Review of Income and Wealth
Series 38, Number 4, December 1992

REVISED REAL CANADIAN GNP ESTIMATES AND CANADIAN ECONOMIC GROWTH, 1870-1926

BY MORRIS ALTMAN

University of Saskatchewan

Revised Canadian real GNP estimates for the 1870-1926 period, based on the nominal GNP estimates constructed by M. C. Urquhart and on a variety of sector-specific price indexes, are presented below. The construction of this revised real GNP series allows for the creation of real output estimates for the major sectors of the Canadian economy as well as for a new implicit price index series. These revised estimates cast new light on our present understanding of Canadian economic growth and reinforce the view that the Canadian wheat boom probably played an important and positive role in the process of Canadian economic development.

1. INTRODUCTION

A new Canadian nominal GNP series has been recently constructed for the 1870-1926 period by M. C. Urquhart (1986) in association with Alan Green, M. C. McInnis, Thomas Rymes, Alasdair Sinclair, and Marion Steel. Urquhart deflates this series largely with a cost of living index to generate a new real GNP series for the 1870-1926 period. These new real GNP estimates mark an important improvement over the earlier estimates developed by Firestone (1958) due to the greater number of data sets which comprise the Urquhart nominal GNP estimates and the more rigorous manner in which they are constructed. This is particularly true of the estimates for the intercensal years (Dales, 1986).[1]

In this article, a new set of *real* GNP estimates are produced, which build on Urquhart's *nominal* GNP estimates.[2] Serious deficiencies are found to exist

Note: The author thanks Edward Wolff, the anonymous referees, and Louise Lamontagne for their helpful comments and suggestions.

[1]Urquhart (1986) is not clear as to how his nominal estimates differ from Firestone's. However, it is clear from Firestone (1958, pp. 277-280), that his real GNP estimates, particularly from 1870 to 1910 are spurious, being based on backward interpolations from his 1910 real GNP estimate. The 1870-1910 series is derived from a weighted series for the volume of wheat, fish, potatoes, coal, tea, coffee, sugar, raw wool, and tobacco produced net of exports minus imports, plus the number of passengers carried by steam railways. Also used are estimates of government expenditures, exports and imports, and estimates of the apparent consumption of construction material. In effect, Firestone produces no nominal GNP estimates for the 1870-1910 period. His estimates for the later period are based on adjusted estimates of other scholars. Finally, detailed estimates upon which Firestone's aggregate real GNP estimates are based remain unpublished and are apparently lost. These factors have precluded any serious use of the Firestone series over the years. In contrast, important components of the Urquhart series have been published (Urquhart, 1986; Green, 1986; McInnis, 1986). Also, Urquhart's interpolators for intercensal years appear to be more extensive than those used by Firestone (1986, pp. 69-71) and, many of these are published. As with Firestone, the most rigorous estimates of the Urquhart series are for the census years, 1870-71, 1880-81, 1890-91, 1900-01, 1910-11, 1920-21. For some insight into the basis of the differences between the Urquhart and the Firestone GNP series see McInnis, (1986, pp. 738-741).

[2]Table 1 presents the new real annual GNP estimates as well as the new annual implicit price index for the 1870-1926 period. The 1927-1930 series is taken from Urquhart (1988, pp. 9-11), which is, in turn, taken from Statistics Canada files. Urquhart's real GNP estimates are from (Urquhart, 1986, pp. 30-31). Urquhart's nominal GNP estimates are presented in Urquhart (1986, pp. 11-15).

with the price index numbers used by Urquhart to deflate his nominal GNP estimates. This raises some questions as to their capacity to reflect movements and levels in the actual prices of the components of Urquhart's nominal GNP estimates. Therefore, an alternative set of price index numbers, built largely on available wholesale price index numbers, are constructed to deflate nominal GNP.

The revised real GNP estimates provide a basis for revisions and additions to Urquhart's growth estimates and to his estimates for the structure of the Canadian economy over the 1870–1926 period. These new estimates shed further light on the much debated question of whether there was a positive break in the Canadian economy which coincided with the Canadian wheat boom, circa 1896–1913. In particular, the revised real GNP estimates indicate more forcefully than do Urquhart's that the period of the wheat boom did indeed represent an important positive break in the economic development of Canada and that the Canadian economy was, by all measures, the fastest growing of all "western" economies in the 1870–1910 period.[3] Also, the revised real GNP estimates yield new implicit price deflators which differ in important ways from Urquhart's. Finally, in the process of constructing the revised real GNP estimates, new real output estimates are provided for many of the important components of Urquhart's nominal GNP series, including the all important manufacturing sector.[4]

II. The Revised Real GNP Estimates

Urquhart deflates his nominal GNP estimates *net* of gross domestic fixed capital formation (GDCF) using three sets of cost of living price indexes, one each for the 1870–1900, 1900–1913, and 1913–26 periods respectively (Urquhart, 1986, pp. 29, 85–87). Gross domestic capital formation is deflated using a price index for the cost of capital goods. GDCF is estimated, from Urquhart (1986, pp. 33–34), to represent about 15 percent of nominal GNP, with the significant exception of the 1906–14 period, where it represented, on average, 25.5 percent of GNP. Therefore, in Urquhart's general GNP deflator, the price index for the cost of capital goods is, in effect, given a weight of about 15 percent whereas the cost of living price index is given the weight of the residual GNP, about 85 percent.

The price index numbers used by Urquhart for the years 1870 to 1910 are plagued by serious problems. For the 1870–1900 period the Barnett consumer price index is used. This price index is built on price data from the Kingston, Ontario area alone and contains no data on rents and clothing (Urquhart, 1986, pp. 85–86; Barnett, 1963). For the period 1900 to 1913 the Bertram–Percy consumer price index is used. However, for the years 1901–1904 and 1906–1908, the price index numbers for this series consist of interpolations from expenditure-based weighted wholesale price index numbers for food, fuel and light, rent, and clothing for the years 1900, 1905 and 1909 (Urquhart, 1986, pp. 85–86; Bertram

[3]See Pomfret (1981) and Altman (1987) for a discussion of some of the debates surrounding the question of the significance of the wheat boom to Canadian economic growth. See Maddison (1989, pp. 44–45), for comparative growth estimates of what are today's advanced industrial economies.

[4]Space limitations preclude all but a presentation of new real componant output estimates and the price index numbers used in their construction for sample years only (see Table 2). The years chosen are largely census years which form the basis of most of my growth estimates (see Table 3). For the complete series see Altman (1989).

and Percy, 1979). For the period 1913–26 a much more rigorously constructed cost of living index is used. For these years data on rents, food, clothing, fuel and light, and miscellaneous expenses are incorporated. However, the weights assigned to these categories and to the price data within each category are based on the consumption of the relevant commodities in the year 1913 (Urquhart and Buckley, 1966, p. 288), and not on the component distribution of nominal output in Urquhart's nominal GNP series.

Given the many problems with the cost of living index used by Urquhart, in particular the components of his index are not representative of the components of his nominal GNP series, it is fair to ask whether GNP price deflators based upon the prices of the *actual* components of nominal GNP would yield different real GNP estimates and, thereby, different growth and structural change estimates from those yielded by Urquhart's composite price index numbers.[5] For this reason, price index numbers for manufacturing, transportation, and construction are developed for this article to deflate Urquhart's nominal output estimates for these components of GNP while the Dominion Bureau of Statistics' (DBS) sector wholesale price index numbers for mining, fishing, and forestry are used to deflate Urquhart's nominal estimates for mining, fishing, and forestry. Output estimates for the wholesale and retail trade are deflated using the DBS' sector price index numbers for this sector. Finally, Marvin McInnis' nominal agricultural output estimates (which form part of Urquhart's nominal GNP estimates) plus his price index for agriculture, converted to the appropriate base year, are used to generate real agriculture output estimates (Altman, 1989).

The residual output, which varied at about 30 percent of nominal GNP for most of the 1870–1926 period, is deflated using Urquhart's composite price index numbers.[6] This deflation procedure yields real GNP estimates and implicit price index numbers which differ from Urquhart's (see Table 1 and Figures One to Four). In effect, the new set of GNP deflators is composed of weighted price index numbers constructed by weighting the different price index numbers used in this article by their respective outputs' contribution to nominal GNP. In contrast, Urquhart deflates the output of each and every component of GNP by the same composite price index numbers.

The manufacturing component of Urquhart's nominal GNP estimates is composed of manufacturing value added estimates which consistently contributed approximately 20 percent to total nominal GNP throughout the 1870–1926 period. The manufacturing value added consists of the value added of seventeen sectors (Urquhart, 1986, pp. 54–59). I deflate each sector's value added largely using sector-specific wholesale price index data provided by the DBS (Urquhart and Buckley, 1965, series J34–44, pp. 293–294) brought to a 1900 base year, the base year adopted by Urquhart (1986). My annual real manufacturing value added

[5]In Altman (1987), a similar question is posed with respect to Bertram's (1964) deflation of nominal manufacturing output estimates. Bertram (1964) deflates these nominal estimates using sector specific output deflators *unweighted* for each sector's contribution to total output. When these deflators are appropriately weighted and then applied to deflate the nominal output estimates, the real output estimates generated thereby differ considerably from Bertram's.

[6]The share of the residual in nominal GNP is derived from Urquhart (1988, Table 2.1).

TABLE 1

CANADIAN GROSS NATIONAL PRODUCT AND IMPLICIT PRICE INDEXES; 1900 PRICES ($000)

	Urq GNP	Revised real GNP		Implicit price index		
	Real	variant A	variant B	Urq	New A	New B
1870	369,500	328,053	328,053	1.04	1.17	1.17
1871	385,900	345,454	342,686	1.07	1.20	1.20
1872	382,800	351,573	346,149	1.17	1.29	1.27
1873	419,300	390,046	381,007	1.16	1.28	1.25
1874	427,800	396,132	387,974	1.13	1.25	1.23
1875	417,100	371,745	368,632	1.08	1.22	1.22
1876	391,100	360,928	363,519	1.08	1.16	1.17
1877	416,500	389,488	391,781	1.04	1.11	1.12
1878	402,600	371,636	380,134	1.02	1.08	1.10
1879	441,800	429,138	433,498	1.01	1.03	1.04
1880	462,100	446,193	446,193	1.04	1.08	1.08
1881	527,000	529,788	519,630	1.08	1.09	1.07
1882	547,200	544,068	530,051	1.13	1.17	1.14
1883	545,700	539,886	528,788	1.12	1.16	1.13
1884	592,000	538,087	532,757	0.99	1.10	1.09
1885	556,300	530,337	533,920	1.00	1.04	1.05
1886	559,400	547,721	554,204	1.00	1.01	1.02
1887	579,000	591,093	592,020	1.06	1.03	1.03
1888	616,100	591,733	593,302	1.02	1.06	1.06
1889	620,900	608,135	609,099	1.06	1.08	1.08
1890	657,400	649,102	649,102	1.04	1.06	1.06
1891	679,900	666,670	666,761	1.04	1.06	1.06
1892	676,200	668,567	673,331	1.04	1.04	1.05
1893	666,900	654,175	667,094	1.02	1.02	1.04
1894	700,600	635,553	662,625	0.93	0.98	1.02
1895	698,900	631,326	669,823	0.91	0.95	1.00
1896	680,700	649,313	690,439	0.94	0.93	0.99
1897	757,200	765,363	791,987	0.95	0.90	0.94
1898	786,500	802,687	821,766	0.98	0.93	0.96
1899	857,800	853,015	865,006	0.96	0.95	0.97
1900	907,800	907,000	906,999	1.00	1.00	1.00
1901	984,100	996,284	994,548	1.01	1.00	0.99
1902	1,073,600	1,104,860	1,094,381	1.04	1.02	1.01
1903	1,115,100	1,123,147	1,118,309	1.06	1.05	1.05
1904	1,131,400	1,115,396	1,123,461	1.07	1.07	1.08
1905	1,248,200	1,270,020	1,268,193	1.09	1.07	1.07
1906	1,380,600	1,395,296	1,384,390	1.11	1.10	1.09
1907	1,456,000	1,533,787	1,510,639	1.19	1.15	1.13
1908	1,383,300	1,410,138	1,422,007	1.20	1.16	1.17
1909	1,520,400	1,575,188	1,579,863	1.21	1.16	1.17
1910	1,655,400	1,715,388	1,715,388	1.22	1.18	1.18
1911	1,770,700	1,849,412	1,846,746	1.26	1.21	1.21
1912	1,905,400	2,049,816	2,039,695	1.28	1.22	1.22
1913	1,979,800	2,138,683	2,140,311	1.34	1.24	1.24
1914	1,835,600	1,889,105	1,965,166	1.33	1.24	1.30
1915	1,964,400	1,948,041	2,026,454	1.37	1.33	1.38
1916	2,182,500	2,202,635	2,236,962	1.49	1.45	1.47
1917	2,273,200	2,252,187	2,236,502	1.76	1.79	1.77
1918	2,141,400	2,103,412	2,098,946	1.99	2.03	2.03
1919	1,994,900	1,985,938	2,006,591	2.19	2.18	2.20
1920	1,992,000	2,001,163	2,001,163	2.54	2.53	2.53
1921	1,800,300	1,804,558	1,898,715	2.26	2.14	2.26
1922	2,060,900	2,182,030	2,273,840	2.05	1.85	1.94
1923	2,194,000	2,415,103	2,477,084	2.08	1.83	1.89

TABLE 1—continued
CANADIAN GROSS NATIONAL PRODUCT AND IMPLICIT PRICE INDEXES; 1900 PRICES ($000)

	Urq GNP	Revised real GNP		Implicit price index		
	Real	variant A	variant B	Urq	New A	New B
1924	2,210,100	2,410,468	2,485,018	2.04	1.80	1.87
1925	2,450,300	2,619,524	2,648,298	2.04	1.88	1.91
1926	2,611,800	2,848,858	2,848,858	2.05	1.88	1.88
1927	2,851,795	3,124,157	3,124,157	1.95	1.78	1.78
1928	3,118,557	3,418,079	3,418,079	1.94	1.77	1.77
1929	3,132,143	3,429,609	3,429,609	1.96	1.79	1.79
1930	2,994,764	3,268,571	3,268,571	1.91	1.75	1.75

Sources and notes: See text.

estimates comprise the sum of the sector real value added estimates.[7] Alternatively, one can deflate value added by deflating gross outputs and inputs by separate deflators and, thereafter, subtracting the resulting constant dollar input estimates from the constant dollar gross output estimates. It remains unclear which approach is more accurate given imperfect price data (Altman, 1987, p. 99). However, presently available price data for the entire 1870–1926 period makes the former deflation procedure the most appropriate.[8]

My real transportation sector output estimates are generated by deflating Urquhart's nominal transportation sector output, which accounts for about 5 to 8 percent of nominal GNP, using price data for freight and passenger rail transportation (see Table 2). Apparently this sector's output consists entirely of railway output (Urquhart, 1986, p. 66).[9] Thus, the railway sector based deflator is the appropriate one. This deflator is constructed from data on passenger and freight rates per mile produced by Green (1986, p. 811) for the period 1875–1926 and from data on railway revenue derived from freight and passenger services in Urquhart and Buckley (1965, series S53–63, p. 530 and series S129–144, p. 537). The percentage distribution of total railway revenue between freight and passenger related services serves as weights for the price data of these two services, generating weighted average prices for freight and passenger services. The resulting series of average prices for the period 1875–1926 is converted to price index numbers

[7]I also use Michell's hides and leather price index numbers (Urquhart and Buckley, 1965, series J8, p. 291) to deflate leather sector value added. Food and beverage value added is deflated by weighted averages of the DBS's vegetable products and animals and their products price index numbers (Urquhart and Buckley, 1965, series J36 and J37, pp. 293–294). The weights assigned to each set of index numbers are derived from my census data estimates of the percentage contribution of vegetable products and animal related products to food and beverages value added. The weights are: 6.9 and 93.1 percent, 1871; 8.9 and 91.1 percent, 1881; 15.1 and 84.9 percent, 1891; 26.8 and 73.2 percent, 1901; 24.9 and 75.1 percent, 1911; and 41.1 and 58.9 percent, 1921, respectively. The 1921 weights are applied to the 1926 estimates. These weights are used to interpolate weights for the intercensal years. See Altman (1989) for detailed annual sector price deflators and real value added estimates. See also, Altman (1987).

[8]Elsewhere (ibid.), both deflation techniques are used since the construction of constant dollar output estimates is restricted to the census years 1871, 1881, 1891, 1901, 1911 only.

[9]Urquhart's (1986, Table 2.1) estimates for transportation output deviate only marginally from Green's (1986, p. 791) estimates for income plus gross fixed capital formation in the railway sector.

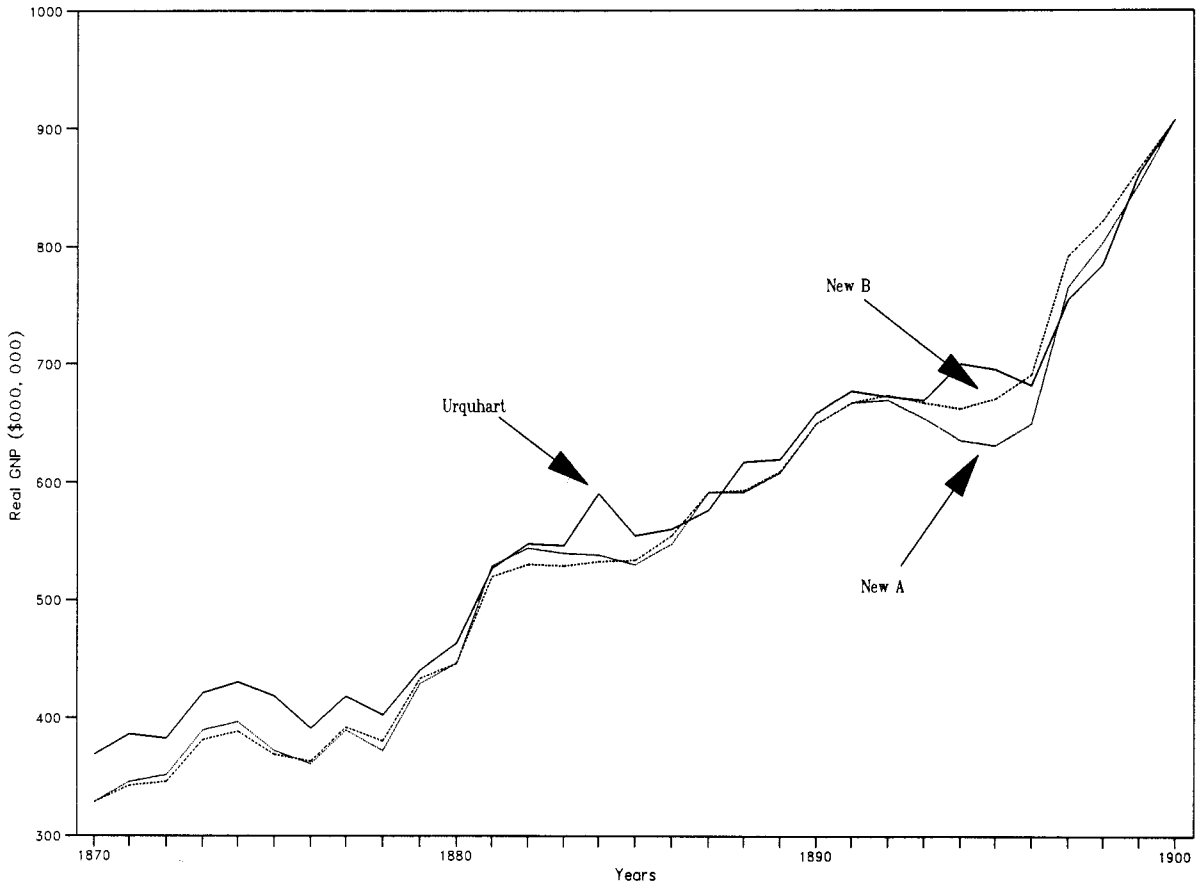

Figure 1. Real GNP, 1870-1900

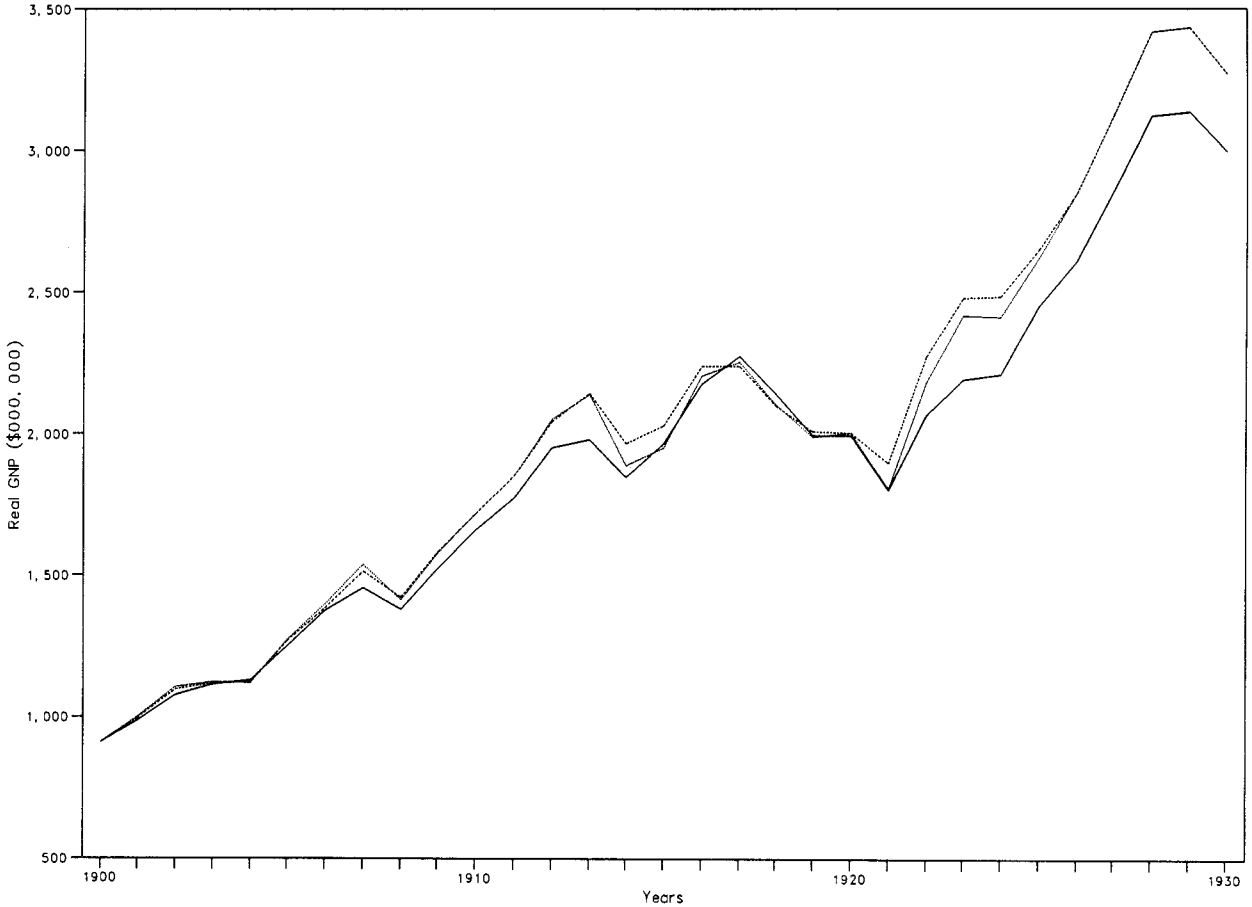

Figure 2. Real GNP, 1900–1930

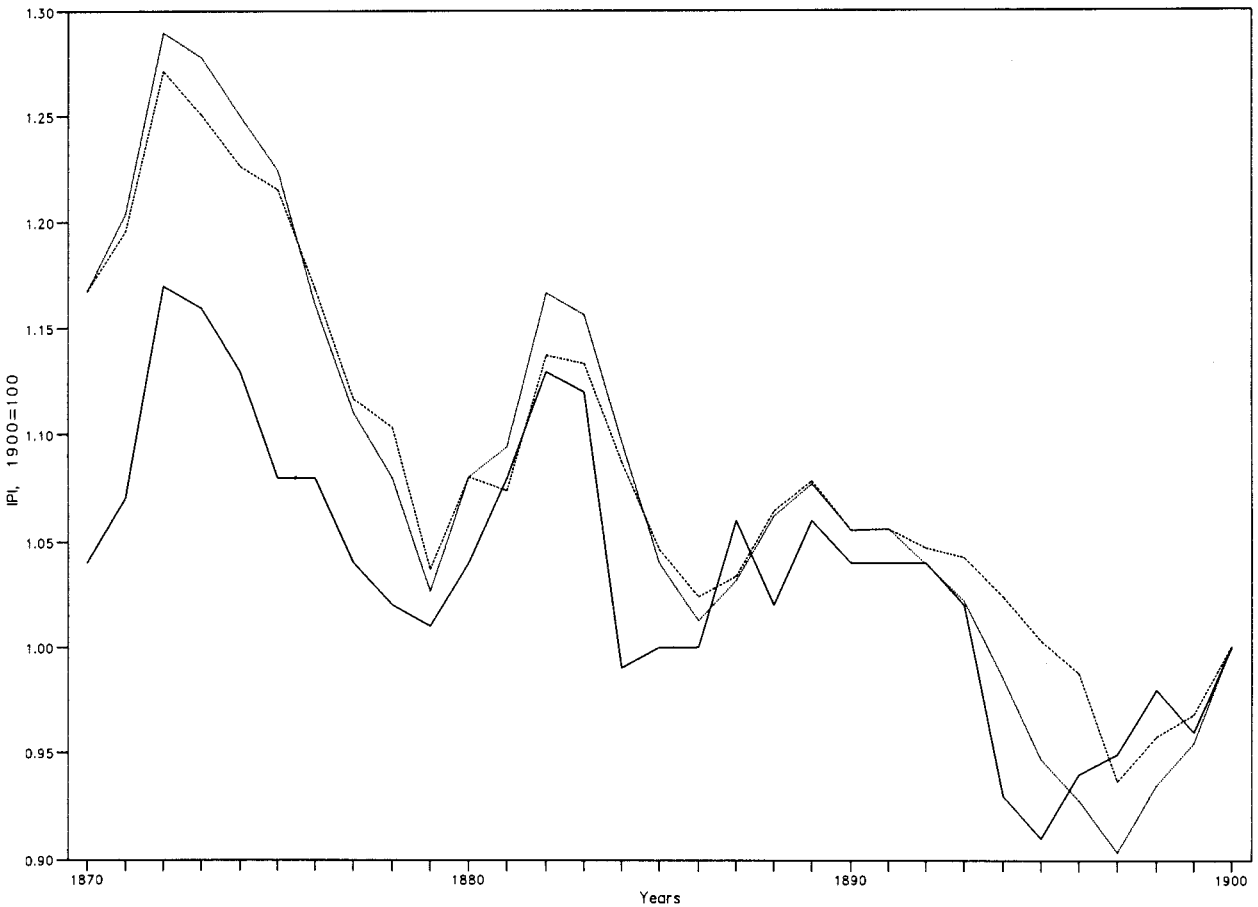

Figure 3. IPI, 1870–1900

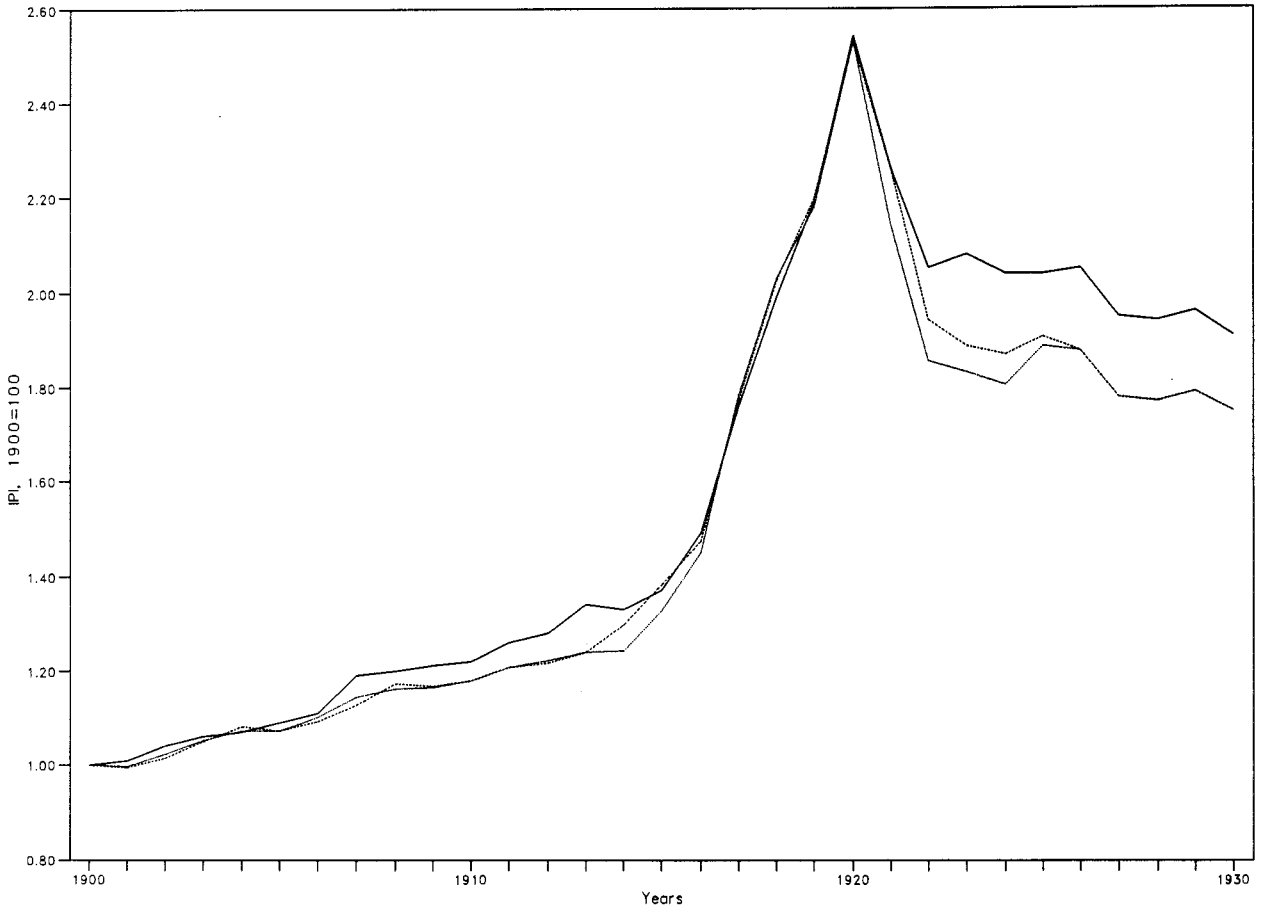

Figure 4. IPI, 1900–1930

with a 1900 base year. These index numbers serve as our deflators of Urquhart's nominal transportation sector output. Since price data are not available for 1870 to 1874, hypothetical price index numbers are constructed for the years 1870 to 1874 inclusive. I regress the transportation price index for the period 1875–1885 on Urquhart's implicit GNP price index for this period and assume that the statistical relationship between these two variables found to exist in this period existed in the 1870–1874 period as well. This yields hypothetical transportation price index numbers for the latter period.[10] This, in turn, yields constant dollar hypothetical transportation output estimates for the 1870–1874 period.

TABLE 2

COMPONENTS OF THE CANADIAN REAL GNP (SELECTED YEARS)

	1871	1881	1891	1896	1901	1911	1913	1921	1925
Manufacturing									
New	80,421	120,651	172,503	156,859	206,353	418,651	444,750	417,707	512,019
Urquhart	83,557	113,818	165,873	147,607	201,922	372,671	386,411	386,273	467,597
Railroad									
New	9,002	14,337	28,647	39,138	64,317	195,689	283,414	267,099	344,335
Urquhart	21,130	25,860	38,308	46,264	63,162	138,774	184,082	153,977	180,874
Mining									
New	3,860	4,855	14,971	19,625	48,766	61,343	80,558	68,385	88,898
Urquhart	5,004	5,004	14,163	17,553	47,448	45,259	61,122	50,964	64,958
Construction									
New	17,302	21,240	32,796	21,856	41,486	131,149	150,091	69,014	90,922
Urquhart	19,630	20,748	29,989	21,275	40,500	141,454	163,868	77,625	97,162
Forestry									
New	9,651	10,374	11,796	13,749	14,542	16,390	15,450	11,821	26,353
Urquhart	6,505	7,336	10,678	12,938	14,296	19,894	18,165	16,677	32,353
Fishing									
New	3,937	9,546	9,149	9,928	12,340	11,530	10,881	10,362	12,216
Urquhart	3,142	6,461	8,348	10,435	12,035	12,793	11,969	8,459	11,725
Agriculture									
New	111,184	175,912	170,881	168,375	246,703	348,753	388,359	247,992	476,512
Urquhart	135,777	182,427	181,835	167,181	241,004	372,741	386,427	299,931	485,855
Wholesale & retail output									
Nominal	23,389	38,735	54,142	42,853	74,241	222,653	255,926	328,998	480,643
New	17,952	33,385	50,349	47,836	72,726	171,314	191,485	143,162	224,156
Urquhart	21,859	35,866	52,059	45,588	73,506	176,709	190,990	145,574	235,609
Community, business, & personal service									
Nominal	28,988	44,615	62,170	52,461	90,326	160,763	182,938	231,325	296,768
New	27,091	41,310	59,779	55,809	89,431	127,589	136,521	102,356	145,474

Sources and notes: See text.

[10]The following equation is applied:

[Transportation price index = constant + b(Urquhart price index)].

The constant equals 1.5483 and b equals 0.5219. One could have used the DBS' (Urquhart and Buckley, 1965, series J34–44, p. 294) unweighted general wholesale price index as an independent variable as opposed to Urquhart's price index. The resulting hypothetical real transportation output estimates are similar to those presented here.

Nominal construction sector output, which contributed less than 5 percent to nominal GNP for most years in the 1870–1926 period (from Urquhart, 1986, pp. 11–15), is deflated using price index numbers which I construct from estimates for industry-specific construction price index numbers and for industry-specific current dollar nonresidential investment expenditure published by Statistics Canada (1978). Appropriate estimates are available for 27 industries. The price index numbers are weighted in accordance with the percentage distribution of nonresidential investment expenditure among the 27 industries. This yields weighted average price index numbers for the construction industry which are converted to a 1900 base year (Altman, 1989). These index numbers are used to generate real construction output estimates (see Table 2).

I deflate the nominal output of the forestry sector (see Table 2), which contributed less than 5 percent to nominal GNP (from Urquhart, 1986, pp. 11–15), using the DBS' wholesale price index numbers for wood, wood products, and paper (Urquhart and Buckley, 1965, series J39, pp. 293–294). Nominal fishing output (see Table 2), which was of even less importance to total nominal GNP, is deflated using Michell's (Urquhart and Buckley, 1965, series J5, p. 291) wholesale price index numbers for fish. With the exception of the late 1890s and the early 1900s, the mining sector (see Table 2) contributed less than 5 percent to total nominal GNP. I deflate this sector's nominal output using unweighted average price index numbers which I construct from the DBS' wholesale price index numbers for iron and its products, nonferrous metals and their products, and nonmetallic minerals and their products (Urquhart and Buckley, 1965, series J40–41, and J43, pp. 293–294).

Finally, I deflate the wholesale and retail trade's nominal output, which contributed between 7 and 10 percent to nominal GNP (from Urquhart, 1986, pp. 11–15), using the DBS' wholesale price index numbers for the period 1870–1926 (Urquhart and Buckley, 1965, series J34, pp. 293–294) which are converted to a 1900 base year.[11] However, Urquhart did not publish the nominal output estimates for this sector nor for the community, business, and personal service sector estimates (Urquhart, 1986, pp. 11–15). These are the only sectors for which Urquhart only presents estimates for the census years. One can infer what Urquhart's intercensal output estimates for these two sectors *combined* are by subtracting his published sector output estimates from his nominal GNP estimates. However, to deflate annual estimates for the wholesale and retail trade alone it is necessary to construct nominal estimates for both this sector and the community, business, and personal service sector.

To construct such nominal output estimates, I assume that the percentage deviation of "actual" from trend nominal output in these two sectors for the 1870–1926 period, is the same as the percentage deviation of "actual" from trend nominal GNP, net of the nominal output in these sectors.[12] The trend values for

[11]See Urquhart and Buckley (1965, pp. 281–283), for a discussion of the construction of these price index numbers.

[12]Urquhart (1986, p. 10) does not specify the method by which he constructs the nominal estimates for these two sectors. He only points out that no satisfactory annual interpolators exist for these sectors. The approach adopted in this study to estimate the intercensal nominal output for these sectors yields numbers which, when added to Urquhart's other sector-specific annual estimates, generate Urquhart's GNP at market prices.

these two sectors and for net GNP are derived by log-linear interpolation through the bench-mark years. Bench-mark years of 1870, 1880, 1890, 1900, 1910, 1920, and 1926 are chosen since these are the only years for which relatively solid nominal output estimates exist for the wholesale and retail trade sector and for the community, business, and personal service sector. The difference between the log of actual and the log of trend net GNP is the percentage deviation of the actual from the trend values. Applying this percentage to the trend values for the wholesale and retail trade sector and for the community, business, and personal service sector for the 1870–1926 period yields intercensal nominal output estimates for these two sectors. These nominal output estimates, when added to Urquhart's intercensal nominal estimates for the other sectors of the economy, yield my adjusted nominal GNP estimates which are little different from Urquhart's nominal GNP at market prices. The differences which exist between these two sets of nominal GNP estimates are a product of my combined estimates for the wholesale and retail trade sector and for the community, business, and personal service sector differing from the estimates for these sectors inferred from Urquhart's published nominal output estimates.[13]

The marginal differences between my adjusted nominal GNP estimates at market prices and Urquhart's nominal GNP estimates yield two different sets of real GNP estimates: Variant A and Variant B. My Variant A estimates differ from my Variant B estimates since, in the Variant A estimates, the residual nominal GNP—the output not deflated by sector-specific deflators and which is therefore deflated by Urquhart's general GNP deflators—incorporates my intercensal estimates for the wholesale and retail trade and for the community, business, and personal services sector (the adjusted nominal GNP), whereas in the Variant B estimates, the residual output equals Urquhart's nominal GNP at market prices net of the nominal output to be deflated by the sector-specific price indexes. In the Variant B estimates, therefore, the Urquhart estimates for the residual components of nominal GNP are either increased or reduced depending on whether the adjusted nominal GNP estimates exceed or fall below Urquhart's nominal GNP estimates. Be this as it may, my two variants of real GNP are almost identical for most of the 1870–1926 period (see Table 1 and Figures One and Two).

The revised real GNP estimates and the two nominal GNP estimates yield two variants of revised implicit GNP deflators. These two variants, like their real GNP counterparts, are almost identical for most of the 1870–1926 period and they both differ from Urquhart's largely in terms of the value of the index numbers for specific periods. Thus, from 1870 to 1896, the new deflators are above Urquhart's except for 1881 and 1887. This gap is widest from 1870 to 1878. From 1907 to 1914 and from 1922 to 1926 the new deflators lie clearly below Urquhart's deflators. This gap is most substantial in the latter period. The *movements* of these index numbers are similar but for a few years in the periods 1884–89, 1895–99, and 1922–26 (see Table 1 and Figures Three and Four). Moreover, the measured volatility of the new and Urquhart price deflators is not much different.

[13]My adjusted nominal GNP series is not presented in this article, but it can be easily derived by multiplying my Variant A real GNP estimates by their corresponding Variant A implicit price index numbers (see Table 1).

Volatility is measured by the standard deviation of deviations (SDDT). My SDDTs reveal that the new series is more volatile than Urquhart's for the entire 1870–1928 period, but by only 11 percent. However, the new series is less volatile than Urquhart's during the 1870–1908 subperiod by 25 percent. From 1908 to 1928 the new series is 21 percent more volatile than the Urquhart series.[14]

III. The Revised Real GNP and Economic Growth

Both variants of the revised real GNP estimates yield growth rates which differ from those generated by Urquhart's real GNP estimates. I focus on the Variant A estimates and, like Urquhart (1986, p. 36; 1988, p. 51), I compute extensive GNP growth rates from three year averages of real GNP centred on the bench-mark years 1871, 1881, 1891, 1901, 1911, 1921, 1925. Unlike Urquhart (1988, p. 52) who uses only population estimates for the above bench-mark years to compute per capita or intensive growth rates, I construct the population growth rates from population estimates for the above three year averages so as to be more consistent with the output growth rates. The population estimates are those of Urquhart (1986, pp. 30–31). This difference in procedure has some marginal effects on the per capita growth rates.[15] To estimate growth rates of labour productivity I rely largely on Urquhart's (1988, pp. 14a–14b, Table 3) estimates of labour employment for the above bench-mark or census years. Growth rates are computed using the Urquhart, the revised, and the Firestone real GNP estimates (see Table 3).

The revised and Urquhart extensive growth rates differ substantially from Firestone's for most periods examined. However, for both the 1871–1925 and 1871–1911 periods the Urquhart growth rates exceed Firestone's by only 5 and 2 percent respectively while the revised growth rates exceed Firestone's by 15 and 12 percent respectively. An important distinction between both the revised and Urquhart, and the Firestone growth rates is that for the latter two estimates, especially for the revised estimates, the 1910s and the 1920s stand out as the periods of the most rapid growth whereas, according to the Firestone GNP estimates, the growth experience of the early twentieth century had little by which to distinguish itself. Finally, in stark contrast to both the revised and Urquhart GNP estimates, the Firestone estimates suggest that the 1880s, which follows the implementation of Canada's National Policy of relatively high tariffs and of government sponsored transcontinental railway construction, was characterized

[14]I use the same method for calculating volatility as that used by Romer (1989), Balke and Gordon (1989), and Altman (1992) to measure the volatility of GNP. Critical to this exercise is the detrending of the price index series and therefore the choice of bench-mark years. Log-linear trend lines through logarithms of the price index numbers for selected bench-mark years are constructed. Bench-mark years approximate "points of mid-expansion in the business cycle" (Romer, 1989, p. 18; Altman, 1992). The bench-mark years for both the new (Variant A) and Urquhart series are: 1871, 1880, 1892, 1900, 1914, 1922, 1928. The SDDTs for the 1870–1928 period are 8.16 percent for the new series (Variant A) and 7.37 percent for Urquhart's. The SDDTs are 3.50 and 4.67 percent for these two series respectively in the 1870–1908 period and 12.83 and 10.59 percent respectively in the 1908–1928 period. Elsewhere (Altman, 1992), I find that the SDDT (5.66 percent) for the revised real GNP (Variant A) for the 1870–1928 period is 98 percent of the SDDT (5.79 percent) for the Urquhart real GNP estimates.

[15]Compare Urquhart (1986, p. 32, Table 2.10) to Table 3 below.

TABLE 3

MEASURES OF ECONOMIC GROWTH

	% PA Growth Rate			% PA Growth Rate Per Capita			% PA Growth Rate Per Worker			Population % PA Growth Rate	Employees %PA Growth Rate
	Urquhart	Revised	Firestone	Urquhart	Revised	Firestone	Urquhart	Revised	Firestone		
1871-1925	3.49	3.85	3.34	1.77	2.12	1.61	1.42	1.78	1.27	1.73	2.07
1871-1901	3.24	3.65	3.50	1.97	2.38	2.23	1.66	2.07	1.92	1.27	1.58
1871-1911	3.94	4.34	3.87	2.25	2.66	2.18	1.73	2.13	1.66	1.68	2.21
1901-1925	3.81	4.09	3.15	1.51	1.80	0.85	1.11	1.40	0.45	2.30	2.70
1871-1881	3.04	4.02	4.41	1.46	2.43	2.83	1.15	2.13	2.52	1.59	1.89
1881-1891	2.74	2.70	0.73	1.61	1.57	−0.39	1.16	1.12	−0.84	1.13	1.58
1891-1901	3.95	4.25	5.40	2.85	3.15	4.30	2.68	2.98	4.13	1.10	1.27
1901-1911	6.04	6.44	4.99	3.11	3.51	2.06	1.91	2.31	0.86	2.93	4.13
1911-1921	0.94	0.65	1.21	−1.04	−1.34	−0.77	−0.50	−0.79	−0.23	1.98	1.44
1921-1925	5.58	7.10	3.46	4.06	5.59	1.95	3.28	4.81	1.17	1.51	2.30
1871-1891	2.89	3.36		1.54	2.00		1.16	1.62		1.36	1.74
1871-1896	2.55	2.80		1.27	1.52		1.19	1.44		1.28	1.36
1891-1896	1.20	0.61		0.21	−0.37		1.32	0.74		0.98	−0.13
1896-1913	5.96	6.61		3.54	4.18		2.52	3.17		2.43	3.44
1913-1928	3.34	3.56		1.63	1.85		1.33	1.55		1.71	2.01

Notes and sources: See text.

by an inconsequential growth rate. This story changes but little when one refers to either the per capita growth or to the labour productivity growth rates; only now the differences between both the revised and Urquhart growth rates, and the Firestone growth rates become accentuated.

An important distinction between the revised and the Urquhart extensive growth rates is that the revised growth rates exceed Urquhart's for all periods examined but for the 1880s when the two growth rates are about the same and for the 1910s when Urquhart's growth rate exceeds the revised one by 31 percent. The revised growth rates exceed Urquhart's by the widest margin in the 1870s and in the 1920-25 period, by 32 and 27 percent respectively. These differences in growth rates are accentuated in terms of the growth of output per capita and the growth of labour productivity. The revised per capita and labour productivity growth rates exceed Urquhart's by 67 and 84 percent and by 38 and 46 percent in the 1870s and in the 1921-25 period respectively. During the 1900-1910 period the revised extensive, intensive, and labour productivity growth rate exceeds Urquhart's by 7, 13, and 21 percent respectively. Over the entire 1871-1925 period the revised extensive, intensive, and labour productivity growth rates exceed Urquhart's by 10, 20, and 25 percent respectively. However, for both the revised and the Urquhart GNP estimates the break between the 1901-1911 period and the previous decade is not as dramatic for intensive as for extensive growth. This is due to the surge in population growth which took place in the 1900-1910 period. Population grew by 2.93 percent per annum in this last decade compared to only 1.10 percent in the 1890s. Moreover, in terms of labour productivity growth both sets of estimates suggest that the 1901-1911 period, the 1890s and the 1921-25 period were characterized by higher growth rates than the 1901-1911 period. Therefore, the labour productivity estimates suggest that labour productivity growth cannot be correlated in any significant way with the wheat boom. This is contrary to what I find here for both extensive and intensive growth and to what I have found elsewhere for the labour productivity growth in the manufacturing sector (Altman, 1987, 102-103).

However, since these labour productivity estimates are computed for census years alone, one is not truly estimating labour productivity growth during the long upswing in the Canadian economy which begins in 1896 and ends in 1913 (see Figures One and Two). This sustained period of expansion coincides with a period of significant increases in wheat and flour exports from Canada.[16] Using the new real GNP estimates fror 1896 and 1913, in addition to new employment estimates for 1896 and 1913, it is possible to estimate labour productivity growth for the 1896-1913 period as well as for the 1871-96 and 1913-28 periods; periods which correspond to different peak to peak phases of extensive economic growth (see Figures One and Two). In this way the period of the wheat boom can be

[16]The Canadian exports of wheat and flour averaged only 3,722,000 bushels in the 1886-1891 period (in 1891 it was only 940,000 bushels). During the years 1892-1895 wheat and flour exports averaged 10,644,000 bushels, an increase of 1.86 times from the previous period. Canada exported an average of 15,854,000 bushels by the period 1896-1900 and by 1901-1905 an average of 25,828,000 bushels were exported. During the 1906-1910 period Canadian wheat and flour exports averaged 53,163,000 bushels. By 1911-1915, an average of 99,616,000 bushels of wheat and flour were exported from Canada. In the 1921-1930 period even more wheat and flour was exported: an average of 271,586,000 bushels (calculated from Urquhart and Buckley (1965), series L139-146, pp. 363-364).

placed in the context of the growth experiences of those years which came before and after it.

This procedure requires the estimation of employment for interdecal years. Urquhart adjusts the census data on the number of gainfully employed individuals to generate estimates for labour employment for the census years which are used to construct the above labour productivity estimates.[17] For 1896 and 1913 there are no estimates for the number of gainfully employed from which to construct employment estimates. However, such estimates can be constructed by regressing the index numbers for the readily available annual employment estimates for the years 1921 to 1928 on the index numbers of my revised estimates for real GNP for these years. All index numbers are to a base year of 1921. This yields the following:

$$\text{Labour Employment} = 0.73927 + 0.249497 * (\text{Real GNP}).$$

These results are used to generate index numbers for labour employment for the years 1891-1896 and 1911-13 which are, in turn, used to construct employment estimates for 1896 and 1913 of 1,584,000 and 2,817,000 respectively.[18]

Both the revised and Urquhart labour productivity growth estimates identify the 1896-1913 period as the one with the highest rate of labour productivity growth of all periods examined. Both growth estimates for this period are about twice that for the 1871-96 and 1913-26 periods, with the revised growth rates exceeding those derived using Urquhart's GNP estimates by 34, 39, and 17 percent in the 1871-96, 1896-1913, and 1913-26 periods respectively. The wheat boom clearly coincides with a sharp rise in labour productivity growth. These tentative labour productivity growth estimates, therefore, lend some support to the hypothesis that the wheat boom positively affected the growth of Canadian labour productivity. Finally, the extensive and intensive growth estimates for these periods also suggest that the 1896-1913 period stands alone in the 1870-1928 era as the leading period of sustained economic growth.[19]

[17]Urquhart's 1871 employment estimate is taken from Firestone (1958, p. 184, Table 65). The Firestone (1958, pp. 318-319) estimate for 1871 is based on educated guesswork which has as its basis data contained in the 1881 and later censuses. Urquhart's estimates for gainful employment for the census years in the 1881-1911 period, upon which his employment estimates are based, are the estimates in Urquhart and Buckley (1965, p. 59, Series 2) adjusted for McInnis's upward (1986, pp. 753-756) revisions of the estimates for gainfully employed in agriculture. These adjustments revise upward the Urquhart and Buckley gainfully employed series for all occupations by less than one percent for all years except for 1901 (2.93 percent) and 1911 (1.00 percent). The 1921 employment estimate is from Urquhart and Buckley (1965, series 51, p. 61) as are the 1925 and the 1928 employment estimates used in this article. Urquhart assumes that the percentage of the gainfully employed who were working in 1881, 1891, 1901, and 1911 was 98.5 percent, the same as in 1921, the earliest year for which such an estimate can be made. The employment estimates for these years in thousands of people are: 1,130 (1871), 1,363 (1881), 1,594 (1891), 1,808 (1901), 2,710 (1911), 3,126 (1921), 3,423 (1925), and 3,796 (1928).

[18]The index numbers for labour employment for 1896 and 1913 are converted to base years of 1891 and 1911 respectively yielding index numbers of 0.99343 and 1.039343 for 1896 and 1913 respectively. The index numbers for 1896 and 1913 are multiplied by the employment estimates for 1891 (1,594,000) and 1911 (2,710,000) to generate the employment estimates for 1896 and 1913.

[19]One can construct estimates for the output structure of the Canadian economy and the manufacturing sector in terms of the percentage distribution of the major components of Gross Domestic Product and of the manufacturing sector. Such estimates are best constructed for census years, years for which the data are the most reliable. Urquhart (1986, pp. 42, 60) presents such

IV. Conclusion

The revised real GNP estimates presented here are built upon the important nominal estimates constructed by Urquhart and upon a more consistent and representative set of price index series than those used by Urquhart to generate his real GNP series. In effect, the revised real GNP series is derived by deflating the various nominal components of GNP by sector-specific deflators. In the process of constructing the revised GNP series, real output estimates for the most important sectors of the economy are generated. These estimates provide scholars with an additional source of information with which to examine many much discussed and debated questions in Canadian economic history. The revised real GNP estimates differ most significantly from Urquhart's in terms of the level of output. The same is true of the new implicit price index which is a by-product of the construction of the revised GNP estimates.

The revised GNP estimates also generate higher annual extensive, intensive, and labour productivity growth rates than do the Urquhart estimates. In particular, although the revised estimates affirm the pattern of growth suggested by the Urquhart estimates, the revised estimates reveal a much more significant break between the pre and post-1900 period. The latter finding is reinforced by the growth estimates constructed for interdecal periods. This finding which suggests an important statistical relationship between the wheat boom and significant growth in the Canadian economy, is reaffirmed by the new estimates constructed for structural change in the Canadian economy. Therefore, the revised real GNP estimates furnish a basis for estimates which provide strong evidence suggesting

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estimates for nominal output. These estimates would be no different if constructed for Urquhart's real GNP or real manufacturing output since every component's nominal output would be deflated by the *same* composite price index numbers. Revised estimates for the structure of GDP, based on the new real GNP estimates, provide the basis for re-examining the extent of structural change in the Canadian economy from one census year to the next over the 1870–1920 period. To measure the extent of structural change, I estimate the Duncan Index of Dissimilarity for both the structure of GDP and of manufacturing. This index is constructed by subtracting the percentage share of each sector in the base year from their respective share in the target year. The absolute values of these differences are summed and divided by two. Zero indicates no structural change. One hundred indicates complete structural change. The Duncan Index for the revised and Urquhart GDP series respectively is: 3.6 and 3.8, 1871–81; 9.7 and 8.6, 1881–91; 8.1 and 6.9, 1891–1901; 12.3 and 8.7, 1901–11; and 9 and 5.6, 1911–21. Both GDP series reveal that the 1880s and the 1901–1911 periods were the most significant periods of structural change, with the revised GDP estimates indicating much more significant structural change than the Urquhart series. More specifically, (see Altman, 1989 for details) only the revised estimates suggest that transportation sector's share in real GDP increased by 58 percent in the 1880s, and by another 58 percent from 1900 to 1910, after its share had risen by 57 percent during the 1890s. The revised estimates also suggest an increase in the share of the transportation sector by 50 percent during the 1910s as compared to an increase of only 6 percent for the Urquhart estimates. Since the transportation sector was dominated by the railway, and the railway was driven by efforts to open up the Canadian West to settlement where wheat production would be of great importance, the revised estimates suggest the importance of Canada's wheat economy to this important sector of the Canadian economy (see also Altman, 1988). For manufacturing the Duncan Index for the revised and Urquhart series respectively is: 8.1 and 8.7, 1871–81; 12.4 and 6.9, 1881–91; 10.0 and 7.1, 1891–1901; 16.4 and 8.9, 1901–1911; and 12.8 and 13.2, 1911– 1921. Only the Duncan Index for the revised estimates suggests that structural change of any relative importance took place during the 1880s and the 1901–1911 period. In particular, the revised constant dollar estimates indicate that the period 1900–1910, the period embodying the Canadian wheat boom, coincides with a "rise to prominence of key sectors" (Altman, 1987, pp. 104–107).

that the era of the wheat boom was a *unique* period of very high economic growth in the sixty-odd years spanning Confederation to the Great Depression.[20]

Finally, the new growth estimates indicate that the Canadian economy was the fastest growing (extensively or intensively) of all the advanced industrial economies of the time, including the United States, the United Kingdom, Germany, and France (Maddison, 1989, pp. 44–45). In particular, for the 1870–1910 period, only the growth performance of the American economy approached Canada's. The U.S. experienced an annual growth rate of real GNP of only 3.9 percent compared to the 4.3 percent experienced in Canada while the per capita growth rate for the U.S. and Canada was 1.8 and 2.7 percent respectively. Nevertheless, American extensive growth lagged behind Canadian extensive growth only during the 1900–1910 sub-period when the U.S. witnessed a 3.5 percent growth rate compared to the 6.4 percent growth rate in Canada. In this period American per capita growth also lagged behind the Canadian: 1.6 percent compared to 3.5 percent. It was, therefore, Canada's exceptional growth during the Canadian wheat boom which was responsible for Canada's superior growth performance over the entire 1870–1910 period.[21]

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[20]Inwood and Stengos (1991), using Urquhart's real GNP estimates and measures of extensive economic growth plus estimates for investment, find that the wheat boom (the "shock" which it provided to the Canadian economy in 1896) positively affected the growth process in the 1870–1939 era.

[21]The extensive growth rates of real American GNP are derived from, Balke and Gordon (1989, pp. 84–85). To construct intensive growth rates, the population estimates for the U.S. in, U.S. Department of Commerce (1975, series A6–8, p. 8), are used. One should note that per capita growth was greater in Canada than in the U.S. from 1900 to 1910 in spite of Canada's population growing at an annual rate of 2.9 percent as compared to the 1.9 percent growth rate experienced in the U.S. From 1870 to 1900 the American economy grew extensively at a faster pace than the Canadian: 4.0 compared to 3.7 percent. However, the much faster rate of population growth in the U.S. of 2.17 percent as compared to Canada's 1.27 percent, resulted in the per capita growth in America for this period being less than in Canada: 1.9 as compared to 2.4 percent respectively.

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