

Explaining the Reefton Paradox

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ECONOMIC THEORY has it that during the period of the gold standard, because of gold's fixed nominal price, the output of gold should have varied counter-cyclically with fluctuations in the level of economic activity. However, the history of Reefton, which was New Zealand's second biggest gold field, poses something of a paradox in the field's first four decades before 1914:¹ although Reefton's level of output varied during the periods of economic expansion and depression, and then expansion again, in New Zealand during this period, the variations in the field's output of gold demonstrated the opposite to this theory from 1873 to 1914.

Reefton's gold mining industry boomed during the inflationary Vogel boom in New Zealand in the 1870s, and was depressed during New Zealand's 'long depression' from 1883 to 1895 despite the favourable economic conditions at that time for gold mining associated with substantial deflation. In turn, Reefton's gold output expanded during the economic recovery and inflationary period in New Zealand from 1896 to 1914.

This paper analyses the factors pertaining in Reefton from 1873 to 1914 the economic effects of which were more dominant than the effect of the changes in the real price of gold during this period, which helps explain the 'Reefton paradox'.²

Normally, it could be expected that it would have been the level of inflation and deflation in New Zealand that decided the output of the gold mining industry in that country during the pre-1914 period. Under the gold standard the price of gold was fixed, but while its nominal value was constant, its real price or value changed with movements in the level of prices in the economy. When the level of prices fell, the real price or value of gold increased (and *vice versa*): in a depression, with falling prices, wages and interest rates, the production of gold should have become more profitable, and gold output should have expanded.³ This increased production of gold would have resulted in the authorities issuing more money, because under the gold standard they were required to buy any quantity of gold offered to them at the official price.⁴ This expansion of the money supply would have moderated, or halted the decline of prices in the economy. The converse would have occurred when prices rose, as the tendency of a rise in the level of prices to depress gold output was symmetrical with the tendency of a

fall in the price level to increase gold production. While a general expansion of economic activity resulted from increased gold supplies, this also coincided with the beginnings of a reverse movement for the gold mining industry because prices and wages tended to increase.⁵ This increase in costs would have deterred any expansion in gold output, and would have resulted in a decrease in the supply of gold. Paradoxically, the experience of the gold mining industry in Reefton in this period was the opposite of this theory.⁶

Table I: Price level inflation and deflation in New Zealand, and the average annual output of gold in Reefton, in each of the periods 1873-1882, 1883-1895 and 1896-1914.



Note: The price level deflated 2.7 per cent in the 1873-1882 period mainly because of the 16.3 per cent deflation in 1879 in the aftermath of the collapse of the Vogel boom, but with the exception of this year, prices inflated by 10.9 per cent over this period.

Reefton production

When 81 years of quartz-mining activity at Reefton on the South Island of New Zealand came to end in 1951, the quartz mines of the Reefton goldfield had produced more than two million ounces of gold, today worth more than \$AUD1.2 billion.⁷ This two million ounces was about eight per cent of New Zealand's total output to that time, and Reefton was New Zealand's second biggest gold producer.⁸

Reefton boomed for its first ten years, producing nearly a quarter of a million ounces of gold that enabled the Reefton mining companies to pay dividends totalling £212,775 in that period.⁹ This was despite the fact that the 1870s was a period of economic expansion during the Vogel boom in New Zealand¹⁰ (even though the level of prices in 1882 ended up approximately where it had been ten years before, there had been inflation of prices most years in this period which was wiped out by a 16.3 per cent tumble in the price level in 1879, after the Vogel boom burst).¹¹

During this early period Reefton had boomed from the discovery of the gold reefs because many were rich. The 'bonanza' grades of these reefs saw a very high proportion of the value of gold recovered accruing as profit - in some cases profit represented six-sevenths of the gold recovered, which meant that the profitability of mining them was not sensitive to costs and the concurrent inflation.

Although the discoveries were made in mountainous country, the rugged topography enabled easy initial underground access to the reefs by driving adits, or horizontal tunnels, into the steep hillsides. Also the easy money during the Vogel boom allowed share speculation to flourish, and the consequent local share market boom facilitated the raising of capital for gold mining.

The inevitable aftermath of the excesses of the Vogel boom was depression: prices in New Zealand deflated by 30.5 per cent between 1883 and 1895.¹² During this long depression in New Zealand when gold mining could have been expected to have expanded and even boom, the industry in Reefton defied theory and was also depressed. Reefton did produce another quarter of a million ounces of gold in this 13-year period, but the annual output fell by a quarter to an average 19,000 ounces a year, and the amount of dividends paid each year also diminished proportionately. A better gauge of the financial health or illness of the industry is demonstrated by the fact that although dividends totalling £288,430 were paid from 1883 to 1895, this sum was exceeded by £375,840 calls made to finance losses.¹³

The readily-mined surface ore at Reefton had been worked out in the earlier period, and access to the almost vertically disposed reefs was now by costlier shaft sinking, with more elaborate hoisting arrangements required to bring the ore to grass.¹⁴ In addition, the era of easy money, which had fueled the share market speculation that had bankrolled the mining boom in the earlier period, had come to an end. However, these were not the most important factors in Reefton's depression, as leading causes were a combination of physical and institutional constraints, the effects of which outweighed the economic benefits from the substantial price deflation experienced in this period from 1883 to 1895.

One of the main problems was a physical one, in that the rocks of the Reefton gold field had been severely stressed by shearing with consequent faulting. This had occurred since the deposition of the quartz reefs, with the result that the many faults displaced blocks of the orebodies.¹⁵ Consequently, probing underground by drives and crosscuts necessary to pick up the faulted blocks of ore added considerably to mining costs. In some cases, the faulted offsets of the reefs being mined were never located, despite considerable expenditure on underground exploration.¹⁶

In addition, the Reefton ore was to some extent refractory, and only about half the gold in the ore was recovered by amalgamation. Better recoveries had been obtained in the early period from the ore near the surface, which was oxidised, with the gold more amenable to recovery by simple amalgamation. The fairly primitive stamp batteries erected on the field provided unsophisticated ore treatment facilities, and the gold not recovered in them by amalgamation from the deeper, unoxidised and hence more refractory ore, was run to waste in the tailings. By 1895, it is likely that a staggering half a million ounces of gold had been discarded in this fashion. This was a reflection of the poor standard of management at Reefton, which was resistant to change, exhibiting a marked reluctance not only to innovate, but to consider any technical improvement.¹⁷ Of course, in the early days it was difficult or impossible to recover this gold, but with one notable exception, no effort was made by the Reefton management to stack these rich tailings for possible later treatment.¹⁸ The Reefton tailings, which contained more gold per ton than the average head grade of the ore being mined in Bendigo, were sluiced away and lost in the fast running streams and rivers into which they were dumped.

Even if more enlightened management had wished to install better equipment, or plant to implement the new processes to recover the gold lost in the tailings, they were

prevented by the lack of capital for gold mining investment. One of the constraints which prevented the Reefton mines from benefiting from the price deflation in this period was the financial arrangement of the industry, for the New Zealand government had declined to adopt the no liability company system of financing gold mining, which had been so efficacious in Australia, where it had been developed.¹⁹ Instead, New Zealand relied upon the limited liability form of company structure.²⁰ However, it was the policy of the local promoters and mining company directors to employ a feature of the no liability company structure when raising capital for mining by issuing partly-paid, contributing shares. Because these shares were necessarily issued in limited liability companies, this policy exacerbated market crashes in difficult times, as investors dumped their shares in panic to avoid the likelihood of calls for which they were liable. It also made wealthy individuals unwilling to invest in gold mining shares. The policy of issuing contributing shares in limited liability companies with capital called up in instalments had been designed to make mining investment attractive with a form of time payment for shares. However, its effect was not only to make it difficult for legitimate ventures to raise substantial capital in the market, but it laid further obstacles in the path of the local industry: to further complicate the institutional arrangements in Reefton, features of the Cornish cost book system of mining had also been adopted by the local companies, and these were inconsistent with their limited liability company structure. The Cornish cost book feature employed in Reefton involved the mines distributing all their profits as dividends as soon as they were realised, with no retention for reserves, and then relying upon the payment of calls made on their contributing shares to fund development work and capital expenditure on plant, and to finance losses. Under this inappropriate, hybrid financial system with its inherent contradictions, the Reefton industry suffered an understandable paucity of capital.

Reorganisation and overseas capital

Gold mining in Reefton then expanded during the economic expansion in New Zealand after 1895 in defiance of gold standard theory, which suggests that it should have contracted. In the 19 years from 1896 to 1914, while New Zealand prices inflated by 63.1 per cent,²¹ gold output at Reefton nearly doubled to an average 38,000 ounces a year as the mining companies produced nearly three-quarters of a million ounces of gold, and paid dividends which averaged more than £50,000 a year. As theory predicted, with its fixed price the real price of gold fell and it became less valuable in

these inflationary times, and the industry's costs should have suffered from the pressures of inflation of prices, however these factors were completely over-ridden by the effects of more dominant forces which were being unleashed concurrently, and the effect of these revolutionary changes was to be predominant for the following several decades.

A complete reorganisation of the Reefton industry occurred in early 1896 with the investment of overseas capital on a massive scale and the introduction of modern management methods, more efficient mining practices and new technology. The benefits of these improvements had greater impact on costs than the inflationary forces arising from the concurrent expansion of the domestic economy. This transformation of the local industry in 1896 was all due to a South African mining investor, David Ziman, who played a pivotal role in this crucial change in the outlook for Reefton.²²

In early 1896, Ziman arranged for overseas capital to be invested in Reefton that was six-times the share market capitalisation of the entire field the year before.²³ Holidaying in New Zealand as a tourist from South Africa, Ziman's first visit to Reefton was in 1895, when it was still depressed.²⁴ Ever alert for possibilities for making money, Ziman immediately recognised the unrealised potential in Reefton. Ziman was a brilliant negotiator, and he soon arranged short term options over most of the productive mines on the field, obtaining them with exercise prices²⁵ which looked extravagant to the locals, but which Ziman knew were modest compared with what the mines could be sold for in London. Denied the promoter's profit that he initially sought in London because of the September 1895 collapse of the Kaffir Circus boom in Rand gold shares on the London Stock Exchange, and the disastrous effect on the market of the subsequent Jameson Raid, Ziman was still able to arrange a substantial float in London with the Rothschilds' operating company, the Exploration Company. A quarter of a million pounds in cash was subscribed to a new company, Consolidated Gold Fields of New Zealand Ltd, to enable it to implement the restructuring and modernisation of the industry in Reefton. Ziman had a founder's share entitling him to a quarter of this company's profit each year once distributed dividends equalled the issued capital.

This strongly financed and well-connected company appointed American experts from the Rocky Mountain mining camps of USA as its management in Reefton, and introduced new methods in management, operation and equipment. The operations of several contiguous mines were merged, with a central treatment plant installed, to achieve cost reductions through economies of scale. After low gold output in the first

couple of years when ore extraction was curtailed so as to develop the mines and establish ore reserves to allow sustainable production at a greatly increased rate, the output from Reefton soared impressively.²⁶ The Consolidated Gold Fields of New Zealand group of companies went on to operate for more than half a century, until finally defeated by inflation in 1951, which resulted in the closing down of the quartz goldmining industry in New Zealand.²⁷

The gold standard explanation of fluctuations in the output of gold implies movements along a stable supply curve caused by changes in the real price of gold. The changes in the real price of gold in New Zealand in the 40 years before 1914 were not inconsiderable due to the substantial variations in inflation and deflation, but the elements peculiar to Reefton were more dominant than the effect of the changes in the real price of gold because they actually resulted in shifts in the gold supply curve.

The accepted economic theory of gold output, which embodies the gold standard scenario, assumes that the output of newly mined gold was responsive to relative prices. This has been questioned in the recent work of Eichengreen and McLean, who cast doubt on the existing statistical estimates of the price elasticity of supply of gold, and conclude that ‘factors other than gold prices had an important bearing on gold production’.²⁸

The history of Reefton, where the effect on output of other factors affecting the industry was more dominant than the effect of fluctuations in the real price of gold, provides an example substantiating this conclusion.

Endnotes

¹ Brian R. Hill, ‘“The Little Man” David Ziman, mining giant: The biography of an entrepreneur,’ PhD thesis, Flinders University, Adelaide 2000, pp. i, 25-30, 324-27.

² The real price of gold is the nominal price of gold deflated by the general price level, or the Consumer Price Index.

³ Leo Katzen, *Gold and the South African Economy. The influence of the goldmining industry on business cycles and economic growth in South Africa, 1886-1961*, Cape Town 1964, p. 2.

⁴ Between 1717 and 1914 the official price of gold in sterling was established as £4.24773 per fine ounce. See Katzen, *Gold and the South African Economy*, p. 2. Gold produced in Reefton was 976 fine, or 1.424 carats above standard 22 carats, and it was worth an averaged £4.2.10d an ounce. See ‘Mines Minister’s Statement’, *Journals of the House of Representatives* [hereafter *AJHR*] C-2 Papers, *Mines Statements* 1891, Wellington, 1891, p. 8. The New Zealand pound and the British pound sterling were interchangeable and had the same value in the period under review.

⁵ Patrick Bertola, ‘Kalgoorlie, Gold, and the World Economy, 1893-1972’, PhD thesis, Curtin University of Technology, Perth 1993, pp. 10-11.

⁶ *Ibid.*, ‘Table I.’

⁷ J.M. Barry, *The History and Mineral Resources of the Reefton Goldfield. Resource Information Report 15*, Wellington, 1993, p. 2.

⁸ One ounce in 60 of all the gold estimated to have been produced in the world has been mined in New Zealand, which ranks 13th in gold-producing countries. See Hill, 'David Ziman', p. xix.

⁹ The records are incomplete. Dividends paid in 1880 were not recorded, although 22,620 ounces of gold were produced that year. See table 'Reefton Returns,' in Appendix I.

¹⁰ A national scheme of borrowing, immigration and public works launched by the New Zealand Prime Minister, Julius Vogel, unleashed an overseas borrowing spree by the New Zealand government to finance the provision of infrastructure and railroad building. The expenditure of this borrowed capital triggered an inflationary boom in the 1870s.

¹¹ See table 'Price inflation and deflation in New Zealand,' in Appendix II.

¹² *Ibid.*

¹³ See table 'Reefton Returns,' in Appendix I. Although they were established as limited liability companies, not only had the Reefton companies adopted the no liability company practice of issuing partly paid contributing shares, with the capital called up in instalments, but they had also copied the Cornish cost book system of distributing all profits as dividends and then relying upon the payment of calls to bankroll losses, and to finance development work.

¹⁴ Some of the deepest shafts in New Zealand were sunk on the Reefton mines, with shafts as deep as 878 metres, penetrating hundreds of metres below sea level. See, Darrell Latham, 'Mining Statistics. Depths of Principal Shafts. Reefton District', *The Golden Reefs. An account of the Great Days of Quartz-Mining at Reefton, Waiuta and Lyell*, Christchurch 1984, 2nd rev. edn 1992, p. 306.

¹⁵ Barry, *History and Mineral Resources*, p. 11.

¹⁶ J.F. Downey, *Quartz Reefs of the West Coast Mining District, New Zealand*, Wellington, 1928, p. 56.

¹⁷ The reliance upon accepted local custom in Reefton and the refusal to consider any technical advances resulted in technological inertia. The Mines Department annual reports frequently lambasted the backwardness of the local mines' management.

¹⁸ Although the cyanide process, which had been invented in 1887, was introduced to New Zealand in 1889, it was not adopted in Reefton until the late 1890s. There had been some earlier use of the more expensive chlorination method of treating gravity concentrates recovered from some of the tailings.

¹⁹ Ralph W. Birrell, *Staking a Claim. Gold and Development of Victorian Mining Law*, Melbourne, 1998, pp. 98-99; and Richard D. Morris, 'The Origins of the No-Liability Mining Company and its Accounting Regulations,' in T.E. Cooke and C.W. Nobes, (eds), *The Development of Accounting in an International Context: a festschrift in honour of R.H. Parker*, London 1997, pp 90-120.

²⁰ 'Joint Stock Companies Act, 1860,' in *Statutes of New Zealand, 1860*, Auckland 1860, pp. 53-94.

²¹ *Ibid.*, table 'Price inflation and deflation in New Zealand,' Appendix II.

²² Born in Russian Poland in 1862, Ziman had fled Russia while a teenager to escape the oppression of Jews there. Initially a trader of ostrich feathers in the Cape Colony, Ziman was a founding broker of the Johannesburg Stock Exchange in South Africa in 1888. He was bankrupted by the collapse of the first boom in Rand gold shares in 1890, but with adroit trading he soon restored his wealth. See, Latham, 'Mining Statistics', pp. 212-15; and also a biography of Ziman in Hill, 'David Ziman'.

²³ In May 1895, when Ziman first visited Reefton, because of the slump there, the market capitalisation of all the local mining companies on the Reefton stock exchange was only £42,400, even though these companies had distributed dividends totalling almost £500,000 in the previous 20 years.

²⁴ Ziman was on a holiday in New Zealand to visit his wife's family who lived in Wellington when he was induced to visit the languishing West Coast gold field by the Prime Minister, Richard Seddon, who drew Ziman's attention to the possibilities for investment in the depressed industry there.

²⁵ An 'Exercise price' is the strike price of an option, which is the price at which the option can be exercised. For a technical discussion of mine options, see, Jesse Hoover, *The Economics of Mining*, Stanford, 1933, pp. 25-29, 369.

²⁶ See table 'Reefton Returns,' in Appendix I.

²⁷ Ziman's company floated several satellite companies to operate various mines that Ziman had acquired in Reefton. The successful promotion of Consolidated Gold Fields of New Zealand by Ziman with the Rothschilds triggered a mining boom in New Zealand as other promoters were galvanised to float New Zealand mining companies in London. Only six of the 162 goldmining companies formed in London at that time to operate in New Zealand ever paid dividends exceeding their capital, and three of these were companies in Ziman's Consolidated Gold Fields of New Zealand group of companies.

²⁸ Barry Eichengreen, and Ian W. McLean, 'The supply of gold under the pre-1914 gold standard', *Economic History Review*, vol. XLVII, no. 2, 1994, p. 289.

Appendix I

Reefton Returns: *Statement of the comparative annual returns of all the mines in the Reefton District, 1873-1914.*

Years	Calls made £	Divs. declared £	Quartz crushed Tons	Yield of Gold Oz.	Value of Gold £
1873	n/a	n/a	6,490	6,779	n/a
1874	n/a	n/a	16,223	15,542	n/a
1875	n/a	12,944	22,810	18,340	n/a
1876	n/a	27,510	33,064	24,278	n/a
1877	n/a	50,613	33,969	30,628	n/a
1878	n/a	41,967	36,691	63,508	n/a
1879	n/a	22,465	28,070	26,000	n/a
1880	n/a	n/a	n/a	22,620	n/a
1873-1880	n/a	**£155,482	177,317	207,695	n/a
1881	10,219	19,650	29,926	17,598	68,630
1882	25,504	37,643	14,894	20,154	78,600
1883	64,345	32,600	18,928	19,194	74,857
1884	49,456	16,500	23,433	16,547	64,533
1885	29,333	34,100	34,349	23,997	93,588
1886	24,565	14,500	27,198	14,591	56,905
1887	21,596	33,450	23,930	21,143	83,172
1888	30,432	17,550	24,403	16,775	66,030
1889	38,919	16,688	28,564	18,663	72,720
1890	27,531	18,250	32,394	17,780	69,677
1891	20,404	27,325	39,643	23,347	91,998
1892	25,956	30,743	35,562	23,390	95,885
1893	18,800	16,900	37,693	20,171	80,894
1894	14,350	18,832	34,518	18,413	73,753
1895	10,153	11,012	26,602	13,426	53,509
1896	8,418	25,925	29,816	22,025	87,936
1897	9,033	4,900	13,270	8,365	33,824
1898	7,859	50	9,751	4,266	18,253
1899	5,920	900	42,305	21,488	87,587
1900	10,747	47,050	58,277	26,693	108,456
1901	12,059	93,499	180,488	80,055	321,276
1902	6,900	48,475	98,485	46,561	188,655
1903	4,587	57,641	109,571	58,840	195,469
1904	5,262	54,674	113,375	49,694	215,996
1905	3,870	55,343	106,150	44,091	177,463
1906	1,996	57,826	96,246	40,295	156,168
1881-1906	£488,216	£792,026	1,285,771	687,555	£2,715,839
1907	n/a	n/a	95,112	n/a	152,355
1908	n/a	n/a	91,037	n/a	151,098
1909	n/a	n/a	101,127	53,120	201,971
1910	n/a	n/a	121,105	59,791	229,314
1911	n/a	n/a	126,067	57,259	222,840
1912	n/a	n/a	49,922	28,004	107,033
1913	n/a	n/a	116,813	49,779	166,278
1914	n/a	n/a	131,848	58,150	230,353
1907-1920	n/a	n/a	833,031	**306,103	**£1,461,242
1873-1920	*£488,216	**£947,508	**2,296,119	**1,201,353	**£4,751,928

Sources: The figures for 1873 to 1880 have been gleaned from the 'Reefton Warden's Report' in each year's 'Mines Statement', *Journals of the House of Representatives [AJHR]*, C-3A papers. The period from 1881 to 1906 was tabulated in 'Warden's Report, Greymouth,' *AJHR*, C-3A papers, *Mines Statement* 1907, p. 53. The figures for 1907 to 1914 were extracted from each year's *Mines Statement*, 'Table 3: Statement showing quantity of quartz crushed and gold obtained,' *AJHR*, C-2 papers.

Notes: **Incomplete because unfortunately, the same statistical records were not reported each year.

1901 is an extended period incorporating 21 months. During this year the reporting date was extended to 31st December from 31st March. All years before 1901 are reported for the twelve months to 31st March and all subsequent years for the twelve months to 31st December.

After its earlier bonanza period in the 1870s, Reefton was in slump from 1883 to 1895, with the dividends paid being exceeded by calls made in 1883, 1884, 1886, 1888-1890, and 1893.

Output was down sharply in the period from 1897-1899, as the companies in Ziman's Consolidated Gold Fields of New Zealand group curtailed production to concentrate on establishing ore reserves, and developing their mines for increased rates of production. At the end of the nineteenth century, Ziman's companies introduced cyanidation to recover gold previously lost in the tailings. The returns from 1900 on, not only reveal the expanded output, but also confirm the improved results obtained: a higher percentage of the gold value produced was paid as dividends after 1900 compared with the earlier years.

The Blackwater mine, which became the second biggest gold producer in New Zealand, commenced production in 1908.

The field's output in 1912 was affected by a six months' strike in Consolidated Gold Fields of New Zealand group's Reefton mines, including the Blackwater.

Appendix II

The estimated annual rates of price inflation and deflation in New Zealand each year in the period, 1873-1914.

CPI calendar average (A%)							
1873	(3.8)	1884	(4.6)	1895	0.0	1905	2.7
1874	n/a	1885	(7.0)	1896	3.0	1906	n/a
1875	(3.9)	1886	(7.2)	1897	n/a	1907	n/a
1876	2.0	1887	(7.5)	1898	n/a	1908	n/a
1877	0.0	1888	(5.1)	1899	(2.9)	1909	n/a
1878	2.1	1889	(2.7)	1900	3.0	1910	2.6
1879	(16.3)	1890	n/a	1901	5.9	1911	n/a
1880	4.6	1891	4.2	1902	2.8	1912	5.1
1881	3.6	1892	n/a	1903	n/a	1913	2.4
1882	2.3	1893	0.0	1904	N/a	1914	5.3
1883	(2.3)	1894	(2.9)				

Source: D. Brash, Reserve Bank of New Zealand, Wellington, personal communication, 2000. The figures are unofficial estimates by the Reserve Bank. Only after 1914 did Statistics New Zealand publish an official quarterly Consumer Price Index series.

Notes: Numbers in parentheses are negative numbers denoting deflation.

Cumulative figures for the period 1873-1882 are 2.7 per cent, 1882-1895, 30.5 per cent, and 1895-1914, 63.1 per cent. These figures must be treated with some caution, because where no figure is available because the Reserve Bank has not been able to make an estimate, I have taken the mean between the figures for the preceding and following years as the figure for that year in order to calculate an estimate of the cumulative inflation or deflation for the period.