did Canada have relatively low net output before 1890 and high net output afterwards? Previous studies have suggested that most nineteenth century Canadian manufacturers operated at a smaller scale of production with relatively low capital intensity relative to American manufacturers. Accordingly, levels of manufacturing efficiency in Canada failed to match the United States. This argument is convincing given the size and particularly impressive endowments of land and coal in the United States. However, A more interesting and unanswered question remains, was Canadian manufacturing in the long nineteenth century operating at a smaller scale with less capital intensity when compared with other settler economies? Table 3.2 displays the machinery, plant and implements per establishment and per worker for Victoria, New South Wales, New Zealand and the Cape Colony relative to Ontario and Quebec.

In the 1880s, Canada clearly had a lower capital intensity both on a per establishment basis and a per worker basis in all areas of manufacturing when compared with other settler economies. The story was more mixed in 1890. Overall Canada was still less capital intensive than the other settler economies, including the Cape Colony. Victoria remained the most capital intensive of the colonies by a significant margin.[17] However, Canada was more capital intensive than New Zealand and the Cape Colony in several important categories of manufacturing including iron and steel, metal manufacturing and paper and printing. By 1900 Canada was at least as capital intensive as any of the other settler economies aside from New South Wales (New South Wales had a slight advantage in capital per establishment and capital per worker). In some categories such as iron and steel, Canada was noticeably more

[17]No data could be presented on New South Wales in 1890 which was likely very similar to Victoria given its high capital intensity in 1900.

capital intensive by 1900. Over the next decade Canada moved well ahead of the other colonies in terms of capital per establishment and capital per worker. By 1910, both overall and in virtually every category of manufacturing, save food and tobacco products, Canada had become the most capital intensive country.
In summary, it seems that Canada was guilty of a low level of capital intensity relative to other settler economies up to the 1890s. From the 1890s Canadian manufacturing began catching-up in terms of capital intensity, a process that was complete before World War One. This epoch of capital accumulation in Canadian manufacturing from the 1890s to World War One coincides directly with the onset of the Canadian Wheat Boom and Canada's overall process of catching-up on world leaders in terms of GDP per worker and GDP per capita. Hence, the aggregate picture is consistent with manufacturing success driven by capital accumulation in the late nineteenth century.

IV.3 Horse Power of Engines

The introduction of steam, gas, oil and electricity as a source of power in nineteenth century manufacturing heralded major advances in production.[18] If Canadian manufacturers operated at a smaller scale than their counterparts in other settler economies then one would expect a much lower usage of these advanced forms of power that require a greater capital investment. No data is available on the horse power of engines used in Canadian manufacturing before the 1901 census. A comparison of engine horse power by category of manufacturing for 1900 and 1910 are shown in table 3.3. In both 1900 and 1910 Canadian manufacturers were using significantly higher amounts of engine power in production. The Australasian colonies were using between one third and one half the horse power generated from engines while the Cape Colony was using only one tenth. Canada was using particularly high levels of engine power in the production of iron and steel products, leather products and land vehicles. The only categories of manufacturing where Canada exhibited a relatively low usage of engine power were clay, stone and glass products and tobacco products. Again these results imply a larger scale of production and a higher capital intensity in Canadian manufacturing relative to other settler economies from at least 1900 and possibly earlier. It is likely given the evidence presented above that capital intensity coupled with the use of engine power were higher in Canadian manufacturing around 1890. This suggests that capital accumulation during the 1880s and 1890s played a key role in Canada's ability to overtake its ri-

[18] I have excluded water, wind and horse power from measures of motive power.

val settler economies in net output per establishment around the turn of the century.

IV.4 Resource Intensity

Arguments on the success of American manufacturing have often focused on the liberal use of resources in production. American manufacturing firms in the long nineteenth century had high levels of output per worker due partially to a more capital intensive process of production and partially to a more resource intensive one. Assuming similar levels of labour force participation, high levels of output per worker meant high levels of output per capita. Hence resource use was a key element in the United States becoming the world leader in per capita incomes. No attempt has been made in the literature to determine if Canadian manufacturing, had a comparatively high or low resource intensity in the context of other settler economies. Table 3.4 indicates the amount of relative resources used per establishment and per worker.[19]

Canadian manufacturing does appear to have been relatively resource intensive in the long nineteenth century. This was particularly the case in 1900 when Canadian manufacturing establishments were using approximately twice the materials during production as compared with New Zealand or the Cape Colony. On a per worker basis, Canada was also more resource intensive than Victoria as early as 1900. Looking more closely at specific categories reveals iron and steel products, paper and printing products and chemicals to have been relatively resource intensive industries for Canada from the 1880s. By 1900, textiles had also emerged as one of the most relatively resource intensive areas of Canadian manufacturing. By contrast, the manufacture of food products was always less resource intensive in Canada over the long nineteenth century.

As with capital, Canadian manufacturers were generally using relatively low levels of resources in production during the 1880s. This observation was changing in many categories of manufacturing by 1890 and had turned on its head in 1900. All of these facts point to a larger scale of production in Canadian manufacturing around the turn of the twentieth century that was both capital intensive and resource intensive in relation to other settler economies. The areas of Canadian manufacturing that exhibited the highest relative capital and resource intensity were significant industries of the second industrial revolution: iron and steel, paper and chemicals.

[19] Resources include raw, crude and intermediate materials used.

V Growth Accounting

Several recent studies have claimed that Canadian failure relative to the United States in the nineteenth century was simply the product of a reliance on labour productivity as a tool for cross country comparisons of efficiency. Keay (2000)[47] argued that estimates of TFP showed no evidence of technical inefficiency on behalf of Canadian manufacturers (relative to American manufacturers). TFP was calculated for Canadian and American industries using a Tornqvist index, assuming underlying translog cost and production functions, Constant Returns to Scale (CRS) in production and Hicks-neutral multiplicatively separable productivity parameters.[20] His results indicated that from the mid-1920s Canadian firms were at least as technically efficient as American firms and in some industries they were more efficient. Other studies, such as Baldwin and Gorecki (1986)[6] have also found a high relative TFP in Canadian manufacturing for the interwar period. Hence an important consideration in this paper is to provide a comprehensive comparison of Canadian manufacturing in the context of settler economies by adopting methods that measure TFP.

One method used to explain the combined sources of output growth is growth accounting. Growth accounting is conducted in order to decompose changes in net output into various components. If we begin with a Cobb-Douglas production function with Constant Returns to Scale (CRS) and Hicks neutral technological change:

$$Y_t = A_t K_t^{\alpha} L_t^{(1-\alpha)} \tag{3.1}$$

where Y_t is net output in period t, A_t is the residual or TFP in period t, K_t is a measure of capital in period t and L_t is a measure of labour in period t.

Using continuous time, taking logarithms and the derivative with respect to time yields the following:

$$\frac{\dot{Y}}{Y} = \frac{\dot{A}}{A} + \alpha\frac{\dot{K}}{K} + (1-\alpha)\frac{\dot{L}}{L} \tag{3.2}$$

where $\frac{\dot{Y}}{Y}$ is the growth rate in net output, $\frac{\dot{A}}{A}$ is the growth residual or TFP, $\frac{\dot{K}}{K}$ is

[20] These assumptions allow calculation of a cost based Tornqvist index given by:
$\frac{A^i}{A^j} = \frac{W_L^i}{W_L^j}^{0.5(SL^i+SL^j)} \frac{W_M^i}{W_M^j}^{0.5(SL^i+SL^j)} \frac{W_K^i}{W_K^j}^{0.5(SL^i+SL^j)} \frac{P^j}{P^i}$
and a production based Tornqvist index given by:
$\frac{A^i}{A^j} = \frac{\frac{Q}{L}^i}{\frac{Q}{L}^j}^{0.5(SL^i+SL^j)} \frac{\frac{Q}{M}^i}{\frac{Q}{M}^j}^{0.5(SL^i+SL^j)} \frac{\frac{Q}{K}^i}{\frac{Q}{K}^j}^{0.5(SL^i+SL^j)}$.

the growth rate in the capital stock and $\frac{\dot{L}}{L}$ is the growth rate in labour employed. Note that α and $1-\alpha$ reflect the payments to capital and labour and α is generally assumed to be between 0.4 and 0.5.

Applying growth accounting to data on the number of hands employed, capital owned and value added in manufacturing during census years allows the estimation of overall efficiency or TFP. Table 3.6 displays the annual estimated growth rates of capital, labour, productivity and net output over several decades.[21] Canadian output growth lagged Victoria but was still relatively strong during the 1880s. This was largely the result of capital accumulation with almost no growth in TFP. Canada did poorly in the 1890s relative to other periods but managed to avoid the sort of serious downturn that Australia experienced during this period. The first decade of the twentieth century was a boom period for Canada with an extremely strong annual output growth rate of 9.9% in manufacturing. This boom was driven by exceptional growth in both capital and TFP. Canadian manufacturing performed exceptionally well during this period relative to other settler economies. While growth accounting and observations on manufacturing are valuable, a more comprehensive approach is required. Growth rates say nothing about the relative level of efficiency which can only be estimated using a more intensive method. The next section outlines how such a method can be undertaken.

VI Data Envelopment Analysis

VI.1 Theoretical Approach

As was discussed in the introduction, there has been a recent push to consider Canadian manufacturing performance on the basis of total rather than partial efficiency measures. The advantage in moving from partial to TFP is in the combination of all inputs into a single ratio which avoids the loss of information. Traditional estimation of relative TFP in the method described above implies TFP is a weighted average of relative partial productivities. Hence, this measure still relies on partial factor productivity estimates for each input as well as the choice of weights and the assumptions of CRS production and Hicks-neutral multiplicatively separable pro-

[21]Keeping in mind that no accurate price series exists for manufacturing categories and there is little data available on quantities I have simply presented growth rates based on original series in current rather than constant prices. As the framework is meant to be comparative across countries rather than over time I believe this is an acceptable approach.

duction or Hicks-neutral technological change. Data Envelopment Analysis (DEA) permits the estimation of a combined measure of partial factor productivity for each input that is not dependent on any limiting assumptions. By solving a series of Linear Programming (LP) problems DEA estimation provides an aggregate measure of efficiency with the most optimal weights assigned to each input. DEA is conducted as follows,

If we are interested in calculating relative efficiency in Canadian manufacturing industries then partial factor productivity for a given input in a given industry is calculated as:

$$\theta_x^i = \frac{Output}{Input} = \frac{Q^i}{x^i} \tag{3.3}$$

where Q represents output in industry i and x represents one of the factors of production in industry i.

If we wanted to determine TFP in a given industry using the traditional limiting assumptions it could be calculated as:

$$\theta_{x,y,z}^i = \frac{WeightedOutput}{WeightedInput} = \left(\frac{Q^i}{x^i}\right)^{\alpha} \left(\frac{Q^i}{y^i}\right)^{\beta} \left(\frac{Q^i}{z^i}\right)^{1-\alpha-\beta} \tag{3.4}$$

where Q represents output in industry i and x,y,z represent the three factors of production in industry i.

To determine relative efficiency we can then compare TFP for Canadian manufacturers in industry i against TFP for manufacturers in other countries in industry i. This would require guesses for α and β in addition to the other limiting assumptions. Alternatively, we could use DEA in order to determine relative efficiency.[22] If we utilised DEA, efficiency in a given industry for each country would be calculated as:

$$\theta_c^i = \frac{VirtualOutput}{VirtualInput} = \frac{Q_c^i}{v_1 x_c^i + v_2 y_c^i + v_3 z_c^i} \tag{3.5}$$

where Q represents output in industry i and country c, x,y,z represent the three

[22]For a good description of the general theories of DEA see Cooper, Seiford and Tone (2006)[23].

factors of production in industry i and $v_j(j = 1, 2, 3)$ represent the three weights on inputs when the optimal solution to the LP problem is obtained.

For industry i in Canada the Fractional Problem assuming CRS can be solved as:

$$\theta^{i^*}{}_{CAN} = \max_{v_j^i} \frac{Q^i_{CAN}}{v^i_1 x^i_{CAN} + v^i_2 y^i_{CAN} + v^i_3 z^i_{CAN}} \tag{3.6}$$

subject to

$$\begin{aligned} \frac{Q^i_c}{v^i_1 x^i_c + v^i_2 y^i_c + v^i_3 z^i_c} &\leq 1 \quad \forall c = CAN, VIC, NSW, NZL, CPE \\ v^i_1, v^i_2, v^i_3 &\geq 0 \end{aligned}$$

The same LP problem is solved simultaneously for each country in industry i. The constraints imply that the ratio of 'virtual outputs' over 'virtual inputs' should not exceed 1 for every country (a value of 1 implies the country is on the frontier and fully efficient in industry i).[23]

The model above assumes Constant Returns to Scale (CRS) production and solves for input oriented efficiency.[24] Output oriented efficiency can easily be calculated in addition to input oriented efficiency, I leave the models from this analysis. The assumption of Constant Returns to Scale can also be replaced with one of Variable Returns to Scale (Increasing or Decreasing Returns to Scale). Variable Returns to Scale (VRS) requires an additional constraint be added to the LP problem that forces the efficiency frontier to be a convex hull around the production possibility set.[25]

Solving the CRS model and the VRS model provide two efficiency values for each country in a given industry. These specifications of the efficiency measure allow efficiency to be decomposed into pure technical efficiency and scale efficiency. The relationship is given by:

Technical Efficiency (θ_{CRS}) = Pure Technical Efficiency (θ_{VRS}) x Scale Efficiency $(\frac{\theta_{CRS}}{\theta_{VRS}})$

[23] While this method is theoretically valid it is simpler to replace this problem with the Linear Programming problem which is equivalent. See the appendix for a complete description of the methods used.

[24] Input efficiency is when output is held fixed and inputs can be reduced to improve efficiency.

[25] The constraint would be $\lambda_{CAN} + \lambda_{VIC} + ... + \lambda_{CPE} = 1$ if added to the DLP problem.

Another issue is in the calculation of technical efficiency rather than allocative efficiency. Technical efficiency is useful in cases where input costs are unknown and some measure of efficiency is required. The problem in using technical efficiency is that it measures only advantages in technology and ignores advantages in input costs. If significant cost advantages exist then the seemingly excessive use of some inputs may still be cost minimising and manufacturers may be achieving allocative efficiency but not technical efficiency. Fortunately, another advantage of DEA is that it can be used to discern relative allocative efficiency. Allocative efficiency is given by the relationship:

Overall Efficiency (Cost Minimisation) = Allocative Efficiency x Technical Efficiency

Technical efficiency can be calculated by solving the LP problem given above. Allocative efficiency is a residual efficiency after solving for technical efficiency and overall efficiency. Overall efficiency can be calculated by solving an LP problem that minimises input costs as follows:

$$\theta_{px}^{i*} = \min_{x^i,\lambda^i} p^i x^i \tag{3.7}$$

subject to

$$\begin{aligned} x^i &\leq X^i \lambda^i \\ Q_c^i &\leq Q^i \lambda^i \\ \lambda^i &\geq 0 \end{aligned}$$

where $p^i = (p_1^i, p_2^i, p_3^i)$ is the input-price or unit-cost vector for each country in industry i. X^i is an $(3x5)$ matrix of inputs for each country in industry i. Q^i is a $(1x5)$ vector of outputs for each country in industry i. $\lambda^i = (\lambda_{CAN}^i, \lambda_{VIC}^i, ..., \lambda_{CPE}^i)$ is a non-negative vector of variables in industry i. Q_c^i represents a minimum output level of country c that is maintained whilst reducing inputs radially. This approach is only appropriate when common input costs exit, which is not the case in a cross-country analysis on production. Hence, this model will fail to recognise the existence of other cheaper input mixes. A slight adjustment to both the LP problem for technical efficiency and overall efficiency yields the correct results. This new approach discovered by Tone (2002)[109] recognises efficiency differences between decision making units (countries in this case) that would be indistinguishable if the standard model of cost minimisation were applied.[26]

VI.2 Empirical Analysis

Results from solving the various LP problems are displayed for each census year in tables 3.7 - 3.9. A value of 1 indicates full efficiency given the sample group. In this case full efficiency implies that a country is on the 'settler efficiency frontier' in a particular area of manufacturing. Inputs in the LP problem are the value of wages, value of fixed capital (land, buildings and equipment) and the value of materials used. Output is gross output rather than net output (it is appropriate to use gross output since materials used in production are included in the model as an input). Unit-input-costs and the number of unit-inputs are irrelevant since the model requires unit-values (cost x units) and a vector of ones to solve the LP problem. The value of wages paid for each industry were available for all countries in 1910 but were unavailable for Victoria and the Cape Colony in 1900 and 1890. Where missing, wages were estimated using the number of hands employed in missing years and the relationship between wages and numbers employed in 1910 for each manufacturing category.[27] Value of fixed capital has been used rather than machinery alone as there was little difference in the results and greater data available on combined fixed capital. Some general observations on the results follow.

The average of all categories indicates that manufacturers in Ontario and Quebec had the highest level of overall efficiency in 1890, 1900 and 1910. The gap between Canada and the other settler economies in overall efficiency was actually most pronounced in 1890. This was at least partially the result of New South Wales being excluded from the 1890 LP problem. Although no comparison with New South Wales was possible for 1890 there are clear signs that it was the closest rival to Canada in manufacturing. In 1900 New South Wales had 95% of the Canadian level of average overall efficiency.[28] This figure had risen to virtual parity by 1910 (average overall efficiency for New South Wales was 99% of the Canadian level). New Zealand was also a relatively efficient manufacturer compared with the other settler

[26]See the appendix for the new cost and new technology formulations under different unit-costs using the Tone(2002)[109] approach.

[27]Alternative methods for estimating wages taking into account the number of hands employed were also attempted, for example the relative relationship between Canadian wages paid per worker and Australian wages per worker were fixed in 1910 and applied to previous years. Almost no change in the solution to LP models resulted from alternative methods and so they have been excluded from the results.

[28]Calculated as $0.856/0.902 = 0.95$.

economies with 75% of Canada's average overall efficiency in 1890.[29] This figure was 85% in 1900 and 81% in 1910. Victoria and the Cape Colony had caught-up significantly by 1910 but an efficiency gap with Canada remained.

Breaking overall efficiency down into allocative efficiency and technical efficiency explains the gap. In 1890 there was a much smaller gap between Canada and the other settler economies in terms of average technical efficiency than in terms of average allocative efficiency. New Zealand was on par with Canada in terms of average technical efficiency while Victoria had 95% of Canadian average technical efficiency.[30] In 1900 virtually all of the settler economies were on par in terms of average technical efficiency aside from the Cape Colony which had progressed little since 1890. Only Victoria had backtracked, presumably a result of the precarious conditions it faced in the 1890s. By 1910 Victoria had rebounded in terms of average technical efficiency and had reached 97% of the Canadian level. The Cape Colony had made marginal progress sitting at 89% of the Canadian level.

The gap in technical efficiency can be further divided into scale efficiency and pure technical efficiency. Scale efficiency was similar amongst settler economies in 1890, implying that technical efficiency gaps were almost entirely the result of pure technical inefficiencies. In 1900 substantial gaps in scale efficiency arose between countries. Victoria and the Cape Colony each had 10% lower levels of average scale efficiency than Canada. Similar scale inefficiencies existed in the Cape Colony in 1910 but had largely disappeared in Victoria. Overall we can conclude that issues in technical efficiency were essentially issues of pure technical inefficiency (distance to the frontier of production) rather than issues in scale inefficiency (distance between the Constant Returns to Scale frontier and the Variable Returns to Scale frontier).

In terms of average allocative efficiency Canada did have a substantial advantage in the nineteenth century. In 1890, Victoria, New Zealand and the Cape Colony all had approximately 70% of the Canadian level of average allocative efficiency. By 1900 Victoria and New Zealand had 83% and 87% of Canada's efficiency respectively, an improvement but a substantial gap still persisted. Meanwhile the Cape Colony had fallen behind with only 64% of the Canadian level of average allocative efficiency. As Cape Colony data are from 1903 rather than 1900 there could have been substantial price shocks around the Boar War or the recession of the early 1900s that limited allocative efficiency. In 1910 the Cape Colony had rebounded and caught up to New Zealand in terms of average allocative efficiency at around 86% of the Canadian level. New South Wales was on par with Canada while Victoria was about

[29] Calculated as 0.725/0.968 = 0.75.

[30] New Zealand calculated as (0.978/0.992 = 0.99), Victoria calculated as (0.941/0.992 = 95%).

10% under the Canadian level of efficiency.

Analysis by industry reveals that Canada was on the manufacturing frontier in terms of overall efficiency in thirteen of the seventeen categories in 1890 and seven of the seventeen categories in 1900 and 1910. Canada was fully efficient throughout the long nineteenth century in only three categories: clay, glass and stone products, tobacco and its manufactures, and vehicles for land. Other notable categories where Canada never fell below an overall efficiency value of 90% were iron and steel products, timber and lumber products and chemical and allied products. These results may surprise some readers since they do not suggest a manufacturing sector that was highly dependent on staple linkages. Of the several new and advanced areas of manufacturing in the second industrial revolution Canada seems the most successful. The only other settler economy to compare favourably in overall efficiency in this respect was New South Wales, which also had 100% overall efficiency scores in seven of the seventeen categories in 1900 and 1910. The most advanced categories included metal and its manufactures and power and light in both years.

Undoubtably Canada would have been behind the frontier in other categories in 1890, and had a lower average overall efficiency score, if New South Wales were included in that year. New Zealand was the only other colony on the frontier in any of the matched categories. New Zealand was on the frontier in four categories in 1890, three categories in 1900 and one category in 1910. Victoria and the Cape Colony were on the frontier in only one category in 1910 and these were the miscellaneous and unmatched categories. Clearly, Canada and New South Wales were significantly more advanced than the other colonies in terms of efficiency in areas of modern manufacturing before World War One. New Zealand was somewhere in the middle with Victoria and the Cape Colony operating at much lower levels of TFP in several advanced industries.

Analysis of allocative efficiency and technical efficiency indicates that any issues were largely due to allocative and not technical inefficiency. Ontario and Quebec had full technical efficiency in sixteen out of seventeen categories of manufacturing in 1890 and 1900, and fourteen out of seventeen categories in 1910. In other words, in several categories Canada was on the technological frontier but was less than fully efficient overall because of relative input costs (wage rates, resource prices and the rental rate of capital). By contrast other settler economies faced issues of both allocative and technical inefficiency. For example, the Cape Colony was on the technology frontier in only five of the seventeen categories. These results conform well with recent studies that have found nineteenth century Canadian manufacturers to have been relatively strong in measures of TFP despite operating at a smaller scale than their American counterparts and having lower levels of labour productivity. Manufacturing in Ontario and Quebec faced some cost disadvantages when compared with other settler economies but they were technically efficient and in many cases were operating on the technology frontier for settler economies.

VII A Case Study: Agricultural Implements

Theories of directed technical change suggest that settler economies sought to develop labour saving technology due to their relative abundance of land and relative scarcity of labour. In many settler economies this process was manifested in the rapid advancement of agricultural machinery. As highlighted in the introduction, Canadian manufacturers of agricultural implements received great fanfare at home and abroad. For some time after Confederation the sector remained small scale with numerous operations producing implements for domestic consumption. The Massey Company and the Harris Company made trips to the United States and were influenced by American techniques. According to Norrie and Owram (1991)[66] the industry began to change in the 1880s when a protective tariff on agricultural implements was raised from 17% to 35%. Output increased significantly in the 1890s until World War One and the industry became more concentrated. The Canadian market became dominated by several large scale producers. The Massey and Harris company combined and absorbed the Patterson-Wisner company making it a major player in the industry. A plant was opened in the United States in 1910 giving it multinational status. The slightly smaller Cockshutt company and a branch plant of the American company International Harvester were also important manufacturers. In total, 221 firms produced \$7.5 million of output in 1890, 114 firms produced \$9.6 million of output in 1900 and 88 firms produced \$20.7 million of output in 1910.[31] Employment almost doubled over the same period and the value of capital had risen by a factor of five.

Near the end of the nineteenth century Canadian agricultural implement makers began to export their products abroad. Figure B.1 displays the increasing share of agricultural implement exports out of total exports. In the early 1890s agricultural implement exports made up less than half a percent of total exports for Canada. This figure increased rapidly after 1896, in line with the growing agricultural boom in Canada and its spill-over effects on manufacturing production. By World War One agricultural implements made up approximately 2% of total Canadian exports.

[31] Norrie and Owram (1991)[66] based on census data.

This was a period of rapid export growth, hence we can conclude that agricultural implements were being exported on a significantly larger scale in 1910 than in 1890. Figure B.2 indicates that much of this increase in the export of agricultural implements was the result of growing demand in other settler economies. There was little change in the share of agricultural implement exports going to the United States and a falling share going to Britain. Other settler economies had rapidly growing agricultural sectors that required an influx of new implements. It is interesting that linkages did not develop this area of manufacturing in other settler economies as in Canada. Perhaps the influence of American technology and skills were essential in developing this type of secondary manufacturing. For whatever reason, virtually no agricultural implements were imported into Canada from other settler economies. Demand was satisfied by domestic production and imports from the United States, which made up close to 99% of the share of agricultural implement imports into Canada before World War One.

Table B.8 displays various cross-country characteristics of agricultural implement manufacturers. Production of agricultural implements in Ontario and Quebec were more labour intensive than in Victoria or New Zealand in 1890. Each worker had significantly less capital in Canada and this led to a lower level of labour productivity. In 1900 the scale of production had increased dramatically in Ontario and Quebec. Canadian implement manufacturers had a much higher level of capital per worker, more resources were used in production and yet the number of employees per establishment remained much higher than in other settler economies. As a result Canada was generating significantly more value added per establishment and per worker in this sector. The process of capital accumulation continued through the 1900s and by 1910 capital per establishment was extremely high in Ontario and Quebec. Firms had reduced the number of workers per establishment but they had replaced these workers with a substantial investment in fixed capital. Value added per establishment and labour productivity were very high in Canada relative to other settler economies.

Turning again to DEA allows the estimation of overall efficiency in agricultural implement manufacturing. Table B.9 displays the results after solving the various LP problems. In terms of overall efficiency, implement manufacturers in Canada were slightly less efficient than their counterparts in Australia in 1890. Technical efficiency was an issue, however this was the result of pure technical inefficiency rather than scale inefficiency. In 1900 Canada was on the frontier in implement manufacturing. Victoria had issues of pure technical inefficiency while New South Wales and New Zealand had issues of allocative inefficiency. By 1910 Canada was no longer on the frontier in terms of overall efficiency. This was likely the result of the large investment in fixed capital during the boom period of the early 1900s. The issue appears to have been allocative inefficiency rather than issues of pure technical inefficiency or scale inefficiency. Although Canada was producing more value added per establishment there were issues in the degree of inputs used given relative factor prices. In summary, the results seem to conform well to the observations made by other authors and contemporary accounts. Agricultural implement manufacturers in Canada were growing in scale from the 1890s and were increasing their levels of output and efficiency dramatically. The sector looks to have been highly efficient at the turn of the century relative to other settler economies and was able not only to satisfy domestic demand but to export implements to other settler economies. Combined with previous analysis there is ample reason to believe that agricultural implement production was generally representative of Canadian manufacturing in several new and important second industrial revolution categories such as iron and steel, chemicals and automobiles.

VIII Conclusion

After six months and over 5 million visitors the Indian and Colonial Exhibit closed on the 10th November 1886. Few could argue that Canada, particularly due to its manufactured products, hadn't captured the Empire's attention. The *New South Wales Herald* described the Canadian exhibit as 'beautifully designed' with 'manufactures shown very extensively'. *The Auckland Weekly News* declared that Canada confronts the old world by pointing to 'her labour-saving machinery, her fisheries, her wool, her furniture, her sewing machines, to her pianos, organs, tweeds and woollen goods.' At the close of the exhibit guests remarked that Canada was 'one of the brightest jewels in the British Crown and certain to make enormous advances in the immediate future.'[32]

This paper has shown that optimism proved to be rightly founded, even if it may have been as yet unrealised in 1886. Canada was still a laggard in terms of the capital intensity and scale of manufacturing in the 1880s but this was a period of transition. Sometime in the 1890s things changed. Canadian manufacturing increased its capital intensity, resource intensity and labour productivity dramatically. Other settler economies had fallen behind Canada by the turn of the century in all of the key

[32] Comments on the exhibit from various newspapers were summarised in *The Standard*, November 1886.

statistics. DEA reveals that Canadian firms were already ahead in measures of total rather than partial factor productivity by 1890. In several important categories of manufacturing Canada was well ahead in allocative and technical efficiency. All of this lends weight to the argument that Canadian manufacturing had advanced substantially from the late 1880s on the back of policy changes and westward expansion. This paper confirms that Canadian manufacturing was performing well as early as 1890 when placed in the context of other settler economies rather than the United States.

Table 3.1: Share of Value Added in Manufacturing

Canada				Victoria				New Zealand			
Category	1890	1900	1910	Category	1890	1900	1910	Category	1890	1900	1910
Food & Drink	16.9	18.7	18.5	Food & Drink	24.9	36.5	24.0	Food & Drink	42.2	48.3	24.9
Textiles	15.1	15.3	11.3	Clothing & Textiles	11.1	18.5	20.2	Textiles	12.4	11.4	16.7
Iron, Steel & Metals	11.8	14.9	17.9	Metals & Jewellery	19.5	15.3	18.2	Metal Works	6.5	6.6	9.5
Timber & Lumber	19.5	19.2	16.0	Wood & Furniture	17.0	7.0	8.2	Wood & Furniture	15.0	14.4	16.4
Leather Products	7.5	6.1	5.0	Leatherware	0.2	0.2	0.5	Harness & Saddlery	10.7	5.7	3.3
Paper & Printing	3.8	6.2	5.2	Paper & Printing	10.5	8.2	9.8	Paper & Books	4.6	5.1	10.0
Chemicals & Allied	1.8	2.2	2.4	Chemals & Oils	2.3	2.6	4.0	Chemicals	0.3	0.4	0.2
Clay, Glass & Stone	3.7	2.9	3.9	Stone, Clay & Glass	7.1	4.0	4.3	Stone, Clay & Glass	1.4	1.6	3.7
Vehicles for Land	5.0	4.4	6.2	Vehicles & Saddlery	3.4	2.9	3.3	Carriages & Vehicles	1.8	1.6	2.7
Vehicles for Water	1.0	0.6	0.8	Shipbuilding	0.1	0.2	0.2	Ships & Boats	0.8	0.5	1.3
Miscellaneous	13.5	9.5	12.6	Small Wares & Power	4.1	4.7	7.4	Small Wares & Power	4.3	4.4	11.4
Total	100.0	100.0	100.0	Total	100.0	100.0	100.0	Total	100.0	100.0	100.0

Sources: See appendix tables B.3-B.7 for list of sources. See section III.1 for a description of data.

Notes: Categories are not matched across countries, for example saddlery is included with vehicles for land in Victoria and not leather. Food & Drink includes tobacco products in Canada and raw materials and animal products in Victoria and New Zealand

Table 3.2: Relative Capital Intensity

Machinery Per Establishment (Ontario & Quebec = 100)																
	1880				1890				1900				1910			
Category	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE
Food Products	482	–	247	–	1134	–	402	211	772	1340	520	426	463	800	450	295
Textiles	594	–	816	–	951	–	790	38	56	21	45	3	21	18	21	2
Iron & Steel	165	–	139	–	171	–	78	24	49	49	31	30	14	23	14	13
Timber & Lumber	411	–	872	–	398	–	276	136	64	50	63	31	35	46	82	34
Leather Products	804	–	623	–	971	–	478	643	43	40	24	19	23	33	18	22
Paper & Printing	160	–	104	–	182	–	69	116	67	45	40	47	33	35	36	35
Liquors & Drinks	136	–	120	–	247	–	48	162	52	30	15	42	42	35	21	47
Chemicals & Drugs	155	–	545	–	492	–	225	139	78	98	42	23	31	38	17	16
Clay, Glass, & Stone	686	–	731	–	809	–	285	137	492	389	224	501	51	115	78	24
Metal Manufactures	1093	–	796	–	757	–	106	75	36	447	9	9	7	123	4	3
Tobacco Products	322	–	–	–	513	–	–	37	405	638	–	70	412	499	7	101
Vehicles for Land	421	–	386	–	325	–	126	102	97	110	15	24	22	56	145	8
Vehicles for Water	1598	–	299	–	2177	–	2785	3553	318	512	294	415	182	285	19	–
Miscellaneous	265	–	449	–	234	–	220	110	46	83	22	84	32	38	14	20
Power & Light	1071	–	640	–	767	–	393	186	38	27	92	175	47	22	29	89
Hand Trades	6945	–	383	–	5908	–	320	1731	394	3	4	85	204	10	9	299
Unmatched	1051	–	175	–	272	–	336	–	7	9	23	8	5	12	37	6
TOTAL	710	–	665	–	857	–	348	185	99	111	68	56	45	71	50	55

Machinery Per Worker (Ontario & Quebec = 100)																
	1880				1890				1900				1910			
Category	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE
Food Products	164	–	168	–	315	–	181	124	250	364	282	223	124	219	199	107
Textiles	187	–	340	–	207	–	205	33	77	43	100	17	42	35	70	9
Iron & Steel	135	–	102	–	125	–	95	81	96	77	57	80	46	47	48	46
Timber & Lumber	163	–	314	–	158	–	160	82	98	97	107	75	50	69	154	44
Leather Products	171	–	138	–	174	–	83	207	80	93	84	107	44	77	71	37
Paper & Printing	105	–	120	–	119	–	74	134	81	73	72	73	50	59	75	53
Liquors & Drinks	121	–	239	–	167	–	98	147	87	73	55	97	68	72	64	67
Chemicals & Drugs	183	–	268	–	284	–	306	44	159	133	158	26	56	57	69	30
Clay, Glass, & Stone	455	–	801	–	376	–	394	72	348	367	354	289	61	121	148	43
Metal Manufactures	226	–	186	–	199	–	54	53	56	216	37	30	23	138	24	14
Tobacco Products	280	–	–	–	337	–	–	140	226	378	–	191	156	212	199	150
Vehicles for Land	165	–	208	–	116	–	98	76	100	77	41	53	50	79	500	28
Vehicles for Water	1340	–	915	–	792	–	3331	2054	1520	480	3151	815	569	184	37	–
Miscellaneous	254	–	477	–	241	–	262	257	103	229	78	64	61	113	66	38
Power & Light	1439	–	676	–	610	–	846	323	110	102	228	72	49	49	64	60
Hand Trades	1051	–	188	–	1257	–	111	438	191	11	20	80	140	38	74	544
Unmatched	441	–	131	–	212	–	225	–	16	6	123	17	8	32	110	12
TOTAL	241	–	305	–	243	–	205	122	106	126	119	104	53	82	97	80

Sources: See appendix tables B.3-B.7 for list of sources. See section III.1 for a description of data.
Notes: Machinery includes Plant, Tools & Implements. Machinery for Ontario & Quebec in 1880 (1910) are based on the breakdown of Total Capital in each subcategory of manufacturing for 1890 (1900). Canadian $ converted to £sterling at 4s 2d per $. New Zealand data are for 1885 and not 1880.

Table 3.3: Horse Power Used

Horse Power Per Establishment (Ontario & Quebec = 100)								
	1900				1910			
Category	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE
Food Products	351	492	372	151	214	335	303	132
Textiles	50	17	52	0	24	23	41	0
Iron & Steel	18	19	20	17	9	21	15	8
Timber & Lumber	20	20	29	6	20	33	39	17
Leather Products	14	19	11	10	17	32	17	15
Paper & Printing	40	22	26	16	18	24	29	13
Liquors & Drinks	20	16	11	25	26	17	15	23
Chemicals & Drugs	21	19	26	5	47	52	26	35
Clay, Glass, & Stone	166	134	130	175	29	65	60	8
Metal Manufactures	10	351	2	1	4	134	3	2
Tobacco Products	122	151	–	113	291	749	16	87
Vehicles for Land	20	30	6	9	6	30	6	5
Vehicles for Water	65	114	33	40	153	113	14	–
Miscellaneous	20	26	20	52	16	22	13	12
Power & Light	20	10	15	51	38	90	50	41
Hand Trades	133	4	6	96	44	13	7	54
Unmatched	11	4	23	3	6	9	35	6
TOTAL	39	44	38	20	25	74	40	21

Sources: See appendix tables B.3-B.7 for list of sources. See section III.1 for a description of data.

Notes: Horse Power is for steam, gas, oil & electric engines only (excludes water wheels).

Table 3.4: Relative Resource Intensity

Materials Used Per Establishment (Ontario & Quebec = 100)	1880				1890				1900				1910			
Category	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE
Food Products	279	–	92	–	601	–	143	154	315	379	122	178	421	517	392	144
Textiles	406	–	160	–	859	–	245	108	68	42	44	18	25	26	18	9
Iron & Steel	94	–	79	–	155	–	73	17	48	58	57	62	17	32	16	9
Timber & Lumber	438	–	38	–	419	–	77	253	57	78	10	59	60	81	56	36
Leather Products	611	–	392	–	782	–	757	838	50	28	41	16	45	66	46	32
Paper & Printing	131	–	23	–	165	–	37	50	56	37	31	37	41	29	20	21
Liquors & Drinks	136	–	39	–	188	–	46	125	69	36	29	56	53	45	35	61
Chemicals & Drugs	79	–	10	–	209	–	82	30	34	65	43	27	46	76	27	15
Clay, Glass, & Stone	180	–	33	–	116	–	6	99	350	221	85	315	80	100	84	28
Metal Manufactures	836	–	602	–	598	–	92	61	43	559	19	14	11	182	7	4
Tobacco Products	222	–	–	–	237	–	–	31	226	516	–	63	245	426	7	71
Vehicles for Land	207	–	117	–	181	–	67	113	62	77	17	29	17	23	9	11
Vehicles for Water	33	–	61	–	90	–	121	230	22	121	14	13	28	115	36	–
Miscellaneous	182	–	122	–	170	–	90	100	42	48	26	290	44	56	20	62
Power & Light	97	–	61	–	221	–	68	63	56	45	53	306	57	45	55	72
Hand Trades	1716	–	45	–	1525	–	846	804	179	19	8	35	262	30	4	216
Unmatched	1300	–	81	–	112	–	831	–	23	102	41	34	18	16	103	22
TOTAL	395	–	136	–	480	–	191	198	92	100	51	56	65	97	69	53

Materials Used Per Worker (Ontario & Quebec = 100)	1880				1890				1900				1910			
Category	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE
Food Products	95	–	62	–	167	–	64	90	102	103	66	93	112	141	173	52
Textiles	128	–	67	–	187	–	63	94	94	85	96	92	50	50	59	44
Iron & Steel	77	–	58	–	113	–	88	58	95	91	106	165	55	66	55	33
Timber & Lumber	174	–	14	–	166	–	45	152	87	149	17	143	86	123	104	47
Leather Products	130	–	87	–	140	–	131	270	93	65	140	90	87	156	185	54
Paper & Printing	85	–	27	–	108	–	40	58	68	60	57	58	63	50	42	32
Liquors & Drinks	122	–	78	–	127	–	94	114	116	87	106	131	85	94	105	87
Chemicals & Drugs	93	–	5	–	121	–	112	9	70	88	162	31	83	116	112	27
Clay, Glass, & Stone	120	–	36	–	54	–	8	53	248	209	135	182	95	106	159	52
Metal Manufactures	173	–	140	–	157	–	47	43	68	270	78	50	35	204	42	19
Tobacco Products	193	–	–	–	155	–	–	118	126	306	–	172	93	181	183	105
Vehicles for Land	81	–	63	–	65	–	52	85	64	54	49	66	39	32	32	37
Vehicles for Water	27	–	187	–	33	–	144	133	105	114	147	26	89	74	69	–
Miscellaneous	174	–	130	–	176	–	107	233	94	133	96	223	84	165	96	117
Power & Light	131	–	65	–	175	–	147	109	162	170	133	126	60	101	121	49
Hand Trades	260	–	22	–	324	–	294	203	87	74	44	33	180	119	32	392
Unmatched	545	–	61	–	87	–	538	–	52	63	217	70	30	45	304	45
TOTAL	134	–	62	–	136	–	86	131	98	113	89	104	77	112	133	77

Sources: See appendix tables B.3-B.7 for list of sources. See section III.1 for a description of data.
Notes: Canadian $ converted to £s sterling at 4s 2d per $. New Zealand data are for 1885 and not 1880.

Table 3.5: Relative Output Generated

Net Output Per Establishment (Ontario & Quebec = 100)																
	1880				1890				1900				1910			
Category	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE
Food Products	319	–	162	–	665	–	789	161	469	438	866	181	213	253	169	129
Textiles	435	–	337	–	529	–	296	77	49	43	37	16	21	26	17	14
Iron & Steel	89	–	135	–	143	–	62	20	38	56	43	31	19	31	20	4
Timber & Lumber	346	–	629	–	507	–	308	192	63	60	95	32	64	62	69	54
Leather Products	523	–	782	–	601	–	1007	327	35	28	32	10	22	22	15	21
Paper & Printing	166	–	68	–	216	–	63	109	52	62	51	77	41	33	41	38
Liquors & Drinks	111	–	58	–	143	–	46	48	41	44	27	20	19	19	12	14
Chemicals & Drugs	95	–	355	–	245	–	56	51	25	36	19	13	30	36	10	17
Clay, Glass, & Stone	250	–	167	–	302	–	80	108	138	137	74	100	56	77	45	15
Metal Manufactures	458	–	268	–	324	–	106	64	34	421	20	14	15	147	11	8
Tobacco Products	135	–	–	–	191	–	–	13	68	105	–	19	197	247	3	28
Vehicles for Land	215	–	250	–	170	–	109	83	56	106	24	27	22	41	25	8
Vehicles for Water	70	–	73	–	61	–	99	89	20	106	13	12	30	115	45	–
Miscellaneous	116	–	157	–	142	–	92	24	27	36	21	50	37	27	16	31
Power & Light	126	–	121	–	215	–	93	33	44	53	55	80	67	53	56	64
Hand Trades	1057	–	311	–	657	–	261	269	138	24	13	15	130	21	12	66
Unmatched	656	–	139	–	109	–	336	–	31	63	20	30	26	12	24	18
TOTAL	373	–	389	–	494	–	348	129	79	98	86	40	47	64	39	36

Net Output Per Worker (Ontario & Quebec = 100)																
	1880				1890				1900				1910			
Category	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE	VIC	NSW	NZL	CPE
Food Products	109	–	110	–	185	–	356	95	152	119	468	95	57	69	75	47
Textiles	137	–	140	–	115	–	77	68	68	87	81	86	41	50	57	68
Iron & Steel	73	–	100	–	104	–	75	66	75	87	80	83	62	64	70	13
Timber & Lumber	137	–	227	–	201	–	179	115	96	115	161	78	91	93	129	70
Leather Products	111	–	173	–	108	–	174	105	65	65	111	57	43	53	60	34
Paper & Printing	109	–	80	–	141	–	68	127	63	100	93	120	62	56	87	58
Liquors & Drinks	99	–	116	–	97	–	94	43	68	107	100	48	31	40	36	20
Chemicals & Drugs	112	–	175	–	141	–	76	16	51	49	73	15	55	54	40	31
Clay, Glass, & Stone	166	–	182	–	140	–	110	57	98	129	117	58	67	81	85	27
Metal Manufactures	95	–	62	–	85	–	54	45	54	204	80	48	49	165	67	36
Tobacco Products	117	–	–	–	125	–	–	49	38	62	–	51	75	105	86	41
Vehicles for Land	84	–	135	–	61	–	85	62	57	75	66	60	51	57	85	26
Vehicles for Water	59	–	224	–	22	–	119	52	98	100	134	24	93	74	85	–
Miscellaneous	111	–	167	–	146	–	109	57	60	99	76	38	71	80	74	58
Power & Light	169	–	127	–	171	–	201	58	126	201	136	33	70	119	124	44
Hand Trades	160	–	152	–	140	–	91	68	67	91	73	14	89	82	95	119
Unmatched	275	–	104	–	84	–	217	–	71	39	105	61	43	33	70	37
TOTAL	126	–	179	–	140	–	157	85	84	110	149	73	56	74	75	52

Sources: See appendix tables B.3-B.7 for list of sources. See section III.1 for a description of data.
Notes: Canadian $s converted to £s sterling at 4s 2d per $. New Zealand data are for 1885 and not 1880. Net Output is Gross Output less Materials Used.

Table 3.6: Annual Growth Rates in Manufacturing (%)

	1880-1890				1890-1900				1900-1910			
Colony	K	L	A	Y	K	L	A	Y	K	L	A	Y
Ontario & Quebec	7.7	3.4	0.0	5.1	2.7	-1.2	-0.6	-0.2	11.3	3.7	3.2	9.9
Victoria	8.4	4.0	1.0	6.8	-3.2	1.3	-2.4	-2.8	4.9	4.2	2.1	6.6
New South Wales	–	–	–	–	–	–	–	–	8.6	5.1	0.5	7.0
New Zealand	3.4	3.2	0.7	4.0	4.5	6.2	1.1	6.7	7.1	1.8	-3.2	0.8
Cape Colony	–	–	–	–	8.4	6.0	-1.6	5.4	0.9	-3.5	0.6	-1.1

Sources: See appendix tables B.3-B.7 for list of sources. See section III.1 for a description of data.

Notes: 0.4 was used as capital's share of output, 0.6 was used as labour's share of output. New Zealand data are for 1885-1890 not 1880-1890. K is Machinery & Plant, L is Hands Employed, A is Total Factor Productivity, Y is Net Output. All are were calculated in current prices.

Table 3.7: 1890 DEA Results

	Technical Efficiency					Scale Efficiency				
Category	CAN	VIC	NSW	NZL	CPE	CAN	VIC	NSW	NZL	CPE
Food	1.000	1.000	–	1.000	0.812	1.000	1.000	–	1.000	0.963
Textiles	1.000	1.000	–	1.000	0.800	1.000	1.000	–	1.000	1.000
Iron & Steel	–	0.956	–	0.910	1.000	–	0.956	–	0.993	1.000
Lumber	1.000	1.000	–	1.000	1.000	1.000	–	–	1.000	–
Leathers	0.868	0.791	–	1.000	1.000	1.000	1.000	–	1.000	1.000
Printing	1.000	1.000	–	0.918	1.000	1.000	1.000	–	1.000	1.000
Drinks	1.000	0.874	–	1.000	0.917	1.000	0.874	–	1.000	1.000
Chemicals	1.000	1.000	–	0.813	1.000	1.000	1.000	–	1.000	1.000
Clay, &c	1.000	0.957	–	1.000	0.974	1.000	0.957	–	1.000	0.995
Metals	1.000	1.000	–	1.000	0.946	1.000	1.000	–	1.000	1.000
Tobacco	1.000	0.959	–	–	0.740	1.000	0.959	–	–	1.000
Carriages	1.000	0.751	–	1.000	0.842	1.000	0.751	–	1.000	1.000
Ships	1.000	0.769	–	1.000	0.578	1.000	1.000	–	1.000	0.578
Misc.	1.000	1.000	–	1.000	1.000	1.000	1.000	–	1.000	1.000
Power	1.000	0.948	–	1.000	0.687	1.000	0.948	–	1.000	1.000
Trades	1.000	1.000	–	1.000	0.599	1.000	1.000	–	1.000	0.647
Other	1.000	0.984	–	1.000	–	1.000	0.984	–	1.000	–
AVERAGE	0.992	0.941	–	0.978	0.869	1.000	0.964	–	1.000	0.946

	Overall Efficiency					Allocative Efficiency				
Category	CAN	VIC	NSW	NZL	CPE	CAN	VIC	NSW	NZL	CPE
Food	0.777	0.648	–	1.000	0.681	0.777	0.648	–	1.000	0.839
Textiles	1.000	0.762	–	0.656	0.539	1.000	0.762	–	0.656	0.673
Iron & Steel	1.000	0.868	–	0.817	0.653	–	0.908	–	0.898	0.653
Lumber	0.999	0.954	–	1.000	0.964	0.999	0.954	–	1.000	0.964
Leathers	0.838	0.689	–	1.000	0.726	0.965	0.871	–	1.000	0.726
Printing	1.000	0.854	–	0.725	0.879	1.000	0.854	–	0.790	0.879
Drinks	1.000	0.588	–	0.867	0.721	1.000	0.673	–	0.867	0.786
Chemicals	1.000	0.737	–	0.640	0.326	1.000	0.737	–	0.787	0.326
Clay &c	1.000	0.526	–	0.444	0.824	1.000	0.549	–	0.444	0.846
Metals	1.000	0.603	–	0.616	0.212	1.000	0.603	–	0.616	0.224
Tobacco	1.000	0.668	–	–	0.599	1.000	0.696	–	–	0.809
Carriages	1.000	0.549	–	0.725	0.819	1.000	0.731	–	0.725	0.972
Ships	1.000	0.029	–	0.143	0.192	1.000	0.038	–	0.143	0.332
Misc.	1.000	0.853	–	0.800	0.718	1.000	0.853	–	0.800	0.718
Power	1.000	0.573	–	0.437	0.446	1.000	0.604	–	0.437	0.649
Trades	1.000	0.422	–	0.726	0.442	1.000	0.422	–	0.726	0.738
Other	0.833	0.372	–	1.000	–	0.833	0.378	–	1.000	–
AVERAGE	0.968	0.629	–	0.725	0.609	0.973	0.664	–	0.743	0.696

Sources: See appendix tables B.3-B.7 for list of sources. See section III.1 for a description of data.
Notes: Canadian $s converted to £s at 4s 2d per $. Inputs include Wages, Value of Fixed K (Land, Buildings & Machinery), and Value of Materials. Output is Value of Gross Output. Lumber includes timber, printing includes paper, drinks includes liquors, chemicals includes drugs, clay includes glass and stone, carriages includes all vehicles for land, ships includes all vehicles for water, power includes light, trades includes all hand trades, other includes all unmatched and undisclosed subcategories

Table 3.8: 1900 DEA Results

	Technical Efficiency					Scale Efficiency				
Category	CAN	VIC	NSW	NZL	CPE	CAN	VIC	NSW	NZL	CPE
Food	1.000	0.765	0.795	1.000	0.805	1.000	0.765	0.795	1.000	0.958
Textiles	1.000	0.862	1.000	0.919	0.955	1.000	0.960	1.000	0.919	0.955
Iron & Steel	1.000	0.882	1.000	1.000	0.977	1.000	0.882	1.000	1.000	0.977
Lumber	1.000	0.684	1.000	1.000	0.753	1.000	0.953	1.000	1.000	0.753
Leathers	1.000	0.890	0.999	1.000	0.864	1.000	0.988	0.999	1.000	0.864
Printing	1.000	0.682	1.000	0.915	1.000	1.000	0.940	1.000	0.915	1.000
Drinks	1.000	0.708	1.000	1.000	0.887	1.000	0.872	1.000	1.000	0.887
Chemicals	1.000	0.875	0.793	1.000	0.749	1.000	0.875	0.882	1.000	0.749
Clay &c	1.000	0.665	0.919	0.882	0.956	1.000	0.665	0.919	0.882	0.956
Metals	1.000	0.897	1.000	1.000	0.978	1.000	0.994	1.000	1.000	0.978
Tobacco	1.000	0.522	1.000	–	0.775	1.000	0.758	1.000	–	1.000
Carriages	1.000	0.797	1.000	1.000	0.878	1.000	0.969	1.000	1.000	0.947
Ships	1.000	0.957	0.920	1.000	0.966	1.000	0.973	0.920	1.000	0.966
Misc.	1.000	0.817	1.000	0.896	1.000	1.000	0.936	1.000	0.896	1.000
Power	0.884	0.745	1.000	0.900	0.467	0.884	0.925	1.000	0.984	0.467
Trades	1.000	0.807	1.000	1.000	0.458	1.000	0.807	1.000	1.000	0.814
Other	1.000	1.000	1.000	1.000	0.897	1.000	1.000	1.000	1.000	0.993
AVERAGE	0.993	0.797	0.966	0.969	0.845	0.993	0.898	0.971	0.975	0.898

	Overall Efficiency					Allocative Efficiency				
Category	CAN	VIC	NSW	NZL	CPE	CAN	VIC	NSW	NZL	CPE
Food	0.705	0.643	0.594	1.000	0.518	0.705	0.840	0.747	1.000	0.643
Textiles	0.879	0.682	1.000	0.675	0.413	0.879	0.791	1.000	0.734	0.433
Iron & Steel	0.995	0.826	1.000	0.962	0.742	0.995	0.937	1.000	0.962	0.759
Lumber	0.953	0.667	0.961	1.000	0.494	0.953	0.975	0.961	1.000	0.656
Leathers	1.000	0.837	0.866	0.953	0.619	1.000	0.940	0.867	0.953	0.716
Printing	0.799	0.547	1.000	0.761	0.700	0.799	0.803	1.000	0.832	0.700
Drinks	0.787	0.680	0.970	1.000	0.596	0.787	0.961	0.970	1.000	0.671
Chemicals	1.000	0.596	0.754	0.751	0.200	1.000	0.682	0.950	0.751	0.267
Clay &c	1.000	0.445	0.615	0.501	0.315	1.000	0.668	0.670	0.568	0.330
Metals	0.918	0.623	1.000	0.736	0.273	0.918	0.694	1.000	0.736	0.279
Tobacco	1.000	0.402	0.537	–	0.433	1.000	0.772	0.537	–	0.558
Carriages	1.000	0.606	0.778	0.749	0.736	1.000	0.760	0.778	0.749	0.838
Ships	1.000	0.060	0.705	0.248	0.119	1.000	0.063	0.766	0.248	0.123
Misc.	1.000	0.711	0.780	0.842	0.880	1.000	0.870	0.780	0.940	0.880
Power	0.715	0.530	1.000	0.500	0.453	0.810	0.712	1.000	0.556	0.970
Trades	0.833	0.503	1.000	0.795	0.123	0.833	0.623	1.000	0.795	0.268
Other	0.747	0.756	1.000	0.788	0.711	0.747	0.756	1.000	0.788	0.792
AVERAGE	0.902	0.595	0.856	0.766	0.490	0.907	0.756	0.884	0.788	0.581

Sources: See appendix tables B.3-B.7 for list of sources. See section III.1 for a description of data.
Notes: Canadian $s converted to £s at 4s 2d per $. Inputs include Wages, Value of Fixed K (Land, Buildings & Machinery), and Value of Materials. Output is Value of Gross Output. Lumber includes timber, printing includes paper, drinks includes liquors, chemicals includes drugs, clay includes glass and stone, carriages includes all vehicles for land, ships includes all vehicles for water, power includes light, trades includes all hand trades, other includes all unmatched and undisclosed subcategories

Table 3.9: 1910 DEA Results

	Technical Efficiency					Scale Efficiency				
Category	CAN	VIC	NSW	NZL	CPE	CAN	VIC	NSW	NZL	CPE
Food	1.000	–	1.000	0.896	0.971	1.000	–	1.000	0.928	0.971
Textiles	1.000	0.889	1.000	0.882	1.000	1.000	0.889	1.000	0.966	1.000
Iron & Steel	1.000	1.000	1.000	1.000	0.601	1.000	1.000	1.000	1.000	0.601
Lumber	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Leathers	1.000	0.965	1.000	0.955	0.878	1.000	0.965	1.000	0.955	0.878
Printing	1.000	0.960	1.000	1.000	0.916	1.000	0.991	1.000	1.000	0.946
Drinks	1.000	0.785	1.000	0.737	0.743	1.000	0.922	1.000	0.737	0.947
Chemicals	1.000	0.938	1.000	0.737	1.000	1.000	0.973	1.000	0.737	1.000
Clay &c	1.000	1.000	0.943	0.742	0.678	1.000	1.000	0.991	0.914	0.678
Metals	0.983	1.000	1.000	1.000	1.000	0.983	1.000	1.000	1.000	1.000
Tobacco	1.000	0.899	1.000	1.000	0.788	1.000	0.899	1.000	1.000	1.000
Carriages	1.000	0.995	1.000	1.000	0.822	1.000	0.995	1.000	1.000	0.822
Ships	1.000	1.000	0.879	1.000	–	1.000	1.000	0.879	1.000	–
Misc.	1.000	1.000	1.000	0.889	1.000	1.000	1.000	1.000	0.889	1.000
Power	0.919	0.993	1.000	0.976	0.813	0.919	0.993	1.000	0.986	0.969
Trades	0.993	1.000	1.000	1.000	1.000	0.993	1.000	1.000	1.000	1.000
Other	1.000	1.000	1.000	1.000	0.912	1.000	1.000	1.000	1.000	0.976
AVERAGE	0.994	0.964	0.990	0.930	0.883	0.994	0.977	0.992	0.948	0.924

	Overall Efficiency					Allocative Efficiency				
Category	CAN	VIC	NSW	NZL	CPE	CAN	VIC	NSW	NZL	CPE
Food	1.000	0.867	0.869	0.838	0.749	1.000	–	0.869	0.936	0.771
Textiles	0.980	0.786	1.000	0.649	0.847	0.980	0.884	1.000	0.736	0.847
Iron & Steel	0.935	0.943	1.000	0.850	0.430	0.935	0.943	1.000	0.850	0.717
Lumber	0.917	0.934	1.000	0.792	0.583	0.917	0.934	1.000	0.792	0.583
Leathers	1.000	0.876	0.911	0.848	0.820	1.000	0.908	0.911	0.887	0.934
Printing	1.000	0.937	0.978	0.824	0.659	1.000	0.976	0.978	0.824	0.720
Drinks	1.000	0.706	0.900	0.668	0.658	1.000	0.899	0.900	0.906	0.886
Chemicals	0.923	0.869	1.000	0.686	0.807	0.923	0.926	1.000	0.932	0.807
Clay &c	1.000	0.976	0.929	0.707	0.616	1.000	0.976	0.986	0.953	0.908
Metals	0.821	0.816	1.000	0.722	0.670	0.835	0.816	1.000	0.722	0.670
Tobacco	1.000	0.794	0.816	0.540	0.671	1.000	0.882	0.816	0.540	0.852
Carriages	1.000	0.786	0.716	0.437	0.704	1.000	0.790	0.716	0.437	0.856
Ships	0.842	0.087	0.488	1.000	–	0.842	0.087	0.555	1.000	–
Misc.	0.873	0.874	0.842	0.758	1.000	0.873	0.874	0.842	0.853	1.000
Power	0.532	0.658	1.000	0.829	0.437	0.579	0.662	1.000	0.849	0.537
Trades	0.824	0.845	1.000	0.637	0.640	0.830	0.845	1.000	0.637	0.640
Other	0.979	1.000	0.973	0.843	0.898	0.979	1.000	0.973	0.843	0.985
AVERAGE	0.919	0.809	0.907	0.743	0.699	0.923	0.838	0.915	0.806	0.795

Sources: See appendix tables B.3-B.7 for list of sources. See section III.1 for a description of data.
Notes: Canadian $s converted to £s at 4s 2d per $. Inputs include Wages, Value of Fixed K (Land, Buildings & Machinery), and Value of Materials. Output is Value of Gross Output. Lumber includes timber, printing includes paper, drinks includes liquors, chemicals includes drugs, clay includes glass and stone, carriages includes all vehicles for land, ships includes all vehicles for water, power includes light, trades includes all hand trades, other includes all unmatched and undisclosed subcategories

Chapter 4

Death by Distance: Market Potential of Australian States before World War One

I Introduction to Chapter 4

Comparisons of GDP per capita from 1870 to World War One indicate some settler economies such as Canada and Argentina were advancing while others like Australia and New Zealand were in decline. One central argument for this decline has been the suggestion that geography played a key role. Australia was fairly unique, being a wealthy export-oriented economy but also extremely remote. For the Australian colonies trade was heavily orientated towards Britain well into the twentieth century despite the vast distances involved in maintaining this trade relationship. This issue motivated one of the most influential works of Australian economic history by Geoffrey Blainey.[1] In his 1966 book Bainey popularised the phrase 'tyranny of distance' in describing Australia's plight. Since the 1960s there has been only modest attempts to quantify the 'peripherality' of Australia. Especially little attention has been paid to the period before World War One when Australia lost its lead in GDP per capita to rival settler colonies around the world. This study attempts to bring a quantitative approach to Blainey's Australian historiography. This work is also the first attempt to measure the 'tyranny of distance' across Australian colonies in a unified framework.

How 'tyrannical' was distance in the nineteenth century and how 'distant' was Australia? One geographical advantage Australia had was access to the sea. The lit-

[1] See Blainey (2001)[8] for an updated version of the 1966 book.

erature on economic geography stresses the importance of access to the sea before World War One as rail freight rates were higher over moderate to long distances. The obvious disadvantage was the substantial sea journey needed to reach European markets. Figure 4.1 shows the most significant trade partners for New South Wales with major trade routes and significant ports.[2] Vast distances resulted in high freight rates relative to most other primary product exporters. Figure 4.2 compares freight rates on bringing grain to market in Britain from several points of origin. Sydney faced more severe freight rates than the principal ports of other wheat exporters. Canadian and American ports were ideally located for Atlantic trade with Britain. Bahia Blanca and Buenos Aires faced less severe freight rates than Sydney but were still at a disadvantage when compared with Montreal, Boston or New York.

Another story evident in figure 4.2 was the falling cost of rail relative to sea transport in settler economies just before World War One. Changes in transport technology were dramatic in the late nineteenth century, interacted with location this may have impacted Australian growth. At the time the Canadian Pacific Railway was completed, in the 1880s, there was a high total cost in transporting grain to Britain from the Canadian interior. By the turn of the century it had become similarly cost effective to transport grain from Regina to Britain as from Sydney to Britain. Australia's disadvantage in bringing grain to European markets meant the demand for foodstuffs could be satisfied by others more efficiently. Despite this disadvantage a large share of Australian agricultural exports shifted from wool to wheat before World War One.

Although very little trade was carried on steamers to/from Australia before 1871 there were significant changes taking place in the nineteenth century. The first regular inter-state steamship service began in 1852 with a service between Melbourne and Hobart. A regular steamship service between New South Wales and Victoria began in 1862 connecting Melbourne, Sydney and Newcastle. In 1875 a regular service began to connect Adelaide and Melbourne. By the 1890s there were several large international shipping lines using some combination of steamers and clippers to carry passengers and freight between Australia, Asia and Europe. Notable examples include The Orient Line, The Penninsular and Oriental Steam Navigation Company, The White Star Line and The British India Steam Navigation Company. Steam had come to dominate the tonnage entering Australia by World War One.

[2] These trade partners have been chosen based on them having a recorded share of Australian trade before Federation. Only a very small share of trade was conducted with any countries outside this sample aside from islands in the South Pacific. Key ports were chosen based on their inclusion as such in contemporary statistical registers.

Similarly, the Australian merchant fleet had more tonnage in steamers than sailing vessels by the turn of the century. Dramatic changes in shipping technology between 1871 and World War One had significant economic effects on the far flung Australian colonies. The 'tyranny of distance' was less pronounced but undoubtably still present.

At the same time, rail technology was increasing in efficiency and railroads were spreading across all the regions of recent settlement. Australian railways seem to have been slower to develop than in other colonies. In 1883 a railway bridge over the River Murray was built at Wodonga to link Melbourne and Sydney. In 1887 the last section of the Victorian line to the South Australian border was completed. New South Wales was linked to Queensland in 1888 with the completion of the junction at Wallangarra (The four capitals of Brisbane, Sydney, Melbourne and Adelaide would not be fully linked until 1889 when the Hawksbury River bridge was completed). The Trans-Australian railway from Port Augusta to Kalgoorlie was completed in 1917 connecting all five capitals of the mainland with a journey time from Brisbane to Perth of six days and forty-seven minutes.

By comparison the first Canadian railway boom was underway in the 1850s. Major completions included The St. Lawrence and Atlantic connecting Montreal and Portland (Maine) in 1853; The Great Western railway connecting Niagara to Detroit via Hamilton and London in 1855; The Ontario, Simcoe and Lake Huron connecting Toronto to Collingwood in 1855. The most ambitious was the Grand Trunk railway which linked Sarnia (Ontario) with Quebec City (Quebec) by 1859 and extended over 2600 miles with branch lines forming a network between the Great Lakes. The 1850s boom was followed by a boom in the 1880s that saw the completion of the Canadian Pacific Railway spanning the entire country and providing a rail link from the Pacific coast to the St. Lawrence River (eventually onward to the Atlantic coast). The first through train to the Rocky Mountains left Montreal at the end of November 1885 with the introduction of regular service from Quebec to the Rocky Mountains. Through trains began running from the Atlantic to the Pacific in June 1886. The Canadian Pacific Railway network was the most extensive in the British Empire with upwards of 1100 miles of branch lines radiating from Montreal, Ottawa (to Toronto and other towns), Winnipeg, and Port Arthur. Although relatively similar in area, the two Dominions were miles apart in railway construction.

Figure 4.3 indicates the increasing length of rail miles in operation in several countries relative to their size. Immense distances between major cities overland, combined with direct access to the sea, meant rail provided less advantage to the Australian colonies. Although inland waterways were relatively scarce in Australia they could be utilised year round, reducing the need for all-weather alternatives; in contrast to Canada where waterways were made useless for three or four months per year due to freezing conditions. Contemporaries also blamed the depreciation of Australian securities in London, the 'sparseness of the population', and the ranges of mountains near the coast requiring large capital expenditures, for the lack of railway coverage.[3] According to Blainey (2001, pg. 293)[8],

> While railways were like a web in the south east corner of the (Australian) continent, elsewhere were vast gaps where no rails would ever be laid. Many places on the coast and innumerable points in the interior were hundreds of miles from the nearest railway. Many adult Australians had never seen a railway. In 1900 one could travel along half the coastline of the continent, from Geraldton (WAU) to Cooktown (QLD) and find only two short railway lines in the intervening country.

The division of interests (geographical, political and economic) amongst the Australian colonies presented further problems which led to the development of separate railway systems. Queensland and Western Australia adopted a 1067 mm gauge for most lines while New South Wales adopted a 1435 mm gauge and Victoria a 1600 mm gauge. South Australia split its lines between the 1067 mm and 1600 mm gauges.[4] The non-conformity of gauge meant passengers and freight often needed to be transferred at stations like Wallangarra on the NSW-QLD border with no direct service to Sydney available until the Brisbane-Kyogle line was opened in 1930. Figure 4.4 shows a breakdown of Australian railway expansion by state. Victoria stands out as having a very dense railway network for its size before World War One. Western Australia relied the most heavily on sea transport given the extreme distances it faced in inter-state journeys (A railway linking Perth to Adelaide was not complete until after World War One).

Australian hinterlands were much closer to urban centres with all arable and pastoral land nearer the coast than in most settler economies. Even in the 21st century, measures of remoteness show how little the Australian interior has been penetrated by any form of productive activity.[5] Geography placed the Australian colonies in a unique position relative to other settler economies. Had rail technology stagnated globally and tramp shipping continued to gain efficiency at the end of the nineteenth century then the Australian story may have been drastically different in a

[3] See Australian *Year Books* for contemporary accounts.

[4] In 1911 approximately $\frac{1}{3}$ of SAU line was the 1600 mm gauge and $\frac{2}{3}$ was the 1067 mm gauge.

[5] For more details see the Accessibility/Remoteness Index of Australia which can be accessed from the Queensland government website at `http://www.oesr.qld.gov.au/index.php`.

comparative context. As it turned out, rapidly improving rail technology did less to solve Australia's isolation than might have been thought given the relatively slow adoption of rail technology in the mirror of other settler economies.

Asymmetric tariff policy and output growth across countries also influenced the 'tyranny of distance' between Australia and the rest of the world. Bairoch (1993)[5] divided the period of globalisation before World War One into three epochs: The European free trade interlude (1860-1879), the gradual return to protectionism (1879-1892), and the period of Continental protectionism vs. British liberalism. The first epoch was characterised by trade liberalisation across Europe and initiated with an Anglo-French treaty in 1860. This treaty was followed by several treaties between France and a number of other countries that led to tariff 'disarmament' in Continental Europe.[6] The second epoch was a gradual return to protection kicked off with a new German tariff in 1879 as part of Bismark's *Realpolitik*. Contributing factors were the coalition between farmers and manufacturers in Continental Europe, coupled with the shift from *ad valorem* tariffs to specific duties during a period of deflation. However, the period before 1892 was not uniformly protectionist, some European countries did not raise tariffs and many liberal policies were yet to expire. The final epoch was one of fairly uniform protectionism across Europe. Germany signed several free trade agreements in the 1890s but shifted towards protection again in 1902. France increased tariff protection throughout the period. Only the Netherlands maintained a truly liberal trade policy from 1870 to World War One.

Outside Europe the Industrial Revolution and European expansion created two spheres of countries with very different trade policies. The European offshoots rapidly became part of the developed world and pursued highly protectionist trade policies. Most notable was the United States (referred to by Paul Bairoch as the 'bastion of modern protectionism') with an effective tariff rate close to 50% for durations of the nineteenth century. The second sphere of developing countries (mostly in Asia and Africa) were forced to adopt extremely liberal trade policies prior to World War One. Hence, the period from 1870 to World War One presented the Australian exporter with asymmetric changes in trade policy over both time and space. In other words, there was no decisive movement towards free trade in Europe and Asia during the long nineteenth century that might have reduced Australia's 'peripherality'.

The final element in Australia's perception of distance was its relationship with foreign markets. The changing relative importance of regional markets had a positive impact on Australia in the twentieth century with the rise of Asia, however

[6] Bairoch (1993)[5] also stresses the importance of the most-favoured-nation clause in this period.

the nineteenth century effect is debatable. Table 4.1 shows the levels of GDP per capita in 1990 international dollars for regions relative to Western Europe. From 1870 to 1913 markets in Asia and Africa became less significant relative to Western Europe while in North and South America they became more significant. Australia and New Zealand increased their share of world GDP over this period but they still represented a tiny share of output compared with other regions. From Australia's perspective, markets that mattered were shifting to more distant regions in the nineteenth century, while the nearer markets of Asia and Africa were becoming less important.

The next section lays out a model of market potential intended to incorporate all of the 'distance' factors discussed and quantify the effect of these on growth. Crafts (2005)[24] has drawn on this approach to calculate regional economic potential for the various disaggregated regions of Britain before and after World War One. I follow Crafts (2005)[24] by applying a model of market potential to measure regional economic potential for each of the Australian states from 1870 to World War One. The appropriateness of the model is that it can combine these various aspects of 'distance' in a unifying framework to measure relative 'peripherality'. Market potential in each Australian state is then assessed over time and across states.

II A Model for Market Potential

As noted by Keeble (1982)[49], regional economic potential can be measured in an analogous way to electrical potential in physics.[7] The goal of this type of model is to predict the potential economic activity a region can engage in once the barriers to trade have been accounted for.

In this context economic potential is given by:

$$P_i = \sum_{j=1}^{n} \frac{M_j}{D_{ij}} \tag{4.1}$$

where:
n = the number of significant markets
P_i = the potential of region 'i'
M_j = a measure of the mass of in region 'j'

[7] This method was originally proposed by Stewart (1947)[108] in a study on population distribution and was adapted by Harris (1954)[36], Clark (1966)[20] and Rich (1975)[95] to measure industrial potential.

D_{ij} = a measure of the distance or cost of transport between 'i' and 'j'

A region must also have some self-potential. Self-potential represents a weighted contribution of a regions own mass. Keeble (1982)[49] suggests this can be calculated by the following equation:[8]

$$D_{ii} = \frac{1}{3}\sqrt{\frac{area\ of\ region_i}{\pi}} \tag{4.2}$$

It is important to note that there is no agreement on how to precisely measure internal distance in determining self-potential. Rich (1975)[95] utilised a value of 0.5 rather than 0.333. Head and Mayor have suggested a value of 0.667.[9] A value of 0.333 implies more clustering of economic activity around metropolitan centres in order to maximise self-potential. Rich (1980)[96] argued that the clustering of chief European centres (London and the South East, Paris and Ile de France) support the use of the smaller radius value as a better approximation to reality. I have adopted the radius value consistent with Keeble (1982)[49], Rich (1980)[96] and Crafts (2005)[24].

A practical specification of the model is given by:

$$P_i = \sum_{j=1}^{n} GDP_j d_{ij}^{\lambda} \tag{4.3}$$

such that:

$$D_{ij} = d_{ij}^{-(\lambda)} \tag{4.4}$$

$$M_j = GDP_j \tag{4.5}$$

where:
n = the number of significant markets
P_i = the economic market potential of region 'i'

[8] Previous authors have suggested alternative methods for calculating self-potential; Ray (1965)[94] adopted an arbitrary five mile distance areal unit, Clark, Wilson and Bradley (1969)[21] defined a fixed minimum transport cost for each region, Rich (1975)[95] designed the approach taken by Keeble (1982)[49].

[9] A value of 0.667 was noted in Keeble (1982)[49].

GDP_j = a measure of output in region 'j'
d_{ij} = a measure of the total costs associated with transport between 'i' and 'j'
λ = a distance exponent based on previous studies

III Empirical Approach

III.1 Sample Selection

The decision on what countries must be included in order to calculate economic potential for each Australian state is made by observing actual trade flows. The final year where trade data on the direction of trade was recorded in the separate statistical abstracts for all the states on an independent basis was 1903. From 1903 trade returns were compiled by the Commonwealth Government for 'Australia as a whole' with places outside the Commonwealth and not as in former years. Shares of Australian trade by state for 1875 and 1903 are given in table 4.2.[10]

Table 4.2 indicates that New South Wales and Victoria were trading with a larger number of countries than other states. As has been observed in numerous studies, there was a clear British bias in Australian trade; a large share of trade from each state was conducted with Britain. The state least dependent on this relationship with the United Kingdom was Queensland. However, Queensland had a much less diverse interstate trade than others and was heavily reliant on trade with New South Wales.[11] A meagre amount of Australian trade was conducted with the rest of Europe before World War One, while a more substantial share of state trade was in Asian markets by 1875.

Many of the trade patterns are largely consistent with a gravity interpretation. Indonesia, Sri Lanka and Malaysia presumably occupied significant places in Australian trade due to their close proximity. China and India were important given both their distance and size. Markets in the United States and Germany had become significant by 1903. Presumably they were doubly important since they occupied a substantial share in world manufactured exports by World War One. Idiosyncrasies in inter-state trade further support the gravity interpretation. New South Wales traded substantially more with Queensland as a share of total trade than other states. Western Australia traded heavily with South Australia, and Tasmania traded with Victoria. These results seem to indicate the importance of distance,

[10] See appendix tables C.2 - C.3 on the direction of state trade in 5 year intervals.

[11] Trade shares include transhipments, which explains some of the inter-state differences. Removing transhipments does not resolve this issue fully.

size and colonial connections, in favour of Neoclassical arguments for trade based on comparative advantage and relative factor prices.

III.2 Determining Mass

Choosing a measure for mass presents two key decisions. Firstly, a decision must be made on whether to use nominal GDP or real GDP. Surprisingly little debate in the literature on gravity models has arisen over the decision to use real or nominal GDP when making cross sectional comparisons. Although the use of panel data would suggest real GDP should be preferred there may be empirical justification for the use of nominal GDP if the deflation process introduces significant error. Previous gravity studies in the long nineteenth century have utilised real GDP rather than nominal GDP.[12] The real PPP adjusted GDP data are more readily available from various backwards projections by Maddison and are often employed 'as is' in conjunction with either nominal trade data or real trade data (nominal trade data in US$ deflated with the US GDP deflator). If nominal PPP adjusted GDP is desired then this can be obtained by applying the US GDP deflator to Maddison's real PPP adjusted GDP data.[13]

Secondly, the researcher must decide whether to use PPP adjusted GDP or exchange rate adjusted GDP. Previous gravity studies have been more divided on this decision. Jacks et. al. (2010;2011)[43][44] use the PPP adjusted data from Maddison (2003)[3] while Estevadeordal et. al. (2002)[27] use exchange rate adjusted GDP. Whether this decision has been made with careful consideration in most gravity studies, and whether this has a large effect on the results is a question that should be posed to trade economists working in economic history. In fact discussion on this issue has arisen in the trade literature dating back to the 1970s.[14] I have chosen to follow Crafts (2005)[24] where exchange rate adjusted nominal GDP was used to measure market potential. This seems to be preferable as market potential should be thought of as the opportunity available at a point in time, determined by surrounding markets. This would be reflected by the actual exchange rate adjusted

[12]See Jacks et. al. (2010; 2011)[43][44], Estevadeordal et. al. (2003)[27].

[13]The source chosen for the US GDP deflator should make little difference in theory. I have analysed the deflator supplied by the FRED database (http://research.stlouisfed.org/fred2/), the Measuring Worth project (http://www.measuringworth.com/) and an implicit deflator based on Maddison's real and nominal GDP series for the US. Comparing these deflators to the implicit deflator calculated from the Penn World Tables reveals little difference for the period 1950-2008. All calculations in this work that use the US GDP deflator are done with the Measuring Worth deflator (full citation given in bibliography under Williamson (2013)[116]).

[14]See David (1972)[25], Kravis, Heston and Summers (1978)[50].

output other countries can offer in trade.

Attempting to attain nominal exchange rate adjusted GDP is no easy task for the period before World War One. Given limited resources the only approach feasible for several countries is to utilise the 'short cut' method described in Prados (2000)[90]. This method estimates nominal GDP by exploiting a stable relationship between exchange rate and PPP adjusted GDP across time and space. Two options are available to the researcher, either prices (purchasing power parities over exchange rates) can be regressed on nominal PPP adjusted GDP per capita and various explanatory variables to back out nominal PPP adjusted GDP or nominal exchange rate adjusted GDP per capita can be regressed directly on nominal PPP adjusted GDP per capita and various explanatory variables. A recent working paper by Klasing and Milionis (2012)[61] has taken the second approach using a model that incorporates geographic characteristics both directly and indirectly through their effect on trade as independent variables.[15] In order to generate my own nominal exchange rate adjusted GDP estimates I have supplemented the latest addition of the Penn World Tables with several exogenous geography variables.[16] I have then applied the approach laid out in Prados (2000)[90] with data discussed to generate estimates of nominal GDP adjusted at exchange rates. A full treatment of my approach with detailed tables can be found in the appendix. The three sets of GDP estimates generated using this procedure are expressed in millions of US$ (real PPP, nominal PPP and nominal ER) and have been included in appendix table C.1.[17]

Finally I have selected a set of preferred estimates for mass from the available options. Priority has been given to nominal GDP from primary sources followed by the use of 'short-cut' estimates from Crafts (2005)[24] and from my own calculations. Nominal GDP for Great Britain are from Mitchell (1962)[62]. Nominal GDP for Belgium, Germany, Spain, France, Italy, the Netherlands and Sweden are from the Historical National Accounts Database.[18] Estimates for the Austrian-Hungarian Empire are from the Global Finance Database for 1881-1911.[19] This series has

[15] Indirect effects of geography are measured in a variable constructed by Frankel et. al. (1999)[97] that incorporates the impact of own and border countries area, population and being landlocked on trade openness.

[16] Geography variables were created using information on shared borders, area and population from the CIA World Factbook. They are explained in the appendix.

[17] For consistency I have converted real GDP and population data from Maddison (2010)[73] into indexes with a 1990 benchmark. The 1990 benchmark has been taken from Penn World Tables rather than Maddison.

[18] The HNA database is part of the Maddison Project at the University of Groningen and is available online (http://www.rug.nl/research/ggdc/data/historical-national-accounts). See Smits et. al. (2009)[102] for the related publication.

[19] The GFD is available online (http://eh.net/databases/Finance/). See Accominotti et. al. (2011)[1] for the related publication.

been spliced with estimates from Crafts (2005)[24] for 1871. Nominal GDP for Australia are from Butlin (1962)[13]. Nominal GDP for New Zealand are from Cashin (1995)[16]. Nominal GDP for Canada are from Urquhart (1986)[111] converted to £s sterling at market exchange rates. Nominal GDP data for the USA are from Williamson (2013)[116]. Nominal GDP for India are from Heston (1983)[37] and Sivasubramonian (1997)[101]. Nominal GDP for Denmark, China, Hong Kong, India, Sri Lanka, Malaysia and South Africa have been estimated using the 'short-cut' method in this study. Estimates for Portugal are from the 'short cut' method used in Crafts (2005)[24]. Nominal GDP for Japan for 1891-1911 are from Ohkawa, Shinohara and Umemora (1974). For the period 1871-1881 these have been spliced with my 'short-cut' estimates. Estimates for Norway are the geometric mean of Crafts (2005)[24] and my 'short-cut method' which produce the closest fit to estimates in other studies. All of the preferred estimates have been converted to British pounds using market exchange rates and are shown in table 4.3.[20]

Inter-state trade comprises a significant portion of total trade given the distance of each state to other foreign countries and hence market potential depends crucially on estimates of state level GDP. Cashin (1995)[16] provides estimates of state GDP from 1861 to 1991. No other estimates of GDP at the state level exist before 1979/80 for Australia (or before 1932/33 for New Zealand). The state GDP estimates have been generated using data on money stocks in each colony. The colonial monetary aggregates are multiplied by velocity to yield estimates of nominal GDP at market prices for each state.[21] Estimates from Cashin (1995)[16] have been adjusted from \$A to £A and are given in table 4.4.

III.3 Calculating Distance

The most significant empirical calculation in this exercise was the calculation of the cost-distance measure (d_{ij}). This requires a choice of an appropriate cost metric based on some combination of transport options. Given that my analysis is focused on Australian states in the period before World War One there is little complication in choosing the cheapest mode of transport. For all foreign countries sea transport was chosen as the cheapest mode of transport. Ports chosen for each country represent the primary port to have received Australian goods as recorded in Aus-

[20] See appendix table C.6 for a comparison of available estimates from several sources for a selection of countries.

[21] For a full description of methods see Cashin (1995)[16].

tralian State Registers.[22] Measures of distances between ports can be found in the appendix. Modern distances were calculated in nautical miles between ports using Dataloy Systems.[23] Most gravity models use distances calculated between major cities either in a direct line or using great circle distances. These methods seem inappropriate when trade is conduced by steamships or by rail and could vary substantially from featureless or great circle distances.

Historical distances between ports have also been collected from Statistical Registers where available. Due to missing observations on some journeys in the Statistical Registers I have chosen to use the modern distances from Dataloy Systems for consistency. In all cases there is little variation between sources. Modern distances are generally shorter (approximately 300 miles on average) but in some cases exceed the nineteenth century estimates (indicating deviations are likely influenced by random errors in measurement rather than substantial differences in routes taken).

Estimates of distance between cities (nodes) must also take account of distance travelled on land between ports and major centres. In most cases this is an insignificant portion of the journey but cannot be overlooked. Some countries like France had a large share of world trade in the nineteenth century, despite Paris being located a fair distance from major sea ports. An even more dramatic example is Vienna. Vienna was the capital of a large European empire but was landlocked with only the Danube to satisfy access to water transport. A 370 mile rail line to Trieste was completed in 1859 serving as the closest link to a sea port.[24] Another example was Madrid. The second oldest rail line in Spain connected Madrid to Aranjuez in 1851 but the projected connection to the Mediterranean was initially abandoned and not completed until 1858. Alicante was the shortest projected sea port, representing a distance of approximately 260 miles.[25] In these cases it is important to calculate the distance from port to node using rail freight rates and convert this into a cost equivalent value using rail freight charges specific to each country.

The process of estimating combined rail and sea cost-distance estimates involves regressing freight rates for each mode of transport on distance travelled to get an estimate of the cost-distance relationship. A model of this kind was set out in Hummels (1999)[39] and Estevadeordal et. al. (2003)[27] as follows:

$$\ln\left(Cost\ per\ ton_i\right) = \alpha + \beta \ln\left(Distance_i\right) + \epsilon_i \tag{4.6}$$

[22]Some ports are noted as significant and distances to these key ports are noted in several additions of nineteenth century State Statistical Registers.

[23]`DataloySystemscanbeaccessedonhttp://www.dataloy.com/`.

[24]A history on Vienna's transport links is explained in Gingrich et. al. (2012)[31].

[25]This distance is based on the modern high speed line that now runs between Madrid and Alicante.

Where i represents the transport technology chosen.

A detail that is often overlooked or irrelevant in standard gravity models is accounting for structural breaks in distances between ports given the availability of better sea routes. This issue is less likely to be significant in analysis after World War Two but there were dramatic changes that took place in the long nineteenth century. The opening of the Suez and the Panama Canals represented significant breaks in shipping distances for Australia. Even so, if the changes in physical distance were uniform for all countries then the use of a static distance term in gravity specifications may not bias the results. More likely there were certain trade routes (namely long distance routes relying on the Cape of Good Hope or Cape Horn) that changed physical distance asymmetrically across countries and this had asymmetric effects on trade flows. For example, in 1912 Sydney-New York via the Cape of Good Hope was approximately 13306 miles, in 1913 Sydney-New York via Panama was 9691 miles.[26] Since this study covers the period between the construction of the Suez Canal and Panama Canal, there is little cause for concern regarding the issue of structural breaks.

In estimating equation 4.6 I have utilised data made available from Jacks and Pendakur (2010)[45] for tramp freight rates and supplemented this data with rail freight rates for several countries.[27] First I turn to the estimation of freight costs associated with the sea portion of the d_{ij} variable. Hummels (1999)[39] reported a β of 0.8 for worldwide postwar data and 0.5 on United States and North American postwar data. Estevadeordal et. al. (2003)[27] find a β of 0.52 using freights from Isserlis (1938) over the period from 1870 to 1939. Results of my sea cost-distance regressions over several periods are consistent with these estimates and are shown in the appendix.

The sea cost-distance coefficients have been generated separately for grain, coal and other general goods. Then they have been generated for short to medium hauls ($\leq$ 9000 Miles) and long hauls ($>$ 9000 Miles) assuming some variation in shipping technology may have been used over long hauls as steam technology replaced sail.

I have re-estimated the terminal and variable shipping costs using a linear rather than a log model to compare my results with average cost estimates in Kaukiainen (2003)[40]. These estimates were calculated on grain and coal shipping in terms of shillings per 100 miles. Results of these estimated shipping rates per ton are shown

[26]These distances before and after the canal are reported in the Statistical Register for New South Wales after the opening of the canal.

[27]Jacks has made his shipping tramp rates available on his website `http://www.sfu.ca/~djacks/data/publications/`. For a full description of the tramp shipping rates in this data set see Jacks and Pendakur (2010)[45].

in table 4.5. The two sets of estimates are closely related with version one falling more rapidly in the variable component and version two falling more rapidly in the terminal component. Both estimates show rising average shipping costs just before World War One (version one in the variable component and version two in the terminal component).

Table 4.6 compares estimated freight costs on shipments to London for various years.[28] These are compared to actual three year averages of freight costs on grain shippments. The coefficients do a good job of estimating shipping costs on wheat and grain. Clearly the freight rates faced by Australian states were significantly higher than in countries with direct access to the Atlantic. The biggest issue for Canadian or Argentinian wheat was getting the grain overland or via internal waterways to the coast.

Unfortunately there is not enough data available on specific rail journeys to estimate the relationship between cost and distance using Ordinary Least Squares (OLS). Instead it is necessary to use the average freight cost per ton mile to convert rail distances into estimated costs. Freight receipts per ton mile for European countries requiring overland transport are shown in appendix table C.8. The cost of each rail journey has been estimated using the freight rate specific to that country where possible. The average freight rate for Europe has been used where country specific data was unavailable.

A value for the distance exponent λ must also be chosen to determine the effect of cost-distance estimates on market potential. Both Keeble (1982)[49] and Crafts (2005)[24] assume $\lambda = -1$. An earlier study by Chisholm and O'Sullivan (1973)[19] based on 1962 road transport data argued that the appropriate empirical distance exponent for road freight in Britain was -2.5, although they chose to use -1 for technical reasons associated with the self-potential calculation. I choose to set the distance exponent $\lambda = -1$ in order to maintain consistency with previous studies but provide alternative estimates by setting $\lambda = -0.9$ and $\lambda = -1.1$ in the appendix.

III.4 Tariff Effects

The calculation of market potential must incorporate not only physical barriers (distance) but also policy barriers (tariffs). As indicated in table 4.7, tariffs were relatively high during the first wave of globalisation in many countries.[29] The most

[28]Grain includes wheat, barley, flax, oats, rice and seeds.

[29]Table 4.7 shows effective tariffs measured as import duties collected over total imports rather than an average tariff based on the rates of each good imported. Effective tariffs give a more

practical way to deal with tariff effects is to assume some equivalence between physical barriers and policy barriers. Once a relationship has been determined, tariff rates facing Australian States can be adjusted into physical distances and added to journey lengths. An obvious approach to estimate the tariff-distance relationship would be to run a gravity model over different decades to determine the comparative effects of tariffs and distance on trade. The relative tariff and distance elasticities of trade in each period form an estimate of the relative importance of each type of barrier on market potential. Alternatively, panel data regressions with fixed time effects can determine an average relationship between tariff rates and physical distances using information over the entire period.

As has been discussed, estimates of gravity equations for the long nineteenth century do exist and their results can be adapted to establish the relationships desired. Estevadeordal et. al. (2003)[27] estimate twelve specifications of the gravity model over the long nineteenth century. First, the geometric mean of distance and tariff elasticities of trade for various estimation methods are calculated. Using these elasticities it is possible to estimate a physical distance equivalent cost adjustment for tariff effects. The results of applying the relative elasticities from each specification to get cost adjustments in each set of years are shown in appendix table C.9. In calculating the final set of cost-distance estimates I assume the pooled OLS method is most appropriate (Estevadeordal et. al. (2003)[27] consider this the preferred specification in gravity estimates).

Another important consideration was Federation and the formation of the Australian Customs Union. The Australian Colonies Government Act of 1850 set out the conditions under which pre-Federated Australian customs regulation would take place. Namely, the act required that tariffs be non-discriminatory and uniform across all trade partners.[30] This implied that before 1901 each state set tariffs for foreign trade that were also applied on inter-state trade. A key element of the push to Federation in the 1890s was the desire to establish a barrier free intra-Australian customs union. This Australian Customs Union came into effect on the 1st of Jan, 1901. States lost their tariff autonomy but commerce between the states did not become duty free until October 1901 when a common external tariff had been decided.[31] Although the *ad valorem* rate on dutiable imports fell there was a decrease in the proportion of free goods admitted leading to an increase in the *ad valorem* rate of duty on all

accurate measure of the barriers facing Australian exporters. In some cases customs and excise had to be used rather than import duties as no information was available.

[30] Historical changes in the Australian Customs Union are set out in Irwin (2006)[42].

[31] Under the terms of the Commonwealth Constitution Act, Western Australia was given autonomy to levy duties on inter-state imports for a period of five years after the imposition of the federal tariff subject to some restrictions.

merchandise entering the Commonwealth. This increase was particularly dramatic for New South Wales which had very low tariffs relative to its population or share in Australian trade.[32]

In an attempt to capture the effects of this change I have applied the full foreign tariff rate to the distance index for 1871, 1881 and 1891 when considering the calculation of market potential between states. For 1901 I have also applied the full tariff rate to account for the fact that tariffs were still being collected on inter-state trade until 1902. For 1911 I have applied no additional tariff effect to the cost-distance estimates between states. Table 4.8 shows the effective tariffs between states before Federation and after the creation of a customs union.

III.5 Inter-State Adjustments

It will be assumed in distance calculations that inter-state trade was also conducted by sea rather than by rail. As mentioned in the introduction, rail links between states were unavailable or inefficient before World War One in most cases. Rail costs per ton mile are shown in table 4.9 for New South Wales, South Australia, Tasmania and several foreign countries. Australian rail costs for shipping goods were high compared both with Britain and other settler economies. One significant difference between Australia and Canada or the United States was access to the sea in the nineteenth century. Reaching the Canadian agricultural hinterland required significantly more rail miles than in Australia. Virtually all inhabited land in Australia was close to the sea and required only short rail journeys to bring agricultural products to port.

In the late nineteenth century, with the introduction of steam shipping and limited incentives to increase rail usage there was an increasing cost for inter-state rail vs. sea transport. In Australia this began to change close to World War One when rail had become so efficient that it was catching-up to steam shipping on short hauls.

Before the 1880s there was little evidence that overland inter-state trade was conducted to any significant degree. From the 1880s to World War One, the assumption that all trade was undertaken by sea due to higher shipping costs between state capitals is less realistic. A considerable amount of inter-state trade was recorded at overland border stations, as shown in figure 4.5. New South Wales and South Australia registered very high shares of inter-state trade overland (approximately

[32]The rates of duty for NSW listed in the Australian Year Books[75] are somewhat misleading since they exclude stimulants and narcotics which were approximately 80% of the import duties collected for NSW but only 30-40% of import duties collected for other states.

50% from the 1890s to Federation). A breakdown of New South Wales border trade is given in the appendix. As would be expected given relative rail to sea costs there was a large share of border trade overland between New South Wales and Victoria and a much smaller share of New South Wales trade with Queensland. Distances from Sydney to Melbourne vs. Sydney to Brisbane implied a longer wait to reach the break-even point of the two technologies. In addition much of the early overland border trade with Queensland was not conducted by rail, given the relatively late completion of an inter-state line.

Victoria had the lowest shares of border trade overland, however it should be noted that the share of inter-state trade on the river Murray was quite high for Victoria. Figure 4.6 shows the share of inter-state trade conducted on the river Murray for Victoria and South Australia. South Australia had moved from river to rail transport for inter-state trade by the 1880s. Victoria was less responsive to the newer form of transport or simply had significant cost advantages in river trade. As late as 1900, over 20% of Victoria's inter-state trade was conducted via the river Murray.

In comparing the market potential of Australian states it would be unfair to assume Western Australia or Tasmania had equal advantage to Victoria or New South Wales given the assumption inter-state trade was always conducted by sea. To adjust for this I have calculated a (transport linked) border effect to reduce the terminal portion of inter-state shipping cost estimates. As with tariffs, the scale of this adjustment is based on the relative elasticities of border effects and distance effects. The elasticity of border effects was also captured in Estevadeordal et. al. (2003)[27] by a border dummy. Again I utilise the average elasticity from pooled OLS regressions to calculate terminal cost adjustments. The terminal cost adjustments for each period are shown in appendix table C.10. The inter-state cost adjustments have been applied only on the distance calculation between border states with an economically viable rail or river option before World War One.[33]

III.6 Combined Cost-Distance Indexes

Combined cost-distance estimates have been created for each state in each decade by combining the sea shipping costs (estimated using distances from key ports and coefficients from model version two in table 4.5) with rail shipping costs (estimated using distances from ports to major city nodes and freight receipts per ton mile for specific countries given in appendix table C.4 and table 4.9) and adjusting for tariff barriers and border trade (adjustments based on tables 4.7, 4.8 and terminal cost

[33]For example the adjustment has been applied for trade between SAU and NSW but not SAU and WAU or TAS.

adjustments found in appendix tables C.9 and C.10). Self-cost-distance estimates have been generated by taking the area of each state (constant after 1861 borders) and applying it to the formula for self-potential. Cost-distance estimates for each state in each year have then been converted to indexes with GDP in Great Britain equal to one in 1871. This implies GDP for Britain contributes directly to the measure of market potential while the GDP of all other countries is adjusted based on the cost-distance indexes relative to Britain. Combined cost-distance indexes (including self-distance measures) for 1871 are contained in appendix tables C.12 and C.13.

The combined cost-distance indexes show that there were serious barriers in trading with Europe compared with Asia. India, China and Japan were between 50-60% of the 'distance' from London. Furthermore there appear to have been two groups of European countries, those to which Australia was 'peripheral' and those to which Australia was *extremely* 'peripheral'. North Sea countries like Belgium, the Netherlands, Denmark, Norway and Sweden had relatively low tariffs and major markets facilitated by sea ports. Australian states faced similar 'distances' in reaching ports in these countries as in reaching London. Countries like Austria, Spain, Germany and France were extremely 'distant' to the Australian states. This was due in some part to tariff policy but was mostly the result of the greater distances needed to reach major inland markets in Vienna, Madrid, Berlin or Paris. New York was a similar 'distance' as London given that the Panama canal was yet to be completed. If San Francisco were used as the node for the USA then Australian market potential would have been higher, however it seems unlikely that the majority of Australian trade with the USA avoided the long journey to the Atlantic East Coast. As expected, Tasmania and South Australia faced greater 'distances' to foreign markets but smaller 'distances' in inter-state trade. Perth was well placed for European trade after the opening of the Suez canal and had a close 'proximity' to Asian markets. However, Perth was located far from its inter-state trading partners and Western Australia had a large hinterland with a high measure of self-distance. Melbourne and Sydney were likely the most balanced in all locational respects.

IV Results and Analysis

IV.1 Indexes of Market Potential

Market potential calculations based on cost-distance adjusted mass are shown in table 4.10. Table 4.11 gives an indication of the relative potential of each state with

New South Wales as a benchmark. The most striking result is the extremely high relative market potential of Western Australia. Despite having lower self-potential and lower market potential from inter-state trade, Western Australia benefitted significantly from the location of Perth on the West Coast. Before World War One, European markets loomed large and the increased market potential from shorter sea journeys was enough to offset the lost market potential from other states. The Suez Canal was opened in 1869 significantly reducing the distance from Perth to European markets. The distance in reaching most Asian trade partners was also shorter from Perth than from other Australian state capitals. Hence, the growth of Japan and eventual rise of India and China presented greater potential benefits for Western Australia than other states.

Nominal GDP per capita and merchandise exports per capita confirm the unique position of Perth before World War One. Although the level of 1871 GDP per capita in Western Australia was approximately 40% of the level in New South Wales (possibly due to the lack of market potential before 1869), Western Australia had virtually caught-up by Federation. In 1871, both Tasmania and Queensland had significantly high levels of GDP per capita compared with Western Australia but both suffered from relatively low levels of market potential. Western Australia had overtaken Tasmania and Queensland by World War One. Merchandise exports grew rapidly for Western Australia reaching extremely high levels just after Federation. Following Federation, Perth clearly took advantage of its relatively high market potential.

Although overshadowed by Western Australia, South Australia also had high market potential in comparison with other states. As with Western Australia this was evidenced by the relative growth in nominal GDP per capita and merchandise exports. South Australia appears to have had a flourishing foreign and inter-state trade with considerably higher levels of merchandise exports per capita than most other states. No doubt this was helped by Adelaide's compromise position between European markets and those of other Australian states (including New Zealand).

Victoria and New South Wales had relatively high levels of nominal GDP per capita and merchandise exports in 1871 but their dominant positions were giving way to Western and South Australia. They also held the middle range of market potential in the period before World War One. Queensland and Tasmania had the lowest levels of market potential, the lowest levels of merchandise exports and the lowest levels of nominal GDP per capita in most years. Brisbane and Hobart were far from both European markets and Asian markets. They were reasonably well placed for inter-state trade although Tasmania did not have a land connection to other states. Just as the opening of the Suez Canal loomed large in the history of Western Australia, the opening of the Panama Canal combined with the rise of the United States after World War One may have significantly altered the relative 'peripherality' of Tasmania and Queensland.

Table 4.12 provides annual growth rates (continuously compounded) for each state and Australia as a whole over several periods. The incredible growth of Western Australia from the opening of the Suez Canal until Federation is clear. Relative to other states annual growth rates in population, nominal GDP and merchandise exports were very high. An attempt has also been made to analyse the changing market potential of the aggregated Australian states over time. Combined cost-distance estimates have been deflated by creating a grain and coal price deflator. Given that sea freight rates were based primarily on grain shipped to Britain and coal shipped from Britain, I have chosen to focus on the price fluctuations in these goods. Unit prices have been calculated using annual quantities and values of trade from Mitchell (1988)[63]. The combined deflator uses the relative values of these two goods as weights. Nominal GDP was then converted to real GDP using the implicit UK GDP deflator from Mitchell (2013)[64]. Real cost-distance estimates were applied to the real GDP estimates to get real market potential. Indexes of real market potential are shown in table 4.13 alongside the real value of GDP and merchandise exports for Australia.

Over the entire period (1871-1911) Australian market potential grew slightly faster than output or merchandise exports but all appear closely related. The 1870s and 1880s were decades of strong growth in market potential and also significant growth in output and exports. Growth in market potential continued but at a slower rate in the 1890s, which was a dismal decade for output growth and a slowing period of export growth. The period from 1901 to World War One saw export growth collapse despite a rebounding growth in output. As expected, the pattern of overall market potential reflects both the changes in Australian output (self and inter-state potential) and exports (potential from foreign demand).

IV.2 Trade Diversion

An important question in the pre-World War One history of Australia is whether 'too much' trade was directed towards the United Kingdom, or within the empire generally. In order to determine the level of Empire trade diversion I have decomposed each state's share of market potential by region and compared these with export shares. Table 4.14 organises the shares of exports and market potential for each state into several broad categories: other Australian states, Great Britain, European Countries (excluding Britain), Western Offshoots and Asian countries.[34] The results indicate that significantly more exports were sent to Britain than were justified by Britain's contribution to Australian market potential. In 1871, over 50% of exports went to Britain when 12.5% were predicted by the share of market potential. Trade diversion to Britain appears to have been a problem across all states in all periods before World War One, however there was an improvement towards the turn of the century. The issue was less extreme in 1901 when approximately one quarter of exports went to Britain and over one tenth was predicted by market potential.

Trade diversion amongst Australian states also seems to have been an issue before World War One. Inter-state exports made up too large a share of total exports. South Australia and Queensland had the highest shares of both inter-state trade and inter-state market potential. The export shares for these states are slightly exaggerated since these states served as entrepts for trade going between other states and to foreign markets. The 1903 trade figures show that almost half the exports recorded from these states were the goods of other Australian states being re-exported. However, accounting for this does not remove the issue completely. Even after removing re-exports there was an overly large share of inter-state exports out of total exports in every state.

In contrast, Western Offshoots received too little of the share of total exports given their contribution to market potential. The problem was extreme in 1871 and started to improve by the turn of the century mainly due to an increased share of exports going to the United States. Other Western Offshoots continued to receive far too small a share of Australian exports considering their contributions to market potential. There are two possible explanations for this. Either we must view the small share of exports to other British colonies as an inefficient response to market potential or a neoclassical interpretation of trade flows must be applied. Although the Western Offshoots represented rapidly growing markets they did not differ enough from Australia in endowments or factor prices to capture larger shares of Australian trade.

The Asian countries show significant fluctuation in the level of trade diversion before World War One. Between 1871 and 1881, Victoria and Western Australia were exporting a significant share of total exports to Asian countries bringing them close to the shares of market potential from Asia. The other states traded far too little

[34]European countries include Austria-Hungary, Belgium, Germany, Denmark, Spain, France, Italy, the Netherlands, Norway, Portugal and Sweden. Western Offshoots include Canada, New Zealand, South Africa and the USA. Asian countries include China, Hong Kong, India, Indonesia, Japan, Sri Lanka (Ceylon) and Malaysia (Straits Settlements).

with Asia. The 1890s stood out as a period where exports to Asia collapsed despite only a small decline in the market potential Asia offered. There was a turn around by Federation, Western Australia was actually trading too heavily with Asia in 1901 (some, but not all, of this can be explained by transhipments through Western Australia).

The most under represented region in terms of export shares was Europe. Europe represented approximately one quarter of total market potential for the Australian states (almost 30% in 1871). Literally no trade with Europe was conducted in 1871 and there was little increase until Federation. Clearly the biggest issue of trade diversion was in trade being diverted to Britain from the rest of Europe. Cutting the share of trade to Britain in half and proportioning this to other European countries would have put Australian trade significantly more in line with estimates of market potential.

Table 4.15 provides a deeper look at the issue of trade diversion within inter-state trade. Generally, export shares match up quite closely with shares of market potential (the biggest exception being for Queensland). New South Wales exported too heavily to Queensland in 1871 but the issue was resolved by Federation. Victoria diverted too much of its exports from Queensland to Tasmania. South Australia did the reverse. Tasmania traded too heavily with Victoria. Western Australia exported far too much to South Australia. Queensland exported virtually everything to New South Wales. Obviously location mattered a great deal in determining patterns of inter-state trade with Adelaide serving as vent for Perth, Victoria for Hobart and Sydney for Brisbane. Removing re-exports does little to change the results, implying that states generally absorbed the exports of their nearest trade partner. Hence, inter-state trade diversion was specific to each state with the greatest issue being Queensland's inability to export to any state beyond New South Wales.

V Sensitivity to Distance

The strength of cost-distance estimates are determined in part by the value of the distance exponent. Adjusting the distance exponent serves as both a sensitivity check and also to judge the effect of changes in cost-distance estimates on market potential. Actual market potential, given an assumed distance exponent of -1 (as suggested in the literature) compared with market potential given a 10% adjustment in the distance exponent in either direction are shown in appendix table C.14. The results indicate that overall market potential is highly sensitive to changes in the distance exponent. Fortunately, the states are impacted symmetrically so that the inter-state rankings hold. Hence, there is little sensitivity in any of the analysis discussed when the distance exponent is altered up or down.

This exercise does highlight how important changes in the cost-distance estimates are on market potential. When 'peripherality' increases or decreases there is a significant impact on market potential. Since market potential seems highly correlated with both exports and output, there are substantial costs to 'distance'.

VI Decomposition of Market Potential

Consider the following question: 'What impact did technological change and tariff policy have on market potential before World War One?' Annual growth rates of each factor contributing to the rise in market potential over time are shown in appendix table C.15. Shipping costs by sea and rail fell rapidly in the 1870s and 1880s and continued to fall at a decreasing rate up to World War One. GDP in the sample group rose consistently with the fastest growth in the last decade before World War One. While average tariffs fell for both foreign countries and Australian states, when considering the entire 1871-1911 period, there was little consistency. Tariff rates fell only during particular decades and only for certain countries.

In order to determine the role of technology, output growth and tariff policy I calculate market potential for each Australian state holding certain factors fixed at their 1871 level. Firstly, I fix the GDP of all sample countries at their 1871 levels to see how market potential was impacted by output growth in Australia's major trade partners. Next, I fix the cost of transport, by sea and by rail, at the 1871 level in all periods to see the effect of technological change on market potential. Finally I fix the tariff rate of all countries and states at the 1871 levels to show the impact of trade policy on market potential. Results are shown in table 4.16. Changes in tariff policies had a minimal impact before World War One. This is unsurprising since changes in tariffs differed across countries and over time. In other words, there was no universal push towards trade liberalisation. Alternatively, falling transport costs and rising world output contributed significantly to increased market potential amongst Australian states. Most striking is the fact that market potential would have been half of its actual level in 1891 in the absence of falling transport costs but still almost three quarters of its actual level if sample GDP growth was zero. Technological advancements that shortened the travel time between Australian states and foreign markets played an even bigger role than the increasing size of those foreign markets.

VII Counterfactuals

One of the interesting aspects of this study is that it allows the researcher to address questions on the relative importance of geography in the long-run growth of settler economies. It is a common theme in Australian literature to lament the 'tyranny of distance'. Adjusting the distance between Australian states and foreign countries allows a quantitative assessment of how tyrannical distance was for Australia before World War One. Using this approach, I ask the following counterfactual questions: 'What if Australia had been located 1,000 miles closer to its trade partners?', 'How would market potential change for Australia if it were located similarly to Argentina?' and 'How would market potential change for Australia if the shares of foreign GDP before World War One matched those of 1990?'. The first counterfactual places every foreign country 1,000 miles closer to Australia, effectively shrinking the world map with Australia in the centre. The second counterfactual shifts Australia into the position of Argentina with direct access to Atlantic shipping routes. The third counterfactual alters the relative size of trade partners before World War One to match 1990 proportions (effectively shrinking the distance of Australia with its key markets given the relative rise of Japan and the relative decline of Europe).[35] The effects of these changes on market potential are shown in table 4.17.

The counterfactuals show, *ceteris paribus*, that market potential before World War One would have been similar if Australia were brought 1,000 miles closer to all foreign countries as if foreign GDP shares matched their 1990 values. In other words, Australia was a lot less 'peripheral' to the global economy given 1990 shares of GDP, irrespective of advancements in transport and communications technology or trade liberalisation. However, the most dramatic shift in market potential occurs when the Australian continent is relocated to the Atlantic. In this scenario Australian cities face the same distance to markets as Buenos Aires. All of the counterfactual scenarios represent exogenous shifts and as such I can project their effects on GDP.[36] Figure 4.7 shows what would happen to GDP under each counterfactual scenario if it were impacted in the same magnitude as market potential. The increase in GDP from any of these counterfactuals would significantly reduce the decline Australia suffered before World War One relative to other settler economies.

[35] 1990 shares of foreign GDP were calculated using the Penn World Tables.

[36] Setting the shares of GDP at their 1990 levels is exogenous since only foreign countries have had GDP shares adjusted.

VIII Geography Rules

How does the importance of geography help explain the relative performance of settler economies? In the past there has been a great deal of debate over the relative importance of institutions and geography in determining long-run growth. Some believe that institutions rule while others have argued for geographical determinism. This debate holds powerful implications for economic development. Settler economies offer a unique laboratory to evaluate the relative importance of these deep determinants. This work has shown that access to markets, a measure of geographical isolation, can be closely linked with performance. Australia's growth rate from 1871-1911 was remarkably similar to its growth in market potential. This is surprising as its market potential was shaped primarily by exogenous factors. A similar and convincing pattern was present at the state level. Western Australia and South Australia both had rapid growth in real output and market potential from 1871-1911. Presumably all of the Australian states shared similar institutions, had similar access to capital, received similar flows of labour, and experienced similar exogenous economic shocks. Hence, one can assume that differences in relative performance can be explained either by different geographical factors or policy decisions. I would argue that these two factors are intertwined.

The link between market potential and long-run growth permits several observations on the relative success of settler economies. Firstly, it is clear that Canada, South Africa and Argentina must have had substantially higher levels of market potential compared with Australia and New Zealand given the counterfactual experiment in section VII. This suggests proximity to Britain, Europe and the United States was vital for sustained long-run growth.

It is also possible that policy had an important role to play in the long-run growth of settler economies precisely because of the geographical issues present. Consider an example, the United States and Canada both pursued policies of cheap land for settlers while Australia and New Zealand typically sold land at a premium. In 1831 no Crown land was to be sold in Australia for less than five shillings an acre, roughly equaling the selling price of land in North America. South Australia was founded in 1836 and the government began selling land for twelve shillings an acre. Land in eastern Australia was being sold at a similar price by 1838. By 1842 the government had set the minimum price on land in Australia to twenty shillings. While this policy continued in Australia, the United States was effectively offering free land to settlers with the introduction of the Homestead Act in 1862. Canada followed the United States model with its own free land act in 1872. The different policy decisions were largely related to the geography of each settlement. While the United States and Canada could attract settlers with free land, Australia needed to use land revenues to subsidise the high cost of passage paid by settlers. The Australian policy allowed free (or heavily discounted) transport to be offered to settlers who paid a premium for their land.[37]

One can also speculate that relative Canadian and Argentinian success from 1870 to World War One was linked to the interplay of technology and favourable geography. This paper has shown that technological change before World War One played a dominant role in determining market potential. Hence, it is likely that Canada and Argentina were able to take part asymmetrically in the growth of nineteenth century technological change relative to Australia and New Zealand. This point was first suggested by Blainey (2001, pg. 178)[8],

> When the industrial revolution and the power of steam were reshaping commerce in western Europe and North America, and railways and steamships and telegraphs were ceasing to be miracles, Australia still relied on the strength of winds and animals to carry virtually all its goods.

Possibly the most important issue connected to geography was that of trade. From 1870 to World War One, Canada pursued a policy of transitioning its trade from Britain to the United States. This made sense given the shift in significance of the United States economy and its close proximity. In contrast, the Australian colonies did not transition away from Britain towards alternative markets despite the decline in the share of market potential generated by Britain. Hence, it is important to remember that various policies on the direction of trade also interacted with geography. Before World War One the decision of Australia to pursue a strong and unwavering trade relationship with Britain, despite the vast distances connecting the two countries, may have facilitated the rapid catching-up of rival settler economies.

IX Conclusion

This study has taken a first step in quantitatively assessing the market effect of location on the comparative growth of the Australian states before World War One. It would be hard not to agree with those who feel Australia suffered from a 'tyranny of distance'. Counterfactual estimates of GDP show how realistic the 'tyranny of

[37] See Blainey (2001)[8] for a full treatment of this issue.

distance' was for Australia. By Federation the USA had overtaken Australia in terms of GDP per capita, an event that would not have occurred until much later had Australia been located closer to its trade partners. Other settler economies such as Argentina and Canada obviously benefitted from their location on the Atlantic with better access to Europe and the USA. Estimates in this paper show that the effect on long-run growth would have been substantial and may help (if not entirely) explain the falling behind of Australia when compared with other settler economies before World War One.

For Australia, distance to major markets interacted with changes in technology and changes in the share of world GDP before World War One. Physical distance to Europe was certainly key but inter-state distances were also important. Distance to Asian markets mattered as well but the relative importance of Asian markets declined before World War One. Improving sea and rail technology meant that the cost of long distance travel was changing relative to short distance travel. This had asymmetric effects on the Australian states which were located at varying distances to Europe and Asia. Policy changes also occurred before World War One that had an effect on total 'distance' calculations. Asian tariff policy was controlled directly or indirectly during the nineteenth century by colonial European powers. This meant Asian countries had relatively low tariffs before World War One. The USA was highly protectionist before World War One, as were many European offshoots. Australian Federation in 1901 created a barrier free inter-state trade union which unevenly increased the market potential of states located closer together. While all of these factors (falling tariffs, falling transport costs and rising GDP) contributed to the increasing market potential of Australia, the most important seems to have been the decline in shipping costs.

A state-by-state comparison has shown that Western Australia was actually far less remote than Queensland or Tasmania. Western Australia had approximately 110% of the market potential of New South Wales before World War One. In other indicators of development, GDP per capita and merchandise exports, Western Australia's growth from 1870 to World War One was impressive. Hence, the modern bias of viewing Perth as extremely remote given its distance from any other major centres (Australian or otherwise) is period specific.[38] In actual fact, Perth was arguably the most ideally located of the Australian capital cities after the opening of the Suez Canal in 1869 and before the opening of the Panama Canal in 1914. This was due to the significant savings on sea voyages from Perth to London (or Perth to New

[38] Perth has been called the most remote place on earth. This is likely an artifact of its time during the 1970s to 1990s where it briefly occupied the title of capital city of over a million people farthest removed from any other city of over a million people.

York) over Hobart or Brisbane.

Looking at comparisons of where market potential was highest and where actual trade was observed has shed further light on the failure of the Australian states to reorientate themselves towards key markets. This however has highlighted the importance of addressing a series of questions on private and public decision making. Why would Australians have chosen to direct so much trade towards a far flung British 'metropole' when opportunities to increase ties in the Pacific Region existed? Why was the decision different when considering trade with other economically important European countries like France or Germany? If 'Britishness' was, as has been argued, such a strong cultural and geo-political concept that it could supersede economic self-interest then why did Australia trade so little with other British 'settler economies'?

Recent studies have suggested a necessary movement away from old historiographical binaries of British 'metropole' and colonial 'periphery'.[39] New theories consider settler economies to be part of an interconnected network with various points of contact and exchange that were often as significant as the core-periphery relationship. I would argue that any competent assessment of trade, immigration and investment data should reinforce rather than refute the old binaries before World War One. Many of the logical explanations for inter-empire trade (shared language, currencies, tastes, institutions and expectations) cannot be used to explain the core-periphery relationship while ignoring the limited periphery-periphery relationships.

This work has wider implications since it emphasises the role of economic geography in a comparative context and highlights the role location played in the relative success of settler economies during the nineteenth century. The most successful settler economy of the period, Canada, likely benefitted more from its proximity to Britain (and Europe) than from its land connection to the United States. It is important to remember that coastal shipping was still preferred to rail before World War One. In other words, it was the location to European markets that mattered most for the relative success of settler economies before World War One. This may have implied that market potential would not have been much higher in Canada before World War One than Argentina or even Australia if they were all located equidistant to London.

While sea transport was the most efficient method for transporting freight before World War One, the wide scale introduction of the motor car in the interwar period resulted in a drastic shock to global market potential. This further heightened the relative 'peripherality' of Australia. Land transport eventually became more

[39]For coverage of this issue see Magee and Thompson (2010)[56].

cost effective for all distances. Coupled with the hegemony of the United States after World War Two, Canada had extreme locational advantages over Australia. The paradox in a comparative context was less the falling behind of Australia but rather its early lead. As world leaders in GDP per capita before 1870 the Australian colonies overcame a very real 'tyranny of distance' which placed significant and measurable limitations on market potential.

Table 4.1: Real PPP Adj. $1990 GDP (W.Europe = 100)

Region	1870	1900	1913	1950	1990
W. Europe	100	100	100	100	100
USA & CAN	31	53	66	112	105
AUS & NZL	2	3	4	6	6
L. America	8	12	14	30	37
E. Asia	115	80	73	61	125
Asia	126	89	81	71	143
Africa	13	11	9	15	15

Sources: Maddison (2003)[3]

Notes: W. Europe is the most significant 30 countries in Western Europe. L. America is for all of Latin America. E. Asia is for the most significant 16 countries of East Asia. Asia is for all of Asia. Africa is for all of Africa. Groupings are based on major groupings found in Maddison (2003)[3].

Table 4.2: Share of State Trade by Principal Destination (%)

	1875						1903					
Destination	NSW	VIC	SAU	WAU	TAS	QLD	NSW	VIC	SAU	WAU	TAS	QLD
Britain	57.2	47.0	55.4	60.1	44.7	31.5	26.6	24.6	24.9	39.0	22.2	28.9
Austria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
France	0.0	0.1	0.0	0.0	0.0	0.0	4.0	2.9	2.3	0.4	0.1	0.5
Germany	0.0	0.0	0.0	0.0	0.0	0.0	5.2	3.6	3.0	1.9	5.4	1.9
Netherlands	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.5	0.1	0.0	0.0
Belgium	0.0	0.1	0.0	0.0	0.0	0.0	2.1	1.6	2.3	0.4	0.0	0.3
Italy	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.1	0.1	0.0	0.0
Spain	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Portugal	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Denmark	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Norway	0.0	0.2	0.0	0.0	0.0	0.0	0.1	0.3	0.0	0.2	0.3	0.0
Sweden	0.0	0.2	0.7	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0
New Zealand	2.3	6.7	0.6	1.3	4.4	0.2	4.0	4.2	0.4	1.2	0.8	0.4
South Africa	0.0	0.0	2.1	0.0	0.0	0.0	1.0	3.3	0.6	4.8	0.5	3.7
United States	1.6	1.5	0.3	0.0	0.0	0.2	8.8	6.1	2.7	3.8	8.6	2.9
Canada	0.0	0.1	0.2	0.0	0.0	0.0	0.4	0.1	0.0	0.2	0.0	0.4
Hong Kong	1.3	0.6	0.3	0.0	0.0	0.4	0.5	0.8	0.1	0.1	0.0	0.7
China	1.7	2.2	0.9	6.2	0.0	2.7	0.4	0.1	0.1	0.2	0.0	0.1
Japan	0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.1	0.1	0.0	0.3
Sri Lanka	2.7	13.6	0.1	0.4	0.0	0.0	1.3	3.7	3.1	11.3	0.0	0.2
India	0.1	0.9	0.7	0.0	0.0	0.0	1.5	7.5	3.1	13.9	0.1	0.5
Indonesia	1.5	1.6	0.7	0.4	0.0	0.1	0.1	1.5	1.6	0.0	0.0	0.0
Malaysia	0.0	0.1	0.1	7.7	0.0	0.2	0.2	0.1	0.1	0.2	0.0	0.1
Other	3.1	1.6	2.0	2.4	2.9	0.2	3.4	1.4	0.3	2.1	0.5	2.1
NSW	–	18.3	12.9	0.1	10.1	57.2	–	20.6	31.9	6.1	24.1	44.7
VIC	8.5	–	18.6	9.9	35.2	3.6	14.3	–	14.0	8.6	34.2	7.4
SAU	3.7	2.3	–	11.5	1.3	3.4	7.7	4.7	–	4.7	0.9	4.2
WAU	0.1	0.2	1.1	–	0.0	0.0	1.9	3.9	5.9	–	0.9	0.1
TAS	1.0	2.1	0.5	0.0	–	0.3	2.2	5.2	0.3	0.3	–	0.6
QLD	15.1	0.6	2.7	0.0	1.4	–	12.5	3.0	2.5	0.2	1.4	–
Britain	57.2	47.0	55.4	60.1	44.7	31.5	26.6	24.6	24.9	39.0	22.2	28.9
Europe	0.0	0.6	0.7	0.0	0.0	0.0	12.0	8.8	8.3	3.2	5.8	2.7
W. Offshoots	3.9	8.3	3.2	1.3	4.4	0.4	14.2	13.7	3.7	10.0	9.9	7.4
Asia	7.4	9.0	2.8	14.7	0.0	3.4	4.4	14.1	18.2	25.8	0.1	1.9
Inter-State	28.4	23.5	35.8	21.5	48.0	64.5	38.6	37.4	54.6	19.9	61.5	57.0

Sources: SRNSW (Various)[78], SRVIC (Various)[87], SRSAU (Various)[4], SCQLD (Various)[93] SCTAS (Various)[104]

Notes: Zero share values of trade are not actually zero but have been rounded to zero. Countries left from this table have actual zero values in most years before WWI. Western Offshoots includes New Zealand, South Africa, Canada & The United States. Europe excludes Britain. Other is mainly Pacific islands

Table 4.3: Preferred Nominal ER Adjusted GDP Estimates (£mn)

Year	AUS	AUT-HUN	BEL	CAN	CHN	DEU	DNK	ESP	FRA	GBR	HKG	IND
1871	78.4	591.3	187.6	81.7	838.9	732.7	40.3	256.4	947.3	1015	0.7	583.8
1881	142.4	580.3	218.5	112.7	893.5	876.7	45.7	376.7	1048.7	1117	1.6	579.2
1891	202.8	658.9	219.9	142.4	941.3	1146.8	58.5	335.0	1162.5	1373	2.6	477.2
1901	189.8	719.1	244.0	199.1	972.2	1571.2	74.5	310.0	1230.1	1727	2.9	570.6
1911	329.3	1178.2	317.4	449.7	1250.9	2173.0	118.3	463.9	1785.1	2076	3.5	808.0
Year	IDN	ITA	JPN	LKA	MYS	NLD	NOR	NZL	PRT	SWE	USA	ZAF
1871	109.5	458.6	141.6	6.9	1.9	81.0	32.5	6.6	45.9	55.3	1564.4	26.4
1881	128.0	516.5	149.1	6.5	3.4	92.7	36.6	16.8	49.7	73.5	2395.5	44.1
1891	140.6	586.7	194.4	9.0	5.0	103.3	43.0	28.6	65.8	82.3	3164.1	63.8
1901	170.9	648.0	461.2	10.5	10.9	123.0	56.2	30.3	63.5	118.5	4583.5	73.1
1911	257.1	854.4	862.4	24.4	15.4	182.2	80.6	41.3	86.2	183.6	7057.9	97.6

Sources: See text section III.2 for description of sources.
Notes: Austria-Hungary based on old empire borders. China based on 'low ball' version of PWT. 1871 estimates from HNA converted with exchange rate of 25 francs, 20 marks, 25 lire, 25 pesetas, 18 krona, 12 Gulden per £ from the Statistical Abstract of Principal Foreign Countries. ERs after 1881 from Accominotti et. al. (2011)[1]. All estimates for the United States were converted at $4.86 per £. All estimates for Canada were converted at 4s 2d per $.

Table 4.4: Australian GDP Estimates by State

	Nominal ER Adjusted GDP (£mn)						Real ER Adjusted GDP (1990 £mn)					
Year	NSW	VIC	SAU	WAU	TAS	QLD	NSW	VIC	SAU	WAU	TAS	QLD
1871	25.90	40.85	7.05	0.55	3.30	5.10	1222.9	1929.7	332.2	25.9	155.5	242.7
1881	51.90	55.65	14.45	1.05	6.80	12.80	2445.7	2622.4	680.9	49.5	320.5	603.2
1891	72.95	81.70	17.95	2.65	8.00	20.80	3614.4	4047.9	890.6	129.6	398.3	1032.0
1901	77.65	69.65	16.90	10.10	7.55	28.20	4017.3	3600.3	874.1	523.1	391.2	1458.4
1911	136.05	105.65	31.45	19.15	9.90	40.70	6411.2	4978.6	1482.0	902.4	466.6	1917.9

Sources: Cashin (1995)[16]
Notes: Converted from Australian $ to pre-1960s £s

Table 4.5: Shipping Rates per Ton on Grain & Coal (Shillings)

Estimates v.1			Estimates v.2		
Range	Terminal (Constant)	Per 100 Miles (Coefficient)	Range	Terminal (Constant)	Per 100 Miles (Coefficient)
1872-1874	13.264	0.3815	1869-1873	12.188	0.3203
1879-1880	11.040	0.2500	1879-1883	7.532	0.2784
1888-1889	8.708	0.1680	1889-1893	3.537	0.2270
1898-1899	6.572	0.1520	1899-1903	3.192	0.1932
1911-1913	5.810	0.1680	1909-1913	4.132	0.1795

Sources: Estimates v.1 are from Kaukiainen (2003)[40], Estimates v.2 were calculated in this study
Notes: Kaukiainen (2003)[40] averages for grain & coal are reported in Crafts (2005)[24], Estimates v.2 use on shipping freight rates from Jacks & Pendakur (2010)[45].

Table 4.6: Estimated/Actual Freight to London on Grains (£ per ton)

	Sydney			Melbourne			Buenos Aires		
Dist. (m.)	11771			11298			6374		
Year	Est. (1)	Est. (2)	Act. (Avg.)	Est. (1)	Est. (2)	Act. (Avg.)	Est. (1)	Est. (2)	Act. (Avg.)
1871	2.505	2.494	–	2.297	2.419	–	1.836	1.630	–
1881	1.820	2.015	–	1.679	1.949	–	1.711	1.264	–
1891	1.910	1.513	–	1.867	1.459	1.410	0.981	0.900	1.170
1901	1.305	1.297	1.484	1.267	1.251	1.200	0.769	0.775	0.874
1911	1.226	1.263	1.269	1.183	1.221	1.242	0.754	0.779	0.734
	New York			Montreal			Odessa		
Dist. (m.)	3375			3230			3457		
Year	Est. (1)	Est. (2)	Act. (Avg.)	Est. (1)	Est. (2)	Act. (Avg.)	Est. (1)	Est. (2)	Act. (Avg.)
1871	1.282	1.150	2.751	1.276	1.127	1.563	1.322	1.163	2.246
1881	1.088	0.846	1.024	1.081	0.826	1.068	1.130	0.858	1.252
1891	0.659	0.560	0.768	0.655	0.544	0.719	0.681	0.569	0.775
1901	0.545	0.486	0.573	0.543	0.472	–	0.562	0.494	0.529
1911	0.543	0.510	0.520	0.541	0.497	–	0.559	0.517	0.627

Sources: Calculated from estimated coefficients in table 4.5 and distances from Dataloy Systems (`http://www.dataloy.com/`)
Notes: Est. (1) are based on the log model which considers short vs. long hauls for all goods, Est. (2) are based on the linear model which considers coal & grain over all distances.

Table 4.7: Foreign Effective Tariff Rates (Import Duties/Imports)

Year	AUS	AUT-HUN	BEL	CAN	CHN	DEU	DNK	ESP	FRA	GBR	HKG	IND
1871	11.92	4.45	0.97	12.67	16.63	2.79	7.85	11.33	3.24	6.10	6.10	11.44
1881	10.42	4.60	0.96	17.40	5.44	4.00	8.71	13.23	5.46	4.84	4.84	8.13
1891	11.70	6.91	1.05	20.99	5.26	8.45	7.35	10.35	6.63	4.52	4.52	4.70
1901	11.70	6.18	1.39	16.61	3.09	9.14	5.92	15.06	6.84	5.10	5.10	8.69
1911	19.70	7.53	0.96	16.28	3.06	7.51	4.62	14.01	7.62	4.87	4.87	7.26
Year	IDN	ITA	JPN	LKA	MYS	NLD	NOR	NZL	PRT	SWE	USA	ZAF
1871	15.58	5.62	5.02	6.15	2.38	0.80	8.08	18.86	26.08	8.96	33.93	14.06
1881	5.66	10.64	4.53	7.65	1.89	0.54	8.93	19.80	22.91	10.22	30.16	14.03
1891	5.48	17.70	3.82	6.85	1.77	0.43	9.37	24.24	20.93	10.11	25.67	12.53
1901	4.82	14.12	5.84	6.69	1.47	0.49	12.15	19.31	20.04	10.61	28.37	9.00
1911	5.49	9.25	8.38	6.39	1.41	0.39	10.52	16.89	17.06	8.73	19.96	14.20

Sources: SAPOFC (Various)[106], SASCOPUK (Various)[105], SABE (Various)[82], SRNSW (Various)[78], SRVIC (Various)[87], SRSAU (Various)[4], SCTAS (Various)[104], SCQLD (Various)[93], SABI (Various)[85], NZLYB (Various)[86], CYB (Various)[18]. Mitchell (2013)[64].

Notes: Austrio-Hungarian, Canadian & Dutch Tariffs are based on imports for home consumption. Indian tariffs are calculated as import duties by sea (including duties on salt) over merchandise trade (excluding government stores). Sri Lanka includes export duties. Denmark is for 1874 not 1871. Non-British colonies are for 1872 not 1871 (compared with Mitchell for 1871 yields same results). Data for Indonesia from 1871-1891 are from Mitchell (2013)[64]. Data for Japan in 1871 are from Mitchell (2013)[64]. Data for South Africa for 1911 are from Mitchell (2013)[64]. Data for Australia for 1911 are from Mitchell (2013)[64] and exclude inter-state trade since Australia was a customs union with free trade between states. Data for Canada in 1911 are from Mitchell (2013)[64] and exclude Newfoundland. Estimates for Sri Lanka in 1911 are based on the change in British Tariffs from 1901 to 1911. Estimates for Malaysia in 1911 are based on the change in British Tariffs from 1901 to 1911, Estimates for 1871 & 1881 are based on the change in British Tariffs from 1871 to 1901. Imports are merchandise only (exclude specie). Some countries include export duties, see text.

Table 4.8: Inter-State Effective Tariff Rates (Customs/Imports)

Year	New South Wales	Victoria	South AUS	Western AUS	Tasmania	Queens-land
1871	13.19	14.97	11.36	22.73	18.12	21.53
1881	8.52	10.40	10.84	26.43	19.04	13.22
1891	9.46	12.13	6.45	20.33	19.96	25.02
1901	7.01	12.65	9.45	16.47	21.60	21.39
1911	0.00	0.00	0.00	0.00	0.00	0.00

Sources: SASCOPUK (Various)[105], SABE (Various)[82], AYB (1908)[75]

Notes: Imports are merchandise only (exclude specie) except for 1901.

Table 4.9: Comparative Rail Freight Receipts (*d.* per ton mile)

Year	South Australia	New South Wales	Tasmania	United States	Canada (CPR)	Algeria & Tunis	Britain	Europe
1871	3.073	3.600	3.684	0.845	0.987	2.129	0.426	1.583
1881	3.006	2.810	3.603	0.604	0.623	1.522	0.306	1.132
1891	1.610	2.020	1.700	0.442	0.455	1.114	0.228	0.809
1901	1.05	1.230	1.730	0.370	0.364	1.288	0.183	0.731
1911	1.02	0.440	1.681	0.374	0.403	0.942	0.188	0.701

Sources: SRNSW (Various)[78], SRSAU (1871-1911)[4], SCTAS (1871-1911)[104], ASASCA (Coghlan 1891-1904)[22], Foxwell & Farrer (1889)[30], SAUS (1878-1911)[79], Urquhart & Buckley (1965)[112], Mitchell (1988)[63], SASCOPUK (1871-1911)[105], SAPOFC (1871-1911)[106]

Notes: Europe is based on a weighted average of several European countries, see appendix table C.8. Observations for NSW between 1871 & 1901 are from linear interpolation. Observations for TAS before 1887 are estimated based on costs relative to NSW and extrapolation. Observations for SAU are an avg. over all major rail lines listed in the Statistical Registers. Observations for the United States are an avg. over all lines listed in the US Statistical Abstract for 1871. Other US observations are provided directly.

Table 4.10: Market Potential (£mn)

Year	NSW	VIC	SAU	WAU	TAS	QLD	Mean	Median
1871	8254	8332	8403	9152	8135	8237	8419	8293
1881	12847	12969	13049	14212	12634	12773	13081	12908
1891	21337	21552	21448	23212	20804	21027	21563	21393
1901	30609	30828	30825	33541	29903	30317	31004	30717
1911	44816	45122	45275	48906	44006	44440	45427	44969

Sources: Based on several tables previously mentioned.

Notes: Calculated as nominal £ mn. Mean is the arithmetic mean. See section IV.1 for a description of methods used.

Table 4.11: Comparative Indexes (NSW=100)

Nominal GDP Per Capita						
Year	NSW	VIC	SAU	WAU	TAS	QLD
1871	100.0	108.7	73.9	42.2	63.1	82.6
1881	100.0	93.4	74.8	51.2	85.1	86.8
1891	100.0	114.4	89.5	85.0	87.1	84.4
1901	100.0	101.5	81.5	96.0	76.6	99.4
1911	100.0	97.2	93.2	82.2	62.7	81.3
Merchandise Exports Per Capita						
Year	NSW	VIC	SAU	WAU	TAS	QLD
1871	100.0	96.5	178.5	72.8	66.1	140.1
1881	100.0	71.1	82.9	90.4	62.1	65.3
1891	100.0	61.8	164.8	72.6	45.3	83.0
1903	100.0	83.4	116.3	285.0	82.6	97.4
Market Potential						
Year	NSW	VIC	SAU	WAU	TAS	QLD
1871	100.0	100.9	101.8	110.9	98.6	99.8
1881	100.0	100.9	101.6	110.6	98.3	99.4
1891	100.0	101.0	100.5	108.8	97.5	98.5
1901	100.0	100.7	100.7	109.6	97.7	99.0
1911	100.0	100.7	101.0	109.1	98.2	99.2

Sources: Population & Merchandise Exports from Statistical Abstract for the Several Colonial and Other Possessions of the United Kingdom. See tables 4.4 & 4.10 for Nominal GDP & Market Potential.

Table 4.12: Annual Growth Rates (%)

Population							
Range	NSW	VIC	SAU	WAU	TAS	QLD	AUS
1871-1881	4.08	1.66	4.19	1.60	1.29	5.92	3.05
1881-1891	4.48	2.83	1.36	5.30	2.40	6.31	3.63
1891-1901	1.55	0.52	1.25	13.97	1.63	2.35	1.62
1901-1911	1.94	0.91	1.19	4.36	1.04	2.01	1.65
1871-1901	3.36	1.67	2.26	6.83	1.77	4.85	2.76
1871-1911	3.00	1.48	1.99	6.21	1.59	4.13	2.48
Nominal GDP							
Range	NSW	VIC	SAU	WAU	TAS	QLD	AUS
1871-1881	7.20	3.14	7.44	6.68	7.50	9.64	5.60
1881-1891	3.46	3.91	2.19	9.70	1.64	4.97	3.64
1891-1901	0.63	-1.58	-0.60	14.32	-0.58	3.09	0.29
1901-1911	5.77	4.25	6.41	6.61	2.75	3.74	5.02
1871-1901	3.73	1.79	2.96	10.19	2.80	5.87	3.15
1871-1911	4.23	2.40	3.81	9.28	2.78	5.33	3.62
Merchandise Exports							
Range	NSW	VIC	SAU	WAU	TAS	QLD	AUS
1871-1881	9.97	4.19	1.96	9.70	6.35	3.70	5.90
1881-1891	4.60	1.52	8.69	3.13	-0.66	9.02	4.54
1891-1903	1.61	3.30	-1.54	25.38	6.91	3.65	3.12
1903-1913	–	–	–	–	–	–	0.16
1871-1903	5.10	3.02	2.67	13.13	4.31	5.31	4.42
1871-1913	–	–	–	–	–	–	3.39

Sources: Population & Merchandise Exports from Statistical Abstract for the Several Colonial and Other Possessions of the United Kingdom. See tables 4.4 & 4.10 for Nominal GDP

Notes: Growth rates are compounded continuously. Merchandise exports for 1913 are from Maddison (2003)

Table 4.13: Australian Potential Over Time

Indexes (1911=100)				Annual Growth Rates (%)			
Year	Real GDP	Real Exports	Real Market Potential	Range	Real GDP	Real Exports	Real Market Potential
1871	23.5	24.9	23.0	1871-81	6.27	6.57	4.88
1881	43.2	47.1	37.0	1881-91	4.01	4.91	4.49
1891	64.0	76.0	57.4	1891-01	-0.23	3.35	1.74
1901	62.6	105.6	68.2	1901-11	4.80	-0.55	3.90
1911	100.0	100.0	100.0				
				1871-11	3.69	3.54	3.74

Sources: Real Merchandise Exports from SAPOFC (Various)[106], see text for Real GDP & Real Market Potential.

Notes: GDP & Exports deflated using UK GDP deflator from Mitchell (2013)[64]. See section IV.1 for description of the deflator for Market Potential. Growth rates are compounded continuously. Merchandise Exports are for 1903 & 1913 not 1901 & 1911.

Table 4.14: Exports vs. Market Potential by Destination for Each State (%)

Destination: Australian States (Inter-State)														
	Share of Exports from:							Share of Market Potential for:						
Year	NSW	VIC	SAU	WAU	TAS	QLD	**AUS**	NSW	VIC	SAU	WAU	TAS	QLD	**AUS**
1871	30.0	11.8	49.3	12.4	49.9	69.5	**24.6**	2.4	1.8	3.0	2.4	3.4	3.1	**2.7**
1881	40.2	24.2	28.1	28.5	61.4	63.2	**32.0**	3.8	3.6	5.0	3.8	5.7	5.0	**4.5**
1891	43.6	28.8	46.6	29.6	71.4	59.0	**41.4**	6.2	5.8	8.0	5.4	9.2	7.8	**7.0**
1901	29.5	43.2	56.5	8.4	54.4	60.8	**35.5**	4.8	5.0	6.3	4.2	7.3	6.0	**5.6**
Destination: Great Britain														
	Share of Exports from:							Share of Market Potential for:						
Year	NSW	VIC	SAU	WAU	TAS	QLD	**AUS**	NSW	VIC	SAU	WAU	TAS	QLD	**AUS**
1871	56.2	58.6	45.4	55.1	45.6	30.3	**55.4**	12.5	12.8	12.8	12.6	12.1	12.0	**12.5**
1881	46.4	47.9	58.7	51.8	32.9	32.8	**49.2**	11.1	11.3	11.3	11.2	10.7	10.5	**11.0**
1891	34.1	49.9	43.0	53.5	26.4	39.8	**41.5**	11.1	11.5	11.4	11.4	10.6	10.5	**11.1**
1901	28.3	16.6	21.5	39.4	21.3	27.6	**26.7**	11.3	11.6	11.6	11.6	10.8	10.7	**11.3**
Destination: European Countries (Excl. GBR)														
	Share of Exports from:							Share of Market Potential for:						
Year	NSW	VIC	SAU	WAU	TAS	QLD	**AUS**	NSW	VIC	SAU	WAU	TAS	QLD	**AUS**
1871	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**	29.5	30.1	29.9	28.9	29.3	28.6	**29.4**
1881	0.0	2.4	0.4	0.0	0.0	0.0	**1.0**	28.3	28.8	28.6	27.7	27.8	27.2	**28.1**
1891	7.8	10.8	2.4	0.9	0.0	0.0	**6.5**	26.9	27.5	27.0	26.5	26.1	25.7	**26.6**
1901	18.7	10.1	10.9	0.3	9.7	2.2	**11.3**	24.6	25.1	24.9	24.4	24.0	23.6	**24.4**
Destination: Western Offshoots (CAN, NZL, ZAF, USA)														
	Share of Exports from:							Share of Market Potential for:						
Year	NSW	VIC	SAU	WAU	TAS	QLD	**AUS**	NSW	VIC	SAU	WAU	TAS	QLD	**AUS**
1871	5.0	7.0	2.4	0.6	4.4	0.1	**5.4**	19.1	19.5	19.3	18.7	19.5	18.7	**19.1**
1881	7.9	5.5	9.4	0.4	5.6	0.0	**6.6**	23.8	24.0	23.7	23.0	24.0	23.1	**23.6**
1891	10.0	4.3	3.2	0.3	2.0	0.3	**6.0**	26.0	26.4	25.8	25.1	26.0	25.1	**25.7**
1901	13.4	10.5	1.7	8.3	14.5	6.4	**10.3**	29.8	30.0	29.7	28.9	29.9	28.9	**29.5**
Destination: Asian Countries														
	Share of Exports from:							Share of Market Potential for:						
Year	NSW	VIC	SAU	WAU	TAS	QLD	**AUS**	NSW	VIC	SAU	WAU	TAS	QLD	**AUS**
1871	5.8	22.4	1.4	29.3	0.2	0.0	**13.4**	36.5	35.8	35.1	37.4	35.7	37.6	**36.3**
1881	2.2	18.5	1.1	18.5	0.0	3.7	**9.0**	33.1	32.2	31.4	34.3	31.9	34.1	**32.8**
1891	2.0	3.9	3.8	14.6	0.0	0.7	**2.8**	29.8	28.9	27.8	31.6	28.1	31.0	**29.6**
1901	5.7	18.9	9.0	41.4	0.0	1.2	**13.9**	29.5	28.3	27.6	30.9	28.0	30.8	**29.2**

Sources: See tables 4.10 & 4.11 for sources.
Notes: Exports include bullion & specie. Transhipments are included. See section IV.2 for methods. Aggregate values for Australia are in bold. Export shares are for 1903, Market Potential shares are for 1901.

Table 4.15: Inter-State Exports vs. Market Potential by State (%)

New South Wales												
	Share of Exports to:						Share of Market Potential from:					
Year	NSW	VIC	SAU	WAU	TAS	QLD	NSW	VIC	SAU	WAU	TAS	QLD
1871	–	66.5	2.8	0.0	1.0	29.7	–	72.8	11.6	0.7	5.8	9.1
1881	–	61.8	6.9	0.0	1.3	29.9	–	62.6	14.6	0.8	7.4	14.6
1891	–	48.1	40.0	0.3	2.2	9.4	–	64.3	12.2	1.2	6.0	16.3
1901/3	–	40.5	27.4	4.8	4.5	22.7	–	55.4	11.6	4.8	5.7	22.5
Victoria												
	Share of Exports to:						Share of Market Potential from:					
Year	NSW	VIC	SAU	WAU	TAS	QLD	NSW	VIC	SAU	WAU	TAS	QLD
1871	64.5	–	12.5	2.4	17.8	2.7	62.5	–	17.4	1.1	8.1	10.9
1881	62.7	–	19.9	2.0	14.8	0.7	60.8	–	17.3	0.9	8.1	12.9
1891	55.5	–	18.1	4.1	15.7	6.6	61.8	–	15.9	1.5	6.9	13.9
1901/3	52.0	–	10.1	14.6	14.7	8.7	58.9	–	13.2	5.1	5.8	17.0
South Australia												
	Share of Exports to:						Share of Market Potential from:					
Year	NSW	VIC	SAU	WAU	TAS	QLD	NSW	VIC	SAU	WAU	TAS	QLD
1871	36.6	53.5	–	1.1	0.0	8.8	32.6	56.7	–	0.6	4.3	5.8
1881	45.7	32.7	–	8.6	0.1	12.9	38.6	47.2	–	0.7	5.3	8.3
1891	79.8	12.3	–	4.6	0.3	3.0	36.5	49.6	–	1.1	4.2	8.5
1901/3	58.7	20.4	–	15.7	0.6	4.5	38.7	41.5	–	4.3	3.9	11.5
Western Australia												
	Share of Exports to:						Share of Market Potential from:					
Year	NSW	VIC	SAU	WAU	TAS	QLD	NSW	VIC	SAU	WAU	TAS	QLD
1871	2.9	19.7	77.4	–	0.0	0.0	30.0	51.2	9.4	–	4.0	5.4
1881	0.0	27.0	73.0	–	0.0	0.0	34.8	41.1	11.5	–	4.8	7.7
1891	4.8	59.0	36.2	–	0.0	0.0	33.9	43.1	10.6	–	4.0	8.3
1901/3	68.8	24.1	7.0	–	0.1	0.1	37.0	37.4	10.1	–	3.8	11.7
Tasmania												
	Share of Exports to:						Share of Market Potential from:					
Year	NSW	VIC	SAU	WAU	TAS	QLD	NSW	VIC	SAU	WAU	TAS	QLD
1871	23.3	71.1	3.4	0.0	–	2.1	32.3	52.9	8.6	0.5	–	5.7
1881	47.0	49.2	3.3	0.0	–	0.5	38.2	42.9	10.2	0.6	–	8.2
1891	41.5	56.2	1.8	0.0	–	0.4	37.3	44.7	8.7	0.9	–	8.4
1901/3	55.4	36.2	1.2	3.2	–	4.0	39.5	37.6	8.1	3.4	–	11.5
Queensland												
	Share of Exports to:						Share of Market Potential from:					
Year	NSW	VIC	SAU	WAU	TAS	QLD	NSW	VIC	SAU	WAU	TAS	QLD
1871	99.2	0.7	0.1	0.0	0.0	–	36.5	50.8	8.2	8.2	4.1	–
1881	99.4	0.3	0.2	0.0	0.0	–	44.5	40.6	9.6	9.6	4.8	–
1891	90.8	8.6	0.5	0.0	0.1	–	46.5	40.9	8.0	8.0	3.9	–
1901/3	87.6	7.5	4.4	0.3	0.2	–	50.1	35.3	7.6	7.6	3.7	–

Sources: See tables 4.10 & 4.11 for sources.

Table 4.16: Alternative Effects on Market Potential

	Avg. AUS Market Potential (£mn)				Avg. AUS Market Potential (Actual=100)			
Year	Actual	No Chng. GDP	No Chng. T. Costs	No Chng. Tariffs	Actual	No Chng. GDP	No Chng. T. Costs	No Chng. Tariffs
1871	8419	8419	8419	8419	100.0	100.0	100.0	100.0
1881	13081	10910	10127	13046	100.0	83.4	77.4	99.7
1891	21564	15358	11842	21488	100.0	71.2	54.9	99.6
1901	31004	17720	14903	30909	100.0	57.2	48.1	99.7
1911	45427	17718	21800	45215	100.0	39.0	48.0	99.5

Sources: See tables C.15 for sources.

Notes: Alternative calculations are based on constant sample output, constant transport costs and constant tariffs. See section VI for a description of calculations.

Table 4.17: Counterfactuals

	Avg. AUS Market Potential (£mn)				Avg. AUS Market Potential (Actual=100)			
Year	Actual	1,000 Mile Shrink	Argentina Relocation	1990 GDP Shares	Actual	1,000 Mile Shrink	Argentina Relocation	1990 GDP. Shares
1871	8419	9127	9423	8692	100.0	108.4	111.9	103.2
1881	13081	14306	15338	13684	100.0	109.4	117.3	104.6
1891	21564	23847	26374	23004	100.0	110.6	122.3	106.7
1901	31004	34262	38825	33169	100.0	110.5	125.2	107.0
1911	45427	49737	56826	48606	100.0	109.5	125.1	107.0

Sources: See table C.15 for sources.

Notes: See section VII for a description of calculations.

Figure 4.1: Australian Shipping Routes from 1870 to World War One

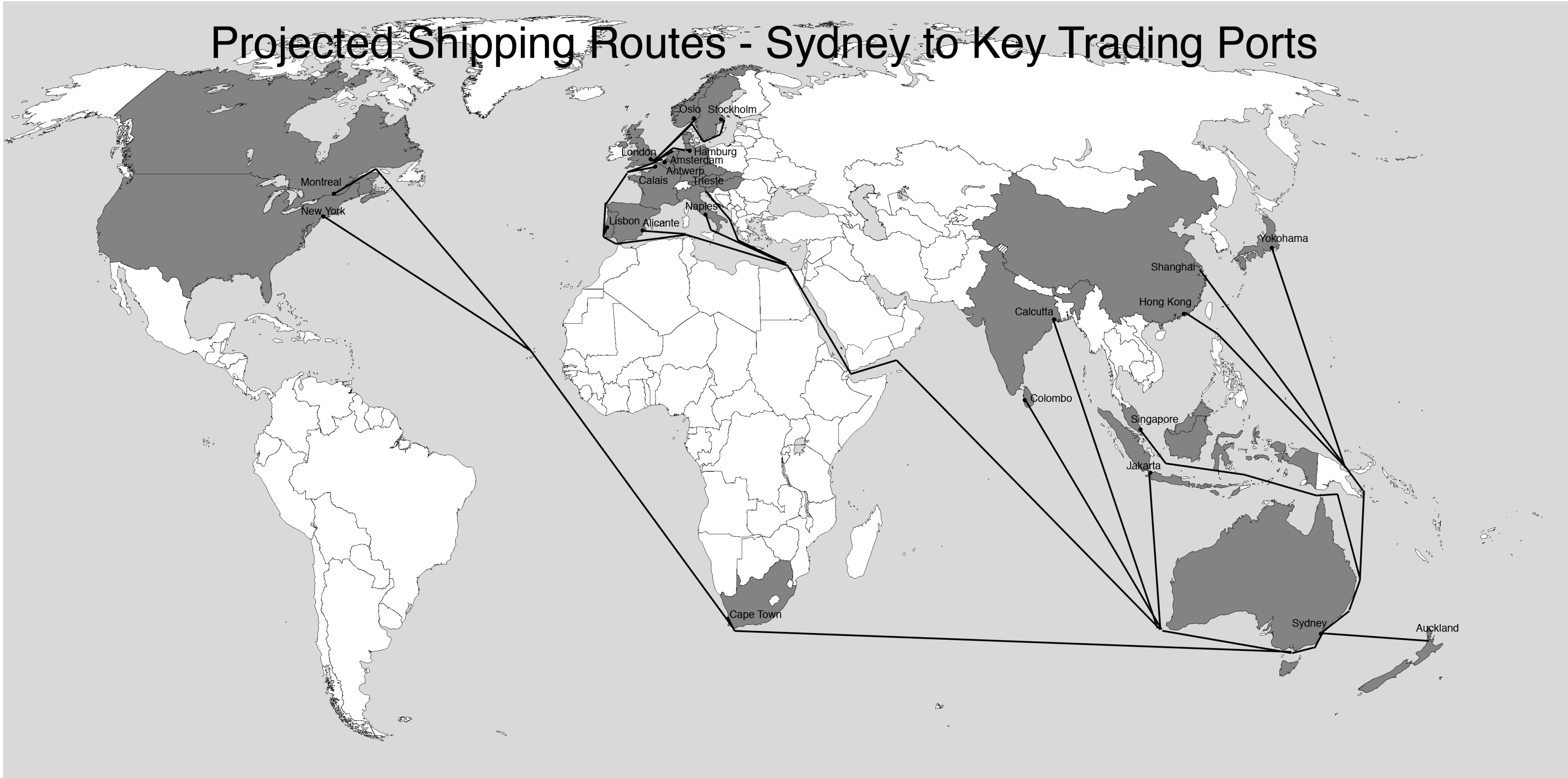
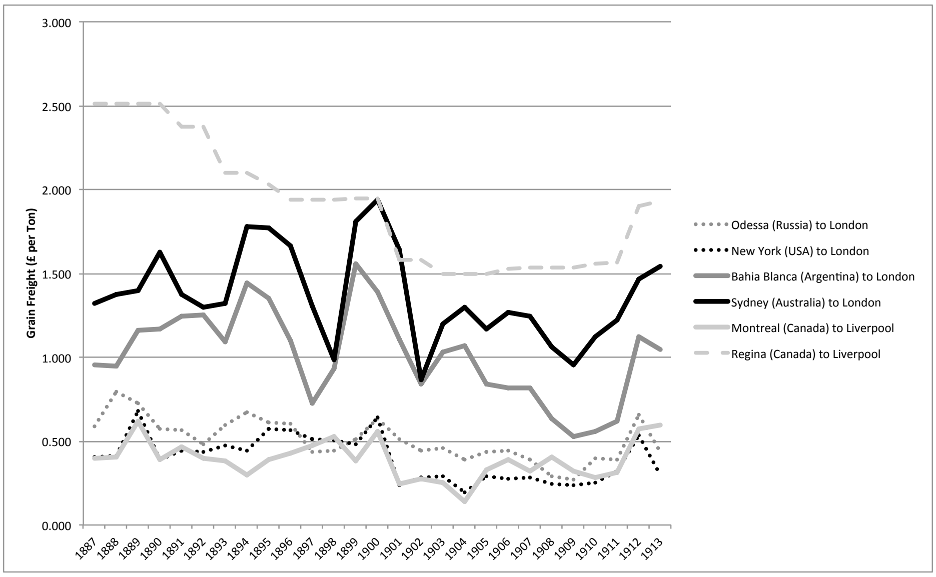
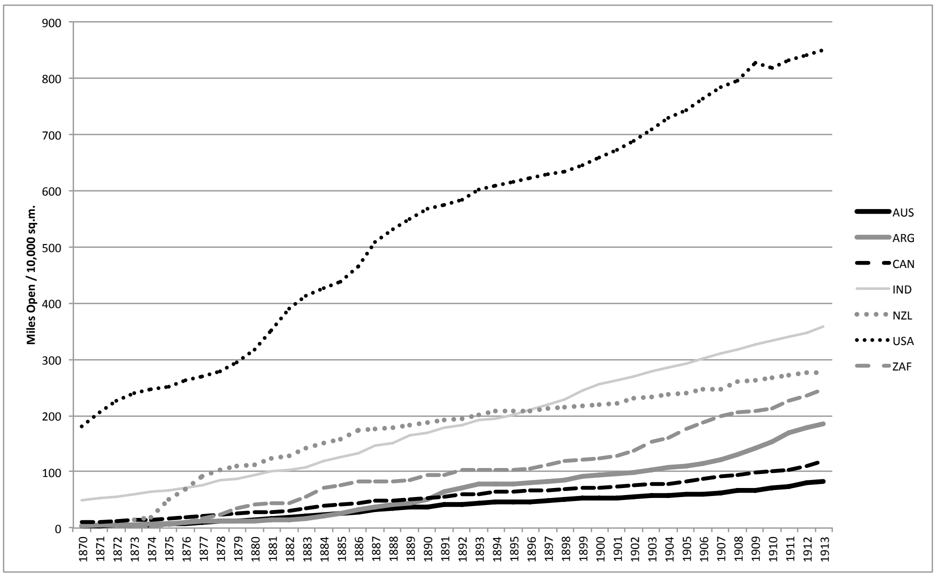


Figure 4.2: Grain Freight Rates to Britain (£ per ton)



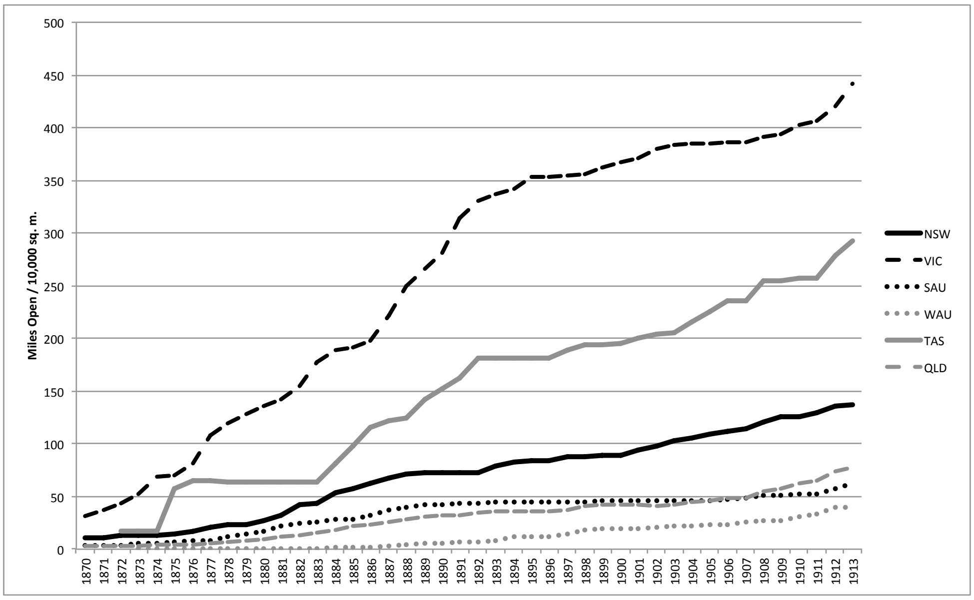
Sources: Comparative Freight Rates to London in 1912 were used as a benchmark and are from Year Book NSW (1916)[77], Indexes of Freight by route are from North (1958)[67]

Figure 4.3: Length of Railway Miles Open by Country (m. per 10,000 sq. m.)



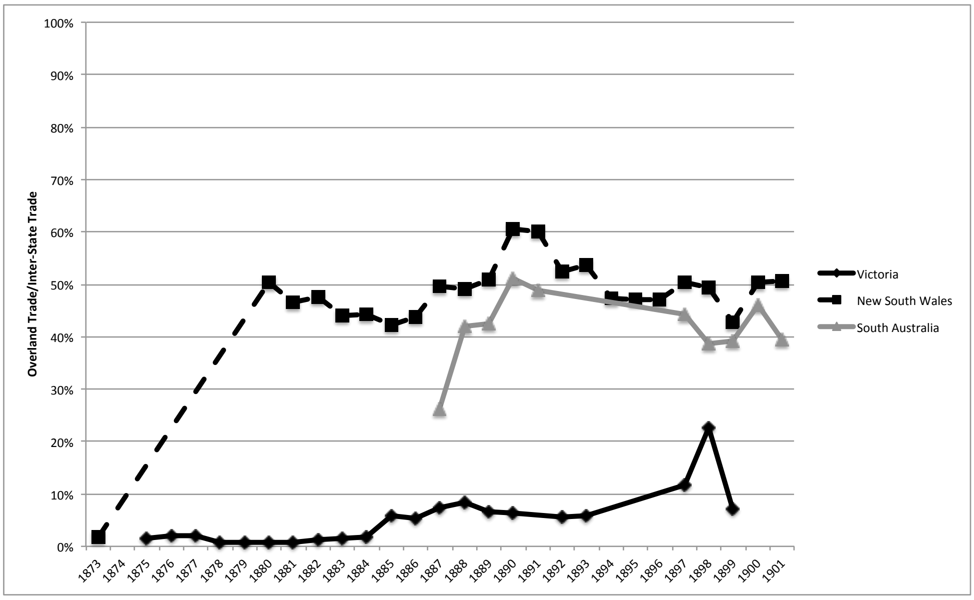
Sources: Mitchell (2013)[64], Coghlan (1904)[22], SAPOFC (Various)[106], SASCOPUK (Various)[105], Year Books NSW (Various)[77], Statistical Abstracts and Statistical Registers for each country.

Figure 4.4: Length of Railway Miles Open by State (m. per 10,000 sq. m.)



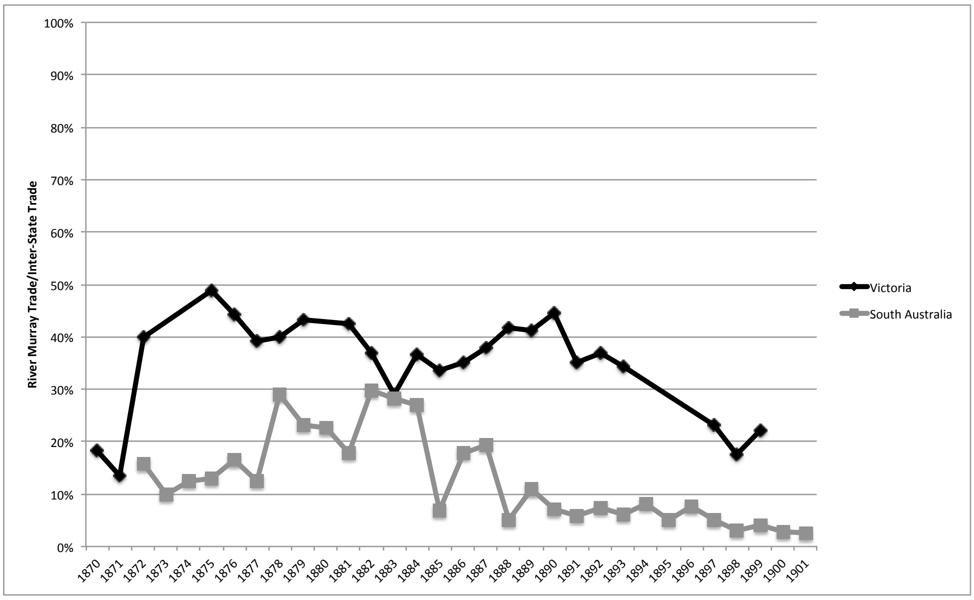
Sources: Mitchell (2013)[64], Coghlan (1904)[22], SAPOFC (Various)[106], SASCOPUK (Various)[105], Year Books for NSW (Various)[77], Statistical Abstracts and Statistical Registers for each country.

Figure 4.5: Overland Trade Share in Inter-State Trade (%)



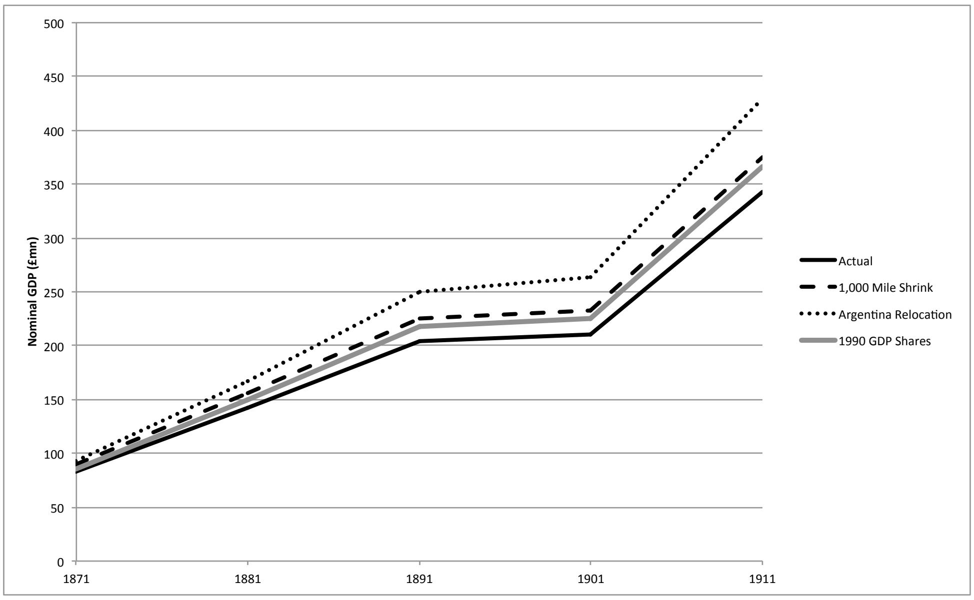
Sources: SRVIC (1871-1905)[87], SRSAU (1871-1905)[4], SRNSW (1871-1905)[78]

Figure 4.6: River Murray Trade Share in Inter-State Trade (%)



Sources: SRVIC (1871-1905)[87], SRSAU (1871-1905)[4], SRNSW (1871-1905)[78]

Figure 4.7: Counterfactual Australian GDP



Sources: See section VII for a description of sources and methods.

Chapter 5

Bibliography

[1] Olivier Accominotti, Marc Flandreau, and Riad Rezzik. The spread of empire: Clio and the measurement of colonial borrowing costs. *Economic History Review*, 64(2):385–407, 2011.

[2] Morris Altman. Revised real canadian gnp estimated and canadian economic growth, 1870–1926. *Review of Income and Wealth*, 38:455–473, 1992.

[3] Maddison Angus. *Development Centre Studies The World Economy Historical Statistics: Historical Statistics*. Development Centre Studies. OECD Publishing, 2003.

[4] South Australia, Australia. Commonwealth Bureau of Census, Statistics. South Australian Office, and Australian Bureau of Statistics. South Australian Office. *Statistical Register of South Australia*. Adelaide: A. B. James, Government Printer., 1871–1903.

[5] Paul Bairoch. *Economics & World History, Myths and Paradoxes*. Chicago: University of Chicago Press, 1993.

[6] John Baldwin and Paul Goreki. *The Role of Scale in Canada/US Productivity Differences in the Manufacturing Sector, 1970–1979*. Toronto: University of Toronto Press, 1986.

[7] Gordon Bertram. Historical statistics on growth and structure of manufacturering in canada, 1870–1957. In Jacques Henripin and Athanasios Asimakopolous, editors, *Canadian Political Science Association Conferences on Statistics 1962 and 1963*, pages 93–146. Toronto, 1964.

[8] Geoffrey Blainey. *The Tyranny of Distance: How Distance Shaped Australia's History*. Macmillan, 2001.

[9] Steve Broadberry. Economic growth in europe and the united states since 1870: A quantitative economic analysis incorporating institutional factors. In David Coates, editor, *Varieties of Capitalism, Varieties of Approaches*, pages 85–105. Basingstoke: Macmillan, 2005.

[10] Steve Broadberry and Carsten Burhop. Comparative productivity in british and german manufacturing before world war 2: Reconciling direct benchmark estimates and time series projections. *The Journal of Economic History*, 67:315–349, 6 2007.

[11] Steve Broadberry, Kyoji Fukao, and Nicholas Zammit. How did japan catch-up on the west? a sectoral analysis of anglo-japanese productivity differences 1885–2000. In *Asian Historical Economics Conference*, 2012.

[12] Steve Broadberry and Douglas Irwin. Lost exceptionalism? comparative income and productivity in australia and the united kingdom, 1861–1948. *The Economic Record*, 83:262–274, 2007.

[13] Noel Butlin. *Australian domestic product, investment and foreign borrowing, 1861-1938/39*. Cambridge: Cambridge University Press, 1962.

[14] Noel Butlin and John Dowie. Estimates of australian workforce and employment, 1861-1961. *Australian Economic History Review*, 9:138–155, 1969.

[15] Statistics Canada. *GDP at factor cost by industry (constant prices)*. Ottawa: Statistics Canada, 1990.

[16] Paul Cashin. Real gdp in the seven colonies of australasia: 1861-1991. *Review of Income and Wealth*, 41(1):19–39, 1995.

[17] Richard Caves. Vent for surplus. In Robert Baldwin, editor, *Trade, Growth and the Balance of Payments: Essays in Honour of Gottfried Haberler*, pages 95–115. Chicago and Amsterdam, 1965.

[18] Census, Statistics Office, Canada. Dominion Bureau of Statistics, Canada. General Statistics Branch, Handbook Statistics. Canada Year Book, and Library Division. *The Canada Year Book*. Ottawa: Statistics Canada, 1913.

[19] Michael Chisholm and Patrick O'Sullivan. *Freight Flows and Spatial Aspects of the British Economy*. Cambridge geographical studies. Cambridge: Cambridge University Press, 1973.

[20] Colin Clark. Industrial location and economic potential. *Lloyds Bank Review*, 82:1–17, 1966.

[21] Colin Clark, Frank Wilson, and John Bradley. Industrial location and economic potential in western europe. *Regional Studies*, 3:197–212, 1969.

[22] Timothy Coghlan. *A Statistical Account of the Seven Colonies of Australasia*. Sydney: Government Printer, 1891–1903/4.

[23] William Cooper, Lawrence Seiford, and Kaoru Tone. *Introduction to Data Envelopment Analysis and Its Uses: With DEA-Solver Software and References*. Springer, 2006.

[24] Nick Crafts. Market potential in british regions, 1871–1931. *Regional Studies*, 39:1159–1166, 2005.

[25] Paul David. Just how misleading are official exchange rate conversions? *The Economic Journal*, 82:979–990, 1972.

[26] Statistics Canada. Current Economic Analysis Division. *CANSIM, Canadian Socio-economic Information Management System*. Ottawa: Statistics Canada, 1986.

[27] Antoni Estevadeordal, Brian Frantz, and Alan Taylor. The rise and fall of world trade, 1870–1939. *The Quarterly Journal of Economics*, 118:359–407, 2003.

[28] O. Firestone. *Canada's Economic Development, 1876–1953, with Reference to Changes In the Country's National Product and National Wealth*. London: Bowes and Bowes, income and wealth series 7 edition, 1958.

[29] John Fogarty. The comparative method and the nineteenth century regions of recent settlement. *Historical Studies*, 19(76):412–429, 1981.

[30] Ernest Foxwell and Thomas Cecil Farrer. *Express Trains, English and Foreign: Being a Statistical Account of All the Express Trains of the World*. London: Smith, Elder & Company, 1889.

[31] Simone Gingrich, Gertrud Haidvogl, and Fridolin Krausmann. The danube and vienna: urban resource use, transport and land use 1800–1910. *Regional Environmental Change*, 12(2):283–294, 2012.

[32] David Greasley and Les Oxley. A tale of two dominions: Comparing the macroeconomic records of australia and canada since 1870. *Economic History Review*, 2:294–318, 1998.

[33] Alan Green. Growth and productivity change in the canadian railway sector 1871–1926. In Stanley Engerman and Robert Gallman, editors, *Long-Term Factors in American Economic Growth*, pages 779–817. Chicago: University of Chicago Press, 1986.

[34] Brian Haig. Manufacturing employment and tariffs in victoria and new south wales, 1861–1911. Centre for Economic Policy Research, ANU, 1989.

[35] Brian Haig. New estimates of australian gdp: 1861–1948/49. *Australian Economic History Review*, 41:1–34, 2001.

[36] Chauncy Harris. The market as a factor in the localization of industry in the united states. *Annals of the Association of American Geographers*, 44:315–348, 1954.

[37] Alan Heston. National income. In D. Kumar, editor, *The Cambridge History of India*, volume 2. Cambridge: Cambridge University Press, 1983.

[38] Alan Heston, Robert Summers, and Bettina Aten. *Penn World Table Version 7.1*. Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, July 2012.

[39] David Hummels. Have international transportation costs declined? `http://www.aerohabitat.eu/uploads/media/11-01-2006_-_D_Hummels__Transportation_cost_declines.pdf`, 1999.

[40] David Hummels. How the price of distance declined: ocean freights for grain and coal from the 1870s to 2000. mimeo, University of Helsinki, 2003.

[41] Kris Inwood and Ian Keay. Bigger establishments in thicker markets: Can we explain early productivity differentials between canada and the united states? *Canadian Journal Of Economics*, 38:1327–1368, 2005.

[42] Douglas Irwin. The impact of federation on australia's trade flows. Working Paper 12160, National Bureau of Economic Research, April 2006.

[43] David Jacks, Christopher Meissner, and Dennis Novy. Trade costs in the first wave of globalization. *Explorations in Economic History*, 47(2):127–141, 2010.

[44] David Jacks, Christopher Meissner, and Dennis Novy. Trade booms, trade busts, and trade costs. *Journal of International Economics*, 83(2):185–201, March 2011.

[45] David Jacks and Krishna Pendakur. Global trade and the maritime transport revolution. *The Review of Economics and Statistics*, 92(4):745–755, November 2010.

[46] Ian Keay. *Assessing the Performance of Canada's Manufacturers: Firm Level Evidence from 1902–1990.* PhD thesis, University of British Columbia, Vancouver, British Columbia, 1999.

[47] Ian Keay. Canadian manufacturers' relative productivity performance, 1907–1990. *The Canadian Journal Of Economics*, 33:1049–1068, 2000.

[48] Ian Keay. Scapegoats or responsive entrepreneurs: Canadian manufacturers, 1907–1990. *Explorations in Economic History*, 37:217–240, 2000.

[49] David Keeble, Peter Owens, and Chris Thompson. Regional accessibility and economic potential in the european community. *Regional Studies*, 16:419–432, 1982.

[50] Iriving Kravis, Alan Heston, and Robert Summers. Real gdp per capita for more than one hundred countries. *The Economic Journal*, 88:215–242, 1978.

[51] Kari Levitt. Silent surrender: The multinational corporation in canada. In Katherine Fierlbeck, editor, *The Development of Political Thought in Canada: An Anthology*, pages 125–144. Toronto: University of Toronto Press, 2005.

[52] Robert Lucas. On the mechanics of economic development. *Journal of Monetary Economics*, 22:3–42, 1988.

[53] Mary MacKinnon. Schooling: Examining some myths. In David Pope and Lee Alston, editors, *Australia's Greatest Asset: Human Resources in the Nineteenth and Twentieth Centuries*, pages 102–129. Annandale NSW:The Federation Press, 1989.

[54] William Mackintosh and John Dales. *The Economic Background of Dominion-Provincial Relations: Appendix III of the Royal Commission Report on*

Dominion-Provincial Relations. Number no. 3 in Carleton library. McClelland and Stewart, 1964.

[55] Gary Magee. Technological development and foreign patenting: Evidence from 19th-century australia. *Explorations in Economic History*, 36:344–359, 1999.

[56] Gary Magee and Andrew Thompson. *Empire and Globalisation: Networks of People, Goods, and Capital in the British World, c. 1850–1914*. Cambridge: Cambridge University Press, 2010.

[57] John McCarty. The staple approach in australian economic history. *Business Archives and History*, 4(1):1–22, 1964.

[58] Dier McCloskey. Essays on a mature economy: Britain after 1840. *Explorations in Economic History*, 9:429–432, 1971.

[59] Marvin McInnis. Output and productivity in canadian agriculture, 1870/71 to 1926/27. In Stanley Engerman and Robert Gallman, editors, *Long-Term Factors in American Economic Growth*, pages 737–778. Chicago: University of Chicago Press, 1986.

[60] Ian McLean. Australian economic growth in historical perspective. *The Economic Record*, 80:330–345, 2004.

[61] Petros Milionis and Mariko Klasing. Reassessing the evolution of world trade, 1870-1949. GGDC Research Memorandum GD–126, Groningen Growth and Development Centre, University of Groningen, 2012.

[62] Brian Mitchell. *Abstract of British Historical Statistics*. Number v. 1 in Applied economic monograph. Cambridge: Cambridge University Press, 1962.

[63] Brian Mitchell. *British Historical Statistics*. Cambridge: Cambridge University Press, 1988.

[64] Brian Mitchell. International historical statistics. `http://0-www.palgraveconnect.com.pugwash.lib.warwick.ac.uk/pc/doifinder/10.1057/9781137305688`, 2013.

[65] Thomas Naylor. *The History of Canadian Business, 1867-1914*. History of Canadian business. Toronto: J. Lorimer Publisher, 1975.

[66] Kenneth Norrie and Douglas Owram. *A History of the Canadian Economy*. Harcourt Brace, 1991.

[67] Douglass North. Ocean freight rates and economic development 1730-1913. *The Journal of Economic History*, 18:537–555, 12 1958.

[68] Ragner Nurkse. *Patterns of Comparative Development*. Oxford: B. Blackwell, 1961.

[69] Australia. Commonwealth Bureau of Census, Melbourne Statistics. Victorian Office, and Victoria. Statist's Office. *Victorian Year-book*. Melbourne: Government Printer, 1869–1913.

[70] Canada. Dept. of Citizenship and Immigration. *Report of the Department of Citizenship and Immigration*. Ottawa, 1966–1996.

[71] Canada. Dept. of Customs. *Tables of the Trade and Navigation of the Dominion of Canada Compiled from Official Returns*. Canada. Dept. of Customs, 1869-1908.

[72] Cape of Good Hope (South Africa). Colonial Secretary's Dept. *Results of a Census of the Colony of the Cape of Good Hope*. South Africa: Solomon, 1875; 1891; 1904; 1911.

[73] The University of Groningen. Historical statistics. `http://www.ggdc.net/MADDISON/Historical\_Statistics/vertical-file\_02-2010.xls`, 2010.

[74] The University of Groningen and The University of Birmingham. The klems growth and productivity accounts: An overview. `http://www.euklems.net/`, 2008.

[75] Australian Bureau of Statistics. *Official Year Book of Australia*. Canberra: Australian Bureau of Statistics, 1919.

[76] Australian Bureau of Statistics. *Australian National Accounts: National income, expenditure and product*. Canberra: Australian Bureau of Statistics, 1992.

[77] Australian Bureau of Statistics, Australia. Commonwealth Bureau of Census, Statistics, New South Wales. Bureau of Statistics, and Economics. *Official Year Book of New South Wales*. Sydney: Government Printer, 1871–1916.

[78] New South Wales. Bureau of Statistics and Economics. *Statistical Register for New South Wales*. Sydney: Government Printer, 1871–1903.

[79] United States. Bureau of the Census, United States. Dept. of the Treasury. Bureau of Statistics, United States. Dept. of Commerce, Labor. Bureau of Statistics, United States. Bureau of Foreign, Domestic Commerce, and U.S.C. Bureau. *Statistical Abstract of the United States*. U.S. Government Printing Office, 1871–1913.

[80] Australia. Dept. of Trade, Customs, and New South Wales. Statistician's Office. *Annual Statement of the Trade of the Commonwealth of Australia with the United Kingdom, British Possessions, and Foreign Countries and of the Customs and Excise Revenue*. Canberra: Australian Bureau of Statistics, 1903-1980.

[81] Canada. Dept. of Trade and Commerce. *Annual Report of the Department of Trade and Commerce for the Fiscal Years Ending March 31*. Ottawa: Department of Trade and Commerce, 1909-1982.

[82] Great Britain. Board of Trade. *Statistical Abstract for the British Empire*. nos. 45–46. London: H.M. Stationery Office, 1906–1913.

[83] Canada. Census Office. *Census of Canada*. Ottawa: S. E. Dawson, 1871; 1881; 1891; 1901; 1911.

[84] Canadian Intellectual Property Office. Annual patent reports. `http://brevets-patents.ic.gc.ca/opic-cipo/cpd/eng/search/advanced.html`, 2013.

[85] Great Britain. India Office. *Statistical Abstract Relating to British India*. no. 4. London: Eyre and Spottiswoode, 1871; 1881; 1891; 1901; 1911.

[86] Registrar-General's Office, New Zealand. Census, and Statistics Office. *New Zealand Official Yearbook*. New Zealand: Government Printer, 1893–1913.

[87] Statist's Office and Victoria. *Statistical Register of the State of Victoria*. Victoria: Registrar-General's Office, 1871–1903.

[88] Western Australia Registrar General Office. *Western Australian Yearbook*. Perth: Government Printer, 1869–1913.

[89] Richard Pomfret. Trade policy in canada and australia in the twentieth century. *Australian Economic History Review*, 40(2):114–126, 2000.

[90] Leandro Prados de la Escosura. International comparisons of real product, 1820–1990. *Explorations in Economic History*, 37:1–41, 2000.

[91] Government Publications. *Statistical Register of the Colony of Western Australia*. Perth: Government Printer, 1871–1911.

[92] Government Publications. *Census of New Zealand*. Appendix to the Journals of the House of Representatives of New Zealand. New Zealand Government Printer, 1871; 1881; 1886; 1901; 1911.

[93] Queensland and Registrar-General's Office. *Statistics of the Colony of Queensland*. Brisbane: Government Printer, 1871–1903.

[94] Michael Ray. Market potential and economic shadow. Research Paper No. 101, 1965.

[95] David Rich. *Accessibility and Economic Activity: a Study of Locational Disadvantage in Scotland*. PhD thesis, University of Cambridge, Cambridge, 1975.

[96] David Rich. Potential models in human geography. *Geoabstracts*, 26, 1980.

[97] David Romer and Jeffrey Alexander Frankel. Does trade cause growth? *American Economic Review*, 89(3):379–399, 1999.

[98] Paul Romer. Increasing returns and long-run growth. *Journal of Political Economy*, 94(5):1002–1037, 1986.

[99] Isabel Sanz-Villarroya. The convergence process of argentina with australia and canada: 1875–2000. *Explorations In Economic History*, 42:439–458, 2005.

[100] Boris Schedvin. Staples and regions of pax britannica. *Economic History Review*, 43(4):533–559, 1990.

[101] Siva Sivasubramonian. Revised estimates of the national income of india, 1900/1 to 1946/7. *Indian Economic and Social History Review*, 34:113–168, 1997.

[102] Jan-Pieter Smits, Pieter Woltjer, and Debin Ma. A dataset on comparative historical national accounts, ca.1870-1950: A time-series perspective. `http://irs.ub.rug.nl/ppn/317810456`, 2009.

[103] Carl Solberg. *The Prairies and the Pampas: Agrarian Policy in Canada and Argentina, 1880-1930*. Comparative studies in history, institutions, and public policy. Stanford: Stanford University Press, 1987.

[104] Tasmania. Statistical and Registration Dept. *Statistics of the Colony of Tasmania*. Tasmania: Government Printer, 1871–1903.

[105] Government Statistician. *Statistical Abstract for the Several Colonial and Other Possessions of the United Kingdom in Each Year.* London: Eyre and Spottiswoode, 1871–1905.

[106] Government Statistician. *Statistical Abstract for the Principal and Other Foreign Countries in Each Year.* no. 11. London: H.M. Stationery Office, 1871–1913.

[107] Government Statistician. *Victorian Yearbook.* Melbourne: Kessinger Publishing, 1871–1913.

[108] Jolin Stewart. Empirical mathmatical rules concerning the distribution and equilibrium of population. *Geography Review*, 37:461–485, 1947.

[109] Kaoru Tone. A strange case of the cost and allocative efficiencies in dea. *Journal of the Operational Research Society*, 53:1225–1231, 2002.

[110] Malcolm Urquhart. Historical statistics of canada. In Kenneth Buckley, editor, *Historical Statistics of Canada.* Ottawa: Statistics Canada, 1983.

[111] Malcolm Urquhart. New estimates of gross national product, canada, 1870–1926: Some implications for canadian development. In Stanley Engerman and Robert Gallman, editors, *Long-Term Factors in American Economic Growth*, pages 9–94. Chicago: University of Chicago Press, 1986.

[112] Malcolm Urquhart and Kenneth Buckley. *Historical Statistics of Canada.* Toronto: Macmillan of Canada, 1965.

[113] Wray Vamplew. *Australians: Historical Statistics.* New South Wales: Fairfax, Syme & Weldon Publishers, 1987.

[114] Mel Watkins. A staple theory of economic growth. *Canadian Journal of Economics and Political Science*, 29(2), 1963.

[115] Mel Watkins. Staples redux. *Studies in Political Economy*, 79(2), 2007.

[116] Samuel Williamson. What was the u.s. gdp then? `http://www.measuringworth.com/`, 2013.

[117] Peter Wylie. *Electrification and Technological Adaptation in Canadian Manufacturing, 1900–1929.* PhD thesis, Queen's University, Kingston, Ontario, 1986.

[118] Peter Wylie. Technological adaptation in canadian manufacturing, 1900–1929. *The Journal of Economic History*, 49(3):569–591, 1989.

[119] Peter Wylie. Scale-biased technological development in canada's industrialization, 1900–1929. *The Review of Economics and Statistics*, 72(2):219–227, 1990.

Appendix A

Table A.1: 1936/37 PPP by Agricultural subsectors

Agriculture						
		Australia		Canada		
Crop	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
All Barley	Bushels	7336767	1522051	71922000	49512000	3.32
Corn (Husking)	Bushels	7246383	1784716	9211400	14830000	6.54
Rye	Bushels	126011	21011	4281000	2980000	4.17
Wheat	Bushels	151389952	40471041	219218000	205327000	3.50
Hay (Total)	Tons	3447647	12104079	14813000	112176000	2.16
Beans	Bushels	64008	52607	876000	1790400	2.49
Peas	Bushels	714105	205767	1229300	1991000	5.62
Potatoes	Tons	474738	2235063	1796851	45125000	5.33
Beet (Sugar)	Tons	31079	65266	595000	3416000	2.73
Turnips	Tons	57960	183304	1733077	13382000	2.44
Grapes	Tons	409016	4232694	10394	495200	4.60
Tobacco	lb.	5198352	437446	46084000	9420200	2.43
Apples	Bushels	10998866	2794633	13501971	9789000	2.85
Apricots	Bushels	830280	288826	1300	4042	8.94
Cherries	Bushels	218699	174580	186800	480300	3.22
Peaches	Bushels	2132654	640433	429900	658000	5.10
Pears	Bushles	2692207	669782	431300	602500	5.62
Plums	Bushels	1115129	333186	158700	241700	5.10
Raspberries	cwt.	74706	82938	84778	703900	7.48
Strawberries	cwt.	23214	54637	308679	1929100	2.66
Pastoral						
		Australia		Canada		
Crop	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Wool	lb.	982831449	67487759	18929000	2782000	4.25
Beef	lb.	233851658	3036239	12416000	830000	5.15
Pork	lb.	32956097	1022121	174493000	28097000	5.19
Mutton	lb.	208458246	5233652	232000	39000	6.70
Dairying & Fishing						
		Australia		Canada		
Crop	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Butter	lb.	19296080	1218908	106381000	19704000	2.93
Cheese	lb.	762231	36640	1032300	138028	2.78
Eggs	doz.	16473894	954578	1204000	326000	4.67
Fish	cwt.	556645	1369332	9443776	30705714	1.32
Lobsters	doz.	151838	142943	1888487	4383428	2.47
Oysters	cwt.	74283	102683	42466	189922	3.24

Sources: Australian Production Bulletin #31, Summary of Australian Production Statistics for 1936/37, CBCS (1936/37)[76], Urquhart & Buckley (1965)[112], CYB (1937)[18]

Notes: Conversions Used: 32 dry quarts = 1 bushel, 1 bushel (fruit) = 0.021772 metric ton, 1 metric ton = 22.04623 cwt (short), doz. lobsters = 15 lbs (average), 1 lb = 0.01 cwt. (short), 1 bbl. = 3.281 bushels. Data on Cattle, Pork & Mutton is based on value and quantity of exports of major agricultural products, Data for Canada on Butter and Cheese are based on Farm (Dairy) Butter and Farm Cheese while data for Australia are based on average metropolitan prices by state of Cheese and Prime Quality Butter

Table A.2: 1936/37 PPP by Manufacturing subsectors

Class I - Treatment of Non-metalliferous & Quarry Products						
		Australia		Canada		
Product	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Coke	Tons	1489896	1755150	2246306	17162838	6.49
Tar (Crude)	gal.	24997979	342159	32192130	1340754	3.04
Tar (Refined)	gal.	2822305	43883	6411014	610209	6.12
Quick Lime	Tons	73091	195356	372511	2843185	2.86
Hydrated Lime	Tons	15397	56044	91742	587657	1.76
Cement (Portland)	Tons	720093	2566740	769187	6908192	2.52

Class II - Bricks, Pottery, Glass, Etc.						
		Australia		Canada		
Product	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Bricks	000s	636815	1986731	130181	1934660	4.76
Fire Bricks	000s	30640	410519	2548	118923	3.48
Tiles	sq. yd.	161751	124900	10860	13798	1.65

Class III - Chemicals, Dyes, Explosives, Paints, Oils & Grease						
		Australia		Canada		
Product	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Acetylene Gas	c. ft.	17456284	144632	41315830	1016256	2.97
Oxygen	c. ft.	54502865	142854	151500660	1438799	3.62
Paints (Water)	lb.	3900204	74178	8802870	524415	3.13
Paints & Varnish	gal.	2999711	1524359	4967042	8999542	3.57
White Lead	cwt.	141809	281105	136349	935442	3.46
Putty	cwt.	61259	27179	57894	203412	7.92
Cooking Oils	Tons	39187	688817	4994	595948	6.79
Linseed Oil	gal.	3121846	608184	4232027	3042278	3.69
Tallow & Glue	cwt.	1117334	1160431	749984	3424327	4.40
Oil (Neatsfoot)	gal.	148253	29266	323157	197501	3.10
Hides & Skins	No.	1410350	928915	1327417	1739309	1.99
Soap	cwt.	942125	1777466	1302582	7869191	3.20
Glycerine	cwt.	60915	306203	95201	1176330	2.46
S. phosphate	Tons	1090225	3579215	79724	990216	3.78
A. Sulphate	Tons	22412	195967	91053	1936135	2.43

Class IV - Industrial Metals, Machines & Conveyances						
		Australia		Canada		
Product	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Pig Iron	Tons	913406	2146118	170751	3327716	8.29
Castings	Tons	57164	609562	136449	17249832	11.86
Motors & Batteries	No.	14089867	711504	33609242	5600310	3.30
Car Parts	No.	2717570	6546087	7241602	93278540	5.35
Complete Cycles	No.	78059	370357	48571	947039	4.11
Vessels & Boats	No.	392	73249	3255	621903	1.02
Farm Implements	No.	218509	845333	892468	3390745	0.98
Metal Rods	cwt.	74140	343236	66625	1060307	3.44
Wire	Tons	113288	1806948	39158	2714748	4.35
Nails	Tons	8834	211051	56162	4022216	3.00
Stoves (All)	No.	34440	180667	302475	9457364	5.96
Gas Meters	No.	37165	130930	13240	165251	3.54
Lead Products	cwt.	79711	174915	43228	413467	4.36
Class VI - Textiles & Textile Goods						
		Australia		Canada		
Product	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Woollens	s. yd.	30324063	4987265	16309907	18067206	6.74
Blankets	Pairs	628131	638391	1810473	3866123	2.10
Rugs & Shawls	No.	206513	134761	16212	156288	14.77
Underwear	doz.	1874563	2137998	4519534	43742157	8.49
Bathing Suits	doz.	47260	194108	58324	898276	3.75
Cardigans	doz.	378107	1201544	502362	5960523	3.73
Rope & Twine	cwt.	208551	817012	817219	7373596	2.30
Class VII - Skins & Leather (not Clothing or Footwear)						
		Australia		Canada		
Product	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Leathers	lb.	28817491	1801546	22316095	6861453	4.92
Upholstery	sq. ft.	30309733	1525683	69908742	11967307	3.40
Harness	No.	24371	47595	119783	320929	1.37
Trunks	No.	4660	3543	72202	403789	7.36
Bags	No.	528447	263155	1373979	1575532	2.30
Leather Coats	No.	15305	35713	183660	910157	2.12

Class VIII - Clothing						
		Australia		Canada		
Product	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Coats	No.	156401	123074	625760	1170324	2.38
Corsets & Belts	doz.	297536	826517	137463	2429896	6.36
Hats & Caps	doz.	404391	1174017	804359	9230965	3.95
Boots & Shoes	Pairs	13307924	6035609	280247	283091	2.23
Slippers & Uppers	Pairs	9611083	970386	25066866	35672223	14.09
Umbrellas	No.	137233	48772	293916	380680	3.64

Class IX - Food, Drink & Tobacco						
		Australia		Canada		
Product	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Wheat	Tons	1499731	14858174	1572480	70244280	4.51
Screenings	Tons	6443	64600	7382	125883	1.70
Breakfast Foods	cwt.	289809	800291	926316	11751616	4.59
Pasta	cwt.	34747	58535	377039	1849748	2.91
Other Grains	cwt.	1088905	1056651	1925037	4073980	2.18
Bread (2lb loaf)	000s	365851	5853478	454644	47658574	6.55
Biscuits	lb.	70933578	2308415	111659726	13282512	3.66
Sugar	Tons	1106547	22086266	481041	38067368	3.96
Molasses	gal.	13445542	58102	3744741	352285	21.77
Syrup	Tons	7766	185664	2472	169096	2.86
Confectionary	lb.	94219869	5055835	80924732	14146081	3.26
Coffee & Spice	lb.	15058982	532287	72668549	11702158	4.56
Peanut Butter	lb.	995521	79322	10045477	1106982	1.38
Baking Powder	lb.	2056526	136247	10062499	1684243	2.53
Self-Raising Flour	cwt.	662865	746126	64231	527549	7.30
Jam & Fruit	lb.	190306245	3801367	101281264	8777989	4.34
Tomato Pulp	cwt.	183848	94432	194968	710369	7.09
Pickles	Pints	5542999	214272	9441289	1695230	4.64
Soups	Pints	5129669	153260	57398310	6256444	3.65
Vinegars	gal.	2902199	120599	4606993	1518543	7.93
Bacon & Ham	lb.	70696566	2978401	168941239	31358801	4.41
Butter & Lard	lb.	377612775	21227332	304718253	64138941	3.74
Milk & Cheese	lb.	121352547	3355378	221265214	29066646	4.75
Preserved Meat	lb.	27475965	569801	98052924	14687580	7.22
Ice	Tons	372822	680515	343811	1393121	2.22
Salt (Refined)	Tons	74117	170452	354996	1773144	2.17
Ale & Beer	gal.	74178368	7938627	56916859	43344707	7.12
Spirits	p. gal.	4104479	631346	4098449	1838203	2.92
Wine	gal.	18361009	1545579	4380686	4158122	11.28
Tobacco	lb.	11514020	3864896	22965056	23017449	2.99
Cigarettes, &c.	No.	2598675	3401059	5727055	49045529	6.54
Ice Cream	gal.	3080745	951111	7517830	8926031	3.85

Class X -Forest Products & Milling						
		Australia		Canada		
Product	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Lumber Sawn	s. ft.	30056439	222321	3412151000	61965540	2.46
Floorboards	s. ft.	50041609	697263	41218000	2263702	3.94
Boxes (Butter)	No.	5390734	295718	1530685	320524	3.82

Class XI - Furniture, Bedding, Etc.						
		Australia		Canada		
Product	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Mattresses	No.	149928	236777	624309	4208282	4.27

Class XIII - Rubber						
		Australia		Canada		
Product	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Rubber Footware	Pairs	3609978	507144	16895643	19274250	8.12
Tyres & Tubes	No.	3495089	4027176	5277077	28864301	4.75
Rubber Garments	No.	153501	80820	571912	994161	3.30
Floor Mats	lb.	386602	25525	4248915	562581	2.01
Rubber (Gloves)	Pairs	194016	12288	725244	236776	5.15

Class XV - Miscellaneous Products						
		Australia		Canada		
Product	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Brushes	Gross	31294	209081	35309	1112512	4.72
Brooms	Gross	14937	191743	24755	1210728	3.81
Balls (Golf)	doz.	84598	67961	50204	212524	5.27

Sources: Australian Production Bulletin #31, Summary of Australian Production Statistics for 1936/37, CBCS (1936/37)[76], Urquhart & Buckley (1965)[112], CYB (1937)[18]
Notes: Conversions Used: see above. Only a selection of manufacturing sub categories were included.

Table A.3: 1936/37 PPP by Construction subsectors

Housing						
Dwellings	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Monthly House Rent	6 Room Unit	1	4.59	1	19.35	4.21

Sources: Australian Production Bulletin #31, Summary of Australian Production Statistics for 1936/37, CBCS (1936/37)[76], Pg. 13 & 15, Table 12 & 16.
Notes: House Rents are based on a geometric mean of modern & non-modern houses averaged monthly.

Table A.4: 1936/37 PPP by Mining subsectors

Metals						
Metal	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Arsenic & Ore	Tons	3592	66525	619	42491	3.70
Bismuth & Ore	cwt.	365	8167	3642	360523	4.42
Cadmium	cwt.	673	10799	7859	699465	5.55
Copper	Tons	18892	796686	190978	39514101	4.91
Gold	F. Oz.	1179751	10214404	3748028	77478612	2.39
Lead	Tons	44871	766094	383180909	14993869	5.05
Silver	Oz.	4162203	368481	18334487	8273804	5.10
Zinc	Tons	269979	934921	151132	11045007	21.10
Minerals (Silicates, Sulfates, Phosphates & Others)						
Mineral	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Felspar	Tons	3691	10347	17846	154475	3.09
Fluorspar	Tons	836	2166	75	900	4.63
Gypsum	Tons	125594	92430	833822	1278971	2.08
Salt	Tons	66326	149234	391316	1773144	2.01
Rocks & Other Mining						
Rock	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Asbestos	cwt.	4780	4193	6642242	9958183	1.71
Coals	Tons	14415306	6987165	15229182	45791934	6.20
Diato. Earth	Tons	2778	6190	615	13650	9.96
Fireclay	Tons	35408	12666	2437	17639	20.23
Limestone Flux	Tons	409581	111161	3731548	3143872	3.10

Sources: Australian Production Bulletin #31, Summary of Australian Production Statistics for 1936/37, CBCS (1936/37)[76], Pg. 47 & 48, Table 75 & 77

Notes: Conversion Used: 1 lb = 0.0004536 metric tons, 1 metric tons = 22.04623 cwt. (short)

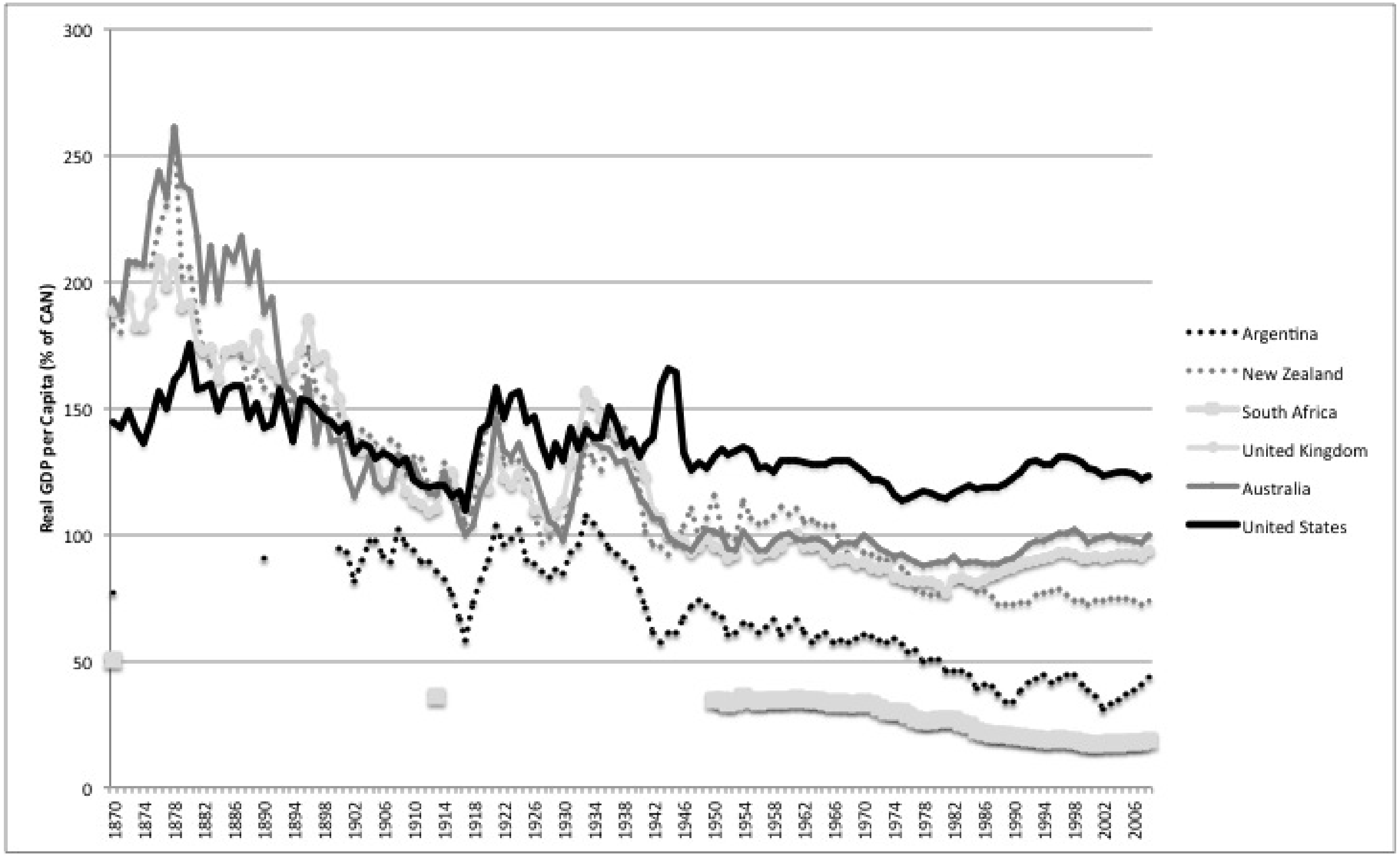
Table A.5: 1936/37 PPP by Service subsectors

Transport & Communications						
		Australia		Canada		
Service	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Rail (Passenger)	Earning M.	1	0.005	1	0.021	4.55
Rail (Freight)	Earning M.	1	0.008	1	0.010	1.27
Property & Finance						
		Australia		Canada		
Service	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Wages/Salaries	Employees	53300	11340000	82000	113000000	6.48
Professional, Personal & Domestic Services						
		Australia		Canada		
Service	Unit	Quantity	Value (£)	Quantity	Value ($)	PPP ($/£)
Wages & Salaries	Employees	323372	67362000	552000	312000000	2.71

Sources: AYB (1938)[75], Butlin (1962)[13], Table 103, pg. 195, Butlin & Dowie (1969)[14], Table 6, pg. Buckley (1983)[110], Table C152-162, pg. 65.

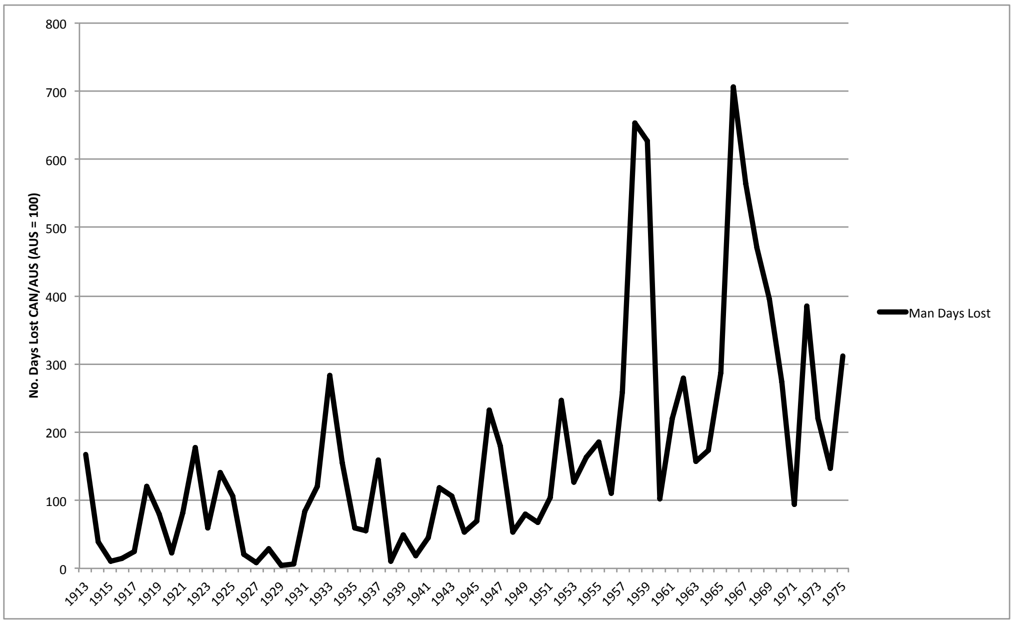
Notes: For Australian "Average Earnings per Passenger Mile" I have weighted the receipts per passenger & pounds from shillings 4 railway lines reported in the Australian Yearbook according to earnings (Converted into £ and pennies) see appendix below for weights. I have removed transport salaries and employees from the total of services for Australia

Figure A.1: Real GDP Per Capita Relative to CAN (1990 Int. GK$)



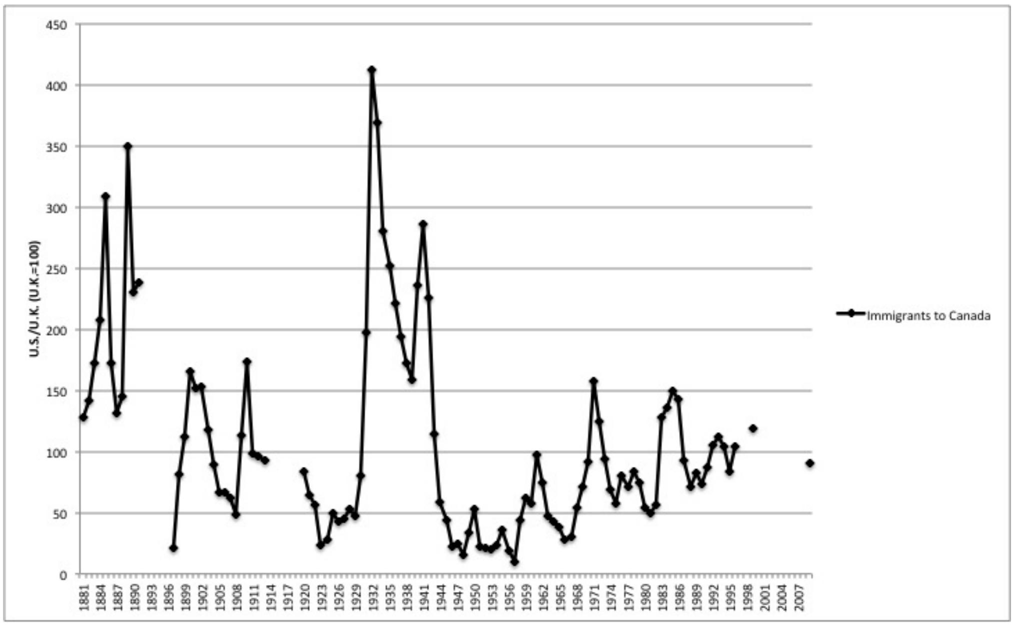
Source: Maddison (2010)[73]

Figure A.2: Man Days Lost Due to Strikes (CAN/AUS)



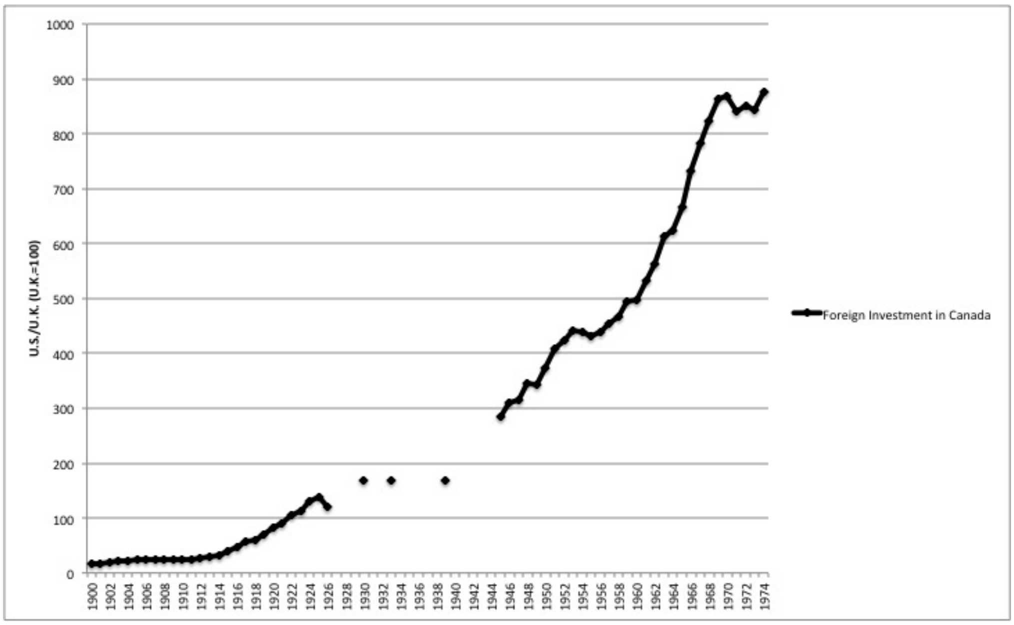
Sources: Mitchell (2013)[64]

Figure A.3: United States/United Kingdom Immigration into Canada



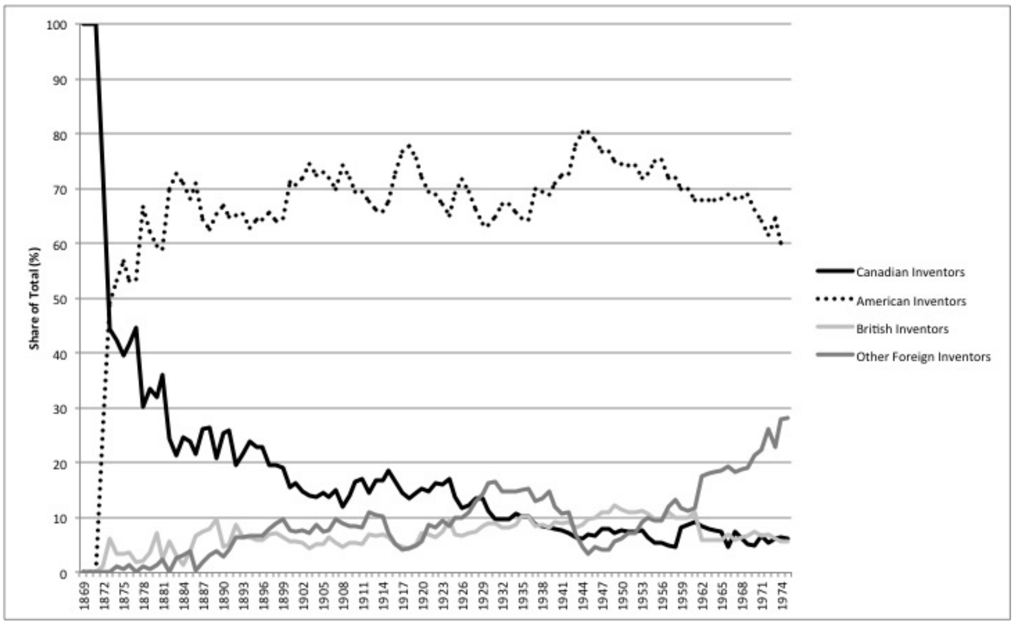
Sources: CYB (Various)[18], Buckley et. al. (1983)[110], CIS (Various)[70]

Figure A.4: United States/United Kingdom Foreign Investment in Canada



Sources: Buckley et. al. (1983)[110]

Figure A.5: Share of Canadian Patents Issued by Inventors Country of Residency



Sources: CYB (Various)[18], CIPO (Online)[84]

Appendix B

DEA Primal and Dual Approach

There are 2 ways to solve the LP problem: Primal (LP) and Dual (DLP).

For each country c in industry i the Primal LP Problem can be solved as:[1]

$$\theta^{i^*} = \max_{v_j^i} Q_c^i \tag{B.1}$$

subject to

$$\begin{aligned} v_1^i x_c^i + v_2^i y_c^i + v_3^i z_c^i &= 1 \\ Q_c^i &\leq v_1^i x_c^i + v_2^i y_c^i + v_3^i z_c^i \quad \forall c = CAN, VIC, ..., CPE \\ v_1^i, v_2^i, v_3^i &\geq 0 \end{aligned}$$

where Q_c^i represents output in industry i and country c, x,y,z represent the three factors of production in industry i and $v_j (j = 1, 2, 3)$ represent the three weights on inputs when the optimal solution to the LP problem is obtained.

For each country c in industry i the Dual LP Problem can be solved as:[2]

$$\min_{\theta^i, \lambda^i} \theta^i \tag{B.2}$$

[1] This is the input oriented LP problem, the output oriented LP problem has not been shown

[2] This is the input oriented DLP problem, the output oriented DLP problem has not been shown

subject to

$$\begin{aligned}
\theta^i x_c^i &\geq \lambda_{CAN}^i x_{CAN}^i + \lambda_{VIC}^i x_{VIC}^i + ... + \lambda_{CPE}^i x_{CPE}^i \\
\theta^i y_c^i &\geq \lambda_{CAN}^i y_{CAN}^i + \lambda_{VIC}^i y_{VIC}^i + ... + \lambda_{CPE}^i y_{CPE}^i \\
\theta^i z_c^i &\geq \lambda_{CAN} z^{CAN} + \lambda_{VIC} z^{VIC} + ... + \lambda_{CPE} z^{CPE} \\
\lambda_{CAN}^i Q_{CAN}^i + \lambda_{VIC}^i Q_{VIC} + ... + \lambda_{CPE}^i Q_{CPE}^i &\geq Q_c^i \\
\lambda_{CAN}^i, \lambda_{VIC}^i, ..., \lambda_{CPE}^i &\geq 0
\end{aligned}$$

where Q_c^i represents output in industry i and country c, x,y,z represent the three factors of production in industry i and λ_c represents the combination of weights of inputs and outputs for each country c needed to produce the optimal input-output combination to the DLP problem.

New Technical and Cost Efficiency Under Different Unit-Costs

New Technical Efficiency

New Technical Efficiency ($\bar{\theta}^{i*}$) can be calculated for each country c in industry i by solving the LP problem given by:[3]

$$\bar{\theta}^{i*} = \min_{\bar{\theta}^i, \lambda^i} \bar{\theta}^i \tag{B.3}$$

subject to

$$\begin{aligned}
\bar{\theta}^i \bar{x}_c &\leq \bar{X}^i \lambda^i \\
Q_c^i &\leq Q^i \lambda^i \\
\lambda^i &\geq 0
\end{aligned}$$

where Q_c^i represents output in industry i and country c, subscript 1,2,3 represent the three factors of production in industry i and λ_c represents the combination of weights of inputs and outputs for each country c needed to produce the optimal input-output combination to the DLP problem. $\bar{X}^i = (\bar{x}_{CAN}^i, \bar{x}_{VIC}^i, ..., \bar{x}_{CPE}^i)$ and $\bar{x}_{j,c}^i = (\bar{x}_{1,CAN}^i p_{1,CAN}^i, \bar{x}_{2,CAN}^i p_{2,CAN}^i, \bar{x}_{3,CAN}^i p_{3,CAN}^i, ...,$
$\bar{x}_{1,CPE}^i p_{1,CPE}^i, \bar{x}_{2,CPE}^i p_{2,CPE}^i, \bar{x}_{3,CPE}^i p_{3,CPE}^i)$.

[3]For a description of all other variables see section VI.1

New Cost Efficiency

New Cost Efficiency ($\bar{\eta}^{i^*} = \frac{e\bar{x}_c^{i^*}}{e\bar{x}_c^i}$) can be calculated for each country c in industry i by solving the LP problem given by:

$$e\bar{x}_c^{i^*} = \min_{\bar{x^i},\lambda^i} e\bar{x}_c^i \tag{B.4}$$

subject to

$$\begin{aligned} \bar{x}^i &\leq \bar{X}^i\lambda^i \\ Q_c^i &\leq Q^i\lambda^i \\ \lambda^i &\geq 0 \end{aligned}$$

where e is a row vector with all elements being equal to 1, Q_c^i represents output in industry i and country c, x,y,z represent the three factors of production in industry i and λ_c represents the combination of weights of inputs and outputs for each country c needed to produce the optimal input-output combination to the DLP problem.

Table B.1: Manufacturing Establishments - Ontario

	Ontario							
	1871				1881			
Category	No.	No. Hands	Total Capital ($000)	Output ($000)	No.	No. Hands	Total Capital ($000)	Output ($000)
Food Products	1864	5823	7051	35031	2416	8415	12252	42327
Textiles	1936	14320	4599	13506	3450	23711	10467	22201
Iron& Steel	328	7042	3433	8147	415	7675	7492	9269
Timber & Lumber	3888	22250	9938	19061	3915	27327	16478	27219
Leather Products	3073	9745	2424	10125	3204	9272	4564	10742
Paper & Printing	230	2591	1521	2823	330	4930	4035	5285
Liquors & Beverages	148	1037	1558	5176	177	1403	4157	5242
Chemicals & Allied	362	1426	1170	3983	264	1311	2515	5383
Clay, Glass & Stone	1031	3961	491	1621	1187	5456	1705	2982
Metal Products	571	1704	641	1776	954	3790	2468	4325
Tobacco Products	42	707	125	693	59	1164	541	1186
Vehicles for Land	1423	4840	1198	3283	1702	7013	3402	6401
Vehicles for Water	57	562	159	434	87	556	202	457
Miscellaneous	618	4630	2473	5009	853	8409	8369	9394
Hand Trades	3472	6643	1093	4039	4177	7876	2304	5577
TOTAL	19043	87281	37874	114707	23190	118308	80951	157990

Sources: COC (1871; 1881)[83]

Notes: Total Capital includes both Fixed capital (Land, Building & Machinery) & Working capital.
Output is Gross Output including repairs.

Table B.2: Manufacturing Establishments - Quebec

	Quebec							
	1871				1881			
Category	No.	No. Hands	Total Capital ($000)	Output ($000)	No.	No. Hands	Total Capital ($000)	Output ($000)
Food Products	1363	3272	4558	18320	1616	5309	7326	22830
Textiles	1131	7267	2665	8457	1965	16491	8622	14978
Iron& Steel	160	3608	1827	3909	195	4500	4943	5834
Timber & Lumber	3044	17010	6311	12898	2980	17961	10815	14538
Leather Products	2079	12239	3100	14181	2237	14457	8120	21196
Paper & Printing	105	1931	1333	1786	123	2887	3471	3430
Liquors & Beverages	33	502	774	1125	34	549	1620	1315
Chemicals & Allied	297	695	680	1478	111	649	1497	2218
Clay, Glass & Stone	520	2412	479	1280	503	2907	978	1678
Metal Products	367	2216	1006	1969	579	2575	1678	2597
Tobacco Products	25	1184	392	1427	29	2433	1243	1750
Vehicles for Land	843	2198	582	1522	971	3443	1483	2998
Vehicles for Water	108	2340	554	1487	64	957	686	648
Miscellaneous	350	3579	2765	3732	498	3993	5409	5255
Hand Trades	3399	6261	1049	3635	3888	6562	1324	3398
TOTAL	13824	66714	28072	77205	15793	85673	59217	104662

Sources: COC (1871; 1881)[83]

Notes: Total Capital includes both Fixed capital (Land, Building & Machinery) & Working capital.
Output is Gross Output including repairs.

Table B.3: Manufacturing Establishments - Canada

	1890				1900				1910			
Category	No.	No. Hands	Total Capital ($000)	Output ($000)	No.	No. Hands	Total Capital ($000)	Output ($000)	No.	No. Hands	Total Capital ($000)	Output ($000)
Food Products	12177	53407	48625	108916	5594	42401	57167	125203	6985	52730	133045	245669
Textiles	15451	72155	44927	67904	1684	64186	60607	67725	1444	72672	108787	135902
Iron& Steel	916	21894	27570	29875	517	24766	40861	34878	824	48558	123561	113641
Timber & Lumber	11615	81757	77519	85979	3034	75704	89959	80341	4999	110049	259890	184630
Leather Products	7774	25677	18873	35209	431	19204	21437	34721	399	22742	48789	62850
Paper & Printing	807	12840	16354	14063	592	15413	26822	20653	773	22894	62678	46458
Liquors & Beverages	387	3116	16923	9356	183	3208	20467	9192	260	4688	43238	28937
Chemicals & Allied	574	3328	7668	9301	128	2868	10273	11437	178	5274	26926	27799
Clay, Glass & Stone	2547	15591	9595	12160	855	10765	8698	7319	771	17699	45860	25782
Metal Products	2681	12092	15217	17861	363	9358	20383	19561	341	17502	67134	73242
Tobacco Products	149	5325	3831	5743	160	6329	7248	11802	173	8763	21660	25329
Vehicles for Land	3378	14528	11325	19866	425	14866	15994	19972	465	35778	49397	69712
Vehicles for Water	639	4068	2525	3639	57	2587	3298	2044	172	4414	10352	6575
Miscellaneous	7299	31149	45085	39819	582	21084	63089	35607	1011	38537	235148	104619
Hand Trades	9570	12668	7178	9569	45	605	613	599	423	8826	11120	14830
TOTAL	75964	36995	353214	469848	14650	313344	446916	481053	19218	471126	1247584	1165976

Sources: CYB (1905; 1912)[18]
Notes: Total Capital includes both Fixed capital (Land, Building & Machinery) & Working capital. Output is Gross Output including repairs.

Table B.4: Manufacturing Establishments - Victoria

	1890				1900				1910			
Category	No.	No. Hands	Fixed Capital (£)	Output (£)	No.	No. Hands	Fixed Capital (£)	Output (£)	No.	No. Hands	Fixed Capital (£)	Output (£)
Treating Materials	383	2895	795999	2148526	306	2988	522275	1887146	324	3298	604844	2549910
Oils & Fats	36	456	250170	353562	25	465	204088	271650	21	596	232702	565989
Stone, Clay, & Glass	344	4700	1269340	875377	149	2512	366612	414064	212	3472	579640	784791
Working in Wood	380	5801	1301857	2699777	215	3770	518174	695425	350	5928	635706	1698773
Metal Works	381	10544	2269572	3629795	354	9545	1523357	2247010	650	15721	2107273	4635569
Food & Drink	510	6624	4187815	5755836	621	10732	3411656	7819983	633	13363	3770344	12645057
Textiles	274	11469	1147942	2706014	628	20994	1291243	3152123	1349	37419	2235282	6701200
Books & Printing	199	5635	1691596	1792348	236	5863	1258123	1081260	369	8280	1611722	2184356
Musical Instruments	6	47	9500	12000	3	28	4840	730	5	150	25471	23416
Arms & Explosives	6	66	48655	27070	4	253	114300	48500	8	386	77542	122066
Vehicles & Saddlery	288	3493	584106	678170	251	2745	295544	467491	410	472	466171	842054
Shipbuilding	17	254	437245	10957	9	126	413140	19879	10	122	477425	34184
Furniture & Bedding	132	2114	457631	518960	107	1561	211132	356524	228	2700	308589	724104
Drugs & Chemicals	29	403	162495	187452	46	671	161060	297868	74	1501	452466	1009201
Surgical & Scientific	6	32	14475	5706	6	30	4485	2380	14	57	13201	11855
Watches & Jewellery	26	404	113295	190675	46	551	79040	127745	69	838	124602	291817
Heat, Light & Power	37	924	1893654	650817	64	953	1470340	484236	77	2426	2714600	1077378
Leatherware	14	86	24772	39170	13	163	19580	56940	30	586	56413	223256
Miscellaneous	22	287	45400	86032	14	257	25960	47826	40	1089	119355	535878
Undisclosed	14	135	67929	22007	–	–	–	–	–	–	–	–
TOTAL	3104	56369	16773448	22390251	3097	64207	11894949	19478780	4873	102176	69373	36660854

Sources: Victorian Year Book (1890; 1900; 1910)[107], SRVIC (1890-91; 1900-1901; 1910-1911)[87]
Notes: Fixed capital includes Land, Building & Machinery. Output is Gross Output including repairs.

Table B.5: Manufacturing Establishments - New South Wales

	1890				1900				1910			
Category	No.	No. Hands	Machin-ery (£)	Output (£)	No.	No. Hands	Fixed Capital (£)	Output (£)	No.	No. Hands	Fixed Capital (£)	Output (£)
Treating Materials	–	1983	110277	729908	256	2981	358653	1190256	272	3890	615631	4591465
Oils & Fats	–	–	–	–	51	698	345153	482218	48	889	448626	978772
Stone, Clay, & Glass	–	7648	507961	2031530	244	3007	381850	606548	309	5695	1349467	1538773
Working in Wood	–	–	–	–	430	5108	554047	1629463	662	8181	1117473	3059227
Metal Works	–	10994	861988	4011746	301	13831	2087748	5606180	509	22862	4634265	12205898
Food & Drink	–	7741	1212259	4899007	673	11372	3719348	8659501	769	14050	4882854	17744466
Textiles	–	7552	68209	1550415	538	14497	324366	2457899	981	26504	880725	5287762
Books & Printing	–	4494	441109	1089319	298	5573	618622	1328922	436	9134	1396530	2269792
Musical Instruments	–	–	–	–	6	226	19720	29342	12	387	37975	146583
Arms & Explosives	–	–	–	–	2	11	1060	4500	5	33	4200	11622
Vehicles & Saddlery	–	2215	40555	455598	246	2541	108812	458003	384	4416	292444	1076110
Shipbuilding	–	1036	135352	323348	25	1541	256243	260599	41	2429	966887	547117
Furniture & Bedding	–	1048	15269	298684	115	2140	69464	432094	197	3534	121148	1047000
Drugs & Chemicals	–	–	–	–	19	450	88893	152745	82	1460	318267	910912
Surgical & Scientific	–	–	–	–	7	69	2100	34668	12	96	4400	26948
Watches & Jewellery	–	–	–	–	14	165	4270	38542	48	753	25770	240554
Heat, Light & Power	–	–	–	–	106	1417	1254169	891351	191	2835	3406878	2127822
Leatherware	–	–	–	–	5	117	24687	53711	20	461	34576	210572
Miscellaneous	–	2026	155903	1377	31	391	21218	76929	61	1055	98971	324616
Undisclosed	–	–	–	–	–	–	–	–	–	–	–	–
TOTAL	–	47958	4246129	16807132	3367	66135	10240423	24393471	5039	108664	20637087	54346011

Sources: Year Book NSW (1891; 1901; 1911)[77], SRNSW (1890-91; 1900-1901; 1910-1911)[78]
Notes: Fixed capital includes Land, Building & Machinery (only Machinery is available for 1890). Output is Gross Output including repairs.

Table B.6: Manufacturing Establishments - New Zealand

	1890				1900				1910			
Category	No.	No. Hands	Fixed Capital (£)	Output (£)	No.	No. Hands	Fixed Capital (£)	Output (£)	No.	No. Hands	Fixed Capital (£)	Output (£)
Animal Food	177	2061	603626	1718588	355	3804	1362259	5440362	441	5742	2819282	11624483
Vegetable Food	186	1027	466271	1169099	148	1683	544989	1045708	141	1891	710452	1858081
Drinks & Narcotics	284	970	393890	546427	291	1567	581758	905149	268	1667	903011	1154991
Animal Matters	33	307	80227	170924	61	438	114092	344037	66	635	221145	532140
Working in Wood	260	3374	517432	853549	385	7106	753634	1343762	563	7078	1847737	2786297
Vegetable Fodder	63	205	36300	63236	80	326	94981	410552	50	147	132277	324091
Paper Factories	10	83	5594	4497	7	81	11499	14217	13	240	60915	62051
Gasworks	27	249	730490	178947	30	572	971559	290567	48	757	1079387	623209
Electric Light	–	–	–	–	6	52	64156	23234	14	170	404681	124951
Electric Tramways	–	–	–	–	–	–	–	–	5	1633	1387635	548842
Stone, Clay & Glass	127	592	153360	76246	150	1103	170394	189685	175	1740	660334	532574
Metals	103	1980	311712	451072	206	4188	503883	1135449	317	4726	984796	1521121
Publications	142	2569	341683	354559	188	3134	559538	704285	241	4222	1302497	1377926
Musical Instruments	–	–	–	–	–	–	–	–	6	17	5274	4954
Small Wares	23	63	6152	7381	30	140	29930	23713	48	219	46532	60722
Sports & Games	–	–	–	–	–	–	–	–	4	35	13407	20165
Designs, Type & Dies	–	–	–	–	–	–	–	–	5	6	2640	1460
Arms & Explosives	–	–	–	–	–	–	–	–	–	–	–	–
Machines & Tools	47	609	80711	157812	45	714	75168	159225	29	779	137345	255343
Carriages & Vehicles	115	709	103514	145315	231	1580	216214	281124	251	1754	465851	488153
Harness & Saddlery	116	1394	167161	1066585	240	2637	338971	2041216	202	2005	411041	2273719
Ships & Boats	78	333	374740	75930	69	474	286256	97929	63	813	121334	235268
Furniture	103	614	103270	136090	168	1416	190972	270553	259	1866	364199	561231
Chemicals & Allied	14	72	31829	49429	24	149	59806	92540	17	115	45043	66126
Textiles	24	1232	270766	293631	26	1754	289707	371342	25	1469	303230	389312
Dress	88	3396	171917	597593	679	10786	750499	1620484	992	13960	1364003	2801621
Fibrous Materials	203	3443	182878	310977	118	1890	119755	291355	93	1479	453865	439595
Undisclosed	31	351	128303	345950	143	1253	318544	756645	66	1069	483446	1060576
TOTAL	2254	25633	5261826	8773837	3680	46847	8408564	17853133	4402	56234	16731359	31729002

Sources: Census of New Zealand (1891; 1901; 1911)[92]
Notes: Fixed capital includes Land, Building & Machinery. Output is Gross Output including repairs.

Table B.7: Manufacturing Establishments - Cape Colony

Category	1890 No.	1890 No. Hands	1890 Fixed Capital (£)	1890 Output (£)	1903 No.	1903 No. Hands	1903 Fixed Capital (£)	1903 Output (£)	1910 No.	1910 No. Hands	1910 Fixed Capital (£)	1910 Output (£)
Animal Food	85	953	46240	43022	36	602	239678	141714	32	402	59082	152386
Vegetable Food	382	2007	610015	1768973	352	3525	1375124	3199284	236	3737	1183911	2439464
Drinks & Stimulants	116	971	257993	336966	233	2352	1113667	966820	159	2840	763546	1331892
Animal Matters	77	1342	210379	948249	34	942	185472	394816	29	1071	95449	392387
Vegetable Matters	7	24	2616	3080	3	15	3165	2362	7	49	2485	8771
Working in Wood	43	544	108474	222161	168	1606	404941	439165	55	950	165518	154987
Houses & Buildings	115	1134	68398	306505	145	3563	296113	813636	33	726	52941	160083
Furniture & Ornaments	26	238	40503	38080	87	1079	382651	196824	59	931	238061	195749
Carriages & Vehicles	471	3016	253079	653023	351	2980	409869	578436	111	1489	129948	252360
Harness & Saddlery					83	472	99376	80595	24	785	76275	173514
Ships & Boats	10	94	64067	11945	2	68	23755	2660	0	0	0	0
Printers & Bookbinders	69	1109	246549	265155	89	1880	536558	511838	80	2021	577678	448074
Designs & Type					31	174	34783	27877	9	81	2185	11675
Lighting	11	126	153469	41533	7	679	630380	163350	8	344	526837	125766
Dress	542	2925	294624	464304	460	2899	573947	529342	168	2383	143601	548294
Fibrous Materials	8	35	12622	15210	6	34	26270	9489	5	25	13717	9107
Metals (Non-Precious)	65	486	83309	86570	188	1673	356120	435015	143	1338	162046	203404
Stone, Clay & Glass	62	756	41494	72354	159	3206	574474	341223	46	485	70378	47718
Textile Fabrics & Dyes	56	1021	117266	71	4	20	4035	2180	1	–	–	–
Chemicals					16	542	240797	99313	9	276	70537	67192
Salt Production					20	266	57380	15445	10	204	23325	10985
Arms & Explosives	6	33	9400	6700	5	1580	864490	67445	3	938	624338	632501
Gold & Silver	11	61	33015	8230	46	155	294542	20550	13	43	10520	6944
Small Misc. Wares	0	0	0	0	2	6	9545	1200	12	156	3137	26846
TOTAL	2162	16875	2653512	5350094	2527	30318	8737132	9040579	1252	21274	4995515	7400099

Sources: Census of the Cape of Good Hope (1891; 1904; 1911)[72]

Notes: 1911 data are for the Cape Colony excluding Natal, the Orange Free State & the Transvaal. No returns for Textile, Fabrics, Dye & Cleaning Works were returned in 1911. Fixed Capital includes Land, Buildings, & Machinery. Output is Gross Output including repairs.

Table B.8: Agricultural Implement Manufacturing

	Workers per Establishment					Fixed K per Establishment				
Year	CAN	VIC	NSW	NZL	CPE	CAN	VIC	NSW	NZL	CPE
1890	22	15	–	15	–	2333	2791	–	2041	–
1900	53	21	12	18	–	8056	2310	1100	1859	–
1910	10	45	31	34	–	28591	3912	1780	6244	–
	Resources per Establishment					Value Added per Establishment				
Year	CAN	VIC	NSW	NZL	CPE	CAN	VIC	NSW	NZL	CPE
1890	3245	3714	–	1099	–	4525	6034	–	2914	–
1900	7949	1964	1056	1487	–	10465	2483	1456	2698	–
1910	31083	6014	12355	4276	–	30745	8832	4734	7411	–
	K per Worker					Value Added per Worker				
Year	CAN	VIC	NSW	NZL	CPE	CAN	VIC	NSW	NZL	CPE
1890	104	182	–	139	–	201	393	–	199	–
1900	152	110	96	105	–	198	119	127	152	–
1910	228	87	58	184	–	246	196	154	218	–

Sources: See appendix tables B.3-B.7 for list of sources. See section III.1 for a description of data.

Notes: Canadian \$s converted to £s at 4s 2d per \$. Inputs include Wages, Value of Fixed K (Land, Buildings & Machinery), and Value of Materials. Output is Value of Gross Output.

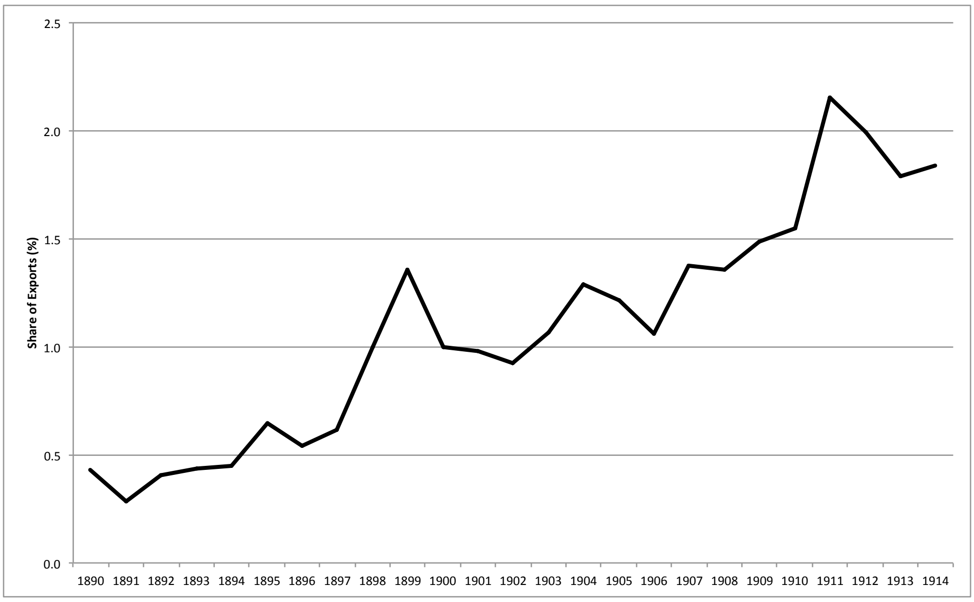
Table B.9: DEA Results for Agricultural Implements

	Technical Efficiency					Scale Efficiency				
Year	CAN	VIC	NSW	NZL	CPE	CAN	VIC	NSW	NZL	CPE
1890	0.954	1.000	–	1.000	–	1.000	1.000	–	1.000	–
1900	1.000	0.851	1.000	1.000	–	1.000	1.000	1.000	1.000	–
1910	1.000	1.000	1.000	1.000	–	1.000	1.000	1.000	1.000	–
	Overall Efficiency					Allocative Efficiency				
Year	CAN	VIC	NSW	NZL	CPE	CAN	VIC	NSW	NZL	CPE
1890	0.864	1.000	–	0.757	–	0.906	1.000	–	0.757	–
1900	1.000	0.754	0.953	0.916	–	1.000	0.886	0.953	0.916	–
1910	0.824	1.000	0.989	0.775	–	0.824	1.000	0.989	0.775	–

Sources: See appendix tables B.3-B.7 for list of sources. See section III.1 for a description of data.

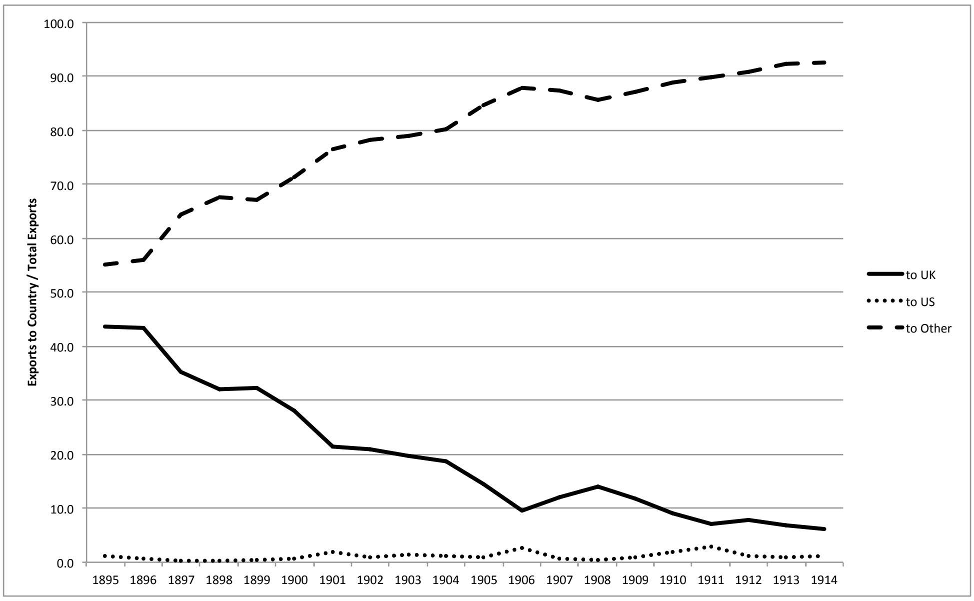
Notes: Canadian \$s converted to £s at 4s 2d per \$. Inputs include Wages, Value of Fixed K (Land, Buildings & Machinery), and Value of Materials. Output is Value of Gross Output.

Figure B.1: Agricultural Implement Exports as a Share of Total Exports (%)



Sources: CYB (1895-1914)[18]

Figure B.2: Share of Agricultural Implement Exports by Destination (%)



Sources: CYB (1895-1914)[18]

Appendix C

'Short-Cut' Method

There is a stable and direct relationship between nominal exchange rate adjusted GDP and real PPP adjusted GDP. This relationship can be exploited empirically by considering each country relative to a base country. The price level as determined by the ratio of nominal to real GDP at any time in any country relative to a base country depends on the price of traded and non-traded goods in those countries. As markets become integrated price gaps will be eliminated and the price of traded goods will equalise for all countries with the base country. The price of non-traded goods will be directly related to the level of income in each country and the overall price level will thus vary systematically with measures of development and openness. The major source of error in calculating nominal GDP does not reside in the short-cut approach but in the application of the structural relationships found in post-World War Two data used to extrapolate out of sample estimates. This data reflects a particular set of benchmark countries that experienced often unique events in a historical context. Structural relationships from this data are projected over time and space to form the estimates of nominal ER adjusted GDP. However, despite these concerns the estimates do extremely well in forecasting out of sample and are arguably preferred for cross country comparisons than the very long-run PPP adjusted real GDP series usually employed.
There are two theoretically valid estimation techniques available. Both are given by the following functional relationships:

$$PL_{ij} = f(GDP_{ij}^{PPP}, X_{ij}) \tag{C.1}$$

$$GDP_{ij}^{ER} = g(GDP_{ij}^{PPP}, X_{ij}) \tag{C.2}$$

where $PL_{ij} = \frac{PPP_{ij}}{ER_{ij}}$ is the price level for country j in year i, GDP_{ij}^{PPP} is the level of nominal GDP for country j in year i in US$ converted at Purchasing Power Parities, GDP_{ij}^{ER} is the level of nominal GDP for country j in year i in US$ converted at market exchange rates, and X_{ij} is a matrix of explanatory variables.

If GDP_{ij}^{PPP} and $PL_{ij} = \frac{PPP_{ij}}{ER_{ij}}$ are known then we can obtain

$GDP_{ij}^{ER} = (GDP_{ij}^{PPP})(\frac{PPP_{ij}}{ER_{ij}})$.

The problem in working with historical data is that we do not know PPPs and have limited knowledge of PPP adjusted GDP. Maddison (2010)[73] gives the most complete estimates of deflated GDP_{ij}^{PPP} using backward projections from modern benchmarks. These can be reflated using an appropriate price series to form estimates of nominal GDP_{ij}^{PPP} in each year. The empirical goal is to estimate either $\frac{PPP_{ij}}{ER_{ij}}$ in order to calculate GDP_{ij}^{ER} or to use this relationship to estimate GDP_{ij}^{ER} directly from GDP_{ij}^{PPP}. Prados (2000) attempts the former while Klasing & Milinios (2012) the latter. Both studies use data from the Penn World Tables from 1950 to 1990 for a set of benchmark (mostly developed) countries.[1] Unlike these studies I have presented results using the full sample of countries (189 countries) over the full period of coverage (1950-2010). I find that restricting the sample to the period before 1990 does improves the forecasts over the period before World War One.[2]
My estimation of exchange rate adjusted nominal GDP has been conducted using the following equation:

$$\ln GDP_i^{ER} = \beta_0 + \beta_1 \ln GDP_i^{PPP} + \beta_2 (\ln GDP_i^{PPP})^2 + \\ \beta_3 \ln Pop_i + \beta_4 \ln Area_i + \beta_5 Landlock_i + \epsilon_i$$

In this equation the price effect of non-traded goods is captured by the measures of population and area. Whether a country is landlocked serves as a natural measure of openness. In place of the landlocked variable, Klasing and Milinios (2012) include a variable intended to capture the natural openness of countries using the geographic share of trade as constructed by Frankel and Romer (1999). This

[1] Prados (2000) uses data on 20 benchmark countries.

[2] Both Mean Square Error and Mean Absolute Error improve for the forecasts when compared with existing estimates of nominal GDP

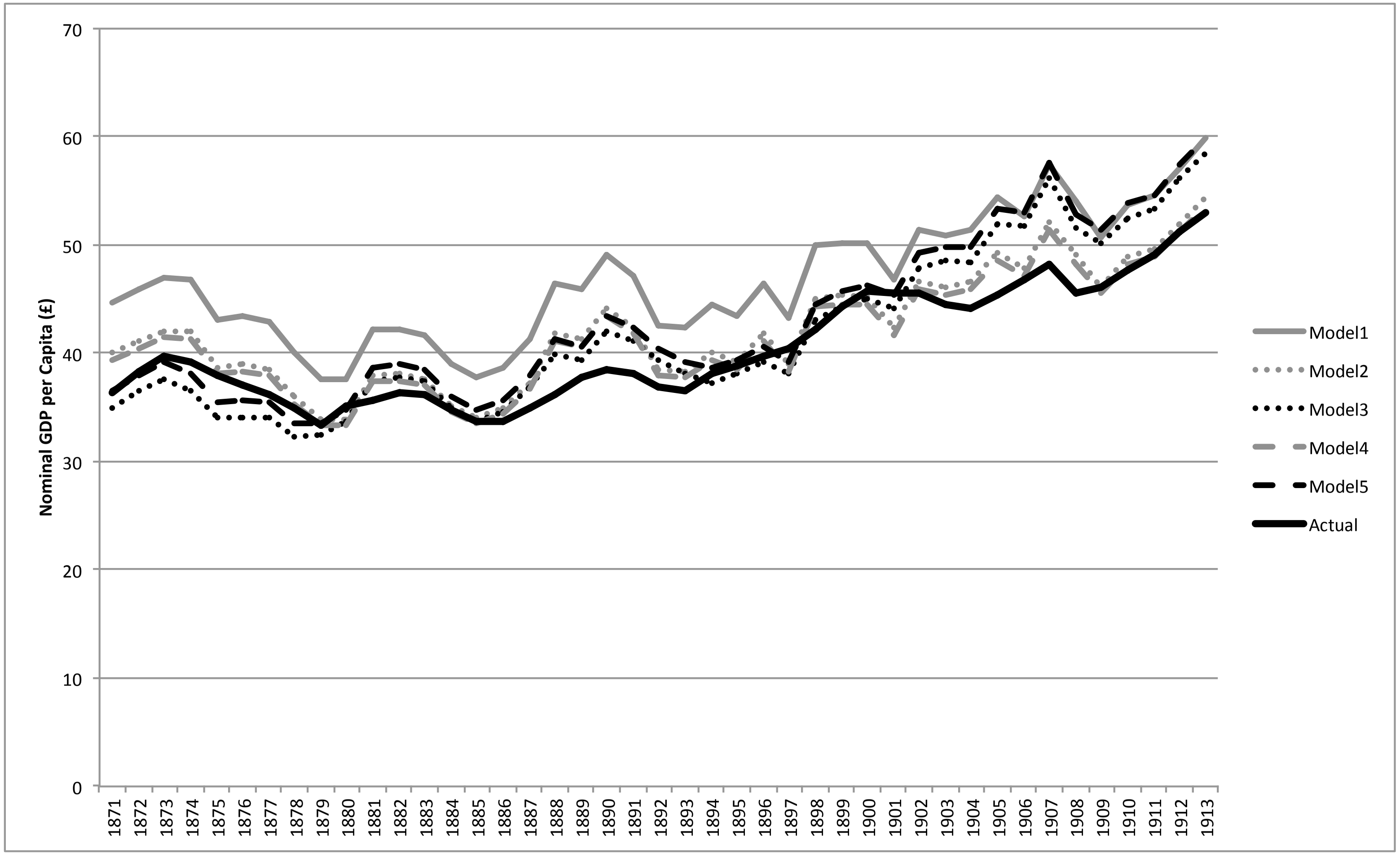
measure relies on the relationship between geography and border countries. I have constructed several variables to measure the natural level of openness by taking the area and population characteristics of each country's neighbours that share a common border. In all cases these border measures did little or nothing to improve the forecasts out-of-sample and were dropped from the analysis.

I have further improved the fit of the forecasts by including a low income intercept dummy. The low income dummy takes a value of 1 if any countries nominal PPP adjusted GDP per capita is less than 25% of the United States.[3] Two low income slope dummies have been included by interacting the low income variable with $\ln GDP_i^{PPP}$ and $(\ln GDP_i^{PPP})^2$. A set of intercept and slope dummies have also been generated to separate the post World War Two Bretton Woods period. Although the adjusted R^2 increases with the inclusion of these currency regime dummies the pre-WWI forecast error increases so they have been omitted from the optimal model chosen. Lastly a Great Britain dummy captures the unique characteristics of Britain before World War One against all other countries.

For all variables (except intercept dummies) observations have been set relative to the United States and logarithms have been taken. The United States has been omitted from the regression as it is restricted to 1 for all observations. Results of these regressions are shown in table C.5. Model 5 has been chosen based on a criteria of minimum absolute mean error in forecasts before 1913. Forecasts have been generated for 1871, 1881, 1891, 1901 & 1911 using nominal PPP adjusted GDP per capita estimates from Maddison (2010)[73] indexes and Penn World Table 2005 benchmarks. Predicted nominal exchange rate adjusted GDP estimates have been converted into US$ using observations on United States nominal GDP and £ using market exchange rates. Figure C.1 gives an indication of the accuracy of the models in predicting British GDP before World War One.

[3]The low income level was tested at 15%, 20%, 25% 30%, 35%, 40% & 45% with 25% yielding the best forecasts

Figure C.1: Exchange Rate Adjusted Nominal GDP per Capita for GBR



Sources: 'Models' estimated from regressions (see table C.5), 'Actual' from Williamson (2013)[116]

Table C.1: 'Short-Cut' Estimates of Total GDP

Real PPP Adjusted GDP (1990 GK $mn)												
Year	AUS	AUT	BEL	CAN	CHN	DEU	DNK	ESP	FRA	GBR	HKG	IND
1871	5585	11052	15646	7047	88982	87661	3888	25833	77394	107505	96	108548
1881	10950	13090	19539	9592	92634	108560	4701	34840	92842	126948	221	115134
1891	16156	16707	23763	12655	96517	141070	6053	36104	105013	153024	345	118636
1901	15782	21156	28721	18115	102724	193898	8254	43420	124050	188249	470	139145
1911	24880	27472	35405	32983	111086	266175	11532	49370	144959	217069	595	167459
Year	IDN	ITA	JPN	LKA	MYS	NLD	NOR	NZL	PRT	SWE	USA	ZAF
1871	12399	48044	28829	1237	346	11531	2748	1002	4049	6661	102004	2449
1881	15134	49486	34512	1431	669	14545	3363	2107	4500	8094	164989	4298
1891	16532	59838	43308	1871	992	17146	3944	2612	5556	9961	222158	6147
1901	20437	72757	60422	2548	1316	20829	4908	3614	6894	13117	344782	7996
1911	27666	103242	76332	2927	1639	26982	6196	6088	7348	17648	471509	9845
Nominal PPP Adjusted GDP (GK $mn)												
Year	AUS	AUT	BEL	CAN	CHN	DEU	DNK	ESP	FRA	GBR	HKG	IND
1871	534	985	1397	631	7898	7812	348	2309	6905	9632	9	9630
1881	817	977	1458	717	7014	8108	351	2594	6937	9502	16	8559
1891	1067	1106	1572	835	6494	9337	400	2390	6957	10131	23	7843
1901	1093	1467	1986	1257	6838	13417	571	3004	8575	13043	33	9731
1911	2147	2367	3052	2845	9409	22987	995	4259	12516	18741	51	14549
Year	IDN	ITA	JPN	LKA	MYS	NLD	NOR	NZL	PRT	SWE	USA	ZAF
1871	1091	4294	2564	113	31	1029	246	90	361	590	9124	218
1881	1097	3709	2561	110	49	1085	252	157	335	603	12367	319
1891	1065	3955	2867	126	63	1132	260	173	365	657	14732	405
1901	1413	5048	4198	181	90	1441	341	250	479	902	23912	556
1911	2376	8897	6578	262	137	2328	535	525	635	1513	40803	850
Nominal ER Adjusted GDP (US $mn)												
Year	AUS	AUT	BEL	CAN	CHN	DEU	DNK	ESP	FRA	GBR	HKG	IND
1871	409	437	701	506	4077	4373	196	1359	4000	5630	3	4421
1881	693	495	849	645	4342	5153	222	1742	4564	6567	8	4586
1891	1007	626	1018	846	4575	6638	284	1770	5139	7778	13	4772
1901	995	744	1173	1141	4725	8524	362	1949	5653	9155	14	5420
1911	1738	1089	1636	2329	6079	13224	575	2465	7527	12003	17	7361
Year	IDN	ITA	JPN	LKA	MYS	NLD	NOR	NZL	PRT	SWE	USA	ZAF
1871	532	2391	1149	34	9	533	157	90	60	369	7603	129
1881	622	2237	1210	32	17	655	178	157	119	418	11642	214
1891	683	2691	1578	44	24	765	207	173	147	518	15378	310
1901	831	2993	2053	51	53	885	234	250	193	633	22276	355
1911	1249	4961	2894	119	75	1293	339	525	357	981	34301	474

Sources: Population & PPP Adjusted Real GDP Indexes from Maddison (2010)[73], 1990 Benchmarks from PWT (2012)[38] & Williamson (2013)[116]

Notes: See appendix for description of the 'short-cut' method used. All are based on modern borders.

Table C.2: Share of Trade by Principal Destination (%)

	New South Wales					Victoria					South Australia				
Destination	1870	1875	1885	1895	1903	1870	1875	1885	1895	1903	1870	1875	1885	1895	1903
United Kingdom	43.6	57.2	47.4	41.6	26.6	49.8	47	50.9	47.5	24.6	52.4	55.4	57.1	33.1	24.9
France	0.5	0.0	1.2	4.0	4.0	0.6	0.1	2.1	1.3	2.9	0.0	0.0	0.6	2.3	2.3
Germany	0.0	0.0	1.0	4.1	5.2	0.0	0.0	0.0	3.3	3.6	0.0	0.0	0.4	2.4	3.0
Netherlands	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.0	0.5
Belgium	0.0	0.0	1.5	2.5	2.1	0.0	0.1	0.6	1.5	1.6	0.0	0.0	0.6	0.9	2.3
Italy	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.1	0.1
Norway	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.6	0.3	0.3	0.0	0.0	0.0	0.0	0.0
Sweden	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.0	0.1	0.0	0.7	0.4	0.3	0.1
New Zealand	3.8	2.3	3.1	2.8	4.0	9.8	6.7	2.5	2.3	4.2	0.6	0.6	0.9	0.3	0.4
South Africa	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.1	3.3	0.1	2.1	2.2	1.5	0.6
United States	1.5	1.6	4.9	3.4	8.8	1.5	1.5	2.7	2.4	6.1	0.5	0.3	1.7	2.0	2.7
Canada	0.0	0.0	0.2	0.2	0.4	0.1	0.1	0.2	0.1	0.1	0.0	0.2	0.1	0.1	0.0
Hong Kong	0.8	1.3	1.4	0.9	0.5	0.7	0.6	0.6	0.6	0.8	0.0	0.3	0.2	0.6	0.1
China	2.2	1.7	0.8	0.4	0.4	1.8	2.2	1.8	0.5	0.1	0.9	0.9	0.5	0.1	0.1
Japan	0.0	0.1	0.0	0.2	0.4	0.0	0.0	0.0	0.2	0.4	0.0	0.0	0.0	0.0	0.1
Sri Lanka	11.2	2.7	0.1	0.3	1.3	17.6	13.6	2.3	1.0	3.7	0.0	0.1	0.1	6.0	3.1
India	0.1	0.1	0.6	0.7	1.5	0.8	0.9	1.1	1.2	7.5	1.2	0.7	1.3	2.0	3.1
Indonesia	0.4	1.5	0.2	0.0	0.1	0.4	1.6	0.3	0.4	1.5	0.3	0.7	0.2	1.3	1.6
Malaysia	0.0	0.0	0.0	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.1
NSW	–	–	–	–	–	8.3	18.3	23.6	16.9	20.6	14.7	12.9	11.8	30.1	31.9
VIC	11.3	8.5	16.7	12.1	14.3	–	–	–	–	–	21.1	18.6	13.9	7.5	14.0
SAU	2.3	3.7	4.2	8.5	7.7	1.4	2.3	3.6	2.9	4.7	–	–	–	–	–
WAU	0.0	0.1	0.1	0.5	1.9	0.2	0.2	0.3	9.0	3.9	1.2	1.1	2.8	6.6	5.9
TAS	0.9	1.0	1.7	1.2	2.2	2.3	2.1	2.8	2.8	5.2	0.3	0.5	0.6	0.2	0.3
QND	14.4	15.1	12.6	14.3	12.5	0.2	0.6	0.8	3.8	3.0	2.7	2.7	2.5	1.9	2.5

Sources: SRNSW (Various)[78], SRVIC (Various)[87] & SRSAU (Various)[4]

Notes: Zero share values of trade are not actually zero but have been rounded to zero. Countries left from this table have actual zero values in most years before WWI.

Table C.3: Share of Trade by Principal Destination (%)

	Western Australia					Tasmania					Queensland				
Destination	1870	1875	1885	1895	1903	1870	1875	1885	1895	1903	1870	1875	1885	1895	1903
United Kingdom	48.8	60.1	51.9	24.9	39.0	37.1	44.7	27.7	21.0	22.2	31.1	31.5	40.6	40.0	28.9
France	0.0	0.0	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.5
Germany	0.0	0.0	0.0	0.1	1.9	0.0	0.0	0.0	0.0	5.4	0.0	0.0	0.1	0.5	1.9
Netherlands	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Belgium	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Italy	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Norway	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0
Sweden	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
New Zealand	0.0	1.3	0.7	0.0	1.2	2.3	4.4	4.2	1.3	0.8	0.0	0.2	0.7	1.0	0.4
South Africa	0.0	0.0	0.0	0.2	4.8	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	3.7
United States	0.3	0.0	0.3	0.5	3.8	0.0	0.0	0.0	0.0	8.6	0.0	0.2	1.1	0.0	2.9
Canada	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Hong Kong	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	2.1	1.0	0.7
China	9.8	6.2	1.4	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.3	0.0	0.1
Japan	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
Sri Lanka	0.3	0.4	0.0	0.0	11.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
India	3.8	0.0	1.1	0.5	13.9	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.3	0.5
Indonesia	1.1	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Malaysia	6.6	7.7	0.0	2.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.1
NSW	0.4	0.1	0.5	3.4	6.1	8.5	10.1	22.7	27.5	24.1	63.0	57.2	46.2	45.6	44.7
VIC	11.4	9.9	12.6	53.6	8.6	46.0	35.2	39.4	48.9	34.2	1.5	3.6	6.5	8.0	7.4
SAU	14.1	11.5	21.3	14.1	4.7	0.7	1.3	1.0	0.7	0.9	3.8	3.4	1.8	1.5	4.2
WAU	–	–	–	–	–	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.1
TAS	0.0	0.0	0.0	0.0	0.3	–	–	–	–	–	0.5	0.3	0.2	0.2	0.6
QND	0.0	0.0	0.0	0.1	0.2	1.1	1.4	1.2	0.1	1.4	–	–	–	–	–

Sources: SWAU (Various)[91], SCTAS (Various)[104] & SCQLD (Various)[93]

Notes: Zero share values of trade are not actually zero but have been rounded to zero. Countries left from this table have actual zero values in most years before WWI.

Table C.4: Distances from AUS Ports to Several Key Foreign Ports (Nautical Miles)

Destination	Sydney	Melbourne	Adelaide	Perth	Brisbane	Hobart
Europe						
London (via Suez)	11771	11298	10971	9852	12271	12227
London (Via Cape of Good Hope)	12625	12156	11892	10970	13125	12228
London (Via Cape Horn)	13564	13840	14218	15396	13778	13621
Marseilles	10066	9593	9266	8147	10567	9866
Bremen	12041	11567	11241	10121	12541	12497
Hamburg	12064	11590	11264	10145	12564	12520
Antwerp	11797	11324	10997	9878	12297	12253
Brindisi	9429	8955	8629	7509	9929	9229
Naples	9604	9131	8804	7685	10105	9404
Trieste	9816	9342	9016	7897	10316	9616
Lisbon	10714	10241	9914	8795	11214	11204
Alicante	10159	9685	9359	8239	10659	9959
North America						
San Francisco	6467	6982	7375	8555	6229	6936
New York (via Cape of Good Hope)	13252	12783	12519	11597	13752	12855
New York (via Cape Horn)	13092	17090	13746	14924	13306	13149
Vancouver	6846	7365	7758	8620	6531	7355
Montreal (via Cape of Good Hope)	13584	13115	12851	11929	14084	13187
Montreal (via Cape Horn)	13092	13963	14341	15519	13901	13744
Asia						
Shangahi	4573	5139	5317	4025	4158	5186
Hong Kong	4480	5045	4780	3488	4064	5093
Yokohama	4350	4916	5309	4522	3932	4963
Colombo	5186	4712	4386	3143	5487	4849
Jakarta	3873	3399	3073	1784	3633	3536
Calcutta	5778	5305	4978	3703	5590	5442
Bombay	6037	5563	5237	3998	6350	5700
Singapore	4361	4054	3727	2460	3945	4191
Africa						
Cape Town	6486	6018	5754	4831	6987	6089
South America						
Valparaiso	6441	6701	7094	8195	6606	6498
Australasia						
Auckland	1287	1657	2051	3230	1370	1532
Sydney	–	597	990	2170	532	646
Melbourne	597	–	516	1696	1098	477
Adelaide	990	516	–	1370	1491	775
Perth (Freemantle)	2170	1696	1370	–	2670	1833
Brisbane	532	1098	1491	2670	–	1145
Hobart	646	477	775	1833	1145	–

Sources: Dataloy Systems (`http://www.dataloy.com/`)

Table C.5: 'Short-Cut' Method Regressions

	DEPENDENT VARIABLE: $\ln NGDP^{ER}$				
INDEPENDENT VARIABLES	(1)	(2)	(3)	(4)	(5)
$\ln NGDP^{PPP}$	1.362***	1.326***	0.888***	1.315***	0.910***
	(0.017)	(0.028)	(0.050)	(0.036)	(0.059)
$(\ln NGDP^{PPP})^2$	0.078***	0.100***	-0.350***	0.104***	-0.269***
	(0.004)	(0.008)	(0.038)	(0.010)	(0.043)
$\ln Pop$	-0.040***	-0.046***	-0.056***	-0.040***	-0.052***
	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)
$\ln Area$	0.055***	0.072***	0.076***	0.069***	0.073***
	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)
Landlocked	-0.169***	-0.186***	-0.198***	-0.219***	-0.235***
	(0.016)	(0.022)	(0.022)	(0.026)	(0.026)
Periphery			-0.143		-0.072
			(0.131)		(0.164)
$Periphery * \ln NGDP^{PPP}$			0.402***		0.398***
			(0.118)		(0.147)
$Periphery * (\ln NGDP^{PPP})^2$			0.441***		0.379***
			(0.044)		(0.051)
Currency			-0.223***		
			(0.034)		
$Currency * \ln NGDP^{PPP}$			-0.107**		
			(0.049)		
$Currency * (\ln NGDP^{PPP})^2$			0.003		
			(0.014)		
GBR					0.121***
					(0.033)
Constant	-0.150***	-0.240***	-0.152***	-0.275***	-0.263***
	(0.014)	(0.022)	(0.019)	(0.028)	(0.021)
Years	1950-2010	1950-1990	1950-1990	1960-1985	1960-1985
Observations	8,787	5,112	5,112	3,630	3,630
R-squared	0.875	0.831	0.838	0.820	0.825

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table C.6: Several Comparisons of Nominal GDP Estimates (£mn)

	France				Germany				Italy			
Year	GFD	HNA	SC1	SC2	GFD	HNA	SC1	SC2	GFD	HNA	SC1	SC2
1871	–	947.3	931.4	823.1	–	732.7	695.8	899.8	–	458.6	437.3	491.9
1881	1048.7	1048.7	945.0	939.1	838.4	876.7	828.6	1060.3	384.5	516.5	471.8	460.3
1891	1162.5	1162.5	1160.1	1163.1	1100.4	1146.8	1243.8	1365.8	461.5	586.7	517.3	553.7
1901	1230.1	1230.1	1370.8	1163.1	1533.0	1571.2	1774.4	1753.9	500.1	648.0	592.2	615.8
1911	1785.1	1785.1	1822.1	1548.8	2350.4	2173.0	2476.8	2720.9	762.8	854.4	848.1	1020.8
	Belgium				Spain				Portugal			
Year	GFD	HNA	SC1	SC2	GFD	HNA	SC1	SC2	GFD	HNA	SC1	SC2
1871	–	187.6	186.0	144.3	–	256.4	271.8	279.7	–	–	45.9	35.4
1881	179.6	218.5	202.6	174.7	363.0	376.7	349.0	358.5	113.9	–	49.7	33.5
1891	190.0	219.9	224.2	209.5	320.2	335.0	352.8	364.1	134.0	–	65.8	41.8
1901	230.3	244.0	266.4	241.4	323.0	310.0	346.3	401.0	125.5	–	63.5	46.8
1911	316.4	317.4	314.6	336.6	463.8	477.6	477.6	507.2	183.2	–	86.2	57.3
	Sweden				Denmark				Norway			
Year	GFD	HNA	SC1	SC2	GFD	HNA	SC1	SC2	GFD	HNA	SC1	SC2
1871	–	55.3	101.5	76.0	–	–	38.7	40.3	–	32.6	32.4	32.5
1881	73.2	73.5	70.6	86.0	45.5	–	43.1	45.7	40.1	36.6	36.6	36.6
1891	82.6	82.3	85.2	106.6	54.9	–	55.3	58.5	43.7	43.4	42.5	43.0
1901	119.0	118.5	137.3	130.2	74.7	–	77.9	74.5	60.0	65.6	48.2	56.2
1911	185.3	183.6	200.4	201.9	112.6	–	116.5	118.3	84.0	93.2	69.8	80.6

Sources: See text.

Notes: Labels are as follows: GFD are from the Global Finance Database, HNA are from the Historical National Accounts database, SC1 are estimated from the 'short-cut' method in Crafts (2005)[24], SC2 were estimated from the 'short-cut' for this study.

Table C.7: Sea Cost-Distance Coefficients

	Grain		Coal		Other		Short Haul ($\leq$ 9000 miles)		Long Haul ($>$ 9000 miles)	
Range	α	β	α	β	α	β	α	β	α	β
1869-1873	-4.193	0.585	-3.685	0.454	-4.741	0.669	-4.186	0.548	-18.931	2.118
1879-1883	-5.854	0.724	-3.841	0.438	-7.958	1.036	-5.516	0.692	-17.823	1.965
1889-1893	-6.200	0.704	-3.841	0.383	-6.227	0.765	-5.346	0.609	-4.632	0.563
1899-1903	-6.903	0.760	-4.301	0.436	-4.530	0.526	-4.855	0.525	-6.425	0.714
1909-1913	-6.073	0.666	-4.250	0.431	-4.023	0.451	-4.673	0.502	-7.857	0.86

Sources: Estimated using shipping freight rates from Jacks (2010).

Notes: Based on log regressions of freight rates in £ and distance in miles. See section III.3 for methods.

Table C.8: European Rail Freight Receipts (d per ton mile)

Year	AUT	BEL	CHE	DEU	FIN	FRA	NLD	NOR	SWE	Europe
1871	**1.700**	**1.398**	**3.332**	**1.514**	**1.792**	**1.487**	**1.331**	**1.972**	**1.750**	1.583
1881	**1.215**	**0.999**	**2.382**	**1.082**	**1.281**	**1.063**	**0.951**	**1.409**	**1.251**	1.132
1891	0.720	**0.731**	1.432	**0.792**	**0.937**	0.842	**0.696**	**1.031**	0.961	0.809
1901	0.736	**0.612**	1.497	0.695	**0.785**	0.740	0.589	1.025	0.853	0.731
1911	0.753	0.619	1.475	0.660	0.793	0.658	0.589	0.873	0.774	0.701

Sources: SAPOFC (Various)[106], SAUS (1878-1911)[79]

Notes: France & Austria in 1891 are actually for 1892. Sweden for 1891 is the geometric mean of state & company railways. All missing observations shown in bold were estimated based on each countries relative efficiency in 1911 to the USA (Britain was also tested with little change). European average is weighted by each countries share of total receipts from goods.

Table C.9: Cost-Distance Effect of Tariffs (Shillings per 1% Tariff Increase)

Year	OLS Pooled	2SLS Pooled	Country FE (OLS)	Avg. 3 Methods
1871	0.02002	0.02007	0.03897	0.02502
1881	0.01740	0.01744	0.03387	0.02175
1891	0.01419	0.01422	0.02762	0.01773
1901	0.01208	0.01211	0.02350	0.01509
1911	0.01122	0.01125	0.02184	0.01402

Sources: See section III.4 for description of elasticities. Terminal shipping costs from table 4.5

Notes: See section III.4 for a description of methods used.

Table C.10: Cost-Distance Effect of a Common Border (Shillings)

Year	OLS Pooled	2SLS Pooled	Country FE (OLS)	Avg. 3 Methods
1871	-0.01174	-0.01174	-0.01745	-0.01340
1881	-0.01020	-0.01020	-0.01517	-0.01164
1891	-0.00832	-0.00832	-0.01237	-0.00949
1901	-0.00708	-0.00708	-0.01053	-0.00808
1911	-0.00658	-0.00658	-0.00978	-0.00751

Sources: See section III.5 for description of elasticities. Terminal shipping costs from table 4.5

Notes: See section III.5 for a description of methods used.

Table C.11: Share of NSW Trade with Border States Overland (%)

	Imports from			Exports to			Total Trade with		
Year	VIC	QLD	SAU	VIC	QLD	SAU	VIC	QLD	SAU
1873	–	0.4	–	–	8.3	–	–	2.9	–
1880	44.1	10.4	35.3	83.5	18.0	84.1	70.8	13.3	61.9
1885	47.0	23.0	43.4	71.0	15.5	76.2	59.2	19.8	59.0
1890	47.0	39.4	76.7	78.7	19.0	93.8	69.8	34.6	87.7
1895	38.0	14.8	68.1	68.4	35.8	92.3	58.4	20.3	85.5
1899	48.3	17.6	80.2	65.3	15.7	84.9	57.8	17.1	83.4

Sources: SRNSW (1873-1901)[78], SRVIC (1873-1901)[87], SRSAU (1873-1901)[4]

Notes: Share of border trade for SAU is trade with NSW & VIC overland relative to sea & land in those states (does not consider SAU other borders in the denominator since no overland trade was conducted with WAU)

Table C.12: Combined Cost-Distance Indexes in 1871 (GBR=1)

State	AUT-HUN	BEL	CAN	CHN	DEU	DNK	ESP	FRA	GBR	HKG	IND
NSW	1.92	1.06	1.12	0.54	1.46	1.04	1.58	1.45	1.00	0.53	0.62
VIC	1.95	1.07	1.12	0.60	1.47	1.04	1.60	1.46	1.00	0.59	0.61
SAU	1.97	1.07	1.13	0.62	1.48	1.04	1.62	1.48	1.00	0.58	0.60
WAU	2.05	1.07	1.15	0.58	1.52	1.04	1.67	1.51	1.00	0.54	0.55
TAS	1.86	1.06	1.06	0.57	1.45	1.04	1.53	1.44	1.00	0.56	0.58
QLD	1.89	1.06	1.10	0.50	1.45	1.04	1.57	1.44	1.00	0.49	0.59
Year	IDN	ITA	JPN	LKA	MYS	NLD	NOR	PRT	SWE	USA	ZAF
NSW	0.50	1.29	0.57	0.58	0.52	1.00	1.04	0.94	1.08	1.10	0.66
VIC	0.48	1.30	0.63	0.57	0.52	1.00	1.04	0.94	1.08	1.11	0.65
SAU	0.47	1.30	0.67	0.56	0.51	1.00	1.04	0.94	1.08	1.12	0.65
WAU	0.42	1.33	0.66	0.51	0.46	1.00	1.04	0.93	1.09	1.14	0.64
TAS	0.46	1.24	0.59	0.54	0.50	1.00	1.03	0.94	1.08	1.05	0.62
QLD	0.47	1.28	0.53	0.58	0.48	1.00	1.03	0.94	1.08	1.08	0.68

Sources: See section III.6 & accompanying tables

Table C.13: Combined Cost-Distance Indexes in 1871 (GBR=1)

State	NSW	VIC	SAU	WAU	TAS	QLD	NZL
NSW	0.25	0.29	0.31	0.39	0.29	0.29	0.33
VIC	0.30	0.25	0.29	0.37	0.29	0.33	0.37
SAU	0.33	0.30	0.26	0.36	0.32	0.37	0.40
WAU	0.44	0.41	0.38	0.29	0.42	0.48	0.52
TAS	0.28	0.27	0.29	0.36	0.24	0.32	0.34
QLD	0.27	0.31	0.33	0.41	0.31	0.25	0.33

Sources: See section III.6 & accompanying tables

Table C.14: Distance Coefficient Effect on Market Potential

	Avg. AUS Market Potential (£mn)			Avg. AUS Market Potential (Indexes)		
Year	$\lambda = -1$	$\lambda = -0.9$	$\lambda = -1.1$	$\lambda = -1$	$\lambda = -0.9$	$\lambda = -1.1$
1871	8419	12265	5790	100.0	145.7	68.8
1881	13081	18551	9251	100.0	141.8	70.7
1891	21564	29441	15858	100.0	136.5	73.5
1901	31004	41858	23040	100.0	135.0	74.3
1911	45427	61438	33686	100.0	135.2	74.2

Sources: See table 4.10 for sources.

Notes: See section V for a description of calculations.

Table C.15: Growth of Factors Determining Market Potential

Annual Growth Rates (%)					
Year	Ship Costs	Rail Costs	Foreign Tariffs	State Tariffs	Sample GDP
1871-81	-2.27	-3.30	-0.23	-3.26	1.88
1881-91	-3.03	-3.30	0.18	1.64	1.66
1891-01	-1.51	-1.01	1.20	-0.34	2.38
1901-11	-0.14	-0.42	-2.06	-10.00	3.86
1871-11	-1.74	-2.02	-0.92	-2.50	2.44

Sources: See tables 4.3, 4.5, C.8, 4.7 & 4.8 for sources.

Notes: All variables are in current prices. Ship costs based on 9000 miles sea journey. Growth rates are compounded continuously, except for State Tariffs using 1911 which are annual average growth since inter-state tariffs dropped to zero. See section VI for methods.