How Much do Changing Terms of Trade matter for Economic Well-Being in Canada?

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Abstract

This paper examines the impacts of changing terms of trade on economic well-being within Canada using the Index of Economic Well-Being and available data on Canadian provinces over the period 1981 to 2014. It notes that the huge swings of the price of oil over the last 34 years have affected Canada's ten provinces very unevenly. The three producing provinces – Alberta, Saskatchewan and Newfoundland – have seen big swings in their terms of trade, largely driven by energy price changes. The terms of trade of the other seven provinces (with 84% of Canada's population) are essentially unrelated to energy price movements and have changed remarkably little over time – hence there has been little impact on economic well-being. However, expectations of future oil prices matter enormously to the per capita natural resource wealth of the three oil-producing provinces. Estimates of natural resource wealth capitalize the net rent to be expected from future output, so the unpredictability of oil prices poses major problems for measurement of the current economic well-being of oil producing provinces, whatever index of well-being is used.

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1. Introduction

Since 1998, the Centre for the Study of Living Standards has been publishing the Index of Economic Well-being (IEWB). The changing availability of data and our evolving understanding of issues have produced a series of methodological vintages of the IEWB (Osberg and Sharpe, 1998, 2002a, 2002b, 2006, 2011).[1] As well, our inter-provincial comparisons within Canada have always been able to use data series that are not available for our international comparisons among Organisation for Economic Cooperation and Development (OECD) nations. Nevertheless, these different exercises in measuring and comparing the level and trend of aggregate economic well-being have all been motivated by the conjecture that examining differentials in economic well-being and its components might assist in the discovery of which public policies might work better than others.

However, good results in economic well-being can be due to good luck or to good management – and conversely for bad results. It is clear that the differences among provinces and nations in economic well-being cannot just be ascribed to wise or foolish public policy choices. Jurisdictions also face widely varying constraints – as when, for example, the international macro-economy moves from boom to bust. When the global economy sank into recession in September 2008 following the financial crisis, cyclical impacts on economic output and employment varied widely across different countries. In a previous paper (Osberg and Sharpe, 2014) we documented the stark differences between OECD nations in the impacts of the global recession on different dimensions of economic well-being. This paper takes a longer term view and examines the differential impact across Canadian provinces of the booms and busts of energy prices.

Section 2 of the paper begins by establishing the context – the huge fluctuations in oil and gas prices of the last forty years and the stark differences across Canada's three producing and seven consuming provinces in terms of trade impacts on well-being. Section 3 then summarizes the IEWB approach to the measurement of economic well-being while Section 4 discusses the impacts of fluctuating terms of trade on wealth, consumption, income distribution and economic insecurity at the provincial level. Section 5 assesses the implications and concludes.

2. Long Term Variability in Provincial Terms of Trade[3]

The real price of oil has been on a wild ride over the last forty years. The U.S. is by far the major market for Canadian oil and gas exports, so Figure 1 presents the real (solid line) and nominal (dotted line) average monthly price per barrel paid for U.S. oil imports from 1974 to 2016. Similar movements can be seen in natural gas prices[4]. However, this variation in real prices has widely varying impacts within Canada[5]. Although, in recent years, it has become common for Canada's dollar to be called a "petro-currency", only three of Canada's ten provinces [Alberta, Saskatchewan and Newfoundland[6]] are major producers. Alberta was the major beneficiary of the drastic increase in real oil price of the late 1970s to its $106 peak (measured in 2016 dollars) in January 1981 – and Alberta was the province most negatively affected by its subsequent drift downwards and early 1986collapse. Following a very short spike in prices during the Gulf War of 1990, for a decade the real price of oil stayed low – bottoming out at $13.62 in December 1998. After 2000, the upward march of the real oil price to its July 2008 peak of $139.07 seemed relentless – and conveniently timed for Newfoundland, where offshore production started in 1998.

In Canada in 2012, the oil and gas sector directly contributed 24.8% of the GDP of Newfoundland, 18.0% of Alberta's GDP and 15.5% of Saskatchewan's – ratios which, due to its many indirect impacts through inter-industry linkages and consumer demand, arguably understate the local importance of the oil and gas sector, and the exposure of these provinces to the 2014 collapse of oil prices. (Among the other provinces, Manitoba's oil and gas output

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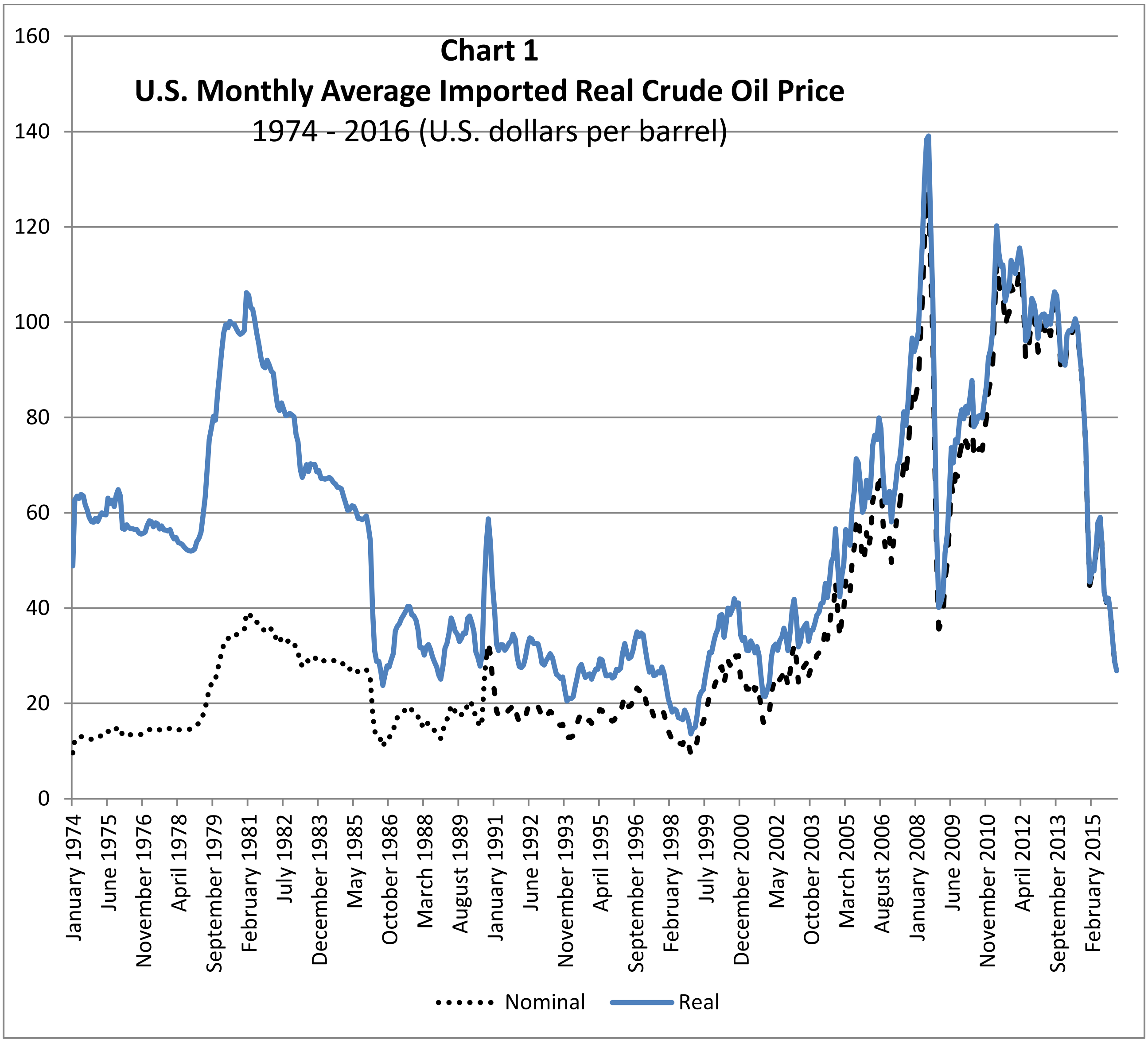
[3] Terms of trade = (implicit export price deflator)/(implicit import price deflator). CANSIM table: 384-0038 provides the implicit export price deflator: (current prices, exports of goods and services)/(constant 2007 prices, exports of goods and services) and the implicit import price deflator: (current prices, imports of goods and services)/(constant 2007 prices, imports of goods and services). This results in a 2007 base - rebased to 1980. For each province we use a measure of exports and imports INCLUDING interprovincial exports and imports.

[4] The consumer price index is used to adjust Nominal prices. See http://www.eia.gov/forecasts/steo/realprices/ for a full selection of real and nominal oil and gas price trends. To conserve space this paper discusses primarily oil prices rather than oil and gas prices, but the same basic picture applies.

[5] Baxter and Kouparitsas (2012) unfortunately restrict themselves to variation in national terms of trade.

[6] To conserve space, this paper will sometimes shorten the correct name of "Newfoundland and Labrador" to "Newfoundland". In 2012, Alberta supplied 69.9% , Saskatchewan 14.7% and Newfoundland 9.5% of total Canadian oil and gas production. See CANSIM Table 379-0030

was largest, at 2.4% of provincial GDP[7].) Notwithstanding Canada's current petro-currency status on foreign exchange markets, seven out of ten Canadian provinces (with 84% of the population) have always been firmly on the consumer end of oil price volatility impacts. Although three provinces are now on the producer side of oil price impacts, the timing and degree of their dependence on the oil and gas sector differs significantly. Alberta has been a major producer since the 1950s. The impact of Saskatchewan's much smaller oil production has grown steadily over time and the impact of offshore oil in Newfoundland is both larger relative to other sectors and quite recent.



Source: EIA Short-Term Energy Outlook,
https://www.eia.gov/forecasts/steo/data.cfm?type=tables

[7] CANSIM Table 379-0030

Because Alberta's economy is about more than oil and gas, variations over time in their prices are only part of what determines the change in Alberta's terms of trade with other provinces and other nations – but it is a large part. As Chart 2a illustrates, the variation since 1981 in the terms of trade of both Alberta and Saskatchewan mirror, with somewhat lesser amplitude, the ups and downs of the real oil price displayed with Chart 1. In contrast, Newfoundland's terms of trade mirrored those of Canada at large until the oil started to flow in 1998, and then accelerated upward with the real price of oil in international markets.

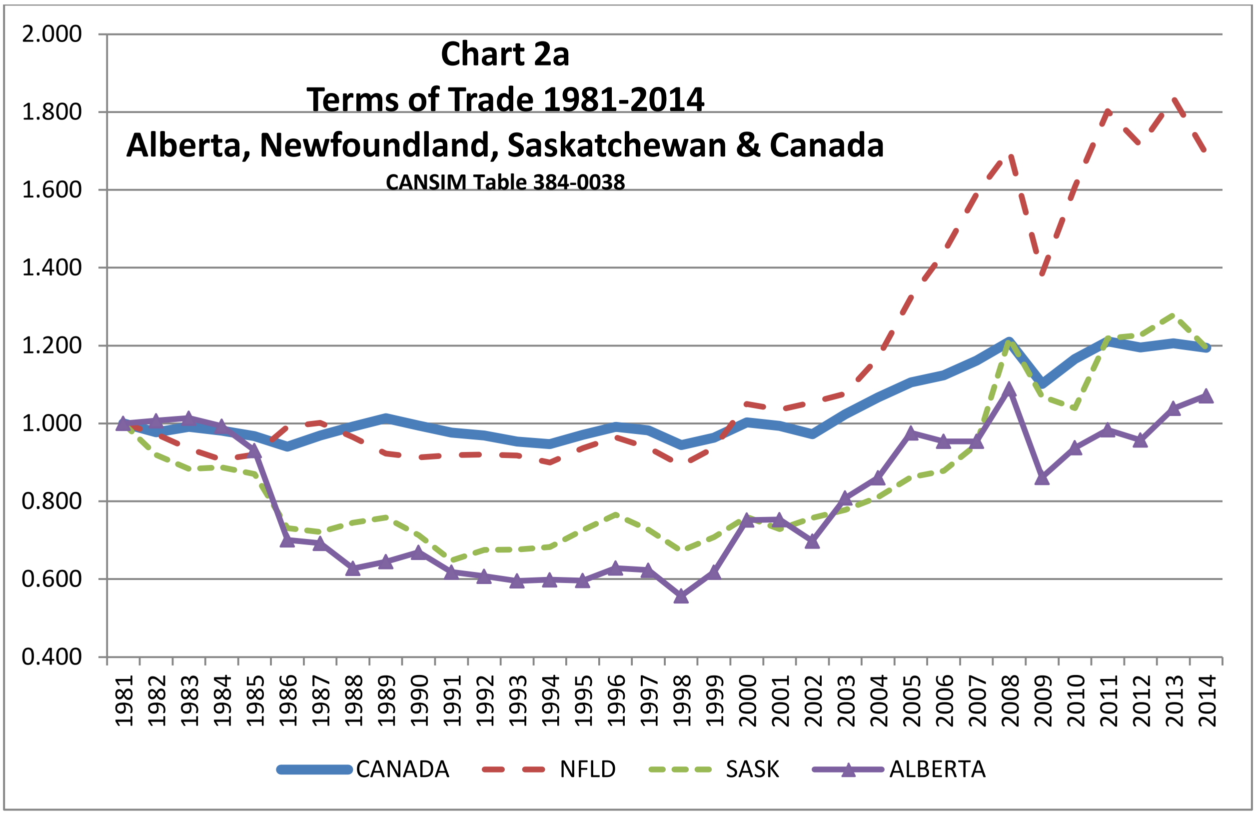


Chart 2b presents the terms of trade (with other nations and other provinces) of the Canadian provinces which do not have significant oil production – the vertical axis is constrained to the same scale as Chart 2a so that the lack of movement over time in their terms of trade can be more easily seen. The lack of volatility, or indeed of movement, in the terms of trade of seven out of ten provinces is noteworthy, not least because other relevant time series have been much more volatile over this period.

For example, for the country as a whole since 1981, the U.S. $ has been as much as 33 % higher (February 2002) and as much as 20% lower (July 2011) than its 1981 level and the effective exchange rate has had a similar amplitude of changes[8]. But for seven out of ten Canadian provinces there is not a lot of variation over time in the Terms of Trade. Hence, the main impacts of shifting terms of trade are found in the three oil producing provinces: Alberta, Saskatchewan and Newfoundland.

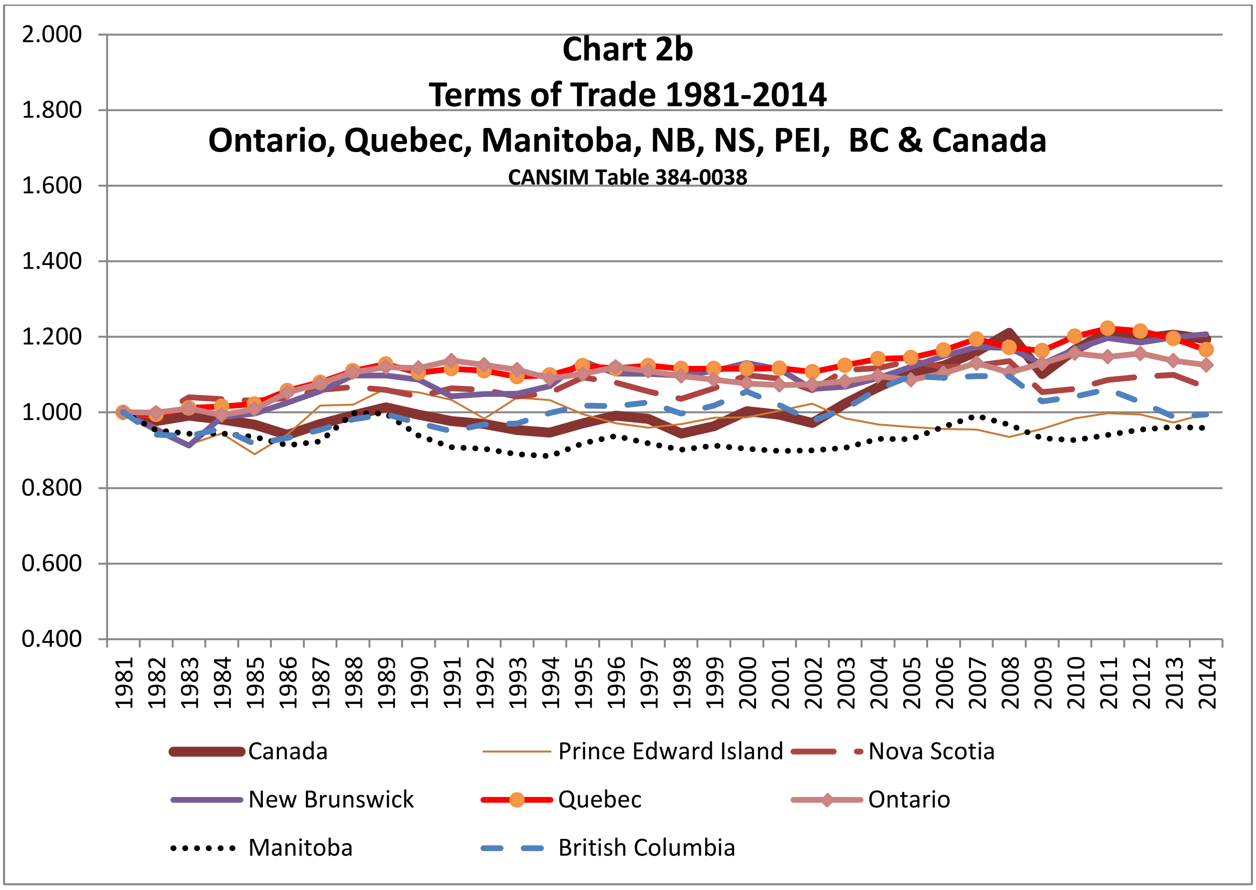


Table 1 confirms the visual impressions of Charts 2a and 2b. It reports results from a simple OLS regression of the year to year change in terms of trade on three commodity price indices (crude oil, energy, and all commodities) for the 1981 to 2014 period, for Canada and for each of the provinces[9]. For Canada as a whole, commodity price movements are very important for the terms of trade, explaining 88% of year to year changes – oil prices and energy prices alone explain 60% of the movement in Canada's terms of trade. This pattern is strongly replicated for the three oil-dependent provinces (Alberta, Saskatchewan and

[8] See Appendix 1.
[9] Table 1 estimates $\%\Delta y_t = \alpha + \beta(\%\Delta x_t)$ where x = commodity price index, and y = the terms of trade. For each province, exports and imports include exports and imports to other provinces, as well as internationally.

Newfoundland) – energy prices explain 85% of the variation in terms of trade for Alberta, for example. But this is absolutely not the case elsewhere. For five provinces (Ontario, Quebec, Manitoba, PEI and New Brunswick) there is essentially no relation between commodity price movements and the provincial terms of trade. For two provinces, (Nova Scotia[10] and British Columbia) energy prices have mattered, but to a much smaller degree.

Table 1

Commodity Price Indices and Terms of Trade: Provincial and National

	Energy Only	R^2	All Commodities	R^2	Crude Oil	R^2
Alberta	0.386**	0.85	0.583**	0.66	0.335**	0.72
	0.029		*0.074*		*0.038*	
Saskatchewan	0.224**	0.38	0.430**	0.48	0.231**	0.45
	0.052		*0.081*		*0.046*	
Newfoundland	0.196**	0.39	0.397**	0.55	0.185**	0.39
	0.044		*0.065*		*0.042*	
Nova Scotia	0.052**	0.24	0.114**	0.38	0.041*	0.16
	0.017		*0.026*		*0.017*	
New Brunswick	0.025	0.04	0.095*	0.18	0.029	0.06
	0.023		*0.036*		*0.022*	
PEI	-0.022	0.02	-0.020	0.01	-0.010	0.01
	0.025		*0.044*		*0.024*	
Ontario	-0.021	0.08	-0.018	0.02	-0.016	0.06
	0.012		*0.022*		*0.012*	
Quebec	-0.003	0.00	0.029	0.06	0.000	0.00
	0.012		*0.021*		*0.012*	
Manitoba	0.012	0.01	0.079*	0.16	0.021	0.04
	0.021		*0.033*		*0.020*	
British Columbia	0.067**	0.26	0.159**	0.52	0.056**	0.21
	0.020		*0.027*		*0.019*	
CANADA	0.107**	0.60	0.221**	0.88	0.100**	0.58
	0.016		*0.015*		*0.015*	

** = 1 per cent significance level; * = 5 per cent significance; # = 10 per cent significance ; Standard Error in italics
Sources: Energy Only and All Commodities Price Indices from Bank of Canada; Crude Oil Price Indices from IMF; Terms of Trade Indices based on Statistics Canada Import & Export data, CANSIM Table 384-0038;
http://www.bankofcanada.ca/rates/price-indexes/bcpi/commodity-price-index-annual/
http://www.imf.org/external/np/res/commod/External_Data.xls

[10] In the Nova Scotia case, past impacts of energy prices on provincial terms of trade are unlikely to recur. Sable Offshore Energy Project (SOEP) gas began flowing in 1999 into the newly constructed Maritimes & Northeast Pipeline to New England. Export volumes were significant for several years, but production has now tailed off and new exploration plays have disappointed – the pipeline now imports gas.

How much do commodity price swings affect economic well-being? One can expect that when trade is important, changes in the prices of what a province or nation sells to the rest of the world, compared to the prices of what it buys, will affect the gains available from trade and, therefore, the economic well-being of that jurisdiction. The big swings of oil and gas prices, and the stark variation within Canada in the degree to which the terms of trade of different provinces are affected by these swings, suggests that the impact of energy price swings on well-being depends very much on what part of Canada one is considering – and on the aspects of economic well-being that one considers more important.

Because some readers of this paper will be unfamiliar with the Index of Economic Well-Being, Section 3 provides a brief outline of the methodology of the IEWB, as well as a summary of trends in the IEWB across provinces. Readers who are already familiar with any of Osberg and Sharpe, 1998, 2002, 2008 or 2014 can save time by skipping directly to Section 4, which compares the differing impacts of Terms of Trade changes on the four components of economic well-being during the 1981-2014 period.

3. The Index of Economic Well-being: Motivation and Framework

The IEWB is an intermediate type of index (Osberg & Sharpe, 2005). While broader in conception than GDP per capita, it still aims only at the "economic" dimension of life. The philosophy of the IEWB is that there is more to "well-being" than economic well-being, but there is more to economic well-being than GDP per capita, and it is useful to have better measures of the economic well-being of society because better measurement may help guide better decisions (Osberg, 1985; Sharpe & Salzman, 2003). The IEWB takes a broad view of "economic well-being" as "access to the resources needed for material consumption" because the narrow focus of GDP accounting omits consideration of many issues (for example, leisure time, longevity of life, asset stock levels, inequality and insecurity) which are important to the command over resources of individuals. However, the IEWB avoids "quality of life" issues, such as crime rates (Di Tella, MacCulloch, & Oswald, 2003) on the grounds that aggregation of very dissimilar dimensions of social and political well-being obscures the nature of social choices. Rather, the IEWB is calculated as the weighted sum of four dimensions of economic well-being—average current consumption flows, aggregate accumulation for future consumption (i.e. per capita wealth—broadly conceived), income distribution and economic security.

Table 2. Dimensions of Economic Well-being

Concept	**Present**	**Future**
"Typical citizen" or "representative agent"	[A] *Average flow of current income*	[B] *Aggregate accumulation of productive stocks*
Heterogeneity of individual citizens	[C] *Distribution of potential consumption—income inequality and poverty*	[D] *Insecurity of future incomes*

Table 2 illustrates our identification of four components of well-being, which recognize trends in both average outcomes and in the diversity of outcomes, both now and in the future. When an average income flow concept, like GDP per capita, is used as a summative index of society's well-being, the analyst implicitly is stopping in quadrant [A]. This assumes (1) that the experience of a representative agent can summarize the well-being of society and (2) that the measured income flow optimally weights consumption and savings, so that one need not explicitly distinguish between present consumption flows and the accumulation of asset stocks which will enable future consumption flows. However, if society is composed of diverse individuals living in an uncertain world who typically "live in the present, anticipating the future," each individual's estimate of societal economic well-being will depend differently on current consumption and the accumulation of productive stocks to enable consumption in the future—i.e. both quadrants [A] and [B] matter.

In addition, real societies are not equal and life is highly uncertain. There is a long tradition in economics that "social welfare" depends on both average incomes and the degree of inequality and poverty in the distribution of incomes—quadrant [C]. *Ex ante*, individuals also do not know who will be affected by the hazards of economic life, and to what degree. When the future is uncertain, and insurance is unobtainable (either privately or through the welfare state), risk-averse people will care about the degree to which the economic future of individuals is secure - quadrant [D].

The four components of the IEWB used in this chapter are added up from a number of underlying variables. The consumption component, measured in prices on a per capita basis, includes private consumption, with adjustments for family size and life expectancy, public consumption, and changes in the value of leisure as proxied by changes in working time. The wealth component, measured in prices on a per capita basis, includes estimates of residential and non-residential physical capital, research and development (R & D) capital, human capital, the net international investment position, and environmental degradation, as proxied by the social costs of greenhouse gases. The equality component is measured as an index, and includes the Gini coefficient of income distribution and poverty intensity (the product of the poverty rate and gap for all persons. The Gini is given a weight of 0.25 and poverty intensity is weighted 0.75. The economic security component, also measured as an index, is aggregated from four subcomponents: the risk from unemployment; the financial risk from illness; the risk from single-parent poverty; and the risk from poverty in old age. Each subcomponent of economic security is weighted by the relative size of the population affected by the risk.

These four components therefore have a logical rationale and a manageable dimensionality—the IEWB is calculated as the weighted sum of per capita consumption + aggregate per capita wealth + an index of equality in income distribution + an index of economic security.

$$\text{IEWB} = \beta_1 \text{(Current Average Consumption)} + \beta_2 \text{(Total Societal Wealth)}$$
$$+ \beta_3 \text{(Index of Equality)} + \beta_4 \text{(Index of Economic Security)}$$
$$\text{Subject to: } \beta_1 + \beta_2 + \beta_3 + \beta_4 = 1$$

Although most people will agree that these four dimensions of well-being are all valuable to some degree[11], individuals differ in their relative preferences for each component. Some people, for example, consider equality to be more important than environmental preservation or per capita wealth, while others think the opposite. Different individuals often assign differing degrees of relative importance to each dimension of well-being. Indeed, each citizen in a democratic society has the right to come to a personal conclusion about the relative weight of each dimension (i.e. choose the relative values of β_1, β_2 , β_3 and β_4 they

[11] Some indices implicitly make a contrary assumption – e.g. using GDP per capita as a well-being index implicitly sets $\beta_3 = \beta_4 = 0$, since GDP per capita ignores inequality and insecurity.

think are appropriate). But because all citizens of a democracy (e.g. all Canadians) are occasionally called upon to exercise choices (e.g., in voting) on issues that affect the collectivity (and some individuals, such as civil servants, make such decisions on a daily basis), citizens have reason sometimes to ask questions of the form: Would this make "the country" better off?

A measure of social well-being can be useful if some people, at least some of the time, want to answer such questions in an evidence-based way. Because individuals know more about their own preferences and their own life situation than anyone else possibly could, statisticians who construct a social index cannot help individuals maximize their own personal utility. However, some individuals do sometimes ask: "But is it good for the country?" People who care about some combination of their own well-being and society's well-being can be seen as maximizing:

$$U_i = \alpha_1 \text{ (own utility)} + \alpha_2 \text{ (Social Index estimate of society's well-being).}$$

If $\alpha_2 = 0$ for all persons, at all times, then there is no point in constructing the IEWB—or any other social index. The construction of a social index presumes that for some people, at least some of the time, $\alpha_2 \neq 0$.

Every year, in the real world, governments have to choose between public spending on policies like education, or health, or the environment that have consequences that cannot be measured in directly comparable units. Hence, individuals often have to come to a summative decision—i.e., have a way of "adding it all up"—across domains that are conceptually dissimilar. We argue that the role of people who construct social indices should be one of helping citizens—e.g., as voters in elections and as bureaucrats in policy making—to come to reasonable summative decisions about the level of society's well-being. From this perspective, the purpose of index construction should be to help individuals think systematically about public policy, without necessarily presuming that all individuals have the same values. Although it may not be possible to define an *objective* index of societal well-being, individuals still have the problem (indeed, the moral responsibility) of coming to a *subjective* evaluation of social states, and they need organized, objective data if they are to do it in a reasonable way.

Appendix 3 presents estimates of each component of the IEWB for each province and for Canada, in 1981 and in 2014, as well as an estimate of the aggregate IEWB, assuming equally weighted components. These are put to an appendix because our focus in this paper is to discuss how and why our estimates are affected by fluctuations in the terms of trade.

4. The Differing Impacts of Terms of Trade Fluctuations

Since the IEWB is calculated as the weighted sum of well-being from current average consumption, total societal wealth, income equality and economic security, we consider these dimensions in turn, beginning with the dimension of well-being (wealth) most vulnerable, for three provinces, to big swings in energy prices and the terms of trade.

4.1 Wealth

Conceptually, a society's "wealth" at any particular point in time is, physically, the stock of productive assets that has been accumulated in the past in order to enable consumption in the future. Putting a value on these assets requires both an estimation of the value of the future flow of consumption which they will enable and a choice of the discount rate appropriate for weighting future period consumption, relative to current consumption.

In calculating the total value of Canada's productive assets, the IEWB has adopted a broader conception of productive stocks than just the physical capital stock now measured in the National Accounts. The IEWB therefore includes, in addition to the market value of physical capital stock of buildings and machinery, estimates of the present value of human capital stocks, R & D investment, natural resource wealth and environmental assets (minus any degradation). Because net debt to foreigners implies that at some future period foreigners will be able to claim real resources from Canadians, the IEWB counts the net value of the financial claims of foreigners vis-à-vis domestic residents[12], but otherwise the IEWB emphasizes the stock of real assets and not financial wealth. In estimating the total wealth of all Canadians, the IEWB sees domestically held financial instruments as claims on the distribution of the future output that productive assets will enable – in aggregate, the value of

[12] The financial claims of foreigners on Canadians include both equity and debt, as do the financial claims of Canadians on foreigners. Since the market value of share equity represents the expected net present value of residual claims on corporate income after production costs and debt payments, it varies with expectations of future profits. In the present context, this implies that the collapse of oil prices has been reflected in the decline in value of oil and gas stocks. Part of the pain of the oil price decline has thus been exported to the foreigners owning such stock.

any domestic financial asset to the holders of financial assets is balanced by the value of the financial liability of the issuer of the financial instrument. Because our emphasis has been on the net accretion of real productive resources, we have held base period prices constant in our estimates of wealth stocks corresponding to real assets. The IEWB estimates of the changes over time in total real asset stocks have reported have been quantity changes only. In particular, estimates of natural resource wealth in the IEWB have taken nominal natural resources estimates from Statistics Canada and deflated them by the GDP deflator to obtain their purchasing power in real terms.

This emphasis on the stocks of real productive resources and the use of market prices to enable aggregation across specific types of assets makes the IEWB estimates of the total value of assets conditional on the prices used for aggregation, i.e. the terms of trade of the jurisdiction under consideration. For seven out of ten Canadian provinces (see Chart 2b) it may not be too unreasonable to make an assumption of unchanging relative prices and terms of trade. Implicitly, models of steady state growth of output of a single good make this assumption in a very strong form, everywhere and at all times. However, the volatility over time of resource prices (Chart 1) and of three of Canada's provinces' Terms of Trade (Chart 2a) raise significant questions for this approach, in these three instances.

When swings in resource prices and the terms of trade are large, these will affect both the income available for consumption at any point in time and the capitalized value of the income which can be expected from existing assets in future periods. The Net Present Value of future income from today's assets is "wealth": estimates of its magnitude capitalize expectations of the relative price of what physical assets will produce – i.e. future terms of trade. For a province like Alberta, natural resource wealth has long been known to be a large fraction of total wealth, although there have been arguments about how large. For example, Sharpe et al (2008) noted that the methodology used by Statistics Canada to estimate the value of the Alberta oil sands[13] understated its importance to Canada's total wealth stocks in that year.

"We find that the use of more reasonable measures of the total oil sands reserves (172.7 billion barrels), extraction rate (a linear increase from 482 million barrels per year in 2007 to 1,350 million barrels in 2015, and constant thereafter) and price ($70 per barrel, 2007 CAD) increases the estimated present value of the oil sands to $1,482.7 billion (2007 CAD),

[13] The original, and technically more accurate, name was the Athabasca Tar Sands – for political correctness, we adopt here the more recent terminology.

4.3 times larger than the official estimate of $342.1 billion. Using our preferred estimate, Canada's total tangible wealth increases by $1.1 trillion (17 per cent), and reaches $8.0 trillion with oil sands now accounting for 18 per cent of Canada's tangible wealth. The importance of these revisions is also demonstrated by their impact on the per-capita wealth of Canadians, which increases from $209,359 to $243,950, or by $34,591 (or 17 per cent). Given the importance of the oil sands for Canada, Statistics Canada should undertake a review of its methodology.(2008,i)"

Many Albertans might protest that since natural resource stocks are owned by the provinces, the per capita value of the oil sands should have been calculated for Alberta's population (4.23 million in 2016) rather than spread over Canada's 36.05 million people. Since total tangible non-oil sands wealth was roughly $192,000 per Canadian in 2008, and the oil sands valuation difference increased Albertans' per capita wealth by much more (roughly $250,000[14]), by this calculation the oil sands alone meant that Albertans' wealth was over twice as high as the per capita wealth of all Canadians.

However, as events have turned out the price received in 2016 has been dramatically lower than expected, which totally dominates any estimate of the present value of the oil sands. Table 3 contains four estimates of the present value in 2016 of the Alberta oil sands. The first, for 2007, essentially recapitulates an estimate from Appendix Table 1 of CSLS (2008).[15] The others, for 2014, 2015 and 2016, are new estimates based on the same valuation method[16]. All estimates are in 2016 Canadian dollars. Two assumptions are compared: 1] that the capital costs of oil sands plants now in place are amortized over the production life of investments and 2] that the investments now in place in the oil sands are sunk costs, with no alternative market value, and therefore are written down to zero. In both

[14] In per capita terms, from $80,837 to $337,196

[15] The main difference between the 2007 estimate in Table 2 and the one in CSLS (2008) is a newer data series for capital stock. Statistics Canada discontinued and replaced the capital stock data used in CSLS (2008). The 2007 estimate was revised using the new capital data, excluding any value assigned to reserves in situ, in order to make it comparable with the 2014 and 2015 estimates.

[16] Let R and C denote the total revenue and total processing cost (*excluding* amortized capital costs) of the nonconventional oil extraction sector in a given year, measured in dollars. Let Q denote the total stock of established reserves in the oil sands, and let q be the annual flow of oil production. Q and q are measured in physical units, e.g. barrels. Let K be the value of the capital stock available for use in production. Assume that R, C and q are expected to remain at their current values in all future years until the reserves are exhausted.[16] This will take T = Q/q years. Then the total undiscounted flow of quasi-rent generated by oil sands production over the lifetime of the reserves is D = (R – C)T – K. The annual flow of rent is d = D/T. Let V denote the value of the oil sands reserves. That value is given by $V = \sum_{t=1}^{T} \beta^t d = \frac{\beta(1-\beta^T)d}{1-\beta}$ where β is the discount factor. Following CSLS (2008), a discount rate of four percent is used (see below) so that $\beta = \frac{1}{1+.04}$. Note that the implied per-barrel oil price is p = R/q, and the implied rent per barrel is r = d/q. Then the implied per-barrel extraction cost (inclusive of amortized capital costs) is c = p – r.

scenarios it is assumed that no additional investment is made in the oil sands and that production therefore continues at its 2015 level.

Following the capital cost amortization approach, between 2007 and 2014 the present value of the net rents of the oil sands increased by 152 percent, from $438 billion to $1,102 billion. This increase was attributable to increases in both annual net production (from 482 to 790 million barrels) and the per-barrel rent (from $36.3 to $55.8 per barrel). Per-barrel rent increased because the price of oil sands output increased from $56.2 in 2007 to $88.5 in 2014. The per-barrel extraction cost (including amortized capital costs) also increased over the period, but not by nearly as much.

Between 2014 and 2015, the story is dramatically different. The collapse in oil prices meant that the nominal present value of the oil sands plunged by 66 percent to $373 billion. Although the sector's net production rose to 865 million barrels in 2015, per-barrel rent fell from $55.8 to $17.3 per barrel. Assuming that the per-barrel extraction cost remained unchanged between 2014 and 2015, the decline in the per-barrel rent is entirely attributable to the 44 percent decline in the per-barrel price, from $88.5 to $49.9 (Cdn.) per barrel. Throughout the first third of 2016, the price of oil has been below the $49.9 price implied by the AER's 2015 industry revenue forecasts. As of May 6, 2016, the price of Western Canada Select oil was $42.33 per barrel.[17] Table 3 uses $42.33 as the per-barrel price and assumes that both net production and the per-barrel extraction cost (inclusive of amortized capital costs) remain at their 2015 levels. Under these assumptions, the value of the oil sands is $209 billion, down 81 percent from 2014, when oil prices averaged $88.50 per barrel. Assuming amortization of capital, each barrel of oil produced delivers an estimated rent of only $9.70 in 2016, compared to $55.80 in 2014.

[17]See http://www.psac.ca/business/firstenergy/

Table 3
Estimates of the Present Value of
the Alberta Oil Sands

		2007	2014	2015	2016
Price per Barrel	Dollars	56.2	88.5	49.9	42.3
Net Production	millions barrels	482	790	865	865
Total Revenue	$ millions	27,088	69,921	43,201	36,623
Reserve Life years		358	210	191	190
Capital Amortization					
Capital Stock	$ billions	71.8	206.6	206.6	206.6
Extraction Cost per Barrel *		19.9	32.7	32.7	32.7
Total Processing Cost $Millions		9,386	24,845	34,521	34,521
Rent per barrel		36.3	55.8	17.3	9.7
Rent per Year	$ millions	17,502	44,094	14,929	8,351
Present Value of Oil Sands $ Million		437,587	1,102,058	373,027	208,666
NPV Rents per Albertan		103,437	260,533	88,186	49,330
NPV Rents per Canadian		12,137	30,570	10,347	5,788
Sunk Cost Approach					
Capital Stock		0	0	0	0
Processing Cost per barrel		19.5	31.4	31.4	31.4
Total Processing Cost $ Million		9,386	24,845	27,196	27,196
Rent per Year	$ millions	17,702	45,076	16,005	9,427
Present Value of Oil Sands $ Million		442,250	1,126,602	399,891	235,529
NPV Rents per Albertan		104,551	266,336	94,537	55,681
NPV Rents per Canadian		12,268	31,251	11,093	6,533

*Note: Extraction cost includes amortized capital cost. $ Cdn throughout

As well, it should be noted that although the spot oil price on May 6, 2016 was $42.33 (Cdn), the year-to-date average price of Western Canada Select on that same date was $30.15. At that price, and at a processing cost of $31.40 not including capital amortization, the oil sands would be worthless. Of course, this highly simplified valuation method assumes that all producers have the same per-barrel extraction cost. In reality, an industry average of $31.40 per barrel processing costs includes some relatively efficient producers with lower costs who could remain profitable at low oil prices. A more precise estimate of how many relatively high-cost projects would become uneconomical would require proprietary firm data which is not available to us. However, the basic point is that there is very much less rent to be had at current 2016 prices, compared to oil prices in 2014 or before.

In 2014, the cost of the capital invested in oil sands extraction is estimated at $206.6 Billion (Cdn)[18]. Since these investments have produced plants and infrastructure that are remote, immobile and highly specialized, economic analysis would say that these investments have no alternative use and are sunk costs. If past oil sands investments in capital stock are therefore written down to zero, and no allowance for amortization is necessary, the net rent available from future production is the differential between current processing costs (estimated at $31.40 per barrel[19]) and price received. On this basis, Table 3 indicates that, if the price remains at $42.30 per barrel, the net present value of the oil sands per Albertan falls by over $210,000 (from $266,336 to $55,681) – i.e. the per Albertan decline in oil sands wealth is considerably larger than the per capita tangible wealth of all Canadians. Nevertheless, there is a residual value in continued production of about $56,000 per Albertan.

The net present value of future net resource revenue could be received by Albertans – but it is less clear how much Albertans really will bear the cost of the stranding of oil sands assets. To put it another way, one can ask: "who was going to get most of the rent from oil sands production, and now will not?" If the net rent from oil sands production were received entirely by out of province owners, then Albertans would not themselves be losing $210,000 per person when the price of oil falls from $88.50 per barrel to $42.30 – out of province owners would take the hit. The actual loss of Alberta residents depends on the ownership share of Albertans, but because data on the ownership shares of Albertans, non-Albertan

[18] Data on capital stock in the nonconventional oil extraction sector were drawn from CANSIM Table 031-0002 (series vector identifier v1070578). This series was discontinued in 2013 and replaced by CANSIM Table 031-0005. In the new table, however, the capital stock series for the nonconventional oil extraction sector have been suppressed due to Statistics Canada's confidentiality requirements. So to construct capital stock data up to 2014, the old data from the discontinued CANSIM Table 031-0002 are used to compute the nonconventional sector's share of total capital in the mining, oil and gas extraction industry through to 2013 (CANSIM series v90968347) and the shares computed in the first step are applied to arrive at an estimate of the capital stock in the nonconventional oil sector.

[19]Obtained by dividing the total operating expenditures of the non-conventional oil extraction sector (in dollars) by the sector's net output (in barrels). Data from Statistics Canada's Annual Oil and Gas Extraction Survey.

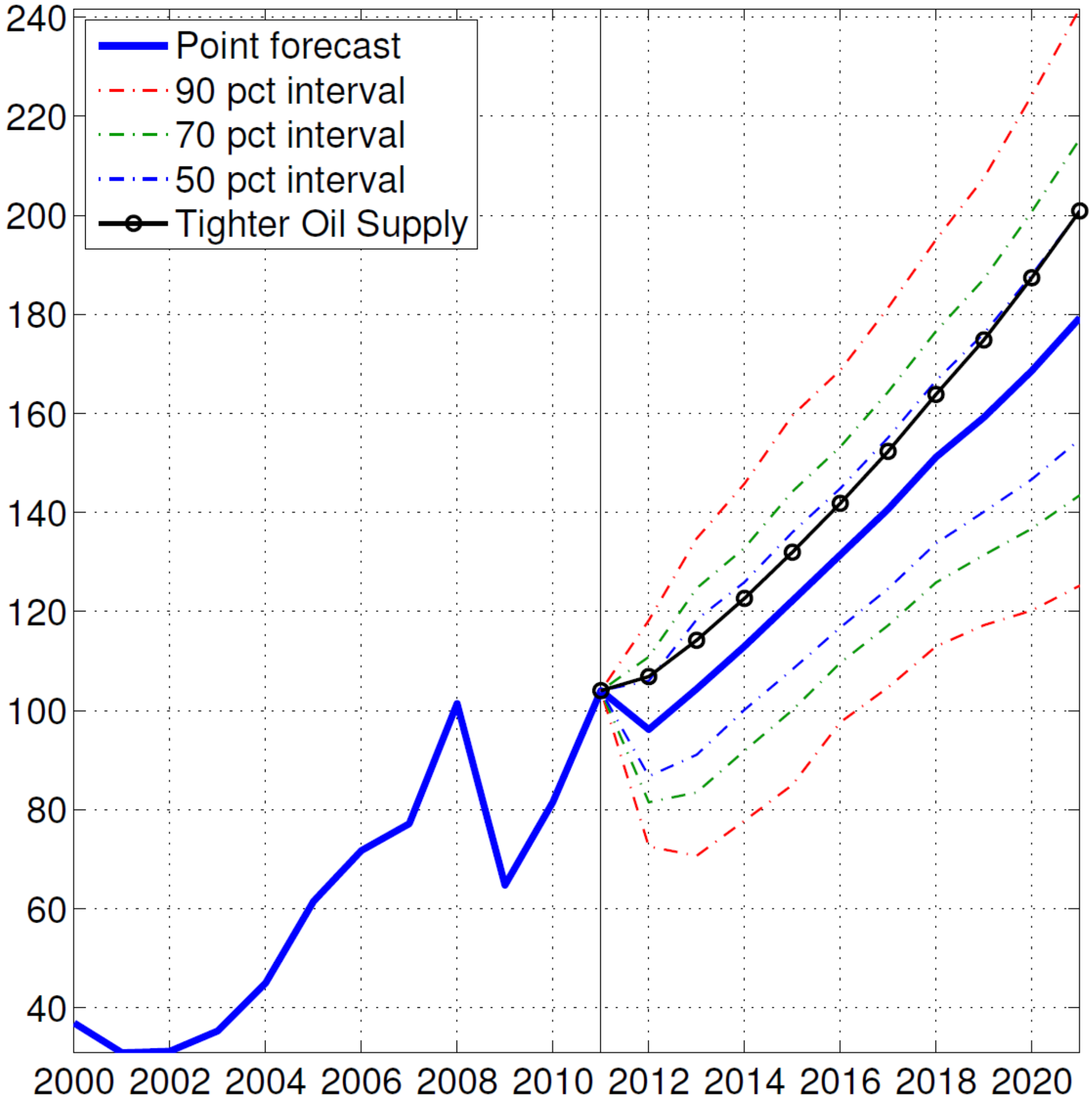
Canadians and foreigners is not available to us, we cannot apportion the loss of net rents. We suspect, however, that for Alberta residents, the primary issue is the percentage of resource rents received by Alberta in royalties and taxes, and the share of Albertans in the federal government transfers and program expenditures financed by federal tax on resource rent incomes.

Although Table 3 refers only to the Alberta oil sands, this reflects only part of the loss of natural resource wealth of Albertans caused by the energy price drop – rents from natural gas and conventional oil production also fall dramatically. As well, natural resource rents from oil and gas production disappeared in Saskatchewan and Newfoundland – and one should note that the Newfoundland offshore is a very high cost operating environment, in which net rent is similarly exposed to oil price variability. The wealth loss per capita calculated in Table 3 is large, but it is only part of the change in wealth of Alberta, Saskatchewan and Newfoundland produced by declining oil prices.

Although it is clear that the price assumption makes a huge difference to the value assigned to natural resource stocks, the volatility of oil prices (see Chart 1) and the size of the historically observed range (from $13 to $139 per barrel – 2016 U.S. dollars) makes it very unclear which price should be assumed for the future[20]. As an illustration of the uncertainties of forecasting, Chart 3 is copied from a technically excellent recent IMF working paper (Benes et al, 2012) which assessed in detail the likely growth of world oil demand, the geologic constraints on future oil production and the likely future evolution of extraction technology. It is to be noted that their projections have a rather wide 90 % confidence interval – for 2016 it spans the considerable range of $100 to $170 (U.S.) per barrel, increasing to the much wider range of $120 to $240 per barrel by 2021. *However, during March 2016, West Texas Intermediate traded in the range $34.56 to $37.99; during April 2016 from $34.30 to $46.03 and on May 9, 2016, it was at $43.45. In short, the actual price of oil in 2016 has been very considerably less than half of the lower bound of the 90% confidence interval on predicted prices of Benes et al (2012)*[21].

[20] Simple extrapolation of past cycles has little to recommend it – for example, although a simple quadratic in time explains much of the variation in real prices in Chart 1 (R^2 = 0.419) it predicts that the current price should be over $100 per barrel.
[21] see https://ycharts.com/indicators/crude_oil_spot_price

Chart 3: Oil Price Forecast with Error Bands (in real 2011 US dollars per barrel)



Source: reproduced from Figure 11 in Benes et al (2012:31)

As well, there is the possibility that past periods of boom and bust in the global oil industry will be a poor guide to oil prices in a future world. If there is a realistic chance that public policy to go carbon-free and rapid technical change will combine to produce a drastic shrinkage of markets for petroleum energy in the medium term future (e.g. after 2025) then the price of oil may remain very low indefinitely. For the immediate future, the actual likelihood of much less future oil dependence in the long term is less important than the current expectations of that future by low cost producers. The oil production decisions today of low-cost producers (principally Saudi Arabia) depend heavily on how much they expect oil which they leave in the ground to be worth in the long term future – if they expect, for example, that very cheap solar power will significantly displace oil demand in the long term future, selling oil now at whatever they can get for it is a better option than saving it to sell for even less later. Hence, the *expectations* of low cost producers of the likelihood of future public policy success in going carbon-free and the rapidity of future technical change in alternative energy sources are crucial to current prices.

If real world economies had balanced, steady state growth at a predictable rate with no fundamental shifts in public energy policy or energy technology or reserves, large swings in energy and other commodity prices would never occur. In such an economy, there would be no possibility of multi-billion dollar stranded assets. In a predictable world, we could take the observed market interest rate as revealed preference evidence on how heavily individuals discount the pleasures of future consumption in their utility maximization, and use that evidence to inform our choice of the social discount rate. Armed with the certainty of stable relative prices and unchanging real interest rates, we could then easily calculate the value of the wealth stock which each generation leaves behind for the benefit of future generations by adding up the value of productive assets, weighted by base period asset prices, because those asset prices would equal the net present value of future income generated, predictably estimated and discounted at the known interest rate.

In addition to big swings in commodity prices, there have been large long term shifts in the level of real interest rates over the past forty years. Fortunately, as appendix 2 discusses in depth, the IEWB is uniquely well suited to deal with uncertainty about the appropriate social discount rate, since IEWB methodology insists that individual users of the index specify their own social discount rate. The IEWB methodology of assuming fixed base period prices for wealth calculations can also be seen as reasonable for seven out of ten provinces in Canada, for whom reasonably constant terms of trade remain a plausible assumption. However, provincial wealth estimates for Alberta, Saskatchewan and Newfoundland are highly dependent on the price that future oil and gas production will obtain, and this is extremely uncertain. Since this uncertainty and the prospect of future instability in commodity markets is a characteristic of the real world it is a problem for any index attempting to summarize the economic well-being of resource dependent jurisdictions.

4.2 Average Consumption, Income Distribution and Economic Security

Tables 4, 5 and 6 examine the relationship between each of the other three components of the IEWB (current average consumption, equality in income distribution and economic security) and the terms of trade, controlling for simultaneous changes in GDP per capita. In each case, a regression on annual data 1981 to 2014 of the form:

$$\%\Delta y_t = \alpha + \beta(\%\Delta GDP_t) + \gamma(\%\Delta TOT)$$

is being run, where y = consumption, equality or security.

Table 4
Average Consumption and the Terms of Trade

Consumption	Real GDP per capita		Terms of Trade		
	Coefficient	SEE	Coefficient	SEE	R^2
CANADA	1.437**	0.244	-0.094	0.179	0.56
Alberta	0.877**	0.186	0.024	0.067	0.45
Saskatchewan	1.746**	0.398	0.303#	0.164	0.42
Newfoundland	0.614*	0.300	-0.157	0.181	0.12
Ontario	1.178**	0.234	0.420	0.397	0.46
Quebec	1.950**	0.366	0.387	0.470	0.51
Nova Scotia	1.006**	0.366	-0.013	0.303	0.20
New Brunswick	1.712**	0.501	0.824*	0.391	0.34
Manitoba	1.403**	0.283	0.016	0.256	0.45
Prince Edward Island	0.605	0.747	0.081	0.498	0.02
British Columbia	1.153**	0.228	0.321	0.211	0.59

** is 1 per cent significance,
* is 5 per cent significance
\# is 10 per cent significance

As one would expect (since consumption expenditures are a major component of GDP) there is a tight statistical relationship between changes in consumption and changes in GDP per capita. The general insignificance of changes in the terms of trade is a bit more surprising.

Table 5
Income Equality and the Terms of Trade

Equality	Real GDP per capita		Terms of Trade		
	Coefficient	SEE	Coefficient	SEE	R^2
CANADA	0.315	0.353	0.281	0.258	0.10
Alberta	1.830**	0.614	-0.046	0.222	0.23
Saskatchewan	-2.302	1.395	0.75	0.574	0.09
Newfoundland	0.002	1.157	0.447	0.699	0.02
Ontario	0.567	0.425	0.069	0.722	0.06
Quebec	-0.334	0.650	0.654	0.835	0.02
Nova Scotia	0.790	0.698	1.216*	0.579	0.16
New Brunswick	-1.080	0.856	2.186**	0.670	0.29
Manitoba	-1.008	0.661	0.241	0.598	0.07
Prince Edward Island	-0.245	0.992	-0.532	0.661	0.02
British Columbia	0.807	0.847	1.833*	0.784	0.25

** is 1 per cent significance
* is 5 per cent significance
# is 10 per cent significance

The general story which Table 5 tells is "no effect". The institutions that determine the distribution of income have great inertia within provinces (particularly among that vast majority of the population who retain employment from year-to-year). Hence, in normal times the income distribution dimension of economic well-being is not very sensitive to year to year variations in output or employment within countries. The exception appears to be Alberta where, during the resource boom period, strong GDP growth, driven by energy sector investment, produced low unemployment and robust growth in real wages for oil patch workers, compressing the income distribution and decreasing income poverty.

Table 6
Economic Security and the Terms of Trade

Security	Real GDP per capita		Terms of Trade		
	Coefficient	SEE	Coefficient	SEE	R^2
CANADA	0.700**	0.196	0.122	0.143	0.39
Alberta	0.724**	0.190	-0.002	0.069	0.34
Saskatchewan	0.055	0.190	0.237**	0.078	0.24
Newfoundland	0.193	0.403	0.053	0.243	0.01
Ontario	0.779**	0.194	0.163	0.330	0.35
Quebec	0.671*	0.266	-0.021	0.342	0.18
Nova Scotia	-0.103	0.466	1.027*	0.386	0.19
New Brunswick	-0.565	0.413	1.552**	0.323	0.46
Manitoba	0.789#	0.399	0.431	0.362	0.16
Prince Edward Island	0.592	0.512	0.432	0.341	0.08
British Columbia	0.500	0.367	0.744*	0.340	0.27

** is 1 per cent significance
* is 5 per cent significance
\# is 10 per cent significance

The component of the IEWB most sensitive to the business cycle is the economic security index, as the probability of unemployment enters the unemployment risk sub-component directly and unemployment is negatively related to GDP growth, so economic security is positively related—no surprise there. However, it is interesting that some provinces appear to be more tied to positive Terms of Trade movements than to GDP changes.

5. Conclusion

As already noted, the philosophy of the IEWB is that individuals typically "live in the present, anticipating the future" . In their anticipations of the future, individuals have reason to care about the uncertainty of future individual outcomes (i.e. economic security) and the aggregate resources available to their society in future periods (i.e. national wealth). Hence, both individual and aggregate uncertainty matter for current economic well-being.

Osberg and Sharpe (2014) examined short term business cycle impacts and argued that the "Great Recession" of 2008 had very different impacts in different countries – that the IEWB and conventional indicators, like unemployment or GDP growth, agree in showing that in some countries (e.g., the US or Spain), the 2008 recession ushered in a prolonged and severe economic downturn, while in other nations (e.g., Australia or Germany) it produced a short negative blip in the data, with few apparent long-term consequences. Since institutional structures with considerable inertia are important determinants of economic insecurity and inequality, but different nations have made different institutional choices in the past, the cyclical output shock of the recession was moderated to considerably varying degrees across nations.

This paper has taken a longer time frame and examined the longer term movements of energy prices. It comes to a somewhat similar conclusion, in the sense that the impacts of terms of trade fluctuations vary widely. Within Canada, oil and gas production is concentrated in three provinces (with only 16% of Canada's population), so the supply side benefits of oil price booms and the costs of oil price busts have been tightly focussed – these three provinces have seen big fluctuations in their terms of trade, driven by energy price movements. By contrast, in consuming provinces fluctuations in terms of trade have been small, and unrelated to energy price movements. Although the Canadian system of equalization payments to provinces from the federal government can be seen as a form of insurance and risk-pooling against commodity price risk across provinces[22], that program has become a relatively small fraction (25%) of federal government transfers to provinces

[22] see Boadway and Hayashi (2002) for fuller discussion.

and constitutes only about 1.1% [23] of national GDP[24]. Hence, the impacts of energy price movements are largely borne by the producing provinces.

Any aggregate index of well-being necessarily imposes some weighting of the components of well-being. This implies that calculations of trends in aggregate indices can be sensitive to the weighting of components, when trends in those components of well-being differ, as was the case across Canada's ten provinces. The starkest differences are in anticipations of the future – i.e. the wealth component. Although wealth stocks are, in a physical sense, accumulated over many years, their value can change overnight, if there is a large change in the relative price of the commodity that they produce.

The value of the natural resource stocks of Alberta, Saskatchewan and Newfoundland depends crucially on the price of oil, which has varied hugely in the past. Even the best economic forecasts of oil prices have been spectacularly unsuccessful. The variability and unpredictability of oil prices means that the wealth of the residents of these three provinces is, in 2016, extremely uncertain.

Although the possibility of large, possibly long term, changes in the terms of trade is inconceivable in balanced growth models of the economy, it is a feature of the real world. For seven out of ten provinces, with 84% of Canada's population, terms of trade uncertainty has not been a problem. For these provinces, we observe roughly constant terms of trade and the IEWB methodology of using constant base period prices in valuing the capital stock remains plausible. However, for the three oil producing provinces the collapse of oil prices in 2014 has created major changes in per capita wealth and the possibility of large stranded assets, with significant, but highly uncertain, implications for economic well-being.

[23] http://www.fin.gc.ca/fedprov/mtp-eng.asp and http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/gdps04a-eng.htm

[24] Alberta received equalization payments from the federal government until 1962, but this was largely forgotten during the euphoria period of rising oil prices. Resentment of equalization payments to "undeserving easterners" arguably underpinned the removal of the equalization components of health and social transfers and their conversion to per capita federal grants under the Harper government.

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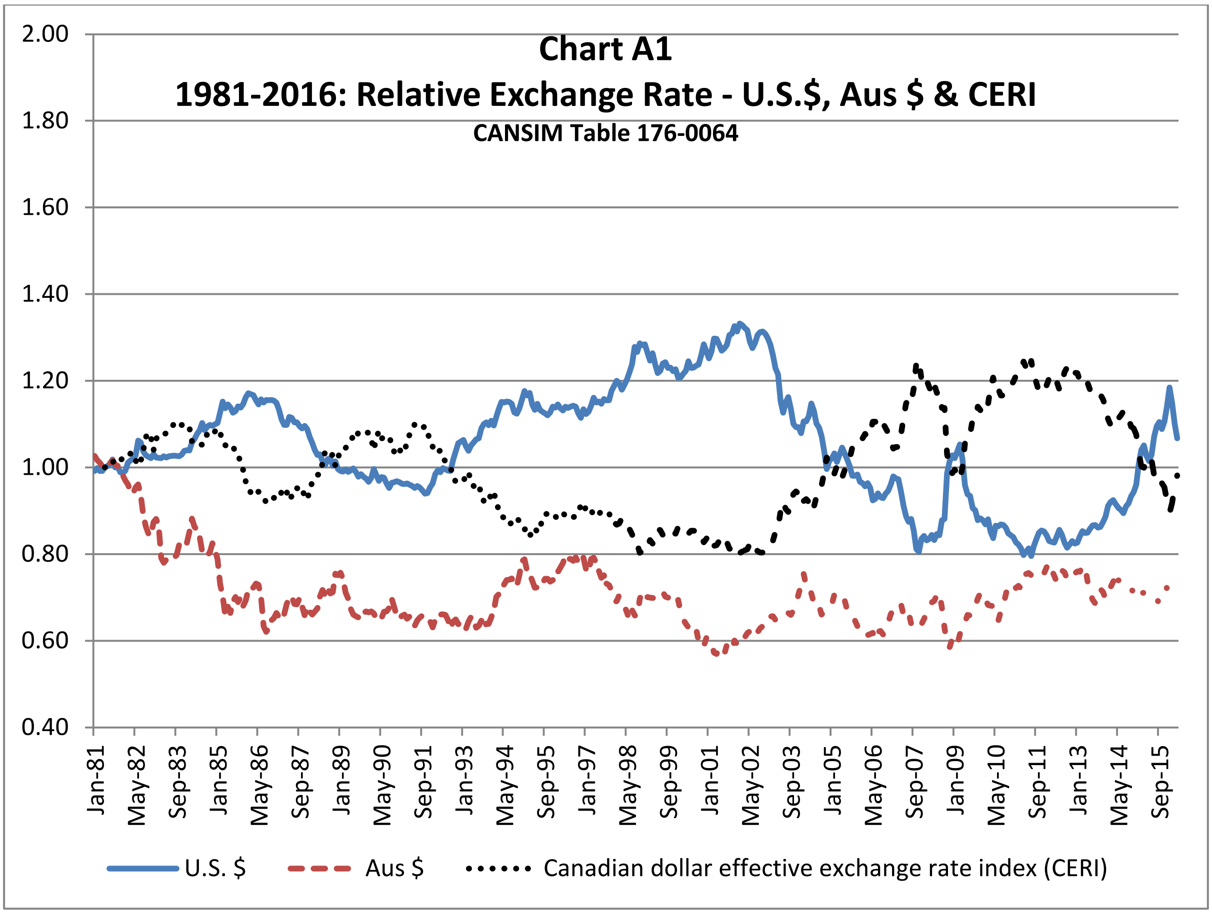
http://larrysummers.com/2016/02/17/the-age-of-secular-stagnation/#more-6233

Appendix 1[25]



[25] Chart A1 presents monthly average nominal exchange rates relative to their May 1981 base, scaled comparably as for Charts 2a and 2b. Australia is included because its resource dependence has often been compared to Canada's. In May 1981 the Canadian dollar cost of $1 U.S. was $1.20 and the cost of $1 Australian was $1.37. Clearly, relative inflation rates, interest rate differentials and much else affects nominal exchange rate movements. But the key point is that not much of the volatility one can see in many time series variables is reflected in Chart A1

Appendix 2

Why the Variation in Interest Rates affects the IEWB less than other Well-Being Indices

The valuation of the wealth stock of a society at any point in time requires both an estimation of the future market value of the consumption flow which capital goods will enable and a choice of the discount rate appropriate for weighting future period consumption, compared to current consumption. Section 3.1 has emphasized the problems that large fluctuations in oil prices and the net rents from future oil production creates for calculation of the wealth component of the IEWB for three of Canada's provinces. However, large fluctuations in real interest rates also create uncertainty about the discount rate that should be used to calculate society's wealth – i.e. the net present value corresponding to any expected stream of future consumption. To illustrate the context, Chart A2 presents the real average mortgage rate (i.e. average nominal rate minus the current consumer price inflation rate) for Canada from 1951 to 2016.

Other interest rate series could be used to make the same point, but for the measurement of well-being, the home mortgage interest rate time series has the advantage of being the single most important long term interest rate which most Canadians directly face – i.e. the long term interest rate on the largest liability of the majority of Canadian households and the implicit rate of return on their savings (via mortgage pay-down) for much of their adult lives. If we want revealed preference evidence on the rate at which most individual Canadians have actually traded long term future personal consumption for current personal consumption, the average real mortgage interest rate is a plausible candidate[26]. Chart A2 presents both a 6 month and 12 month moving average to illustrate that significant short term volatility is still present, even after substantial data smoothing. However, the bigger issue is what longer term fluctuations in the real mortgage interest rate might imply for the discount rate to use in calculating the present value of future income.

[26] Credit card debt is also very common, but arguably reflects transitory income and consumption shocks, or problems with financial self-control, rather than conscious, long term trade-off decisions.

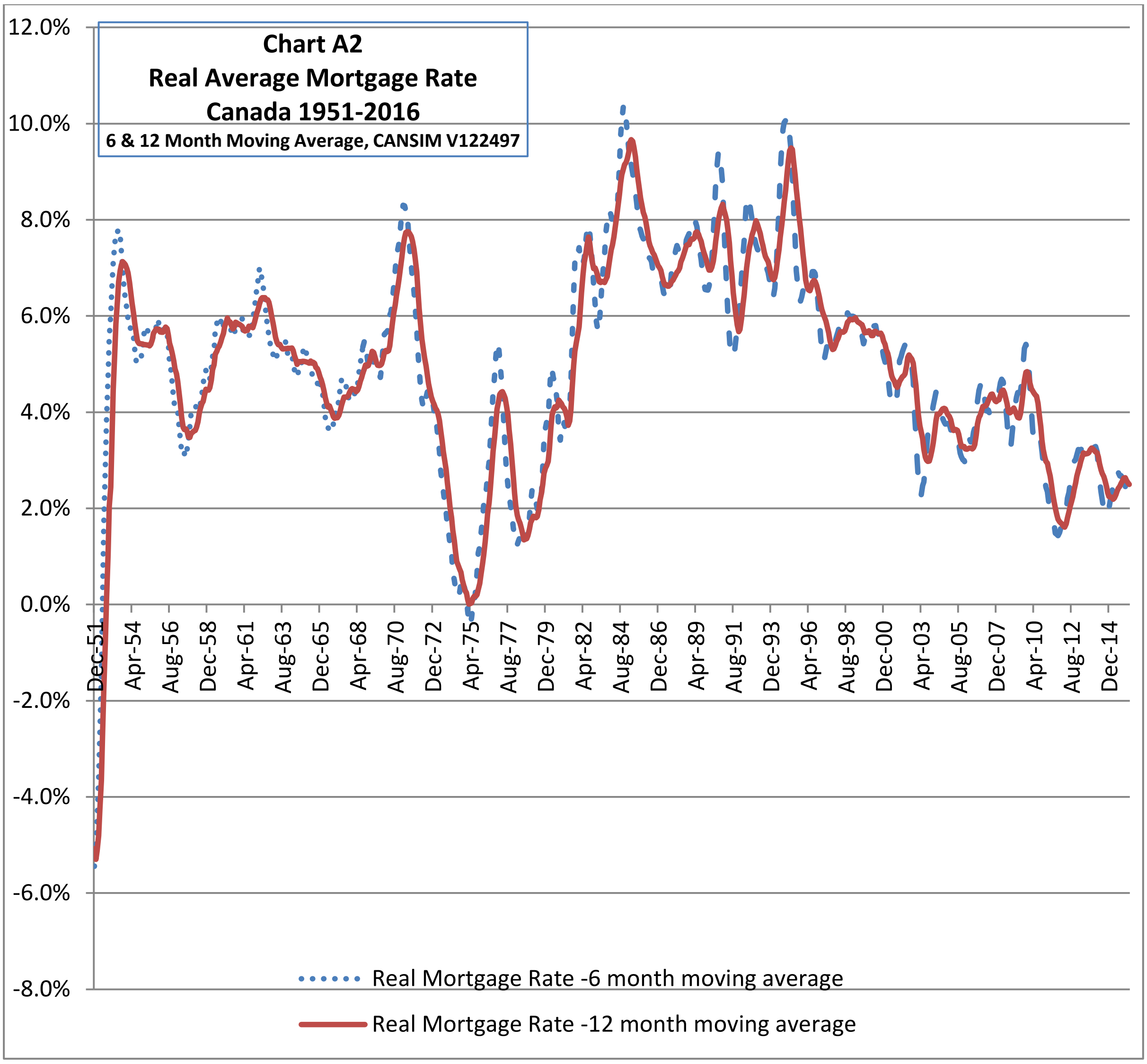


Chart A2 shows clearly the two brief episodes in post-war Canada when a surge in inflation and sluggish changes to nominal interest rates pushed the real interest rate into negative territory. However, if we disregard such episodes and concentrate on finding periods of relative stability, between June 1952 and October 1965 (when inflation averaged 1.3%) the real interest rate fluctuated around an average 5.4%, falling to an average 4.6 % in the late 1960s. The 1970s were a volatile period of higher inflation, during which the real interest rate averaged 3.2%, and there was a drastic increase in nominal interest rates in 1981-1982 (peaking at 21.5% in September 1981). After this, the real interest rate settled into a 14 year period (from 1982 to 1996) when it fluctuated around an average of 7.5%. But although Chart

A2 can be seen as illustrating short term volatility around a mean of roughly 5% from 1952 to 1970, and similar short term volatility around a mean of 7.5% from 1982 to 1996, it also clearly shows the long downward trend in real interest rates since the late 1990s.

King and Low (2014) have also found a strong trend to lower real interest rates since 2000 in international data. Summers (2016) and others have seen this trend as evidence for the 'secular stagnation' hypothesis, that contemporary global capitalism generates an aggregate flow of savings which requires an extremely low, possibly negative, real interest rate to balance with desired investment at full employment (i.e. attempts to maintain higher real interest rates will produce stagnant output and increasing unemployment). In March 2016, the real mortgage interest rate in Canada was 2.5%, which is approximately what it has averaged (2.6%) since January 2010. If the secular stagnation hypothesis is true, the low level of interest rates of 2016 are not a temporary aberration but a predictor of the long-run level of real interest rates, – indeed real interest rates could go even lower.

In theoretical discussions of economic well-being (e.g. Fleurbaey and Blanchet, 2013) the present value of the consumption to be obtained in future periods is calculated by discounting future flows at an exogenous rate of interest. If the economy were on a stable long term growth path and real interest rates were roughly constant over long periods, one could tell a story about how equilibrium real interest rates reflect the revealed preferences of individuals for life cycle and bequest savings. The social discount rate would not generally be the same as the equilibrium real interest rate, since it should reflect adjustments for the externalities and for the risks of individual savings, but it should reflect this evidence on individuals' time preferences.

However, in the real world we observe quite large changes over time in real interest rates. So which time period's discount rate on future consumption is should inform our choice of social discount rate to use for estimates of economic well-being[27]? Is it the 2.6% per year trade-off which Canadians have faced in an average recent year, the 5% per year ratio of the 1952-1970 period or the 7.5% per year trade-off which Canadians faced in the 1980s and early 1990s?[28] Or if there really has been a regime change to a new normal of secular stagnation, will real interest rates in future years be closer to the current Bank of Canada benchmark lending rate of 0.5% ? The choice of discount rate makes a dramatic difference to the net present value of income streams. Since, for example, a 40 year stream of constant returns is worth roughly twice as much at 2.6% discount as at 7.5% discount, the valuation of all types of capital assets depends heavily on the discount rate assumption.

The problem of which discount rate to choose is a deep and intractable issue for authors, such as Fleurbaey and Blanchet (2013) whose methodology depends on the specification of a unique social discount rate. However, the methodology of the IEWB finesses the problem entirely. Because the IEWB starts from the perspective that individual citizens may have different values, it suggests a methodology in which the IEWB is calculated as the weighted sum of four components, in which each citizen chooses the weights to be assigned to each component, as in:

[A2.1] $$\text{IEWB} = \beta_1 (\text{Current Average Consumption}) + \beta_2 (\text{Total Societal Wealth}) + \beta_3 (\text{Equality}) + \beta_4 (\text{Security})$$

$$\text{Subject to: } \beta_1 + \beta_2 + \beta_3 + \beta_4 = 1$$

As already noted, an aggregate income type measure of economic well-being implicitly assumes inequality and insecurity to be unimportant (i.e. sets $\beta_3 = \beta_4 = 0$) and assumes that current consumption and savings always optimally balance social concerns for current and future consumption.

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[27] The calculations of the net present value of the oil sands presented in Table 1 used a 4% discount rate.
[28] Since Ramsey(1928) many authors have also argued that it is ethically inappropriate to discount the utility of future generations at all, hence the time discount rate should be zero.

The IEWB perspective is that individuals differ in their time preference and their relative concern for the well-being of future generations, and that these differences will legitimately find expression in their evaluation of aggregate economic well-being. Adding the subscript i to reflect that this is the time preference of a particular citizen, the discount rate of an individual is r_i , and one can express an individuals' personal relative weight on sciety's future consumption compared to present consumption as:

[A2.2] $\beta_{2i} / \beta_{1i} = 1 / (1 + r_i)$

In the IEWB, the value of natural resource wealth stocks (for example, the net rents from the oil sands), is calculated using an assumed discount rate of 4% and the value of private capital stock is taken from investment data (i.e. reflects the market interest rate). Knowing this, those individuals with $r_i < 0.04$ (i.e. those who think that a 4% discount rate inadequately reflects the value of future consumption) will think that the stock of resource wealth has been under-priced, so they can compensate for that understatement (in their eyes) by adjusting upwards their weighting (β_{2i}) of the wealth component.

Appendix 3

The Index of Economic Well-Being by Dimension and by Province

Chart 1: Consumption Domain

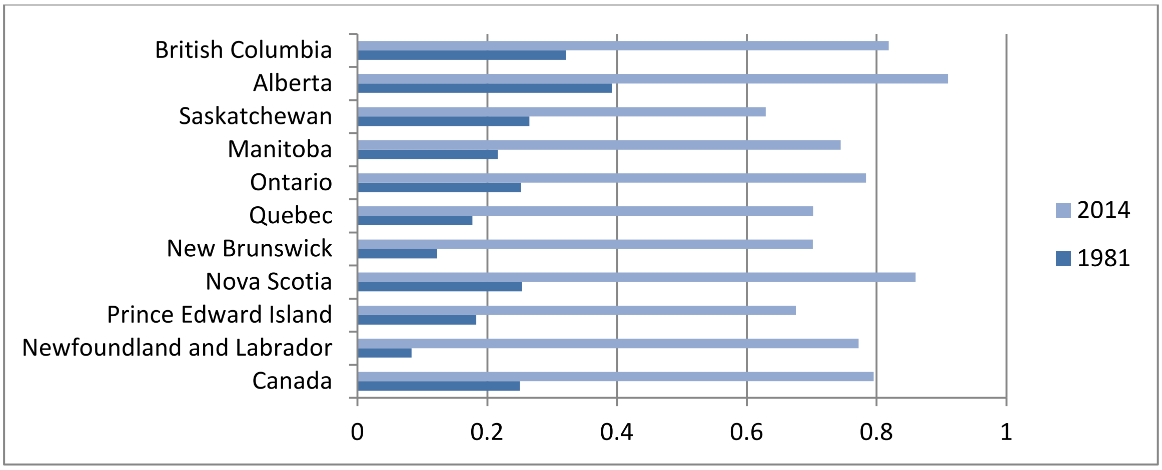

Chart 2: Wealth Domain

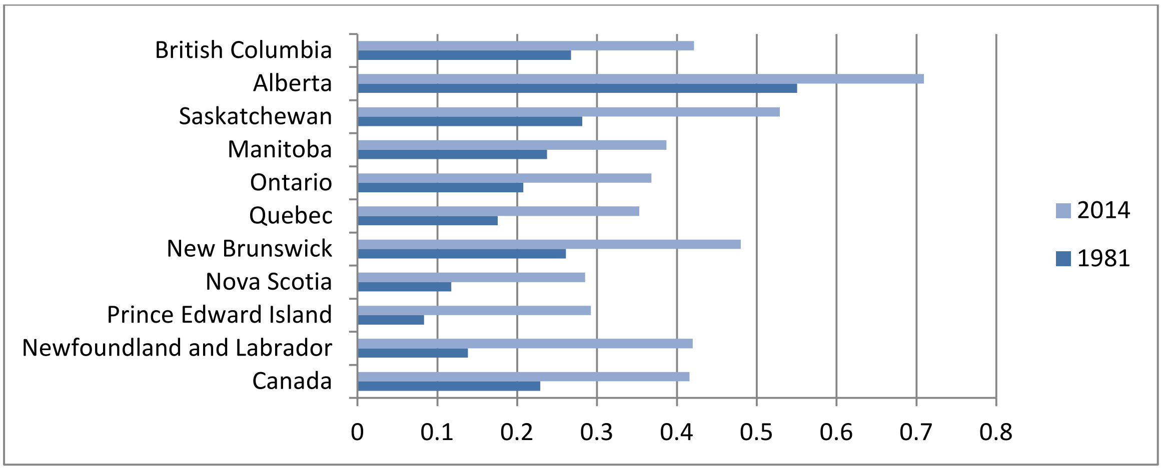

Chart 3: Equality Domain

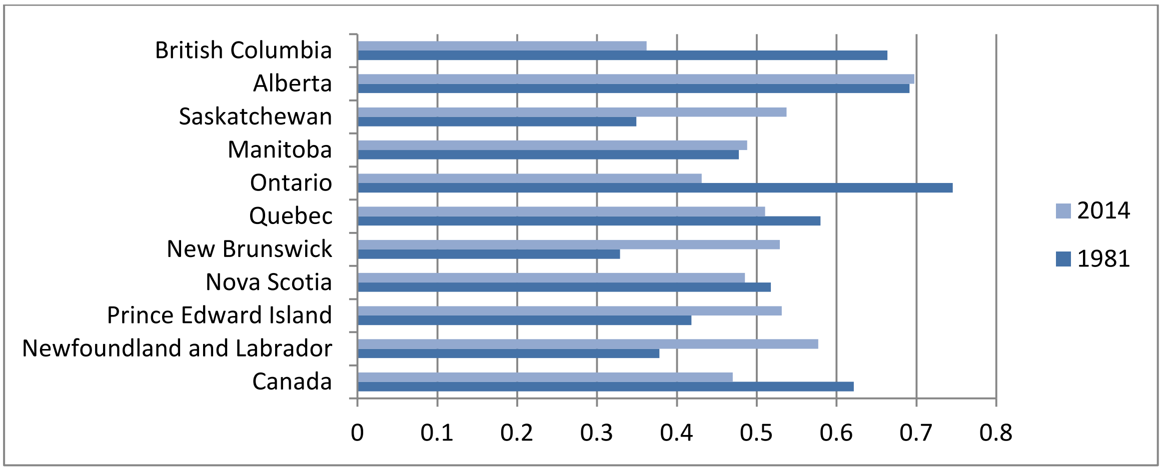

Chart 4: Security Domain

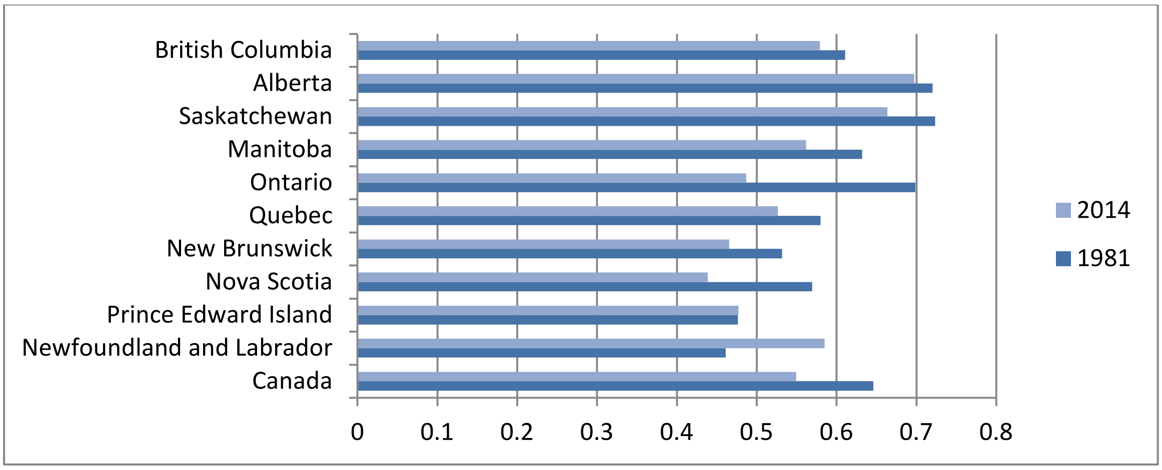

Chart 5: Overall IEWB

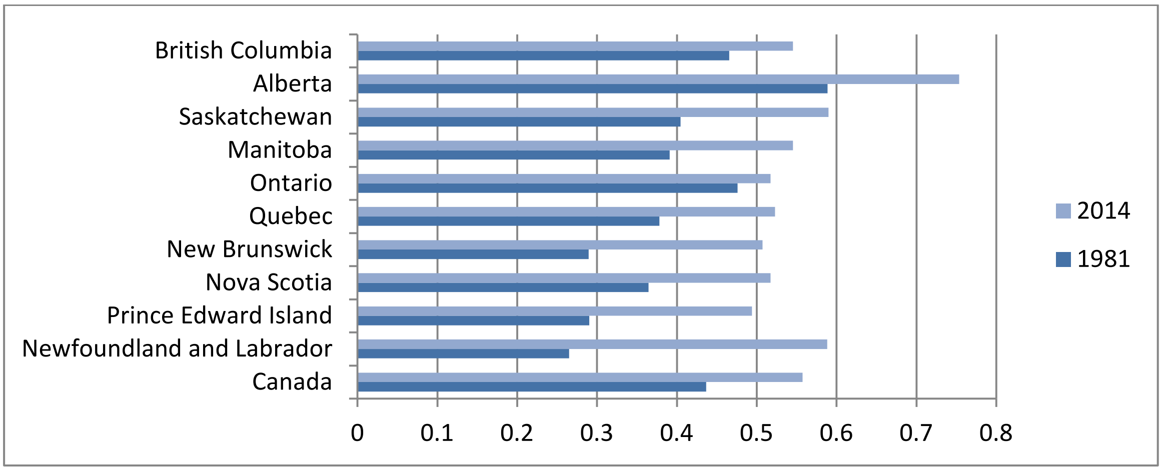

Chart 6: Overall IEWB