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Why did agriculture's share of Australian gross domestic product not decline for a century?

Kym Anderson[1,2]

[1]School of Economics and Public Policy, University of Adelaide, Adelaide, South Australia, Australia

[2]Arndt-Corden Department of Economics, Australian National University, Canberra, Australian Capital Territory, Australia

Correspondence
Kym Anderson, School of Economics and Public Policy, University of Adelaide, 10 Pulteney Street, Level 3, Adelaide, SA 5005, Australia.
Email: kym.anderson@adelaide.edu.au

Abstract

The agricultural sector's share of gross domestic product (GDP) in growing economies typically declines but, for a century from the early 1850s, Australia's did not. Drawing on recent structural transformation literature, this paper seeks explanations for this unusual phenomenon, which is all the more striking because agriculture's share of employment continued to decline throughout and growth in manufacturing was being stimulated by tariff protection from imports. Several factors contributed, including a huge land frontier that took more than a century for settlers to explore, rapid declines in initially crippling domestic and ocean trade costs for farm products, the absence of a need to do any processing of the two main exports during that period (gold and wool) and innovations by farmers and via a strong public agricultural R&D system that contributed to farm labour productivity nearly doubling over those 10 decades. The ban on iron ore exports from 1938 and low export prices for fuels, minerals and metals during the two world wars and in the intervening decades also contributed.

KEYWORDS

agricultural development, farm productivity growth, manufacturing protection, mining booms, trade costs

JEL CLASSIFICATION

F13, F63, N47, O13, Q17

1 | INTRODUCTION

History reveals how open national economies structurally adjust in the course of economic growth and policy developments at home and abroad. Most strikingly, it shows that the agricultural sector of growing economies typically transitions from having a very high to a very low share of gross domestic product (GDP). Yet, for a century from the early 1850s, agriculture's share of the growing Australian economy did not decline. This exceptional case is worth exploring because it may have lessons for those conceiving growth strategies for some later-developing economies that are similarly well-endowed in natural resources per worker. This unusual feature of Australia's economic history has not been highlighted in previous studies.

The purpose of this study was to draw attention to this unusual phenomenon in Australia's history and to draw on the recent structural transformation literature to pose possible explanations for it. Unfortunately, long time series data are available for only a subset of potential explanatory variables, which precludes formal econometric testing of hypotheses. Nonetheless, the data that are available are able to shed light on at least some key contributing factors.

This study has benefitted from the vast array of theoretical and empirical literature on structural transformation that is surveyed by Herrendorf et al. (2014) using a three-sector model of economic growth. It extends that framework in two respects: one is to separate out a fourth sector that is crucial to understanding the fluctuating sectoral structure of Australia's economy over time, namely mining; the other is to allow trade openness to play a central role. As pointed out by Matsuyama (2009), many earlier studies of structural transformation ignore the trade dimension. Thus, they do not take sufficient account of relative factor endowments, which are prime determinants of comparative advantage, or trade-distorting policies, which can alter not only the extent of a country's international trade but also its sectoral pattern of production and trade specialisation.

The paper is structured as follows. Section 2 presents a summary of the data that reveal the nature and extent of the issue to be explained.[1] Section 3 provides a brief review of the literature on the structural transformation of economies as they grow, drawing on trade and development theories to see what is required for a small open growing economy to not structural transform away from agriculture. Since a dominant feature of Australia's economy (including its colonies prior to Federation in 1901) is a series of mining booms and slumps that cause major fluctuations around trends in sectoral GDP and export shares, the standard three-sector framework is extended to include mining in addition to farming, manufacturing and services. Section 4 examines data that shed light on various possible forces behind Australia's structural transformation trends and cycles during the 10 decades in which its share of agriculture in GDP plateaued. Trade-distorting policies and institutional arrangements are shown to have also influenced the outcome. Space limitations preclude a detailed comparison with other countries, but a brief account in Section 5 points to ways Australia differed even from other lightly populated temperate-climate countries of recent European settlement. The paper concludes in Section 6, pointing out that Australia's sectoral export shares are similar now to those in the early 1960s except that mining has swopped with farming.

2 | THE PHENOMENON TO EXPLAIN

When Europeans first settled in New South Wales in 1788, the production of fresh food was the highest priority. For almost all of the next 60 years, agriculture accounted for more than 85%

[1]During 1850 and 1950, real per capita GDP in Australia grew on average at 0.8% per year (Butlin et al., 2015). How structural changes have influenced the mean and variance of Australia's overall income and its economic growth rate are not addressed in what follows. But see, for example, McLean (2013), Madsen (2015) and Greasley and Madsen (2017).

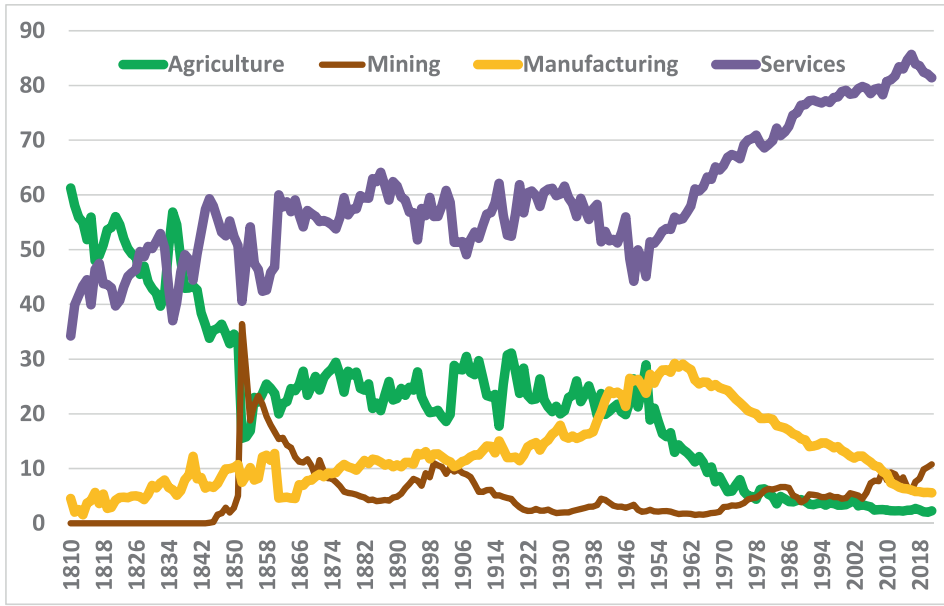

FIGURE 1 Contributions of agriculture, mining, manufacturing and services to Australia's GDP, 1810–2021 (%). *Source*: Vanplew (1987), updated from Butlin, Dixon and Lloyd (2015) and ABS. [Colour figure can be viewed at wileyonlinelibrary.com]

of merchandise GDP (that is, ignoring services).[2] Even so, agriculture's share of GDP nearly halved between 1810 and 1851 while the service sector's share nearly doubled, as was typical of high-income countries then. Agriculture's share of GDP slumped sharply at the start of Victoria's gold rush in the early 1850s, as rural workers abandoned their farm activities and headed for the goldfields.[3] But it soon recovered and remained within the 20–30% range for the next 100 years, dipping only during Western Australia's 1890s gold rush and in World War 1. Only after the Korean War-induced wool price boom of the early 1950s did the agricultural sector resume its relative decline (Figure 1).

Australia's export shares reflect this long interruption to the relative decline of agriculture. The country's international competitiveness was strongest initially in nonperishable agricultural products that were not labour-intensive in their production (because real wages were high in this labour-scarce economy) *and* that had a high-enough price per tonne or cubic metre to cope with the high cost of transport within Australia to the ports and then to the main markets in high-income Europe (Blainey 1966). Up to 1830, whale and seal oil were the main exports, before the quality and quantity of wool was high enough to warrant exporting it in raw form to Britain (Shaw 1990).

Wool production grew from 23kt in 1840 to 140kt in 1880, 301kt in 1920 and an annual average of 480kt in the 1940s, and Australia's share of world wool production was around

[2]Gross domestic product and export data are expressed in current prices throughout, so as to capture the combined effect of changes in quantities and prices. Employment data are person years, not accounting for any changes in hours worked per year. Unless otherwise indicated in the text, figures or tables, the historical macroeconomic and sectoral data on Australia's economy have been compiled from Vanplew (1987), a subset of which have been updated by Butlin, Dixon and Lloyd (2015), with sectoral employment data also from Keating (1973) and Withers et al. (1985). Years shown are calendar years to 1913 (or 1900 in the case of data from Butlin, Dixon and Lloyd 2015) and fiscal years ending on 30 June thereafter. All values are expressed in current Australian dollars.

[3]There was one earlier mining boom: In 1843–1844, copper was discovered in South Australia, shrinking agriculture's share of its GSP from 43% to 29% in just 5 years and replacing wool in the latter 1840s as that colony's dominant export (Figure S1). (This and all subsequent figure and table numbers starting with S refer to ones in the article's Supplementary Material.)

one-quarter during 1910–1945 (Blau, 1946). Since most of that output was exported, Australia had a dominant share of global wool exports: It was still around 50% in the 1980s and 1990s (ABARE, 1999, p. 236). Insofar as that increasing dominance depressed the export price, that would have had a downward impact on agriculture's share of the country's GDP, making its nondecline more puzzling.

With the discovery of gold in 1851 in Victoria and New South Wales, agriculture's share of Australia's GDP halved within a year (from 34% to 16%), and its share of exports more than halved to just 26% as mining's share peaked at 61% in 1852 and stayed above 30% until the mid-1860s (Figure S1, Supplementary Material). Gold's share of merchandise exports was more modest during 1870–1890, before growing again by the turn of the century because of a gold rush in Western Australia (Figure S1).[4] But mining's share of exports had halved again by 1914 and was of minor importance for the next seven decades before booming again from the latter 1960s (Figure 2).

Australia is thus distinguished in being richly endowed in both mineral *and* agricultural resources. The changing extent of Australia's trade specialisation is summarised in Figure 3, using the Balassa (1965) index of 'revealed' comparative advantage (RCA, defined as the sectoral share of a country's exports divided by that sector's share of global exports). In 1913, after Western Australia's gold rush, Australia's RCA indexes for agriculture and mining were both just above 1.5, while that for manufacturing was only 0.13. However, the agricultural RCA index almost doubled between 1913 and 1960–1964 while the mining RCA index fell below 1.0.

The seven-decade hiatus for mining is another intriguing feature of Australia's long-run structural transformation, as is the 11-decade period in which the services share of GDP sat around 60% until the early 1950s (Figure 1). Those two features are not unrelated to the century-long interruption to the decline in the country's agricultural share of GDP.

This stepped decline of agriculture's GDP share is not a feature of other settler New World countries whose farmers similarly pushed the frontier as their populations grew. In fact, Australia was unusual in having a relatively low share of GDP from agriculture compared with other settler New World countries during 1850–1880, before it gradually moved to having a relatively high share after World War 2 (Figure 4). It was only after the early 1950s that Australia again followed other growing economies' relative decline in agriculture.

The plateauing of Australia's agricultural GDP share is not because of a plateauing in its growth in GDP per capita. There was steady growth in per capita income apart from the externally induced sudden downturns in the 1890s, the early 1930s and the two world wars. Leaving aside the 1850s' gold rush decade, Australia's annual GDP per capita growth rate averaged a respectable 1.4% between 1860 and 1970—despite the population growing at 2.2% per year over that long period thanks to continual immigration. That remarkable income growth began even earlier: Panza and Williamson (2019) estimate that GDP per worker in Australia during 1821–1871 grew at about twice the pace of the United States and three times that of Britain. By the end of the 19th century, Australia is believed to have had perhaps the highest per capita income in the world (Broadberry & Irwin, 2007; Inklaar et al., 2018; McLean, 2013). Thereafter, Australia's global ranking fell, but it was still third in 1950 after the United States and Canada. Meanwhile, income inequality remained low throughout compared with other advanced economies (McLean, 2013; Panza &

[4]It was not unusual among settler economies of the New World prior to World War I to have exports highly concentrated on just two primary products. But it is clear from Figure S2 that Australia had one of the highest concentrations. During the five decades after that war, Australia's exports became more diversified, but nonetheless around three-quarters of its value was still contributed by the rural sector (Figure 2b). Even in the most recent five decades, the agricultural share of Australia's merchandise exports has been more than twice the global average, while the manufacturing share has always been well under half the global average.

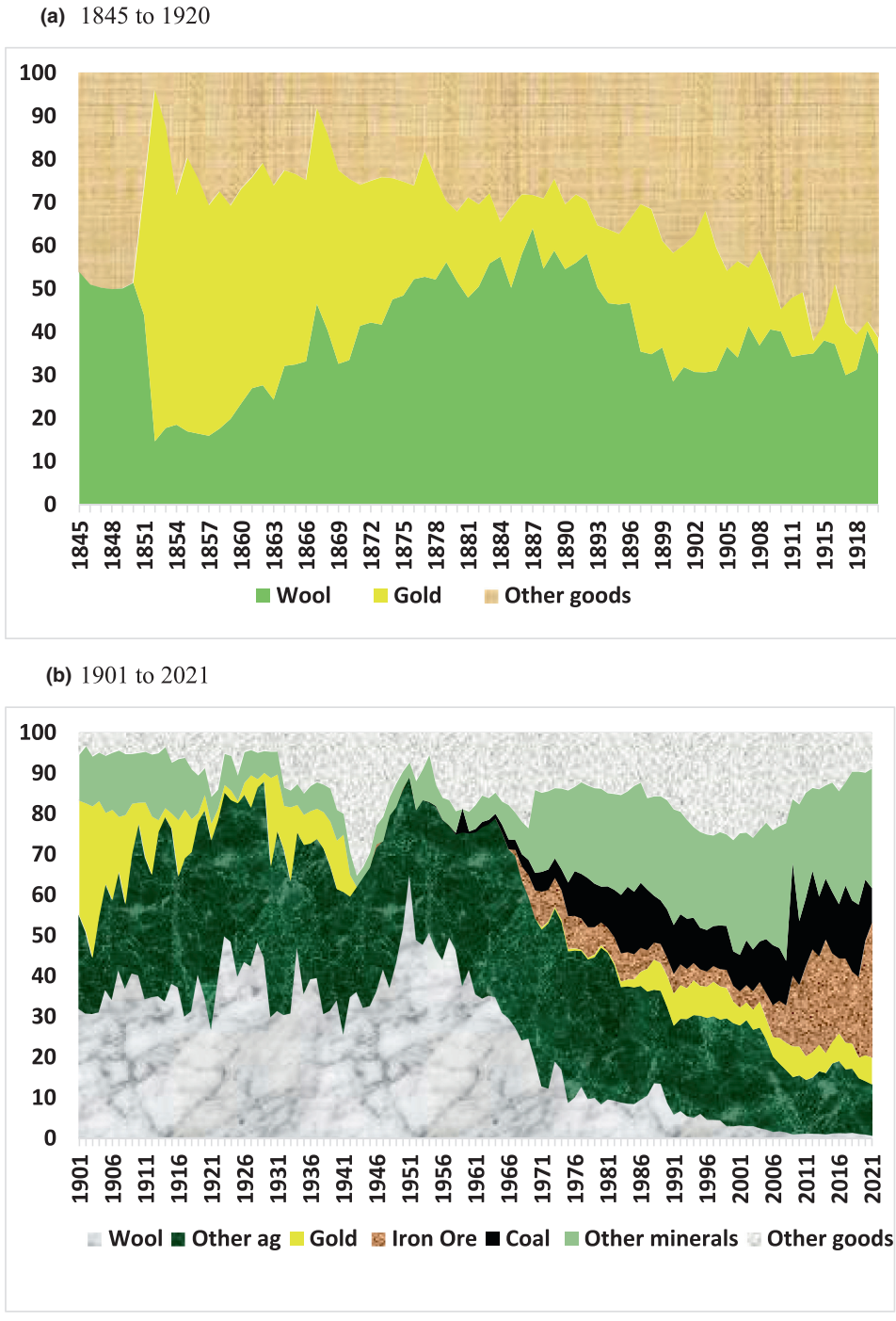

FIGURE 2 Shares of wool, gold and other goods in Australia's merchandise exports, 1845–2021 (%). *Source*: Vanplew (1987), updated from ABARES and ABS. [Colour figure can be viewed at wileyonlinelibrary.com]

Williamson, 2019). In short, Australia has not been subject to a 'resource curse' (van der Ploeg, 2011), despite its exports being dominated by just a few primary products throughout the first two centuries of European settlement.

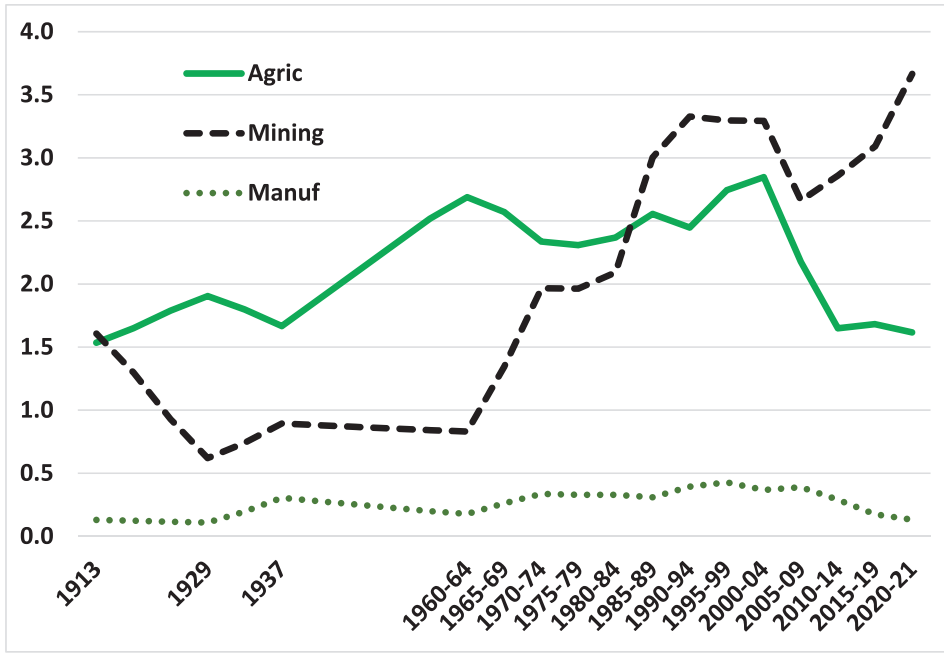

FIGURE 3 Australia's indexes of 'revealed' comparative advantage, 1913, 1929 1937 and 1960–2021. This index is the share of a sector in a country's total goods exports divided by that sector's share in global international trade in all goods (Balassa, 1965). *Source*: Based on World Bank (2023), plus Yates (1959, pp. 222–23) for sectoral shares of global merchandise trade in 1913, 1929 and 1937. [Colour figure can be viewed at wileyonlinelibrary.com]

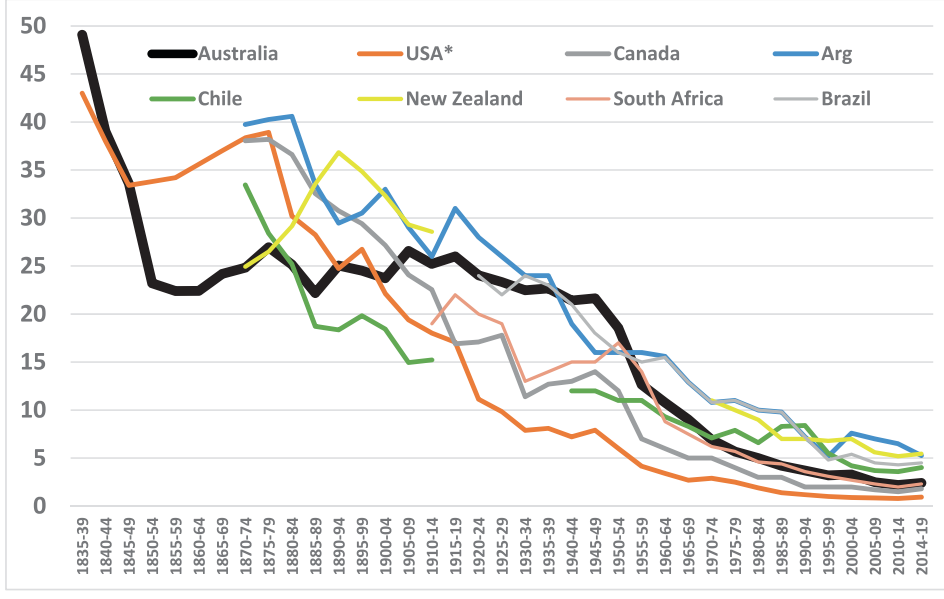

FIGURE 4 Agriculture's share of GDP, Australia and other New World countries, 1835–2019 (%, 5-year averages at current prices). *US shares for the first seven 5-year periods shown are interpolated from estimates by Gallman (1966, Tabs. 3 and A-1) for 1839 (42.7%), 1849 (33.4%) and 1959 (34.2%), and Mitchell (2005) for 1870–1874 (38.4%). *Source*: Author's compilation based on data in Mitchell (2005), Gallman (1966) and World Bank (2023). [Colour figure can be viewed at wileyonlinelibrary.com]

3 | THEORETICAL LITERATURE ON STRUCTURAL TRANSFORMATION OF A GROWING ECONOMY

The normal pattern of structural transformation of a growing economy is for the agricultural sector's initial dominance to decline as workers are attracted to manufacturing and service activities, with (nonfarm labour productivity relatively high and improving with industrial capital accumulation or importation (Lewis, 1954). Later in the development process, the manufacturing sector's share of employment declines as well. Development economists began tracing that pattern of structural transformation many decades ago (Chenery, 1960; Clark, 1940; Fisher, 1939; Kuznets, 1957). They note also that agriculture's employment share typically exceeds its GDP share (Deininger et al., 2022; Timmer, 2009). By contrast, the GDP shares of both manufacturing and mining typically exceed their employment shares.

Those features of development are consistent with the pattern of country-year annual data on sectoral shares of GDP and employment for 130+ countries as their per capita incomes grew during 1990–2020 (Figure S3, Supplementary Material). Very similar evidence is provided in Herrendorf et al. (2014) using additional data sources and much longer time periods. Growing economies also saw their agricultural share of exports decline on average, although the experiences were more varied once countries moved beyond low-income status (Figure S4, Supplementary Material).

To explain that pattern of transformation, it is helpful to begin by first considering a two-sector closed economy, and then an open economy that also includes a sector producing nontradable products and a mining sector. To simplify the analysis, assume that there are no intermediate inputs and all markets are perfectly competitive so that there is full employment of all factors of production. Assume initially that growth comes exogenously from improvements in total factor productivity (TFP),[5] before later considering the contribution that changes in factor endowments could make. Also ignored until the end of this section are government interventions that alter the relative prices of tradable products away from those at the country's border.

3.1 | GDP shares in a closed economy

Consider a closed economy with only two sectors: agriculture and nonagriculture. If its economic growth was due to productivity growth occurring equally rapidly in both sectors, the sectoral supply curves would shift out at the same rate. However, the demand curve shifts out less for agricultural goods than for other products following productivity-improving income growth (that is, the income elasticity of demand for food is below one). Thus, outputs of both sectors rise but less so for agriculture, and the price of farm products falls relative to the price of nonfarm products, and more so the more price inelastic is the demand for food and the more the income and price elasticities of food demand fall further as per capita income rises (Matsuyama, 2019).

Were there to be a faster rate of reduction in marginal costs of production in agriculture than in the rest of the economy (as suggested by the empirical work of Martin & Mitra, 2001 and Gollin et al., 2002), agriculture's GDP share would fall even further because of the low elasticities of demand for that sector's outputs.

This model is appropriate not only for a closed economy but also for the world economy as a whole. It suggests that the ratio of the international prices of agricultural products to those of other products will decline over time as global per capita income grows. That is consistent with what happened to relative prices over the 20th century (Pfaffenzeller et al., 2007).

[5]Sectoral difference in TFP growth rates is found by Herrendorf et al. (2015) to be the dominant force behind structural transformation of the US economy.

3.2 | GDP shares in a small open economy

Consider a small open economy that can export any share of its production or import any share of its consumption of both farm and nonfarm products at the prevailing international terms of trade. Such an economy would have a larger (smaller) share of its GDP coming from agriculture the stronger its comparative advantage in farm products (in manufactures).

If productivity growth occurred in this small open economy but the international terms of trade remained unchanged, agriculture's share of GDP would rise or fall depending only on whether that national growth was biased towards farm or nonfarm production. If economic growth at home and abroad was sectorally unbiased, it would lower the relative price of farm products for the reasons mentioned above, in which case this small economy's international terms of trade would deteriorate as would its GDP share from agriculture. That is, if productivity growth is occurring abroad and is not heavily biased against agriculture, the farms' share of GDP in this small open economy will decline unless its own productivity growth is sufficiently biased towards agriculture for the change in quantity to more than offset its terms of trade deterioration.[6]

However, a large part of each economy involves the production and consumption of nontradable goods and services because of these products' prohibitively high trade costs. The prices of nontradables are determined solely by domestic demand and supply conditions and related policies, because the quantity demanded has to equal the quantity produced domestically.

If one were to combine the two tradable sectors into one 'super sector' of tradables, then the above closed economy conclusion, that agriculture's share of GDP is likely to decline over time, will be stronger if the share of tradables in GDP declines in this open growing economy. The income elasticity of demand for marketed services—which make up the vast majority of nontradables—is well above unity in developing countries and tends to converge towards unity as incomes grow (Lluch et al., 1977, Tab. 3.12). If productivity growth is equally rapid for nontradables as for tradables, while demand grows faster for nontradables than for tradables, both the price and quantity and hence the value of nontradables will increase relative to that of tradables. But if productivity growth is faster in tradables than in nontradables (as suggested by the findings for services by Fuchs, 1980 and Kravis et al., 1983), it is even more likely that the share of nontradables in GDP would rise and the real exchange rate (the price of nontradables relative to tradables) would appreciate. In that case, the share of tradables in GDP would fall, making it more likely that agriculture's share also would decline.

At the global level, the income elasticity of demand for manufactured consumer goods also matters. While that elasticity may be above one in low-income countries, it falls increasingly below one as countries become more affluent.[7] Hence, the manufacturing sector is also likely—thanks to the nature of demand for services—to come under pressure to decline eventually even in small open economies as they become affluent, following the pattern for agriculture. Exceptions could be in those small open economies where manufacturing TFP growth is exceptionally rapid, but even then there is the possibility of faster consequent growth in those economies' demand for nontradables pulling more resources out of manufacturing and other sectors producing tradables. Once the manufacturing share starts to decline, the rise in the services sector's GDP share accelerates (Herrendorf et al., 2014).

[6]If the source of growth was entirely learning-by-doing in the manufacturing sector, it is even more certain that agriculture will decline in this small open economy, as shown formally by Matsuyama (1992).

[7]The share of aggregate consumption expenditure on nonfood manufactures does not seem to differ much across the GDP per capita spectrum, unlike that for processed food which declines sharply and for services which rises sharply as incomes rise (Fig. 6.9 of Herrendorf et al., 2014).

In short, a key condition for agriculture's share of GDP not to decline in a small open growing economy is rapid productivity growth in that sector relative to that in other sectors producing tradables.

3.3 | Employment shares

Given our initial assumption of no changes in aggregate factor endowments, the above reasoning is close to sufficient for describing changes in sectoral shares of labour employment: Agriculture (services) shares decline (rise) as per capita income grows, while manufacturing shares follow an inverted U-shaped path with the services share accelerating once manufacturing begins to decline.

Complications arise, however, when there are lags in labour migrating out of declining sectors or when labour productivity growth differs substantially between sectors. Historically, outmigration from agriculture has been sluggish because it typically requires a physical, social and cultural move from living on or near a farm to a town or city—something that is far less likely to be necessary for an urban worker moving to a new manufacturing or service sector job. Knowledge in farm households about higher income-earning opportunities in urban areas also may be incomplete. Thus, the decline in the share of employment in agriculture may lag the decline in agriculture's share of GDP. That tendency would be reinforced if there was less investment in education in rural than urban areas such that farm households' labour productivity is relatively low.[8]

Productivity impacts on sectoral employment shares can be positive or negative. On the one hand, the adoption by one sector of labour-saving technologies can raise its output and perhaps exports but reduce its employment, thereby *pushing* labour to other sectors (Gollin et al., 2002, 2007). On the other hand, a new farm technology that is land-saving (e.g. a new seed variety) may be so productive as to attract labour to the sector. That is least likely in lightly populated countries in which land rentals are low relative to farm wage rates (Hayami & Ruttan, 1985).

Also, labour could be *pulled out* of a sector due to new job prospects in another sector that is enjoying faster TFP growth or faster demand growth associated with consumers spending more of their higher incomes on nontradables (Gollin et al., 2007; Lucas, 2004).

The push element has always been present for farmers (and, more recently, also for factory workers where robotics and digitalisation are the latest influences in raising labour productivity). This is because as wages rise relative to farmland rentals and interest rates, there is an inducement to develop labour-saving farm technologies (Hayami & Ruttan, 1985). That is most likely to be the case in countries at the technological frontier. Meanwhile, producers in later-emerging economies will choose whatever is the most profitable technology from among the full spectrum available as their relative factor prices change.

In short, agriculture's share of employment is likely to be above its GDP share but least so in high-wage countries that are abundantly endowed with farmland per worker where there is an incentive to develop or import labour-saving farm technologies that displace labour from farms while raising farm productivity and output.

[8]The share of mining in employment, by contrast, is typically less than its share of GDP in settings where mining is highly capital-intensive—which is the norm not only in high-income countries but also in numerous resource-rich developing countries that are open to mining-specific (including human) capital inflows from abroad. Such capital inflows, and the (often associated) discovery of new subsoil or subseabed reserves, can be a significant source of both mining sector GDP growth and structural transformation.

3.4 | What if factor endowments change?

So far, it has been assumed that national income growth comes from exogenous technological change or (as just noted) from investments in innovation or importation and adaptation of foreign technologies. Income growth can also result from net factor accumulation over and above depreciation.

Natural resource capital can be discovered through mining exploration, or made more productive through investment (e.g. clearing and fencing farmable land, developing a system of roads or rail lines and creating new mining or farming technologies) in response to rising relative prices of primary products. Both avenues were part of extending the land frontier in lightly populated countries newly settled by Europeans, accompanied through linkages to varying extents (according to the 'staples' model) by growth in related manufacturing and service activities (Findlay & Lundahl, 2001).

The stock of produced capital can be enhanced as well through domestic investment or by importing such capital from abroad. The stock of labour can grow through immigration exceeding emigration, births exceeding deaths and changes in labour force participation (e.g. more women choosing paid work, more years being absorbed in formal education and people choosing to retire later).

Any of these changes can alter the value of per worker endowments of natural resources and produced capital in that country compared with the rest of the world. That changes the country's comparative advantages, to which we now turn.

3.5 | Export shares

Changes in agriculture's importance in an economy, and especially in its share of exports, depend on changes in the country's comparative advantage. They in turn depend heavily not only on productivity-improving innovations but also on changes in relative trade costs (the tradability of each sector's output) and relative factor endowments.

If a small economy's trade costs fall relative to those of the rest of the world, its comparative advantages will alter, and it would become internationally competitive in a larger number of products (Venables, 2004). Should that country's farm products gain more (less) from a generic decline in trade costs than its nonfarm products, the country would see its comparative advantage in agriculture strengthen (weaken), other things equal.

Factor endowments are crucial in the two key workhorse theories of comparative advantage developed in the 20th century. In the Heckscher–Ohlin–Samuelson model, all (exogenously given) factors of production are intersectorally mobile, while in the specific-factors model, one factor is specific to each sector. These two models have been blended by Krueger (1977) and Deardorff (1984) to account for primary sectors that use specific natural resource capital (farmland and mineral deposits) in addition to intersectorally mobile labour and produced capital. This blended model suggests that we should expect primary products to be exported from economies that are well-endowed with agricultural land and/or mineral resources per worker to those economies that are densely populated with few natural resources per worker.

Leamer (1987) developed this Krueger/Deardorff blended model further and related it to paths of economic development. If the stock of natural resource capital is unchanged, rapid growth of produced capital (physical capital plus human skills and technological knowledge) per hour of available labour tends to strengthen comparative advantage in nonprimary products. By contrast, a discovery of minerals or energy raw materials would strengthen that country's comparative advantage in mining and weaken its comparative advantage in agricultural and other tradable products, other things equal (the so-called 'Dutch disease'). Such a mineral discovery would also boost the country's income and hence the demand for nontradables, which

would cause its sectorally mobile resources to move into the production of nontradable goods and services, further reducing farm and industrial production (Corden, 1984)—and conversely when a mine is exhausted or there is a downturn in the international price of mining products.

The more a resource-rich economy directs some of its capital investment to forms that are specific to primary production, the later it would develop a comparative advantage in manufacturing or services. This is all the more likely if, as real wages rise, new technologies developed for the primary sector become increasingly labour-saving—leading potentially to what are known as factor intensity reversals. This happens when a primary industry in a high-wage country retains competitiveness against low-wage countries by that industry becoming more capital-intensive.

In short, the agricultural sector's share of an economy would decline more slowly, the more (compared with average global rates) a decline in trade costs benefits its farm relative to nonfarm products, its investments and export price changes boost the value of natural capital in agriculture more than in mining, and productivity growth in farm production exceeds that in other sectors.

3.6 | Induced innovations in institutions and policies

Changes in economic institutions, or in taxes, subsidies or quantitative restrictions on the production, consumption or trade of products or of the factors or intermediate inputs used to produce them, can alter nontrivially the structural transformation of an economy.

As an economy develops, its institutions and policies are modified over time as its government responds to the changing objectives of society. Large differences in relative trade costs, in relative factor endowments and hence in comparative advantages among growing economies ensure that concerns vary regarding the consequences of uninhibited structural transformation for such things as rural–urban income disparities, food and energy security, degradation of the natural environment and farm animal welfare.

Responses to those concerns can contribute to systematic differences across sectors and nations in the use of trade interventions and other price-distorting regulatory policies. A survey by Anderson et al. (2013) finds strong empirical support for the hypothesis that as economies develop, their governments gradually change from taxing to subsidising the agricultural sector relative to manufacturing, but at a later stage the stronger their comparative advantage in agriculture.

3.7 | Summary of forces influencing agriculture's share of an economy

According to the above, agriculture's share of a small open economy would decline more slowly:

- The faster is productivity growth in its farm sector's value chain compared with that of other sectors producing tradables,
  - Although less so for agriculture's employment share the more farm productivity growth is biased towards saving labour;
- The faster is the decline in its trade costs for farm products compared with other sectors' products;
- The more domestic prices of its farm products rise compared with those for other sectors; and
- The more its policies, institutions and effective stocks of natural resources, labour and capital change in favour of the farm sector compared with other sectors.

4 | FORCES BEHIND AGRICULTURE'S CHANGING SHARES OF THE AUSTRALIAN ECONOMY

With the above in mind, we turn now to the empirical question posed in the title of this article. Australia's structural transformation away from agriculture was not unusual prior to 1850, nor after 1950. What was unusual and needs explaining is agriculture's share of GDP being virtually constant during the 10 decades in between the early 1850s and early 1950s. In this section, we search for explanations in terms of the above four dot points.

4.1 | Sectoral productivity growth

By the 1880s, Australia was the envy of the New World in terms of the productivity of its sheep industry. Argentina in particular sought to emulate its success (Duncan & Fogarty, 1984, pp. 1–3). Wire fencing helped selective breeding and quality upgrading of livestock (Pickard, 2010). Dairy and meat production were helped by refrigerated shipping from the 1880s. Wheat production by then was rapidly expanding too. It was helped by labour-saving machinery that was locally innovated or imported from the United States where the world's best farm machinery was being developed (McLean, 1973a; Shaw, 1990). As well, public research on crops boosted yields per hectare and extended the crop frontier from the 1870s, just as happened in the United States (Olmstead & Rhode, 2011); by early in the 20th century, R&D had helped reverse the earlier decline in average wheat yields (Figure S5). Also important were public investments in tertiary agricultural colleges and in colonial Departments of Agriculture from the 1870s, which further boosted farmer productivity (McLean, 1982). Later, horticulture and viticulture were helped by public investments in irrigation infrastructure post-World War 1 (Shaw, 1990).[9]

The development and widespread adoption of labour-saving farm (and mining) technologies and machinery was encouraged by the high and rising level of real wages in Australia (Duncan, 1972a). One consequence was that agriculture's share of Australian employment fell throughout the long period in which its GDP share plateaued (Figure 5a). That means labour productivity in Australia on farms (the sector's GDP share divided by its employment share) grew steadily over those 10 decades, particularly relative to labour productivity in manufacturing and services (Figure 5b). According to Broadberry and Irwin (2007), Australia's agricultural labour productivity in the late 1800s was the highest in the world.[10]

4.2 | Domestic and international trade costs

During 1850–1870, Australia had a relatively low share of its GDP coming from agriculture. One reason was that much manufacturing was still naturally protected from imports by high ocean transport costs. As that natural protection gradually fell with the lowering of those trade costs, agriculture's GDP share was under less pressure to fall.

Public investments in rural infrastructure such as roads, railways, telegraph services, telephones and electricity all lowered internal transport and communication costs.[11] The first tele-

[9]Productivity growth in Australia since the start of the 21st century has been faster for farming than for both mining and manufacturing (Productivity Commission, 2022). That is thanks partly to considerable post-World War II public agricultural R&D investment (Duncan, 1972a, 1972b; McLean, 1973a, 1973b; Mullen, 2010; Mullen & Cox, 1995).

[10]Contrary to the common perception that labour is less productive in primary sectors than in manufacturing, the opposite has been true in Australia in most of the past 160 years—and especially so for mining since the 1960s (Figure S6).

[11]For comparison, in the United States, the gains from greater trade in farm products due to the lowering of internal transport costs are estimated to be of a similar magnitude to those from farm technological improvements between 1880 and 1997 (Costinot & Donaldson, 2016).

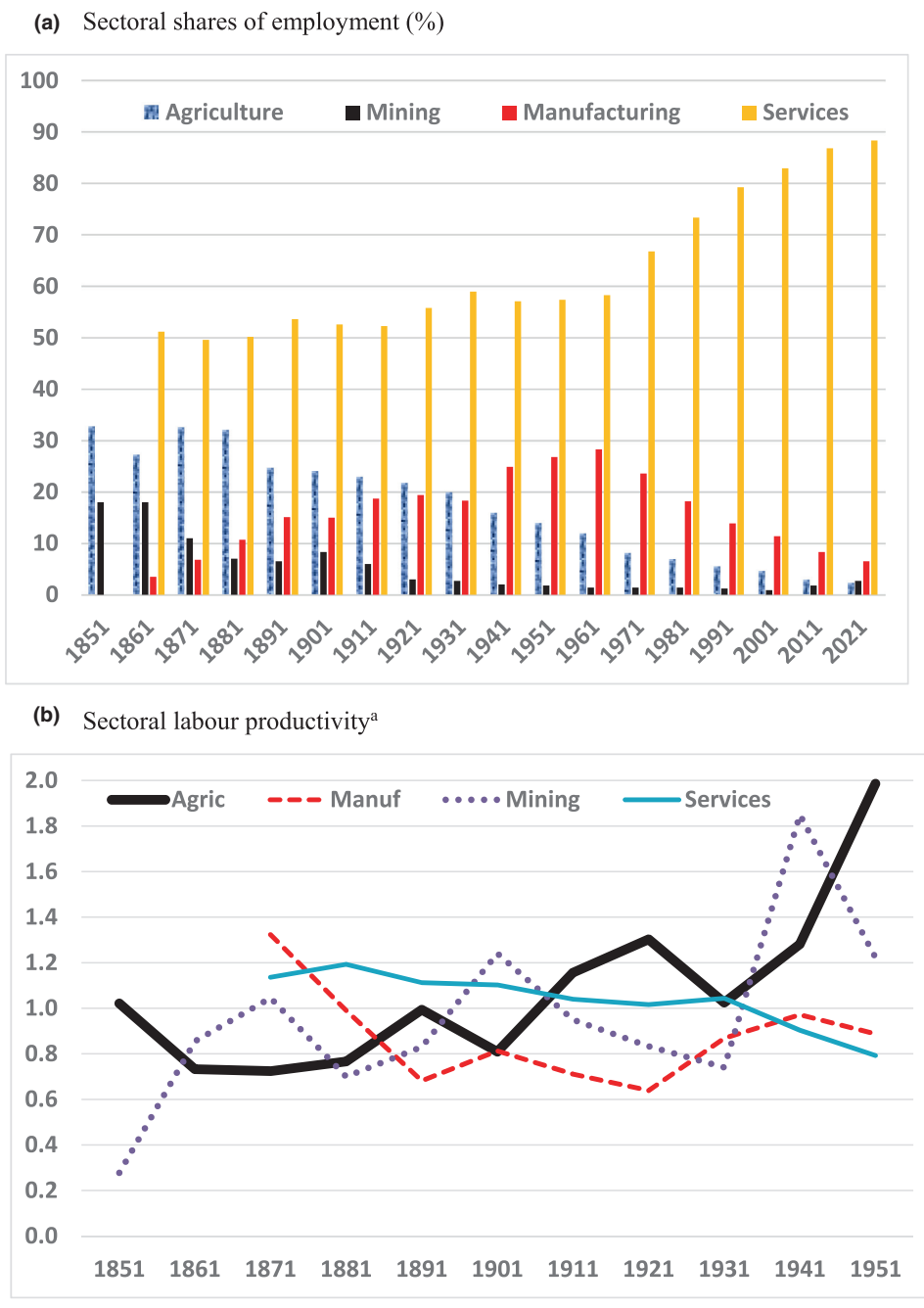

FIGURE 5 Shares of agriculture, mining, manufacturing and services in employment and sectoral labour productivity, Australia, 1851–2021 (%). [a]Sectoral GDP share divided by sectoral employment share. *Source*: Author's compilation from data in Vanplew (1987), updated from ABS. [Colour figure can be viewed at wileyonlinelibrary.com]

graph lines were erected in the south-eastern colonies in the mid-1850s, less than a decade after the first one began operating in the United States. Services in Queensland and Western Australia followed in the 1860s and the Overland Telegraph to Darwin were operational by 1872 and connected to Europe via Jakarta.

Ocean shipping costs and travel times shrunk as steam power and steel hulls replaced wooden sailing ships through the middle half of the 19th century, benefitting Australia more than most countries because of its vast distance to Europe (Jacks et al., 2010). The opening of the Suez Canal in 1869 added to that relative decline in costs of shipping bulky exports from Australia.

Meanwhile, Australia's major gold mining booms of the early 1850s and the 1890s did not depress its farm sector for long because those booms were so large as to stimulate major expansions of the overall economy and its population. The 1850s, for example, saw real incomes per capita rise despite the continent's non-Aboriginal population nearly trebling, ensuring enormous growth in the domestic demand for farm products—many of which were not internationally tradable until late in the 19th century because of high trade costs. That encouraged men to soon return from the gold fields to farming (Maddock & McLean, 1984).

Australia's relatively rapid farm productivity growth and decline in trade costs helped the rural sector maintain a high share of national exports. Agricultural exports were dominated by wool from the 1830s, it being the farm enterprise that was perhaps least intensive in its use of scarce labour relative to abundant grazing land (Davidson, 1981, Ch. 6), and also highly valued in terms of its volume and weight and so able to be competitive despite high domestic and ocean transport costs. Annual wool exports per capita grew from less than $2 in the 1820s to $20 by 1850, and they remained around $20 through to World War I despite the population expanding 12-fold over that period.

The fact that wool (along with skins, hides and tallow and eventually wheat) was exported in raw form meant the farm sector (like gold mining) did not contribute very much to the early development of the local manufacturing sector. It took until refrigeration allowed exports of perishable meat and dairy products before the food processing part of manufacturing got a boost from agriculture. That contribution to manufacturing continued to grow through to 1950, such that agrifood products continued to be the dominant part of manufactured exports in the interwar period (Figure S7).

4.3 | Relative product prices and sectoral assistance policies

The international terms of trade for primary producing countries exporting to the UK and other west European countries in exchange for manufactured goods improved enormously over the 19th century, thanks to the spread of the industrial revolution (Williamson, 2008; Figure 2). That helped farmers in Australia but also in other countries exporting primary products. The 20th century saw the opposite trend in the index of international prices of agricultural products relative to manufactured goods (Pfaffenzeller et al., 2007). For Australia, its international terms of trade fluctuated around a flat trend between 1871 and 1967, just before the mining sector boomed again (Figure S8). Favourable access to the UK market, both pre-World War I and after the signing of the Ottawa Agreement in 1932, would have benefitted Australian (and other Commonwealth member country) exporters. Since farm products dominated exports throughout that period (Figure 2), this suggests the terms of trade would have had a benign effect on the trend share of agriculture in GDP over the century under review.

However, domestic relative prices were not the same as those at the nation's border. Manufacturing and numerous agricultural industries enjoyed considerable natural protection from import competition in the 19th century and through to and during World War I, thanks to high ocean trade costs. While during the colonial period import tariffs added only a little to that protection (Lloyd, 2017), manufacturing tariffs grew very considerably soon after the Federation in 1901 (Anderson & Garnaut, 1987). The manufacturing sector's nominal rate of assistance trebled between 1919 and 1932, to 63%, while assistance to (mainly import-competing) agricultural industries averaged only around 5% (Figure S9).

Iron and steel were among the assisted industries, and they also enjoyed bounties from 1909 to 1948 (Lloyd & MacLaren, 2015). That encouraged the biggest mining company, BHP, to open the Newcastle Steelworks in 1915 and to begin building military aircraft in 1934 and ships from 1941. Effective protection for steelmaking and steel-using manufacturing was raised further in 1938 when the government imposed a ban on exports of iron ore, one that stayed in place until May 1966 (having been partially lifted in November 1960—see Lee, 2013). That, plus low international prices of energy raw materials and falling nonferrous metal prices (Figure S10), diverted miners' investments from mining to steel manufacturing. That is, local mining firms invested their huge profits from the previous 3+ decades not in further exploration and new mining technologies so much as in the less-risky downstream processing of minerals and metals (Blainey, 2003, pp. 276–77). Local demand for the latter had expanded during World War I and, together with food and timber processing, they dominated Australia's manufacturing output (Figure S11). As a result, the mining sector's contributions to GDP, employment and exports were miniscule during 1920–1965 (Figures 1, 2 and 5a).

Thus, while the agricultural sector was made less competitive throughout the middle half of the 20th century by manufacturing protectionism, it was spared 'Dutch disease' pressure from the mining sector for the final one-third of the century-long period under review.

4.4 | Institutional developments

The expansion of grazing in the first half of the 19th century had involved 'squatting' illegally on unfenced native pastures and so required no capital outlay for land. In that era, funds were needed only for purchasing breeders that reproduced plus paying wages for shepherds. But with population growth and dwindling prospects for gold panning, there was a surge in the demand by potential smallholder farmers for farmland. The ensuing squatter/selector conflict in the 1850s was won in favour of selectors: Governments converted some large holdings (especially those close to urban centres) into smaller holdings that were sold as freehold for more-intensive agriculture, where economies of scale were less than for outback pastoral sheep grazing. The rest of the pastoral land that had been squatted on became subject to long-term leases which, by providing new security of tenure, encouraged capital investments in such things as fencing and stock water, and also in the genetic quality of their livestock (Campbell and Dumsday 1990; Raby, 1996; Shaw, 1990; Greasley, 2015). This institutional development reduced the prospect of a few people holding much of the land wealth. It thereby contributed substantially to a more equal distribution of income and wealth in Australia than in most other resource-rich economies (McLean, 2013), and thus to political stability.

Once land became leasehold or freehold in the 1860s, the institutional innovation of stock and station agents provided essential finance and marketing services for both graziers and crop farmers (Barnard, 1958; Ville, 2000). By continuing to provide those services even as regular banks became available in rural areas, those agents contributed greatly to the resilience of Australian farmers in dealing with their fluctuating fortunes during the period under review.

More generally as the 19th century progressed, Australia's colonies put in place what Acemoglu and Robinson (2006, 2013) call inclusive political and economic institutions, providing well-defined and secure property rights, law and order, democratic elections and essential public goods. Those institutions played a major part in ensuring that the primary sectors' contributions to Australia's economic growth were inclusive.

In South Australia in the 1840s, for example, the explicit requirement that half of land sales revenue be used to subsidise immigration from Britain ensured rapid population growth and hence demand for local farm and other products in that colony from the

mid-1840s, and the colonial government's requirement that the land encasing the copper find near Burra had to be purchased as a 20,000-acre lot at £1 per acre meant a broad group of investors became owners of the Burra copper company, which further spread the benefits of mining that site and helped avoid corruption and rent-seeking (Harris & La Croix, 2021).

In Victoria and New South Wales in the 1850s, there were very low barriers to entering alluvial gold mining, as there were no economies of scale and mining licence fees were often evaded—and were replaced in 1855 by a tax (of about 3%) on gold exported from Victoria so that only successful miners bore that burden and only at the point of sale (La Croix, 1992). Also, those two colonies copied South Australia in ensuring that a large portion of that tax revenue was used to subsidise immigration. The resulting inflow reduced the rise in income and wealth inequality as between landholders and others because free immigrants in the 1850s typically had more human and financial capital than locals (Maddock & McLean, 1984; Panza & Williamson, 2019).

With both incomes and the population growing rapidly, the demand for nontradable goods and services also grew, which pushed up real wages for all wage-earners such that the benefits of the mineral discoveries were soon spread widely (Broadberry & Irwin, 2007). That inclusive growth outcome was further helped by the fact that farm land in the 1860s was becoming available faster than the number of people interested in farm work, lowering agricultural land prices and rents relative to unskilled wages (Panza & Williamson, 2019).

4.5 | Relative factor endowment changes

High-quality data on relative factor endowments for the period under review in Australia compared with the rest of the world are not available. However, a crude indicator of primary product comparative advantage (disadvantage) is national versus global land per capita (population density). Changes in that can be found simply from population data, assuming national boundaries do not change. Between 1850 and 1950, Australia's population multiplied 13.7 times. That compares with 2.1 for the world, 1.8 for Asia, 2.0 for Europe, 2.8 for Sub-Saharan Africa, 5.4 for Latin America and for South Africa, 5.6 for Canada and 6.5 for the United States. Only Argentina (15.6) and New Zealand (21.2) saw larger increases than Australia (Inklaar et al., 2018). This relatively rapid increase in Australia's population density over those 10 decades was from an extremely low base though and was evidently not enough to erode the country's competitiveness in farm products.

5 | COMPARISONS WITH OTHER TEMPERATE-ZONE COUNTRIES RECENTLY SETTLED BY EUROPEANS

Australia in the mid-19th century shared many of the characteristics of other temperate-climate countries of recent European settlement such as Argentina, Brazil, Canada, Chile, New Zealand, South Africa, the United States and Uruguay. Those characteristics included being lightly populated by indigenous people, able to attract immigrants and capital from Europe and export primary products back to that advanced industrial region, and initially being heavily dependent for income and export growth on expanding the land frontier.

However, Australia differed in a number of ways that may have contributed to its agricultural share of GDP not trending downwards like that of other countries of recent European

settlement (Figure 4).[12] Space precludes exploring them in detail here, but several are suggested to stimulate future empirical research.

One difference was that Australia had very few aboriginal people per hectare when European settlement began, many of whom soon died from communicable diseases introduced by the new settlers (Butlin, 1982). Nor were the locals involved in commercial agriculture (but see the debate between Pascoe (2014) and Sutton and Walshe (2021)), or capable of preventing new settlers from encroaching on their land.

Second, Australia has always had an exceptionally large endowment of natural resources per worker. Its total land area per capita was 123 times the global average in 1850. That compares with 35 times for Canada, 28 times for New Zealand, 23 times for Argentina and just three times for the United States. By 1950, Australia still had 18 times the world average when Canada had 13 times and the other New World settler economies had less than three times (Figure S13). Of course quality-adjusted farm land area is not evenly distributed across the world's land surface, nor are mineral reserves. An attempt to estimate values of national endowments per worker has been published by the World Bank (2021) for almost all countries (although not for New Zealand). They reveal that in 2018, Australia was endowed per worker with three times as much agricultural capital as the world average, 12 times as much mineral capital and, similar to Canada and the United States, five times as much other (including human) capital. Only Uruguay among the Southern Cone countries had (slightly) more agricultural capital per worker than Australia in 2018. That is, even seven decades after the period under review, Australia remains extremely well-endowed with agricultural (and mineral) resources per worker.

Third, Australia's productivity in wool production was perhaps the highest in the world over the 10-decade period under review (Duncan & Fogarty, 1984), and its investments in farm innovations raised its agricultural labour productivity such that in the late 1800s, it was perhaps the highest in the world (Broadberry & Irwin, 2007). Over the full 10 decades under review, Australia's farm labour productivity grew at about 0.7% per year. That was also the rate in US agriculture over the period 1840–1900, before it accelerated there to 1.3% in 1900–1940 (Figure 3 in Mundlak, 2005).

Fourth, while costs of trading with Europe were relatively high in the antipodes compared with the Americas and South Africa, they fell considerably when the Suez Canal opened in 1869, making Australian exporters more competitive in the UK and continental Europe than previously. Australia's internal trade costs also fell dramatically in the middle half of the 19th century, lowering the cost of shifting product from the farm to urban consumers or to ports (Blainey, 1966), but how much that contributed to improving agricultural competitiveness in Australia versus other New World countries remains an area for further research.

Fifth, Australia's squatter/selector conflict in the 1850s was won in favour of converting some large holdings into smaller holdings sold for more-intensive agriculture. By contrast, the comparable conflict in Argentina and Uruguay led to a small group of large landholders becoming hugely wealthy and politically powerful (Álvarez et al., 2011; Duncan & Fogarty, 1984). Those dominant families probably had far more urban interests than Australian farmland owners, such that they may even have favoured the manufacturing protection that contributed to the declines in their agricultural share of GDP.

[12]Unfortunately, sectoral GDP shares are unavailable for New Zealand before 1875 and from 1915 to 1969. Its agricultural share was higher in 1910–1914 than in 1875–1879 though, so there may well have been, as in Australia, a lengthy period without it trending downward. Its sectoral employment and export share trends are otherwise not dissimilar to Australia's, including a half-century in which gold was a dominant export along with wool; but typically, both its agricultural and manufacturing shares of employment and exports were above Australia's because of very little mining after New Zealand's pre-World War I gold boom (compare Figure S12a,b with Figures 5a and 2). South Africa does not have sectoral GDP data for the 19th century, but its agricultural share fell after the discovery of diamonds in Kimberly in 1870 and gold in Witwatersrand in 1886. Uruguay also has very limited data, but its agricultural share of GDP gradually declined from 15% to 12% between the mid-1930s and early 1960s (Mitchell, 2005).

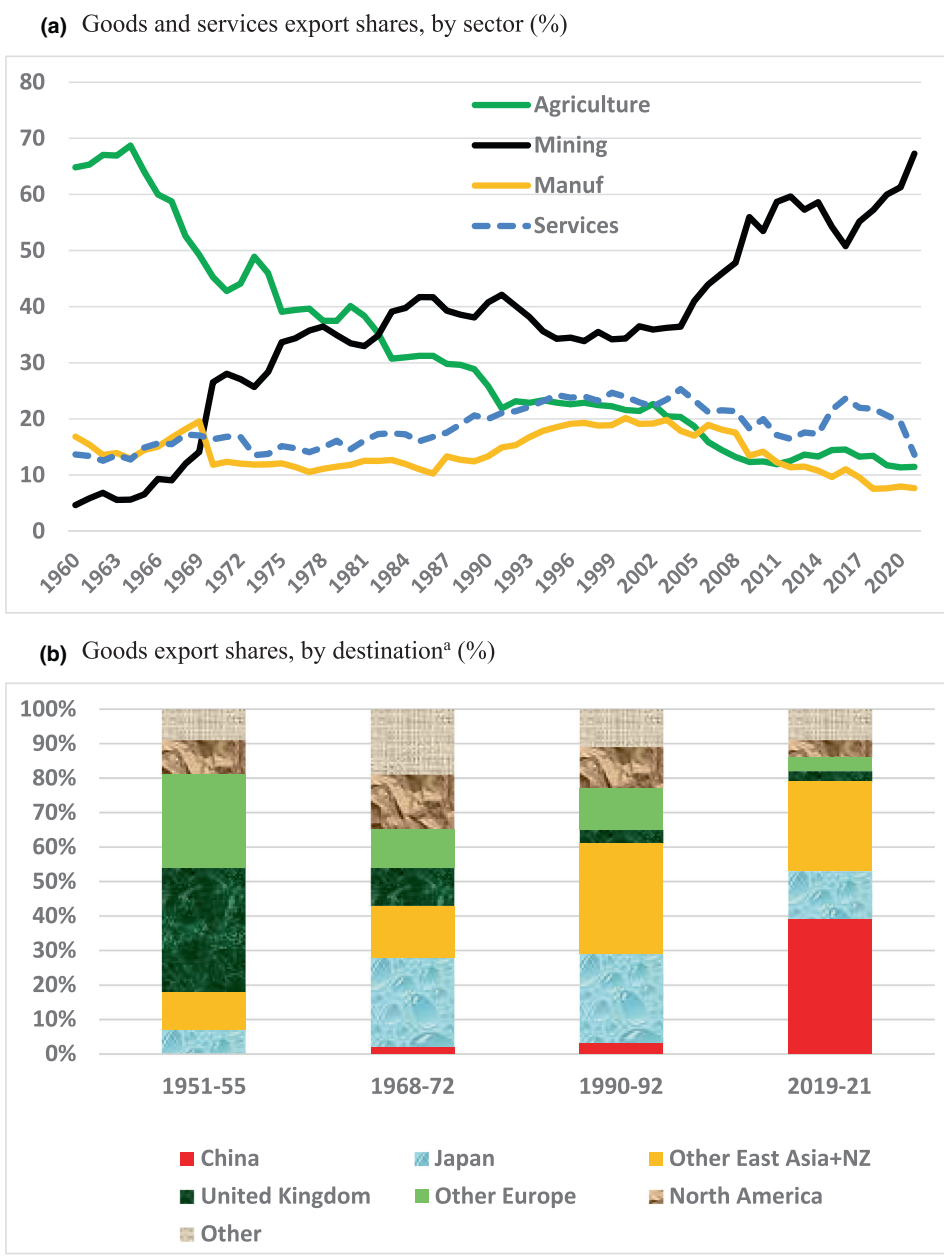

FIGURE 6 Evolving concentration in Australia's production and direction of exports, 1951–2021 (%). [a]China's share of Australian exports of services rose from 2% in 1990–1992 to 18% in 2019–2021, while the rest of Asia's share was just under 40% in both of those periods. *Source*: Author's compilation from Vanplew (1987), updated from ABARES and ABS. [Colour figure can be viewed at wileyonlinelibrary.com]

Sixth, in the United States and Canada, primary product processing accompanied the movement west of the land frontier, expanding their manufacturing sector (Findlay & Lundahl, 2001, p. 100). Possibly, that happened more so than in Australia because internal trade costs were lowered more rapidly in North America, but also because Australia's first exports (wool, hides, skins, tallow and gold) were all able to be shipped unprocessed. By contrast, the mineral richness

of North America did not result in large GDP or export shares for mining from around 1870 but rather in mineral-rich manufactures dominating their production and exports, thereby contributing to the decline in their agricultural shares of GDP (Altman, 2022; Wright, 1990).

Seventh, the fall in real international prices of farm products in the 20th century affected all agricultural exporters. So too did the rise of manufacturing protectionism in most of the newly settled economies, but to varying degrees. The rates of assistance to agriculture relative to manufacturing for Australia averaged −22% during 1946–1954 and just −10% in 1955–1964, while as late as 1965–1969, the average was still −20% in Chile, −24% in New Zealand and −49% in Argentina (but close to zero in Canada and the United States—see Table S1). What further distinguished Australia was that miners' profitability also fell after World War I, making it more attractive for cashed-up mining firms such as BHP to invest in minerals processing and manufacturing with metals rather than in primary mining activities. The ban on iron ore exports from Australia from 1938 to the mid-1960s further contributed to the country's mining hiatus that helped maintain its agricultural shares of GDP and exports.

6 | CONCLUSION

This review has revealed an unusual feature of Australia's structural transformation, namely agriculture's near-constant share of GDP for nearly 100 years from the early 1850s. Remarkably, it occurred despite agriculture's share of employment continuing to decline throughout and industrial growth being stimulated by rising tariff protection for Australia's manufacturers. Several factors contributed, including a huge land frontier that took more than a century for settlers to explore, declines in initially crippling domestic and ocean trade costs for farm products, the absence of a need to do any processing of the two main exports during that period (gold and wool) and innovations by farmers and via a strong public agricultural R&D system that contributed to farm labour productivity nearly doubling over those 10 decades. The ban on iron ore exports from 1938 and low export prices for fuels, minerals and metals during the two world wars and in the intervening decades also contributed.

Ironically, Australia is hardly any more diversified now than it was six decades ago in either the sectoral composition or the direction of its exports. Figure 6 shows that primary products continue to dominate hugely, but that is because minerals since the 1960s have replaced farm goods as the dominant export sector; and East Asia (especially China) has replaced Western Europe (especially the UK) as the dominant region of destination for Australian exports.

A lesson from Australia for those developing countries that are richly endowed with natural resources per worker is that it *is* possible to become a mature high-income economy and simultaneously retain a strong comparative advantage in agriculture. But that may be possible for only a small number of today's developing countries, not least because few have a large yet-to-be-exploited land frontier.

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DATA AVAILABILITY STATEMENT

All data are in the public domain as references in the text.

ORCID

Kym Anderson https://orcid.org/0000-0002-1472-3352

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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