How Much does Commodity Price Volatility Matter for Economic Well-Being in Rich Countries?

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Abstract

This paper examines the impacts of commodity price volatility and changing terms of trade on economic well-being using the Index of Economic Well-Being and available data on fourteen OECD nations over the period 1980to 2014. It notes that the huge swings of commodity prices have had very uneven impacts. Norway, Australia and Canada's three oil producing provinces – Alberta, Saskatchewan and Newfoundland – have seen huge swings in their terms of trade, largely driven by energy price changes. The terms of trade of the other countries examined (Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Spain, Sweden, U.K. and U.S.A.) and of Canada's seven other provinces are largely unrelated to resource price movements and have changed remarkably little over time – hence there has been little impact on economic well-being. However, since estimates of natural resource wealth capitalize the net rent to be expected from future output, expectations of future resource prices matter enormously to the per capita natural resource wealth of the people who live in producing jurisdictions. Resource price uncertainty therefore poses major problems for measurement of their current economic well-being – but is not very important for the vast majority of people who live elsewhere.

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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.[3] 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 within and between 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 2008following 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 of the booms and busts of energy and commodity prices on economic well-being, as measured by the IEWB.

Section 2 of the paper begins by establishing the context – the huge fluctuations in oil and commodity prices of the last forty years and the stark differences between producing and consuming jurisdictions in terms of trade volatility. Section 3 then summarizes the IEWB approach to the measurement of economic well-being. Section 4 discusses why commodity

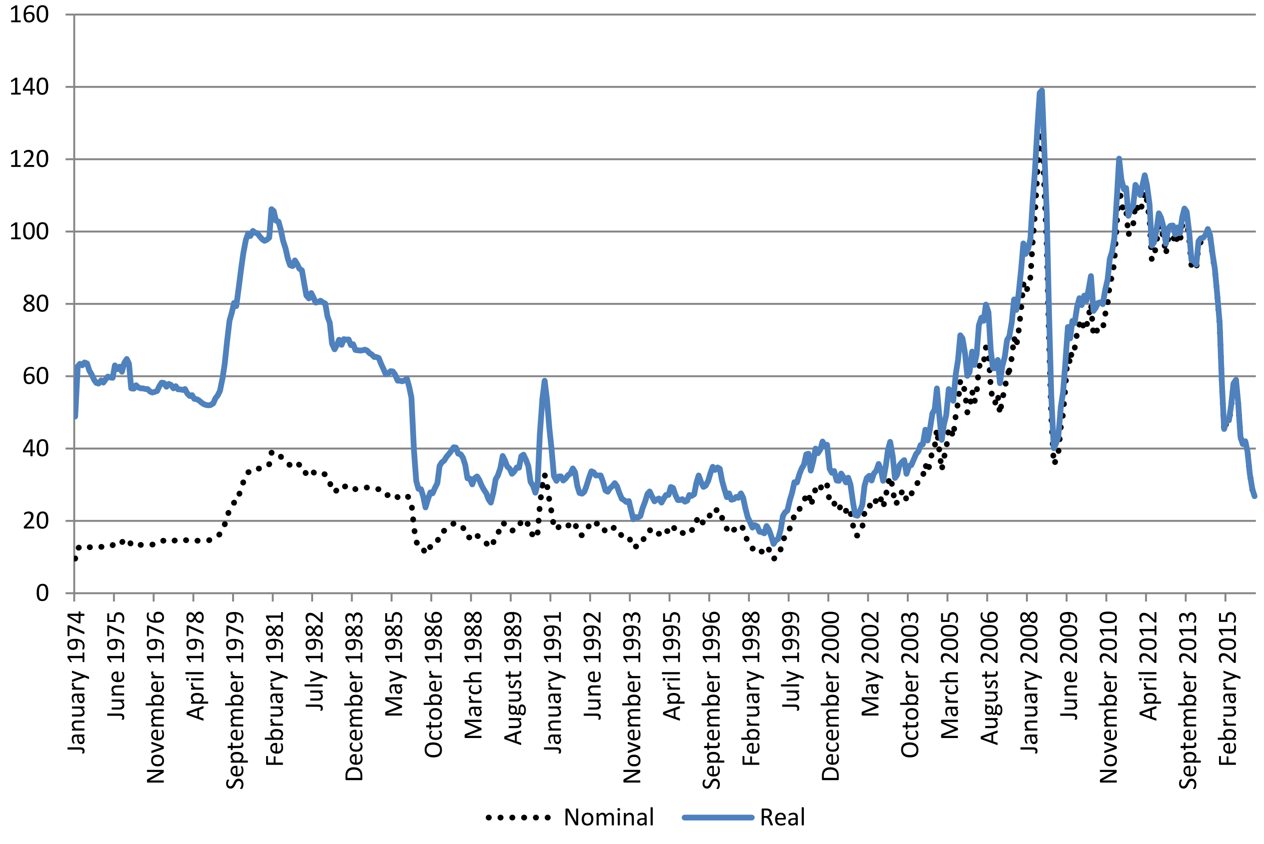
[3] Osberg and Sharpe,(1998, 2002a, 2002b, 2006, 2011); Thomas and Uguccioni (2016a, 2016b)

price volatility and fluctuating terms of trade would affect the components of economic well-being -- wealth, consumption, income distribution and economic insecurity -- and assesses the magnitude of the effects from national accounting and econometric perspectives. Section 5 assesses the implications and concludes.

2. Commodity Price Movements and Long Term Variability in Terms of Trade[4]

The real price of oil has been on a wild ride over the last forty-two years. Chart 1presents the real (solid line) and nominal (dotted line) average monthly price per barrel paid for U.S. oil imports from 1974 to 2016.[5]

Chart 1: Real and Nominal Average Price of Imported Crude Oil, United States, U.S. Dollars per Barrel, 1974-2016



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

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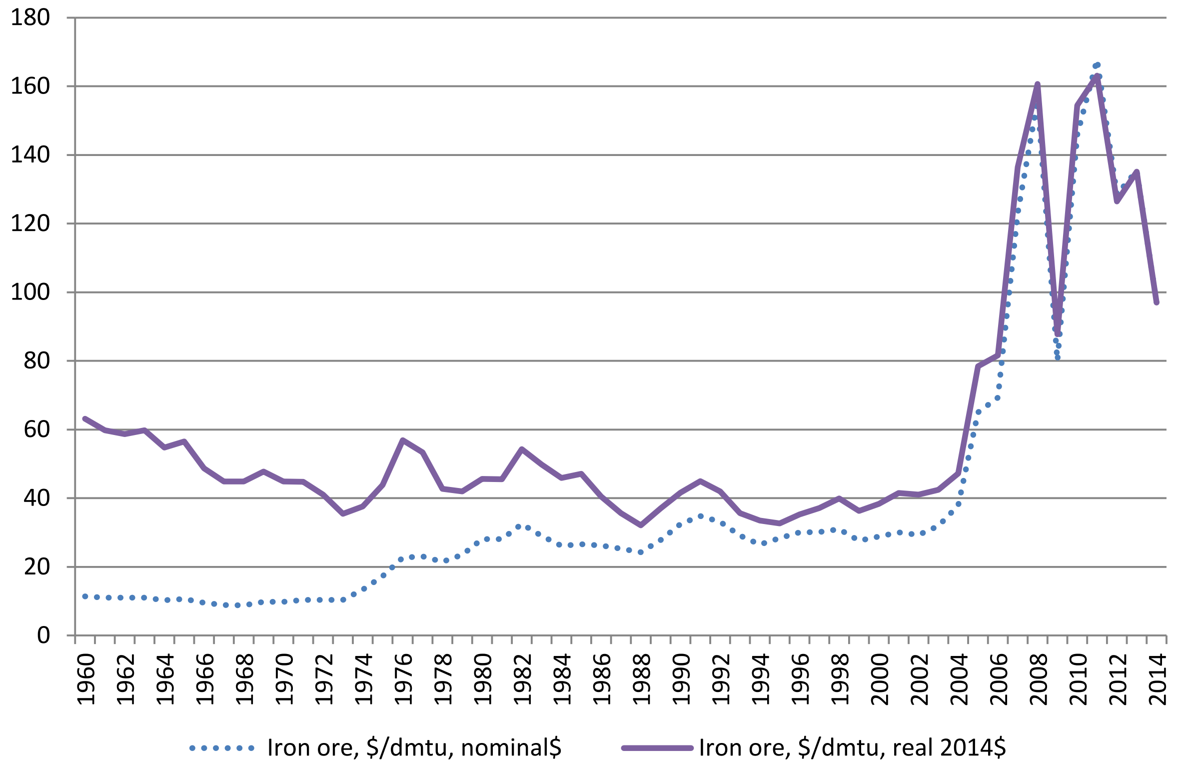
[4] Terms of trade = (implicit export price deflator)/(implicit import price deflator).

[5] The U.S. consumer price index is used to adjust nominal prices. For a full selection of real and nominal oil and gas prices, all with similar trends, seehttp://www.eia.gov/forecasts/steo/realprices/

Chart 2presents an illustration of a different pattern of volatility – the nominal and real price of iron ore, over the period 1960 to 2014. Following a long period of approximate real price stability, after 2004 the real price of iron ore suddenly quadrupled – increasing from approximately $40 to $160 per ton – before descending to $100 per ton in 2014.[6] Other charts for other natural resource prices show somewhat different patterns, but there is a common element – massive occasional variability in real resource prices, with correspondingly large impacts on the countries, and regions within countries, that produce these commodities.

Chart 2: Real and Nominal Price of Iron Ore, U.S. Dollars per Ton, 1960-2014



Source: World Bank
http://databank.worldbank.org/data/reports.aspx?source=Global-Economic-Monitor-(GEM)-Commodities
Underlying data from: Vale; CVRD; UNCTAD; World Bank.

If the production of oil or iron ore or other natural resources were characterized by constant returns to scale, there would be many possible suppliers – taken literally, constant returns to scale implies that each of us would be able to turn to our own backyard oil well and

[6]The price declined further to $41 at the end of 2015, followed by partial recovery to $61 on April 30, 2016. Iron ore traded at $52 on June 30, 2016. See https://ycharts.com/indicators/iron_ore_spot_price_any_origin.

iron mine to obtain what we need. In this case, resource prices might vary over time (perhaps due to changing extraction technologies) but all jurisdictions would be equally affected by price fluctuations. However, in the real world, the production of oil or iron ore or other natural resources depends on a few specific point sources of supply. Typically, the extraction of minerals or natural gas or oil involves substantial indivisible fixed costs and important increasing returns to scale in production.[7] Very large economies of scale mean that the production of natural resources is highly concentrated in a relatively small number of locations – very unlike the consumption of natural resources, which is diffused broadly in all economies.

When natural resource supply is concentrated among relatively few producing locations, but natural resource demand is widely diffused among many consumers, resource price changes are likely to have large impacts on each of the few producers but small impacts on each of the many consumers. How much then do such swings in commodity price affect economic well-being in different places? Changes in the prices of what a jurisdiction sells to the rest of the world, compared to the prices of what it buys, will change the gains available from trade and, therefore, the economic well-being of that jurisdiction. Since resource production is, in all nations, a fraction of economic activity, commodity price volatility will only have substantial effects on the terms of trade for jurisdictions which are heavily specialized in resource production for export.

Chart 3 summarizes fluctuations in national terms of trade for 14 OECD nations over the period 1970-2015. For most nations (i.e. 10 of 14), the last twenty years have been characterized by fairly small (less than 10%) movements in the national terms of trade.[8] Norway and Australia stand out as huge exceptions to that rule – in both, the national terms of trade reached nearly 200% of their 1995 base in 2011-2012, with substantial declines in the years since. Aggregated to a national basis, Canada's appreciating terms of trade since 2000 is notably less, but as Appendix 1 documents in detail, within Canada there have been dramatic disparities. The three oil producing provinces (Alberta, Saskatchewan and Newfoundland, which together account for 16% of Canada's population) have experienced

[7] As an example, see Roe (2016)

[8] As well as the variations in terms of trade attributable to commodity price fluctuations, Chart 3 also shows how the fluctuations in Spain's terms of trade during the 1970s and 1980s have been followed by a long period of stability. As well, Finland's terms of trade have deteriorated over the last twenty years.

terms of trade fluctuations quite similar to Norway's – but the seven oil consuming provinces have had essentially constant terms of trade.

Chart 3: Terms of Trade, Selected OECD Countries, 1995 = 100, 1970-2015

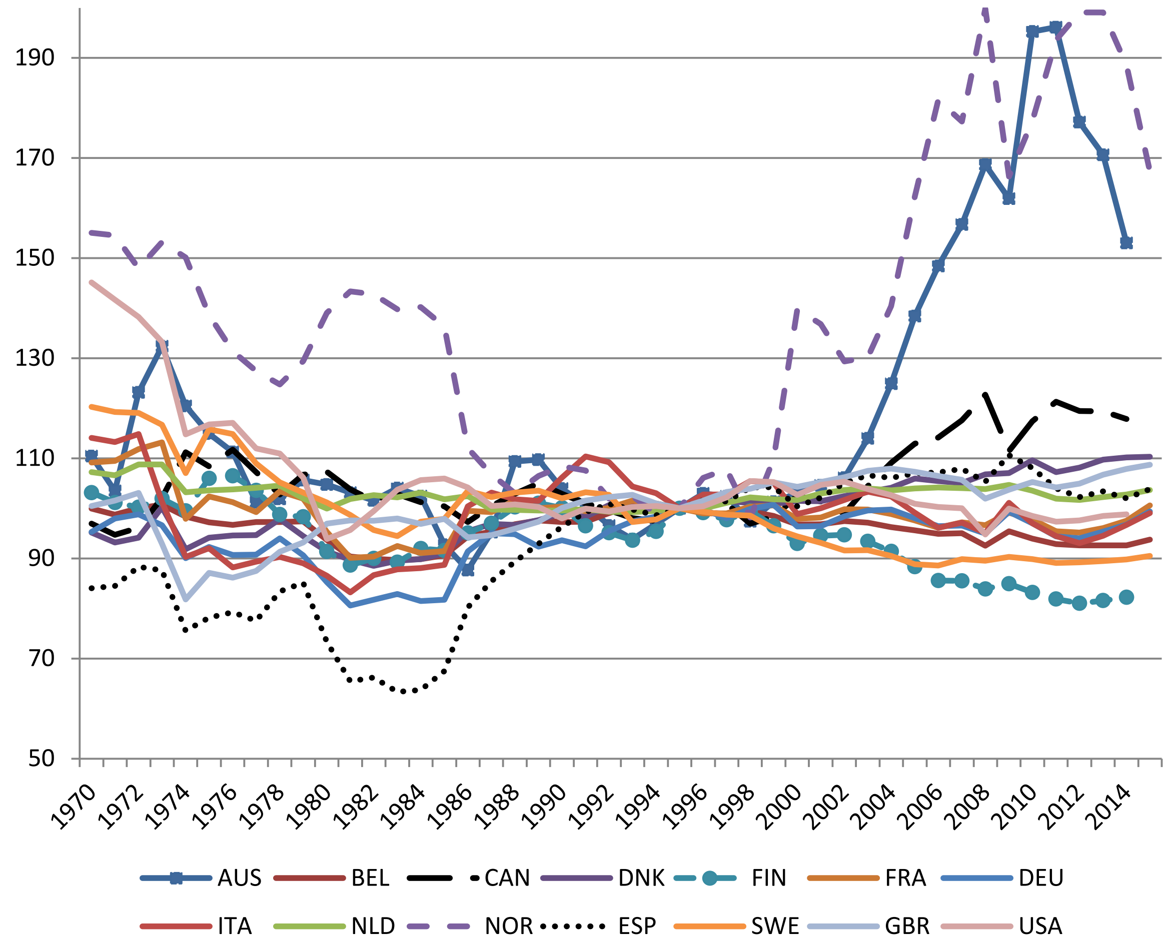


Table 1quantifies these visual impressions a bit. It reports the simple OLS regression

TOT = $\alpha + \beta$ *(INDEX)* estimated over annual data 1970-2014, where *TOT* is a country's terms of trade and *INDEX* is an index of world prices for crude oil, all commodities and iron ore, respectively. Its main message is the heterogeneity of correlations between resource price movements and changes in national terms of trade. Some nations' terms of trade (notably Norway, Australia and Canada) are strongly and positively linked to movements in resource prices. For a few nations (e.g. Denmark, U.K.) resource price movements are statistically and quantitatively insignificantly different from zero, but for most nations resource price movements are a statistically significant but empirically small negative correlate with terms of trade changes.

Table 1: Commodity Price Indices and National Terms of Trade

	Crude Oil		All Commodities		Iron Ore	
	Coefficient	R^2	Coefficient	R^2	Coefficient	R^2
Australia	0.133 (0.005)	0.22	0.367 (0.000)	0.52	0.162 (0.000)	0.33
Belgium	-0.041 (0.000)	0.46	-0.046 (0.013)	0.18	-0.025 (0.016)	0.17
Canada	0.101 (0.000)	0.57	0.209 (0.000)	0.74	0.088 (0.000)	0.43
Denmark	-0.003 (0.730)	0.00	0.007 (0.711)	0.00	0.007 (0.480)	0.02
Finland	-0.052 (0.001)	0.30	-0.060 (0.040)	0.13	-0.026 (0.121)	0.07
France	-0.061 (0.000)	0.44	-0.053 (0.067)	0.10	-0.025 (0.120)	0.07
Germany	-0.074 (0.000)	0.36	-0.074 (0.052)	0.11	-0.042 (0.048)	0.12
Italy	-0.093 (0.000)	0.38	-0.142 (0.001)	0.28	-0.042 (0.108)	0.08
Netherlands	-0.016 (0.007)	0.21	-0.036 (0.001)	0.30	-0.007 (0.292)	0.04
Norway	0.310 (0.000)	0.75	0.411 (0.000)	0.41	0.166 (0.006)	0.21
Spain	-0.087 (0.005)	0.22	-0.089 (0.131)	0.07	-0.019 (0.567)	0.01
Sweden	-0.034 (0.013)	0.18	-0.022 (0.391)	0.02	-0.006 (0.696)	0.01
United Kingdom	0.002 (0.839)	0.00	-0.033 (0.083)	0.09	-0.011 (0.302)	0.03
United States	-0.058 (0.000)	0.39	-0.116 (0.000)	0.49	-0.043 (0.006)	0.21

(p values in parentheses = t test probability β =0)

Source:

World Bank Commodity Price Data (The Pink Sheet): Crude oil, average, $/bbl, nominal US dollars

World Bank Commodity Price Data (The Pink Sheet): Iron ore, cfr, spot, $/dmtu, nominal US dollars

The all commodity price index is the average of annual price indices for energy commodities, non-energy commodities and precious metals in the World Bank Commodity Price Data (The Pink Sheet), Annual Indices (Nominal).

The big swings of oil and other commodity prices, and the stark variation in the degree to which the terms of trade of different jurisdictions are affected by these swings, suggests that the impact of resource price swings on well-being depends very much on what country or province 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 3provides a brief outline of the methodology of the IEWB, as well as a summary of trends in the IEWB. Readers who are already familiar with the IEWB[9] can save time by skipping directly to Section 4, which compares the differing impacts of commodity price volatility on the four IEWB 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) – i.e. while broader in conception than GDP per capita, it 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, unlike Stiglitz, Sen and Fitoussi (2010), 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*

[9]See Osberg and Sharpe, (1998, 2002, 2008 or 2014) or Thomas and Uguccioni2016)

Table 2illustrates our identification of four components of economic 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 full 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].

Each of the four components of the IEWB is comprised of 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.

IEWB = β_1(Current Average Consumption) + β_2 (Total Societal Wealth) + β_3(Index of Equality) + β_4(Index of Economic Security)

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,[10] 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 $\beta_4$they 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, we assume that 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:

[10]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.

$U_i = \alpha_1$ (own utility) + α_2 (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 4 and Appendix 5 compare long term changes in the IEWB (with the four components weighted equally) and its components in different Canadian provinces and in fourteen affluent nations.

4. The Differing Impacts of Commodity Price 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 to big swings in resource prices and changes in the terms of trade.

4.1 Wealth

Conceptually, a society's "wealth" at any particular point in time is 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 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 includes, in addition to the market value of the 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 nationals, the IEWB counts the net value of the financial claims of foreigners vis-à-vis domestic residents,[11]but otherwise the IEWB emphasizes the stock of real assets and not financial wealth. In estimating the total wealth of a jurisdiction, 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 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 the base period price level constant in our estimates of wealth stocks corresponding to real assets. The IEWB estimates of natural resource wealth have taken nominal natural resources stock estimates where available(e.g. from Statistics Canada) and deflated them by the GDP deflator to obtain their purchasing power in real terms.

With respect to natural resource wealth, this approach has been quite commonplace. In World Bank (2011), for example, the valuation of Natural Capital is comprehensive[12]and forward-looking, albeit incomplete in many nations. As World Bank (2011:133) says: “The net present value (NPV) method is the one used by the World Bank in its wealth accounts and recommended in the SEEA. It is the most widely used,…… Country practices differ regarding the assumptions used in application of the NPV method: the chosen discount rates

[11] The financial claims of foreigners on residents include both equity and debt, as do the financial claims of residents 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 commodity prices has been reflected in the decline in value of the stock of firms owning such assets. Part of the pain of the oil price decline has thus been exported to the foreigners owning such stock.

[12]It includes Energy resources (oil, natural gas, hard coal, lignite),Mineral resources (bauxite, copper, gold, iron, lead, nickel, phosphate, silver, tin, zinc),Timber resources, Non-timber forest resources, Crop land, Pasture land and Protected areas. See World Bank (2011:141).

are often around 4 percent, but rates of return vary between 4 and 8 percent. Canada calculates several variants of the NPV method, resulting in upper and lower boundary values." Table 3updates the World Bank (2011) estimates of the value of Natural Capital.

Table 3: Per Capita Wealth, Constant 2010 U.S. Dollars, 2013

	Population	Natural capital	Produced capital	Natural capital as % Produced Capital
Australia	23,125,868	78,015	214,010	36.5%
Belgium	11,182,817	7,713	116,350	6.6%
Canada	35,158,304	52,635	150,452	35.0%
Denmark	5,614,932	24,048	157,764	15.2%
Finland	5,438,972	18,255	149,402	12.2%
France	65,920,302	8,974	134,044	6.7%
Germany	80,645,605	7,413	139,082	5.3%
Italy	60,233,948	7,840	121,868	6.4%
Netherlands	16,804,432	14,242	133,833	10.6%
Norway	5,079,623	114,855	245,763	46.7%
Spain	46,620,045	10,372	91,908	11.3%
Sweden	9,600,379	16,847	111,779	15.1%
United Kingdom	64,106,779	7,832	79,350	9.9%
United States	316,497,531	16,844	151,373	11.1%
Simple Average		27,563	142,641	16.3%
Population weighted average		17,343	137,371	12.6%

Source: special request from World Bank

In World Bank (2011) the "Produced Capital" of Machinery, Equipment and Structures is the stock analogue to investment flows as recorded in the System of National Accounts. The key point of Table 3is that Natural Capital varies far more across rich countries than produced capital[13]– and is far more important in Australia, Canada and Norway than in other nations. However, it is hard to know how much credibility to assign to the specific dollar values assigned to per capita Natural Capital in Table 3, since as Section 2 has shown, there has been huge variability in resource prices and the price assumption matters, fundamentally. With truly epic understatement, the World Bank declares (2011:134): "the main difficulty in applying the NPV method is fluctuating resource rents. Some countries therefore use a weighted moving average to smooth the effect of price changes,

[13]In Table 3, the coefficient of variation of natural capital is 1.17 – almost four times the coefficient of variation of produced capital (0.31).

while others use specific price forecasts."Either methodology sweeps the problem of resource price variability firmly under the carpet.

When market prices are used to aggregate wealth across specific types of assets, the total value of assets is necessarily conditional on the prices used for aggregation. For eleven out of the fourteen nations examined here (and for seven out of ten Canadian provinces – see Appendix 2) 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 Chart 2) and of terms of trade (Chart 3) raise significant questions for this approach in producer countries and provinces.

When swings in resource prices are large and persistent, price variations will affect both current income and the capitalized value of the future income which can be expected from existing assets. The Net Present Value of future income from today's assets(i.e. "wealth") capitalizes expectations of the relative price of what physical assets will produce. A useful example of the magnitude of the impacts of changing expectations can be seen in Canada's province of Alberta, where natural resource wealth has long been known to be a large fraction of total wealth.

Sharpe et al. (2008)noted that in 2008 Statistics Canada's estimate of the value of the Alberta oil sands[14] understated (by about 17 percent) its importance to Canada's total wealth stocks. However, since in Canada natural resource stocks are owned by the provinces, Albertans can reasonably argue that the per capita value of the oil sands should have been calculated for Alberta's population of 4.23 million in2016 (which is not so very different from Norway's 5.27 Million). Since total tangible non-oil sands wealth was roughly $192,000Cdn $ per Canadian in 2008 in current dollars, and the oil sands valuation difference increased Albertans' per capita wealth by much more (roughly $250,000[15]), by this calculation the oil sands alone meant that Albertans' wealth was in 2008 over twice as high as the per capita wealth of all Canadians.

However, those estimates were based on a market price of $70 (CAD) per barrel. 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 oil sands production. Table 4 contains four estimates of the present value of the Alberta oil sands. The first, for 2007,

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

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

essentially recapitulates an estimate from Appendix Table 1 of Sharpe et al. (2008).[16] The others, for 2014, 2015 and 2016, are new estimates based on the same valuation method.[17] 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 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 average 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

[16] The main difference between the 2007 estimate in Table 2 and the one in Sharpe et al. (2008) is a newer data series for capital stock. Statistics Canada discontinued and replaced the capital stock data used in Sharpe et al. (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.

[17] 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. 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 Sharpe et al. (2008), a discount rate of four percent is used 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.

the Alberta Energy Regulator's 2015 industry revenue forecasts. Table 4uses $42.33 as the per-barrel price[18] 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.

As well, 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 two basic points are that: 1] there is very much less natural resource rent to be had at current 2016 oil prices, compared to oil prices in 2014 or before; 2] the fluctuations in the Net Present Value of Oil Sands production per Albertan are large – considerably greater than Table 3's calculation of the average size (roughly $140,000, US[19]) of the produced capital stock of these fourteen nations.

[18] On July 22, 2016, Western Canada Select traded at $38.80 (Cdn), but the calculations underlying Table 4were done in May, 2016 based on the May 6th price of $42.33 per barrel. See http://www.psac.ca/business/firstenergy/

[19] Since it is not clear which date's exchange rate should be used for comparison ofTable 3 and Table 4, the original currency units have been used. The Canadian dollar was worth 0.88 US in July 2006, traded above par in 2011, in the high nineties in 2013 and in July 2016 was at 0.77.

Table 4: 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

In 2014, the cost of the capital invested in oil sands extraction was estimated at $206.6 Billion (Cdn).[20] Since these investments have produced plants and infrastructure that

[20] 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 has been

are remote, immobile and highly specialized, economic analysis would say that this capital has no alternative use and these investments are sunk costs. If past oil sands investments are therefore written down to zero, no allowance for amortization is necessary and the net rent available from future production is the differential between current processing costs (estimated at $31.40 per barrel[21]) and price received. On this basis, Table 4indicates 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.

In measuring well-being, the IEWB takes the view that aggregate wealth matters because it could be used to generate material well-being for all citizens. Table 4's estimates of the net present value of future net resource revenue is wealth that could be received by Albertans – but it is less clear how much they will get and how much Albertans really will bear the cost of the stranding of oil sands assets. 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 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 government in royalties and taxes, and the share of Alberta residents in the federal government transfers and program expenditures financed by federal tax on resource rent incomes.

Although Table 4refers 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 the

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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.

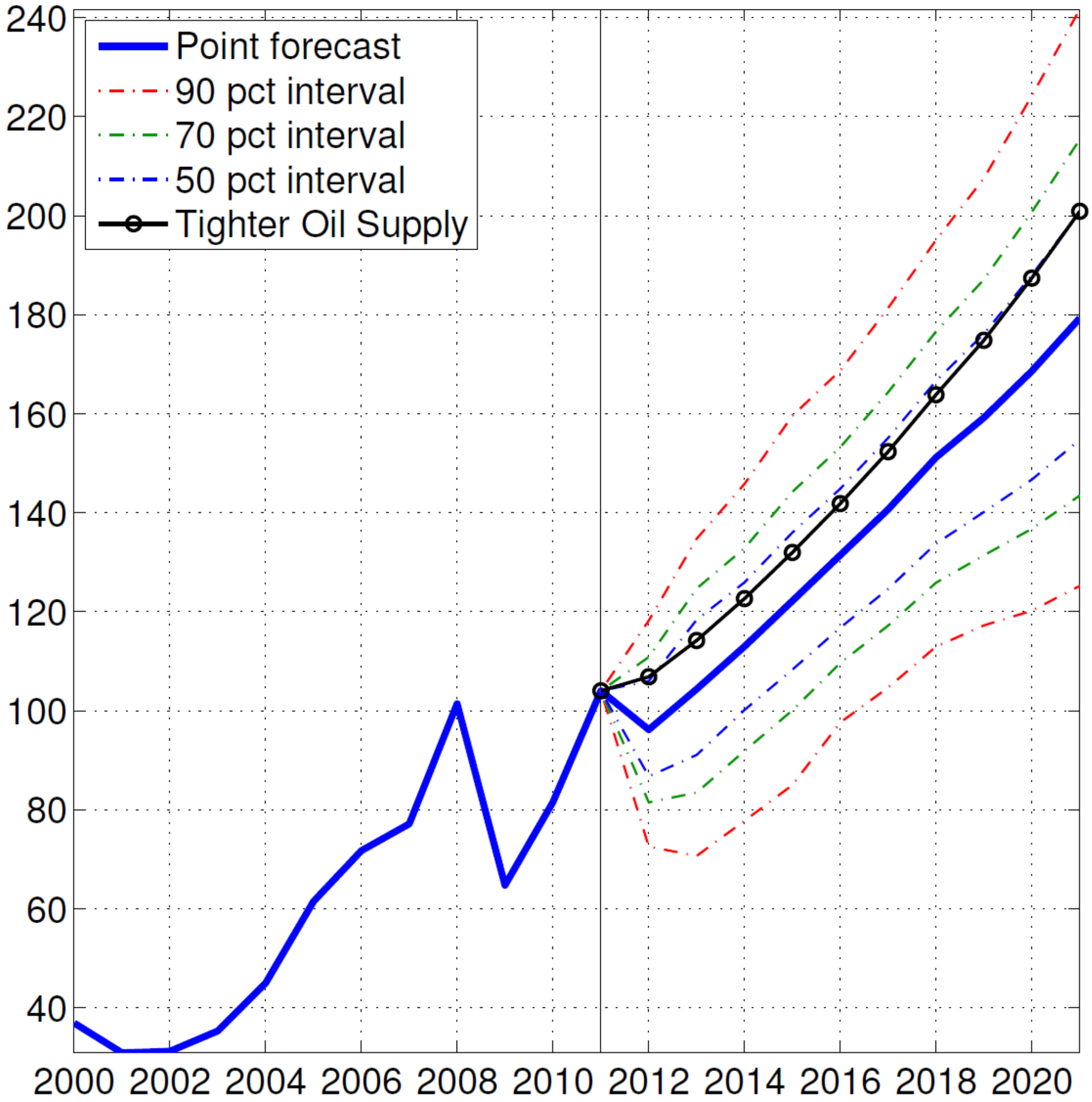
[21]Obtained by dividing the total operating expenditures of the non-conventional oil extraction sector (in dollars) by the sector's net output (in barrels). Data from Statistics Canada's Annual Oil and Gas Extraction Survey.

Newfoundland offshore, like the Norwegian offshore, is a high cost operating environment, in which net rent is similarly exposed to oil price variability. The wealth loss per capita calculated in Table 4is 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. As an illustration of the uncertainties of oil price forecasting, Chart 4is drawn from a technically excellent 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. One could wonder how such a wide confidence interval for oil price estimates is consistent with the precise World Bank estimates of Natural Capital wealth presented in Table 3.[22] However, this range has been insufficient. During March 2016, West Texas Intermediate traded in the range $34.56 to $37.99, trending slightly up thereafter – on July 18, 2016, it was at $45.23. *The actual price of oil in 2016 has thus been considerably less than half of the lower bound of the 90% confidence interval on predicted prices of Benes et al (2012).*[23]

[22]The April 2016 IMF World Economic Outlook projects a similarly wide confidence band for oil prices in 2020 – but the lower range of $15 to $120 per barrel – see Figure 1.SF.1 IMF (2016)
[23]See https://ycharts.com/indicators/crude_oil_spot_price

Chart 4: Real Oil Price Forecast with Error Bands, 2011 U.S. Dollars per Barrel



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

As well, past periods of boom and bust in the global oil industry maybe a poor guide to oil prices in a future world. Public policy on climate change affects oil prices in a historically novel way, quite dissimilar to developments in other commodity markets. If there is a realistic chance that environmental commitments 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 now 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 one 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 reducing carbon emissions 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 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.[24]

But this does not describe the world that natural resource producers live in. The IEWB methodology of assuming fixed base period prices for wealth calculations can be seen as reasonable for most countries examined (and for seven out of ten provinces within Canada), for whom reasonably constant terms of trade remain a plausible assumption. However, the terms of trade of natural resource producers are highly dependent on the uncertain future prices of commodities. 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

[24] 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.

index attempting to summarize the economic well-being of resource dependent jurisdictions.

4.2 Average Consumption, Income Distribution and Economic Security

Resource price volatility affects the different components of economic well-being through different mechanisms. As Section 4.1 has discussed, it affects the aggregate wealth component of economic well-being because it influences expectations of future prices. This section investigates the implications of resource price volatility for the consumption, equality, and economic security components. The effect on consumption arises from the fact that resource prices help determine current aggregate income. The effects on income equality and economic security are subtler. Since the equality and security components of well-being depend on the distributions of individual households' access to resources, resource price volatility will influence these components to the extent that it produces net changes in market outcomes and public transfers at different points in the distributions of outcomes.

Before proceeding further, a caveat is in order. In the development economics literature, substantial attention has been paid to the “resource curse” hypothesis, that countries more heavily dependent on natural resource exploitation tend to grow more slowly, other things equal. However, the political economy arguments that attempt to explain the disappointing growth experience of oil-rich Nigeria also have to find ways to explain the excellent experiences of oil-rich Norway – so theories about how predatory oligarchic coalitions emerge when resource rents are available for appropriation have to be balanced with controls for the impacts of offsetting “good institutions” and favourable initial conditions (e.g. Mehlum et al., 2006). In some versions of this literature, the emergence of good institutions is seen as partly endogenous, in the sense that the local booms and busts created by resource price volatility may make short term opportunism more rational and it may be more difficult for stable political coalitions to support a long-term agenda. Influential writers (e.g. Acemoglu, Johnson and Robinson, 2005) also now stress the combination of exogenous and endogenous roles played by institutions in determining long run growth. And, going back to Kuznets (1965) and many earlier authors, it has been recognized that one implication of long run growth is the declining relative role of resource production and increasing importance of service sector employment even in countries (like Australia or Canada) which were initially very highly dependent on natural resources.

Both macro and micro market outcomes and the institutional arrangements produced by public policy influence specific components of the IEWB.[25] Since the resource curse argument implies that both market outcomes and institutional arrangements might be influenced by resource dependence and resource price volatility, a clean distinction between exogenous and endogenous influences on economic well-being is hard to envisage. Moreover, whatever the general merits of the resource curse argument, the constraints of data availability restrict our analysis to fourteen affluent nations. Because the availability of high quality statistics is undoubtedly correlated with other institutional characteristics, our data could be critiqued as a biased sample, with an implicit sample selection criterion of 'good' institutions. The regressions presented later in this section cannot address the resource curse issue and therefore can only be interpreted as indicating conditional correlations – not causation.

The remainder of this section is organized as follows. Section 4.2.1 provides an analytical discussion of the relationship between IEWB components and resource price shocks based on OECD data and national accounting principles. Section 4.2.2 investigates the statistical relationships between resource prices and the consumption, equality and security components of economic well-being by estimating error correction models (ECMs).

4.2.1 Resource Prices, Trading Gains, and Components of Economic Well-being

Resource prices influence economic well-being by helping to determine per capita real income. Real gross domestic income (GDI) measures the purchasing power of income generated by production activity in a country. Growth in real GDI is equal to growth in real gross domestic product (GDP) plus a *trading gain* (or loss) that captures the effect of changes in relative prices. Kohli (2006) shows that the trading gain can be expressed as the sum of two terms: a *terms of trade effect* and a *real exchange rate effect*. The magnitudes of these effects in part reflect the size of the international trade sector as a share of output.

Let Δi_t denote the log difference in a component of economic well-being between dates t and $t-1$. Let Δy_t be the log difference in per capita real GDI, and suppose that Δi_t and Δy_t are contemporaneously related by some function f, so that $\Delta i_t = f(\Delta y_t)$. Let

[25] For example, the security component contains a calculation of the financial hazard of unemployment, which depends on both the probability of individual unemployment and the replacement rate on earnings provided by unemployment insurance.

αdenote the elasticity of IEWB component growth with respect to per capita GDI growth, $\frac{\partial \Delta i_t}{\partial \Delta y_t}$.[26]

As shown in Appendix 3, real per capita GDI growth can be decomposed as follows:

$$\Delta y_t = \Delta q_t + \omega_{Tt}\Delta\tau_t + \omega_{Rt}\Delta\rho_t$$

where Δq_t is real per capita GDP growth, $\Delta\tau_t$ and $\Delta\rho_t$ are the log changes in the terms of trade (TOT) and the real exchange rate (ER), and ω_{Tt} and ω_{Rt} are weights that depend on the size of imports and exports as a share of nominal GDP. The Appendix shows that ω_{Rt} is close to zero across the OECD countries in the IEWB database, so that GDI growth is well approximated by the sum of GDP growth and the TOT effect,[27]

$$\Delta y_t \approx \Delta q_t + \omega_{Tt}\Delta\tau_t$$

The TOT is the ratio of export prices to import prices. Then $\Delta\tau_t = \Delta p_{Xt} - \Delta p_{Mt}$, where Δp_{Xt} is export price growth and Δp_{Mt} is import price growth. Let Δp_{Ct} be commodities price growth, and suppose that the index of export (import) prices is a Tornqvist index of raw commodity prices and non-commodity prices with weights given by the shares of commodities and non-commodities in exports (imports). Then the elasticity of TOT growth with respect to commodity price growth is given by

$$\frac{\partial \Delta\tau_t}{\partial \Delta p_{Ct}} = \omega_{Ct}^X - \omega_{Ct}^M$$

where ω_{Ct}^X and ω_{Ct}^M are the shares of commodities in nominal exports and imports, respectively.

Using these results, the elasticity of IEWB component growth with respect to resource price growth is

$$\frac{\partial \Delta i_t}{\partial \Delta p_{Ct}} = \alpha\omega_{Tt}(\omega_{Ct}^X - \omega_{Ct}^M)$$

[26] In the case of the consumption component of economic well-being, for example, α is interpretable as the marginal propensity to consume from income.

[27] TOT changes are weighted by the average share of imports and exports in output, while ER changes are weighted by the share of net export in output. Since imports and exports are approximately in balance in most countries, the weight on ER shocks is small.

This expression provides several insights about the relationship between commodity prices and the IEWB. First, well-being is more sensitive to commodity prices in countries with large trade sectors (i.e. a large ω_{Tt}). Second, the sensitivity of well-being to commodity prices depends on the *difference* between the shares of commodities in exports and imports. Even in a country with a large commodity exports sector, the impact of commodity prices on well-being may be small if commodities are also a large share of the country's imports. In addition, well-being in a country with no commodity exports may be very sensitive to commodity prices if commodities make up a large share of the country's imports.

Third, the sensitivity of a component of well-being to commodity prices depends on the functional relationship between GDI and that component of well-being; that is, on the elasticity α. While ω_{Tt}, ω_{Ct}^{X} and ω_{Ct}^{M} are directly observable, α is not. For the consumption component of well-being, α is interpretable as the marginal propensity to consume from income. In principle, the implications of changes in current per capita income should be decomposed into the implications of changes in permanent and transitory income, but in practice it is unclear whether, and to what degree, increasing or decreasing commodity prices are viewed by economic agents (public or private) as transitory. For the equality and economic security components, its interpretation is the reduced form coefficient of net impacts.

Fourth, the sensitivity of well-being to commodity prices changes over time as the weights ω_{Tt}, ω_{Ct}^{X} and ω_{Ct}^{M} change.[28]

The remainder of this subsection uses OECD statistics to assess the magnitude of $\frac{\partial \Delta i_t}{\partial \Delta p_{Ct}}$.

Table 5 displays the average annual growth rate of GDI and its components, GDP and trading gains, over the 1980-2014 period for each OECD country in the IEWB database. As noted earlier, one can think of the trading gain as almost entirely reflecting the size of the trade sector and changes in the TOT.[29] Growth in the trading gain is close to zero on average in most countries over the 1980-2014 period; most of long-term growth in GDI arises from growth in GDP. Norway's average annual trading gain growth rate of 0.44 per cent is the largest in magnitude among the fourteen countries.

[28] In principle, α may change over time as well. Since it is not observable, this cannot easily be assessed.
[29] Recall that there is also an exchange rate effect, but it is quantitatively negligible most of the time.

Table 5: Growth of Real GDI and its Components, Selected OECD Countries, 1980-2014

	Average of Annual Growth Rates			Per Cent of GDI Growth		
	GDI	GDP	Trading Gain	GDI	GDP	Trading Gain
Australia	3.43	3.17	0.24	100	92.6	7.1
Belgium	1.77	1.90	-0.13	100	107.5	-7.2
Canada	2.56	2.45	0.10	100	95.8	3.8
Denmark	1.78	1.62	0.15	100	91.0	8.7
Finland	1.97	2.22	-0.25	100	112.8	-12.5
France	1.77	1.81	-0.04	100	102.2	-2.1
Germany	1.73	1.71	0.02	100	99.1	1.2
Italy	1.26	1.23	0.03	100	98.0	2.2
Netherlands	2.03	2.09	-0.06	100	102.9	-2.8
Norway	3.03	2.57	0.44	100	84.9	14.5
Spain	2.38	2.24	0.14	100	93.9	5.7
Sweden	1.89	2.08	-0.18	100	109.7	-9.6
United Kingdom	2.29	2.18	0.11	100	95.0	5.0
United States	2.63	2.63	-0.01	100	100.3	-0.3

These small mean growth rates mask substantial year-to-year variation in trading gains. Table 6 presents the standard deviation of annual trading gains growth rates for each country over the 1980-2014 period. The standard deviations of the annual trading gains growth rates are large relative to the means. This suggests that although trading gains may not be an important driver of long-run GDI growth, they can cause substantial fluctuations in GDI from year to year. This is the main way in which commodity price volatility may affect GDI and hence economic well-being.

The sensitivity of well-being to commodity price shocks is governed by the trade share of GDP and the share of commodities in exports and in imports. Table 7 displays the average values of these statistics over the 1980-2014 period for each country. There is substantial variation across countries in the average share of trade in GDP. Belgium and the Netherlands exhibit the largest amount of gross trade as a share of GDP, while the United States exhibits the smallest. Perhaps surprisingly, Australia is also near the bottom in terms of the average trade share of GDP. Canada is in the middle of the pack.

Table 6: Volatility of Real GDI and its Components, Selected OECD Countries, 1980-2014

	Volatility of Annual Growth Rates		
	GDI	GDP	Trading Gain
Australia	2.19	1.56	1.26
Belgium	1.63	1.56	0.94
Canada	2.62	2.07	1.01
Denmark	2.26	2.06	0.57
Finland	3.28	3.23	0.76
France	1.48	1.43	0.56
Germany	1.89	1.99	0.78
Italy	1.96	1.95	0.76
Netherlands	1.96	1.94	0.48
Norway	4.21	1.79	3.59
Spain	2.70	2.26	1.00
Sweden	2.38	2.26	0.58
United Kingdom	2.03	2.04	0.43
United States	2.03	1.98	0.39

Note: Values in the table are the standard deviations of the annual growth rates in percentage points.

Table 7: Determinants of the Sensitivity of Well-being to Commodity Price Shocks, Selected OECD Countries, 1980-2014

	Trade Share of GDP	Commodities Share of Exports	Commodities Share of Imports	Difference
Australia	0.19	0.48	0.08	0.41
Belgium	0.65	0.08	0.14	-0.06
Canada	0.31	0.17	0.09	0.08
Denmark	0.39	0.15	0.09	0.06
Finland	0.32	0.02	0.16	-0.14
France	0.24	0.06	0.11	-0.05
Germany	0.28	0.03	0.11	-0.08
Italy	0.23	0.02	0.16	-0.13
Netherlands	0.58	0.08	0.14	-0.06
Norway	0.36	0.45	0.06	0.39
Spain	0.23	0.10	0.17	-0.07
Sweden	0.36	0.03	0.12	-0.09
United Kingdom	0.26	0.09	0.10	0.00
United States	0.11	0.09	0.13	-0.04

Countries also differ a lot in terms of the importance of commodities in their import and export baskets. What matters for the sensitivity of well-being to commodity price shocks is the difference $\omega_{Ct}^{X} - \omega_{Ct}^{M}$, which is displayed in the last column of Table 7. This difference is large for Australia and Norway; commodities comprise a large share of those countries' exports but a small share of their imports. The difference is small for most other countries, including -- perhaps surprisingly -- Canada.

Most of the countries have experienced secular increases in their average trade shares of GDP over time. This trend is a manifestation of the phenomenon of globalization in recent decades, and one of its effects is to increase the sensitivity of countries' well-being to TOT shocks (including commodity price shocks). The first column of Table 8 shows the cumulative growth of the average trade share of GDP in each country over the 1970-2015 period. Norway is the only country in which the trade share became smaller over the period. Among the other countries, the smallest cumulative increase was 38.5 per cent in the United Kingdom. The largest increases were in the United States (180.8 per cent, albeit from a low

Table 8: Changes in Terms of Trade Risk and Exposure in Selected OECD Countries, 1970-2015

	Cumulative Growth in Average Trade Share	TOT Volatility, 1970-1985	TOT Volatility, 1985-2000	TOT Volatility, 2000-2015
Australia	65.0	7.15	5.49	8.18
Belgium	94.3	1.56	1.43	1.30
Canada	58.5	3.79	2.51	4.45
Denmark	76.9	3.47	1.44	1.11
Finland	55.8	3.27	2.72	1.77
France	93.0	4.81	2.54	1.53
Germany	172.1	3.36	3.57	2.05
Italy	87.0	4.77	4.42	2.81
Netherlands	78.8	1.83	0.87	0.75
Norway	-6.2	3.94	9.68	9.35
Spain	144.1	7.03	4.81	2.29
Sweden	92.5	3.66	2.40	0.99
United Kingdom	38.5	5.05	1.66	1.41
United States	180.8	5.46	1.80	2.35

Note: Cumulative growth in the average trade share is in per cent. The three volatility measures are standard deviations of annual growth rates over the periods indicated in the column headers; they are expressed in percentage points.

base), Germany (172.1 per cent) and Spain (144.1 per cent). In Canada, the cumulative increase in the trade share of output was 58.5 per cent.

These increases represent increases in countries' exposures to terms of trade volatility. The next three columns of Table 8 show how the volatility of TOT growth evolved over the three fifteen-year periods since 1970. TOT volatility was lower in 2000-2015 than in 1970-1985 in eleven of the fourteen countries. The three exceptions are Australia, Canada and Norway. It is probably no coincidence that these are the three countries with the largest mining and oil and gas extraction sectors. Norway experienced the largest increase in TOT volatility; the standard deviation of its annual TOT growth increased from 3.94 percentage points in the 1970-1985 period to 9.68 percentage points in the 1985-2000 period, then held steady at 9.35 percentage points in the 2000-2015 period. The 6.2 per cent cumulative decline in Norway's trade share may be interpretable as a rational response to this large increase in TOT volatility.

Table 9 focusses on the 2003-2008 period. During that time, commodity price changes led to large terms of trade improvements in Australia, Norway, and Canada. It is no

Table 9: Trading Gains, Terms of Trade Changes, and Average Trade Shares, Selected OECD Countries, 2003-2008

	Trading Gains	TOT Effect	Trade Share of GDP	Terms of Trade Growth
Australia	1.56	1.55	0.20	7.72
Belgium	-0.64	-0.63	0.71	-0.86
Canada	1.19	1.24	0.35	3.58
Denmark	0.30	0.31	0.45	0.69
Finland	-0.81	-0.77	0.38	-2.02
France	-0.15	-0.14	0.27	-0.54
Germany	-0.26	-0.23	0.35	-0.60
Italy	-0.29	-0.29	0.25	-1.12
Netherlands	0.02	0.01	0.62	0.03
Norway	3.16	2.57	0.35	7.25
Spain	0.03	0.01	0.28	0.03
Sweden	-0.16	-0.15	0.42	-0.38
United Kingdom	-0.18	-0.19	0.27	-0.68
United States	-0.30	-0.23	0.13	-1.76
Average	0.25	0.22	0.36	0.81

surprise that these three countries also experienced the largest TOT effects over that period. The translation of TOT gains into GDI gains via trading gains is mediated by the average trade share of output, and this can be seen by comparing Australia and Norway. The two countries experienced similar growth in their terms of trade; Australia's 7.72 per cent average annual terms of trade improvement was slightly larger than Norway's 7.25 per cent annual improvement. But Norway's average trade share was 0.35 over the period, compared to 0.20 in Australia. As a result, Norway's slightly *smaller* terms of trade increase translated into a significantly *larger* trading gain. Norway's TOT effect was 2.57 per cent per year over the period, a full percentage point larger than Australia's 1.55 per cent per year TOT effect.[30]

The data presented in this section sheds light on the sensitivity of GDI growth to TOT changes and to commodity price changes. The subject of this paper is the effect of TOT changes and commodity price changes on the components of economic well-being. As the analysis at the beginning of this section shows, the connection between economic well-being and commodity price shocks depends on an unobservable elasticity parameter α. This elasticity is not an accounting parameter. It reflects the functional relationship between well-being and income and depends on the preferences of households, the net differences in technology between expanding and contracting firms, the structure of the markets in which they interact and the political economy of public policy responses.

It is beyond the scope of this paper to specify a model of α, but a brief discussion of the mechanisms connecting income with components of economic well-being is warranted.For the consumption component, it has already been mentioned that α is interpretable as a marginal propensity to consume (MPC). The size of this parameter differs across economic models. In frameworks that incorporate the permanent income hypothesis, for example, we might expect the MPC to depend on whether a shock to income is permanent or transitory. If shocks to GDP are regarded as permanent but shocks to trading gains are seen as transitory, then the value of α connecting trading gains to consumption may be quite small (or even zero) – but we do not know how prevalent such perceptions are.[31] On the other hand, if resource price changes are seen as permanent or if a substantial fraction of households are

[30]Norway also had a non-negligible real exchange rate effect over the 2003-2008 period because its net export share was unusually high. This explains the gap between Norway's TOT effect and its total trading gain in Table 9.

[31]The increase in oil and iron ore prices of the early 2000s was, for example, clearly regarded as a permanent shift in relative prices by the firms that invested billions in Alberta’s oil sands or Australia’s iron mines, and by the governments that encouraged them.

hand-to-mouth consumers (because of financial frictions or departures from perfect rationality, for example), then consumption may be highly responsive to income fluctuations arising from trading gains; that is, α may be large.

The equality component of the IEWB is a composite index of measures of poverty and income inequality. Both may be related to trading gains in complex ways that depend on the distribution of the income gains/losses from a terms of trade change. If a terms of trade windfall accrues primarily to workers in the export sector via higher wages, for example, then the impact on poverty and inequality depends on where those workers previously sat in the income distribution. On the other hand, if the windfall mainly accrues to business shareholders and top executives, poverty may be unaffected and inequality may rise. Since changes in trading gains will be partially reflected in the fiscal situation of government, the political economy of policy formation will determine which parts of the income distribution share in the tax and transfer changes which result.

The economic security component of the IEWB incorporates measures of the risk of job loss and unemployment, illness, family breakup, and poverty in old age. Unemployment fluctuates with production activity (i.e. with GDP), and therefore is more closely tied to the business cycle than to trading gains from resource price movements. Although the hazards of illness, old age and household dissolution are driven primarily by demographic and social changes that operate on long time scales, their financial implications for households depend partly on public policy changes with respect to health care funding, pension policy and social assistance that can be strongly affected by the revenue implications for government of resource price fluctuations.

Given that α is not observable, it is not possible to compute the sensitivity of well-being to commodity price changes using the accounting approach above. The next three subsections therefore switch to an econometric approach to assess the empirical relationship between components of economic well-being and changes in the TOT.

4.2.2 Econometric Evidence on Terms of Trade and Components of Economic Well-being

This section presents the conditional correlations between each of the three remaining 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. The right hand side variables essentially decompose rates of change in Gross Domestic Income (GDI) into its two main components – rates of change in Gross Domestic Product (GDP) and rates of change in Terms of Trade (TOT). In each case, a within country regression is run on annual data 1980 to 2014of the form

$$\Delta i_t = \beta_0 + \beta_s \Delta \ln GDP_t + \gamma_s \Delta \ln TOT_t + \beta \ln GDP_{t-1} + \gamma \ln TOT_{t-1} + \theta i_{t-1} + \varepsilon_t$$

where i_t is the natural log of a component of economic well-being and ε_t is a regression error.This specification[32]allows for both short run (β_s, γ_s) "transitory" effects and long run "permanent" effects (β/θ, γ/θ). Since Table 1has already reported that resource price changes only have an empirically significant correlation with Terms of Trade changes in Australia, Norway and Canada, primary attention focuses on those three countries. Osberg, Sharpe and Thomas (2016) report similar results for Canadian provinces.

Consumption

Table 10: Average Consumption, GDP and the Terms of Trade

	β_s $\Delta(\ln GDPpc_t)$	γ_s $\Delta(\ln TOT_t)$	β $(\ln GDPpc_{t-1})$	γ $(\ln TOT_{t-1})$	θ $\ln y_{t-1}$	β/θ	γ/θ	R^2
Australia	0.626*** (0.010)	0.029 (0.623)	0.000** (0.011)	0.001 (0.213)	-0.892** (0.011)	0.000*** (0.000)	-0.001** (0.061)	0.45
Belgium	0.240 (0.246)	0.452** (0.048)	0.000*** (0.003)	0.003** (0.016)	-0.858*** (0.001)	0.000*** (0.000)	-0.004*** (0.000)	0.57
Canada	0.762*** (0.000)	0.031 (0.708)	0.000*** (0.000)	0.003*** (0.001)	-0.472*** (0.000)	0.000*** (0.000)	-0.006*** (0.000)	0.70
Denmark	1.025*** (0.000)	0.190 (0.613)	0.000*** (0.271)	0.001 (0.590)	-0.274 (0.166)	0.000*** (0.081)	-0.005 (0.547)	0.48
Finland	0.806*** (0.000)	0.550** (0.049)	0.000*** (0.000)	-0.003** (0.016)	-1.061*** (0.000)	0.000*** (0.000)	0.002** (0.019)	0.76
France	1.006*** (0.000)	0.017 (0.898)	0.000*** (0.007)	-0.002** (0.020)	-0.677*** (0.003)	0.000*** (0.000)	0.003* (0.057)	0.73
Germany	0.554*** (0.002)	0.247** (0.031)	0.000*** (0.002)	0.002*** (0.009)	-0.756*** (0.000)	0.000*** (0.000)	-0.003*** (0.001)	0.62
Italy	0.790*** (0.000)	0.112 (0.142)	0.000*** (0.004)	0.002*** (0.005)	-0.824*** (0.000)	0.000*** (0.000)	-0.002*** (0.000)	0.83
Netherlands	0.621*** (0.000)	0.459* (0.085)	0.000*** (0.000)	0.013*** (0.000)	-1.164*** (0.000)	0.000*** (0.000)	-0.011*** (0.000)	0.84
Norway	1.082*** (0.000)	-0.008 (0.872)	0.000** (0.020)	0.001** (0.037)	-0.293** (0.021)	0.000*** (0.000)	-0.003*** (0.000)	0.53
Spain	1.453*** (0.000)	0.179* (0.069)	0.000 (0.127)	0.000 (0.671)	-0.638 (0.107)	0.000*** (0.000)	-0.001 (0.600)	0.83
Sweden	0.792*** (0.000)	0.243 (0.297)	0.000** (0.014)	0.002 (0.106)	-0.775** (0.028)	0.000*** (0.000)	-0.003 (0.206)	0.53
United Kingdom	0.934*** (0.001)	-0.415 (0.239)	0.000 (0.342)	0.003 (0.248)	-0.359* (0.076)	0.000** (0.037)	-0.009 (0.349)	0.65
United States	0.289** (0.018)	0.352*** (0.000)	0.000 (0.734)	0.004*** (0.000)	-0.036 (0.568)	0.000 (0.359)	-0.108 (0.586)	0.79

- Note: values in brackets are p-values. For the β/θ, γ/θ we used a non-linear test of joint significance in Stata.
- *** = 1 per cent significance, ** = 5 per cent significance, * = 10 per cent significance

[32]This approach follows a suggestion by Gordon Anderson

Table 10 presents the regression results when the dependent variable is per capita consumption; that is, the consumption component of economic well-being. The results are interesting primarily in a negative sense – there is little sign of a strong terms of trade impact, for the three nations (Australia, Norway and Canada) where one might suspect a resource price influence. 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 statistical insignificance of short run changes in the terms of trade can perhaps, in most countries, be explained by the small size of terms of trade fluctuations. The long run impacts (γ/θ) are invariably very small.

Equality

Table 11: Income Equality, GDP and the Terms of Trade

	β_s $\Delta(\ln GDPpc_t)$	γ_s $\Delta(\ln TOT_t)$	β $(\ln GDPpc_{t-1})$	γ $(\ln TOT_{t-1})$	θ $\ln y_{t-1}$	β/θ	γ/θ	R^2
Australia	0.285 (0.779)	0.425 (0.119)	0.000 (0.809)	0.001 (0.563)	-0.581* (0.069)	0.000 (0.807)	-0.002 (0.571)	0.23
Belgium	0.291 (0.627)	0.579 (0.321)	0.000 (0.242)	-0.003 (0.331)	-0.791*** (0.003)	0.000 (0.274)	0.003 (0.365)	0.34
Canada	-0.109 (0.826)	0.458 (0.149)	0.000 (0.225)	0.000 (0.982)	-0.440 (0.134)	0.000 (0.114)	0.000 (0.982)	0.17
Denmark	0.862* (0.086)	0.200 (0.792)	0.000 (0.148)	0.009 (0.092)	-0.030 (0.812)	0.000 (0.829)	-0.287 (0.822)	0.25
Finland	-0.021 (0.804)	-0.042 (0.710)	0.000 (0.301)	0.000 (0.655)	-0.285 (0.132)	0.000 (0.284)	-0.001 (0.612)	0.17
France	0.922 (0.485)	2.363*** (0.005)	0.000*** (0.010)	0.028*** (0.001)	-0.914*** (0.003)	0.000 (0.000)	-0.031 (0.000)	0.46
Germany	-0.967 (0.244)	-0.559 (0.325)	0.000 (0.234)	0.003 (0.404)	-0.592** (0.020)	0.000 (0.279)	-0.005 (0.435)	0.25
Italy	3.083** (0.016)	0.645 (0.291)	0.000 (0.214)	-0.006 (0.106)	-0.628** (0.033)	0.000 (0.341)	0.010 (0.186)	0.31
Netherlands	1.727 (0.238)	3.846 (0.254)	0.000 (0.608)	0.032 (0.196)	-0.571** (0.050)	0.000 (0.598)	-0.056 (0.131)	0.17
Norway	-0.414 (0.138)	-0.091 (0.119)	0.000 (0.467)	0.000 (0.796)	-0.394*** (0.010)	0.000 (0.460)	0.000 (0.797)	0.33
Spain	1.690* (0.097)	-0.170 (0.712)	0.000 (0.777)	-0.002 (0.467)	-0.118 (0.677)	0.000 (0.824)	0.019 (0.716)	0.15
Sweden	0.484* (0.098)	-0.555 (0.130)	0.000 (0.760)	-0.003 (0.286)	-0.461** (0.018)	0.000 (0.757)	0.007 (0.154)	0.31
United Kingdom	-0.394 (0.537)	0.533 (0.538)	0.000 (0.380)	0.002 (0.743)	-0.452** (0.017)	0.000 (0.406)	-0.005 (0.732)	0.24
United States	0.010 (0.994)	0.558 (0.622)	0.000 (0.762)	-0.003 (0.712)	-0.996* (0.066)	0.000 (0.760)	0.003 (0.723)	0.15

Note: values in brackets are p-values. For the β/θ, γ/θ we used a non-linear test of joint significance in Stata.*** = 1 per cent significance; ** = 5 per cent significance; * = 10 per cent significance

Table 11 presents the regression results when the dependent variable is the economic equality component of the IEWB. The general story which Table 11similarly tells is “no evidence of an effect.”If changes in resource prices influence the terms of trade and the distribution of employment, the distribution of market income will change to the degree that the distribution of employment changes and only to the degree that expanding and contracting industries are “unequally unequal” – i.e. to the degree that the industries losing job share differ in their earnings distribution from the industries that are gaining job share. If the impact of resource price volatility on the terms of trade is small, and if the impact of the terms of trade on employment shares is small and if industries are much alike in their wage inequality, then the overall impact on market income inequality is likely to be very small. As well, the public policies and institutions that determine the distribution of transfer income have been quite different across countries and have great inertia. Hence, in normal times the income distribution dimension of economic well-being is not very sensitive to variations in resource prices.[33]

Economic Security

The regression results with the economic security component of the IEWB as the dependent variable are presented in Table 12. The economic security index is the component of the IEWB most sensitive to short term economic movements, as the probability of unemployment enters the unemployment risk sub-component directly and unemployment is negatively related to GDP growth. Thus, economic security is positively related to GDP—no surprise there. However, it is interesting that some nations appear to be more tied to positive Terms of Trade movements than to GDP changes. Among the three resource nations, only Canada shows any evidence for a positive correlation of terms of trade movements and economic security – both Norway and Australia show insignificant impacts. Long run impacts of terms of trade movements are almost everywhere insignificant.

[33]Alberta may be the exception where 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 12: Economic Security, GDP and the Terms of Trade

	β_s $\Delta(\ln GDPpc_t)$	γ_s $\Delta(\ln TOT_t)$	β $(\ln GDPpc_{t-1})$	γ $(\ln TOT_{t-1})$	θ $\ln y_{t-1}$	β/θ	γ/θ	R^2
Australia	0.755*** (0.001)	0.091 (0.135)	0.000* (0.058)	0.000 (0.779)	-0.815*** (0.004)	0.000 ..	0.000 (0.766)	0.59
Belgium	0.626*** (0.001)	0.088 (0.502)	0.000*** (0.010)	-0.001 (0.116)	-0.081 (0.636)	0.000 (0.632)	0.013 (0.681)	0.48
Canada	0.634*** (0.000)	0.186*** (0.003)	0.000 (0.239)	0.000 (0.255)	-0.311 (0.142)	0.000*** (0.001)	-0.001 (0.397)	0.85
Denmark	0.584*** (0.000)	0.098 (0.528)	0.000 (0.136)	0.000 (0.761)	-0.277* (0.072)	0.000*** (0.003)	0.001 (0.739)	0.63
Finland	0.499*** (0.000)	0.160 (0.136)	0.000 (0.110)	0.000 (0.509)	0.012 (0.880)	0.000 (0.883)	-0.022 (0.885)	0.68
France	0.469*** (0.004)	-0.089 (0.344)	0.000** (0.028)	0.000 (0.735)	-0.252 (0.156)	0.000** (0.011)	0.001 (0.696)	0.51
Germany	0.399** (0.012)	0.072 (0.478)	0.000** (0.037)	0.000 (0.547)	-0.289 (0.091)	0.000** (0.026)	0.001 (0.534)	0.33
Italy	0.219** (0.048)	0.002 (0.967)	0.000** (0.022)	0.000 (0.984)	-0.040 (0.746)	0.000 (0.740)	0.000 (0.984)	0.32
Netherlands	0.058 (0.768)	-0.464 (0.268)	0.000*** (0.003)	-0.004 (0.195)	-0.738*** (0.002)	0.000*** (0.000)	0.005 (0.143)	0.36
Norway	0.417*** (0.009)	0.024 (0.410)	0.000 (0.296)	0.000 (0.396)	-0.067 (0.620)	0.000 (0.716)	-0.003 (0.499)	0.35
Spain	1.359*** (0.000)	-0.167*** (0.007)	0.000*** (0.002)	-0.001*** (0.006)	-0.193*** (0.003)	0.000*** (0.006)	0.006*** (0.006)	0.81
Sweden	0.311*** (0.001)	0.207** (0.048)	0.000 (0.585)	0.000 (0.467)	-0.107 (0.320)	0.000 (0.725)	-0.004 (0.578)	0.47
United Kingdom	0.325*** (0.000)	0.053 (0.575)	0.000*** (0.001)	0.000 (0.597)	-0.426*** (0.000)	0.000*** (0.004)	0.001 (0.602)	0.67
United States	1.976*** (0.000)	-0.372 (0.174)	0.000 (0.163)	-0.007*** (0.003)	-0.304 (0.281)	0.000*** (0.009)	0.022 (0.342)	0.64

Note: values in brackets are p-values. For the β/θ, γ/θ we used a non-linear test of joint significance in Stata.*** = 1 per cent significance; ** = 5 per cent significance; * = 10 per cent significance

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 about the future 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, partly because different nations have made different institutional choices in the past, which implied that the cyclical output shock of the recession on short-term individual economic insecurity was moderated to considerably varying degrees across nations.

This paper has taken a longer time frame and examined the longer term movements of resource prices. It comes to a somewhat similar conclusion, in the sense that the aggregate impacts of natural resource price fluctuations vary widely. Norway, Australia and Canada’s three oil producing provinces – Alberta, Saskatchewan and Newfoundland – have seen huge swings in their terms of trade, largely driven by energy price changes. The terms of trade of the other countries (Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Spain, Sweden, U.K. and U.S.A.) and of Canada’s seven other provinces (with over 95% of total population) are essentially unrelated to resource price movements and have changed remarkably little over time – hence there has been little impact on economic well-being.

The starkest differences across jurisdictions are in anticipations of the future – i.e. the wealth component. Although wealth stocks are, in a physical sense, typically accumulated over many years, their current value depends on summed expectations of the future and can change overnight, if there is a large change in expectations of the relative price of the commodity that they produce. Since 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 oil producing jurisdictions is, in 2016, extremely uncertain.

For eleven out of the fourteen nations examined and seven out of ten Canadian provinces (which altogether have 95% of the total population considered in this paper), resource price variability and long term terms of trade uncertainty has not been much of a problem. For these jurisdictions, we observe roughly constant terms of trade, which implies that the IEWB methodology of using constant base period prices in valuing the capital stock remains plausible, for those jurisdictions.

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. Within jurisdictions with about 4.3% of the population of the data examined, the collapse of commodity prices since 2014 has created major changes in per capita wealth and the possibility of large stranded assets, with significant, but highly uncertain, implications for the wealth component of economic well-being. For the rest, the impacts have been small. But the peculiarities of our data mean it would be misleading to think of the resource price variability issue as a “95% full/5% empty” glass. Since the resource boom of the early 2000s had significant positive impacts on the Middle East, on economic growth in South America and especially on the emerging producers of Sub-Saharan Africa[34], large numbers of people in the world as a whole are affected heavily by resource price variability – even if 95% of the sample we examine in this paper escaped major impact.

Any aggregate index of well-being necessarily requires 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 and among the fourteen nations examined. The volatility and uncertainty of resource prices may not empirically matter much for the economic well-being of most people in rich countries, but they do pose significant problems for the measurement of wealth in producing jurisdictions and thereby impede the construction of a universally applicable measure of economic well-being.

[34] Many of the world’s very poorest people are heavily affected by resource price movements – e.g. the South Sudan, whose government revenue is overwhelmingly (85%) dependent on royalties from oil production.

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Appendix 1

The Within-Canada Impacts of Oil Price Trends

The variation in real oil and gas prices illustrated in Chart 1has had widely varying impacts within Canada.[35] 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] are major producers.[36] 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 was largest, at 2.4% of provincial GDP.)[37] 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.

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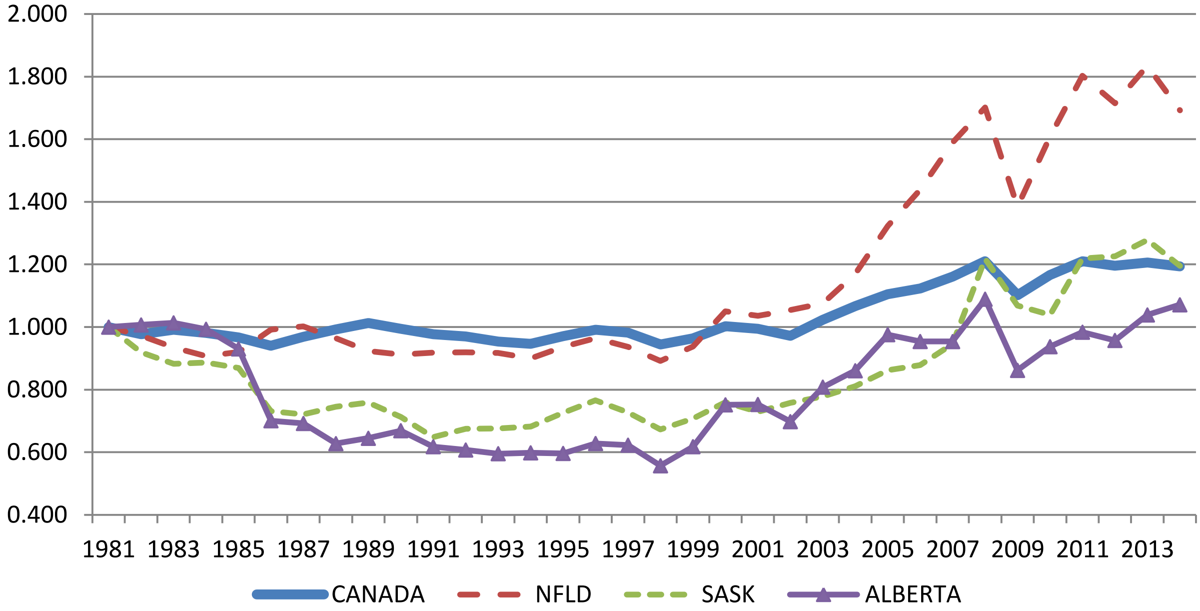
[35]Baxter and Kouparitsas (2012) unfortunately restrict themselves to variation in national terms of trade.
[36]To conserve space, this paper will sometimes shorten the correct name of "Newfoundland and Labrador" to "Newfoundland".In 2012, Alberta supplied 69.9% , Saskatchewan 14.7% and Newfoundland 9.5% of total Canadian oil and gas production. See CANSIM Table 379-0030
[37]CANSIM Table 379-0030

Appendix Chart 1: Terms of Trade, Oil-Producing Provinces, 1981 = 1.00, 1981-2014



Source: CANSIM Table 384-0038.

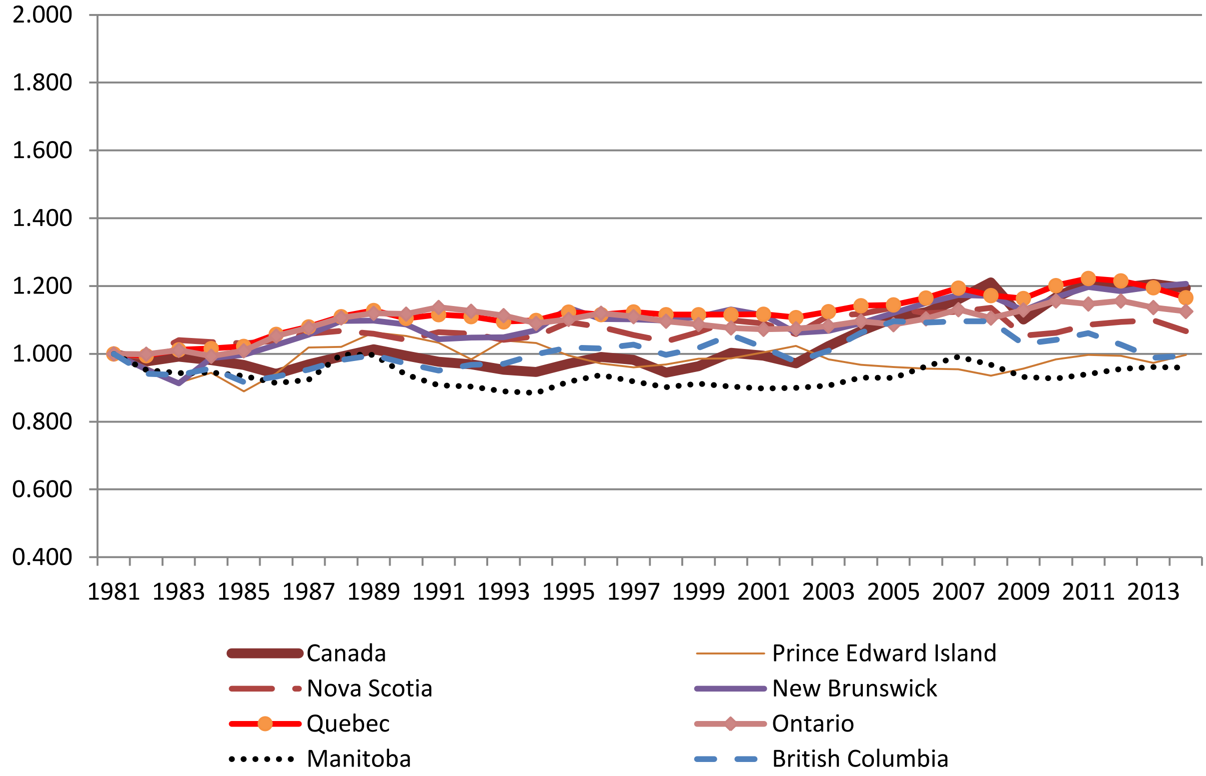
As Appendix Chart 1 illustrates, the variation since 1981 in the terms of trade[38] of both Alberta and Saskatchewan mirror, with somewhat lesser amplitude, the ups and downs of the real oil price displayed with Chart 1. In contrast, Newfoundland's terms of trade mirrored those of Canada at large until the oil started to flow in 1998, and then accelerated upward with the real price of oil in international markets.

Appendix Chart 2presents 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 Appendix Chart 1so 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 per cent higher (February 2002) and as much as 20 per cent lower (July 2011) than its 1981 level and the effective exchange rate has had a similar amplitude of changes. But for seven out of ten Canadian provinces there is not a lot of variation over time in the Terms of Trade.

[38]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.

Appendix Chart 2: Terms of Trade, Non-Oil-Producing Provinces, 1981 = 1.00, 1981-2014



Source: CANSIM Table 384-0038.

Hence, the main impacts of shifting terms of trade are found in the three oil producing provinces: Alberta, Saskatchewan and Newfoundland.

Table A1 confirms the visual impressions of Appendix Chart 1and Appendix Chart 2. 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.[39] 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 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

[39] Table A1 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 toother provinces, as well as internationally.

relation between commodity price movements and the provincial terms of trade. For two provinces (Nova Scotia[40] and British Columbia), energy prices have mattered, but to a much smaller degree.

Table A1

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

[40] 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.

Appendix 2

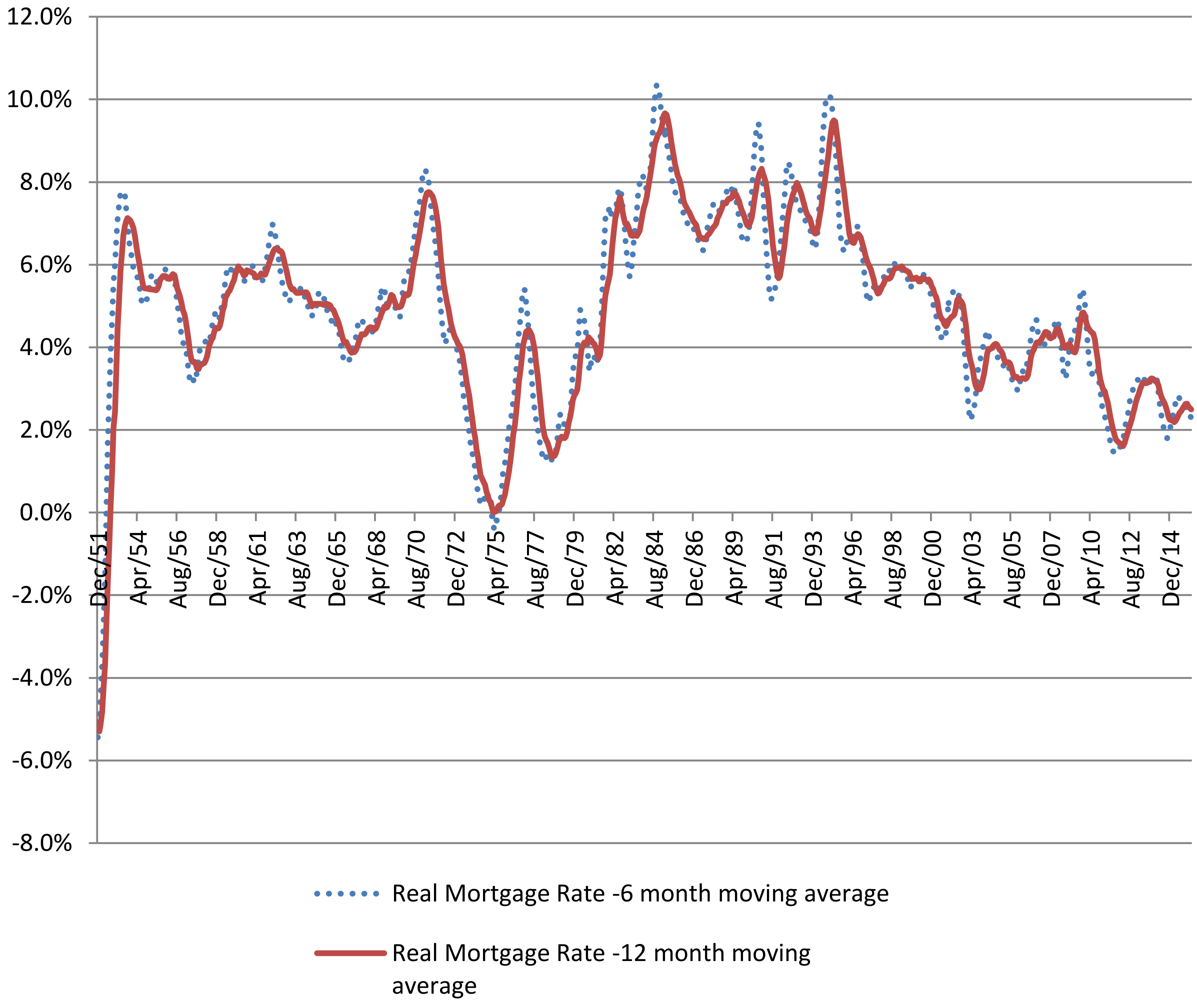
Why theVariability ofInterest Rates Affects the IEWBLess than Other Well-Being Indices

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 consumptionflow which capital goods will enable and a choice of the discount rate appropriate for weighting future period consumption, compared to current consumption. Section 4.1 has emphasized the problems that large fluctuations in natural resource prices and the net rents from future resource production creates for calculation of the wealth componentof the IEWB. However,large fluctuations in real interest ratesalso 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, Appendix Chart 3presents 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 therefore 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 tradedlong term future personal consumption for current personal consumption, the average real mortgage interest rate is a plausible candidate.[41]Appendix Chart 3 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.

[41] 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.

Appendix Chart 3: Real Mortgage Rate, Canada, Per Cent per Year, 1951-2016



Source: CANSIM Series i.d. v122497.

Appendix Chart 3 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 Appendix Chart 3can 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 June 2016, the average real five year fixed term mortgage interest rate in Canada was 1.86%, which is below what it has averaged (2.6%) since January 2010. If the secular stagnation hypothesis is true, the low level of interest rates of 2016arenot 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 externalitiesand 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?[42] 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?[43] 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:

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

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

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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[42] The calculations of the net present value of the oil sands presented in Table 4 used a 4% discount rate.

[43] 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 society'sfuture consumptioncompared to present consumption as:

$$\beta_{2i} / \beta_{1i} = 1 / (1 + r_i)$$

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

GDI and its Components

Although it is commonplace to assess economic progress in terms of the rate of growth of GDP, what a nation produces is less relevant for economic well being than what a nation could consume – i.e. GDI, the purchasing power or total market income of domestic residents. This appendix provides a review of the relationship between real GDI and real GDP. It contains the analytical details that underlie the analysis in Section 4.1 of the main text. An associated set of Appendix Tables, available online, contain detailed time series on GDI and its components and subcomponents for the OECD countries discussed in the main text.[44]

A. Analytical framework

Real gross domestic product (GDP) measures the value of market production in a country, while real gross domestic income (GDI) measures the purchasing power of income generated by production activity in a country. Growth in real GDI is equal to growth in real GDP plus a *trading gain* (or loss) that captures the effect of changes in relative prices. Kohli (2006) shows that the trading gain can be expressed as the sum of two terms: a *terms of trade effect* and a *real exchange rate effect*. The magnitudes of these effects in part reflect the size of the international trade sector as a share of output.

Let Y_t denote nominal GDP at date *t*. National accounting principles imply that Y_t is also equal to nominal GDI.

Let P_t denote the GDP deflator, and let it be defined as a Tornqvist index of the prices of domestic expenditure, exports, and imports, so that

$$\ln\frac{P_t}{P_{t-1}} = \left(\frac{\omega_{Dt}+\omega_{Dt-1}}{2}\right)\ln\frac{P_{Dt}}{P_{Dt-1}} + \left(\frac{\omega_{Xt}+\omega_{Xt-1}}{2}\right)\ln\frac{P_{Xt}}{P_{Xt-1}} - \left(\frac{\omega_{Mt}+\omega_{Mt-1}}{2}\right)\ln\frac{P_{Mt}}{P_{Mt-1}}$$

Here, P_{Dt}, P_{Xt} and P_{Mt} are the price indexes for domestic expenditure, exports, and imports. ω_{Dt}, ω_{Xt} and ω_{Mt} are the shares of domestic expenditure, exports, and imports in nominal GDP.[45]

[44] The Appendix Tables are available at **LINK HERE**.

[45] 'Domestic expenditure' corresponds to the sum of domestic consumption, investment, and government spending.

Nominal GDP and GDI are equal, but real GDP and GDI differ because they are obtained using different price deflators. Let Q_t and M_t denote real GDP and real GDI, respectively. They are defined as

$$Q_t = \frac{Y_t}{P_t}$$

and

$$M_t = \frac{Y_t}{P_{Dt}}$$

Thus, real GDI reflects the purchasing power of a country's income in terms of the domestic prices of consumption and investment goods. Real GDP reflects those same prices, adjusted to account for the value of output sold to the rest of the world and the value of output purchased from the rest of the world.

Let G_t be the ratio of real GDI to real GDP,

$$G_t = \frac{M_t}{Q_t} = \frac{P_t}{P_{Dt}}$$

G_t is the trading gain. Kohli (2006) shows that the growth of the trading gain can be decomposed as follows:

$$\ln\frac{G_t}{G_{t-1}} = \frac{1}{2}\left(\frac{\omega_{Xt}+\omega_{Xt-1}}{2} + \frac{\omega_{Mt}+\omega_{Mt-1}}{2}\right)\ln\frac{T_t}{T_{t-1}} + \left(\frac{\omega_{Xt}+\omega_{Xt-1}}{2} - \frac{\omega_{Mt}+\omega_{Mt-1}}{2}\right)\ln\frac{R_t}{R_{t-1}}$$

Here, $T_t = \frac{P_{Xt}}{P_{Mt}}$ is the terms of trade and $R_t = \frac{P_{Xt}^{\frac{1}{2}} P_{Mt}^{\frac{1}{2}}}{P_{Dt}}$ is a measure of the real exchange rate.[46] The first term on the right-hand side captures the effect on real GDI of changes in the terms of trade. The change in terms of trade is weighted by the average share of *gross* trade in output; terms of trade shocks have a larger effect on GDI in economies with larger trade sectors. The second term captures changes in the relative prices of traded and non-traded goods, weighted by the share of *net* trade in output. The difference between the two weights (gross versus net trade shares) suggests that the trading gain is dominated by terms of trade movements. This is indeed true in the results reported below.

B. Data and empirical implementation

The data were obtained from the OECD System of National Accounts database.[47] For each country in the database of the Index of Economic Well-being (IEWB),[48]series on GDP,

[46] See Macdonald (2010) for a discussion of this notion of the real exchange rate.
[47] The specific source is: OECD Annual National Accounts, Table 1: Gross Domestic Product (GDP). It is located at http://stats.oecd.org/Index.aspx?DataSetCode=SNA_TABLE1.

domestic demand, exports of goods and services, and imports of goods and services in both current prices and constant prices were obtained. All series are at constant PPP, and real series have base year 2010.

The shares ω_{Xt} and ω_{Mt} were computed directly from the current-dollar series on exports, imports, and GDP. The weight ω_{Dt} was obtained using the identity $\omega_{Dt} = 1 - (\omega_{Xt} - \omega_{Mt})$. The GDP deflator P_t and the export and import deflators P_{Xt} and P_{Mt} were obtained using the current-dollar and constant-dollar series for GDP, exports, and imports. The domestic expenditure deflator $P_{Dt}$is obtained by rearranging the Tornqvist formula for the GDP deflator given above.[49]

From here, the decomposition of the trading gain is straightforward.

C. Results

Growth in the trading gain is close to zero on average in most countries over the 1980-2014 period (Appendix Chart 4). Norway's average annual trading gain growth rate of 0.44 per cent is the largest in magnitude among the fourteen countries, followed by Finland at -0.25 per cent. This indicates that trading gains are not a major source of long-term real income growth. Indeed, trading gains account for less than ten percent of average annual GDI growth in twelve of the fourteen countries, and the largest contribution is 14.5 per cent in Norway.

These small means mask substantial year-to-year variation in trading gains. Appendix Chart 5displays the standard deviation of annual trading gains growth rates for each country over the 1980-2014 period. The standard deviations of the annual trading gains growth rates are large relative to the means. There is substantial year-to-year volatility in the trading gain in all countries, though the changes tend to wash out over the longer term.

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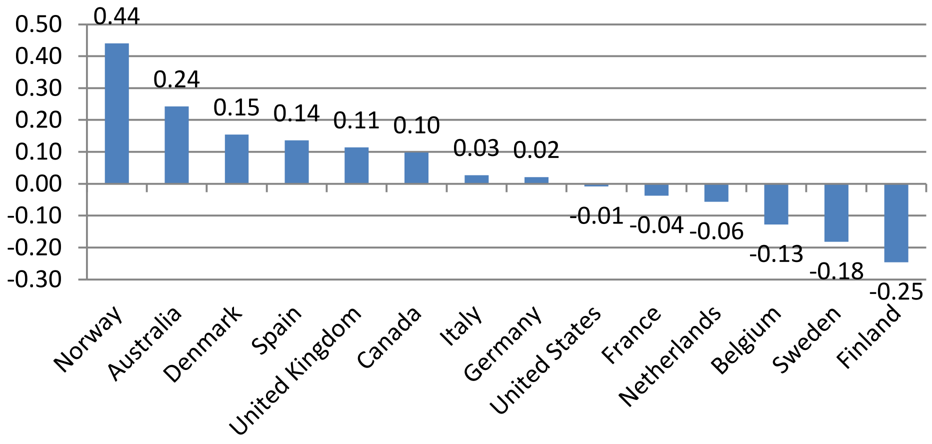
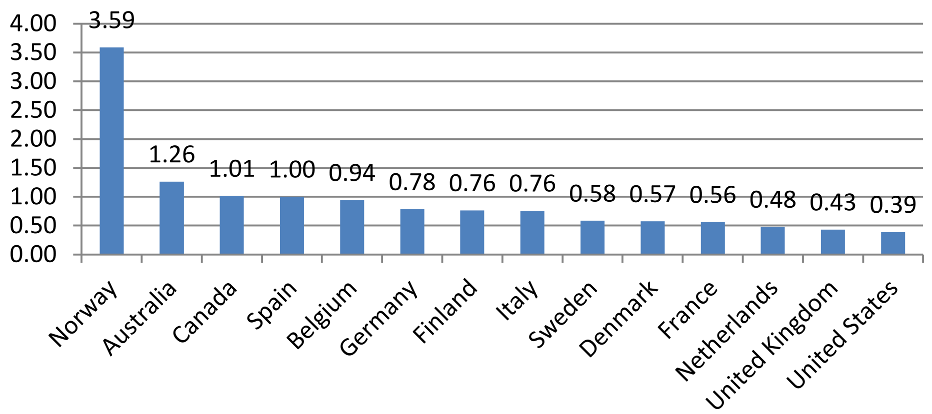
[48] The countries are Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, the United Kingdom, and the United States.

[49] An alternative approach would have been to use the series on real and nominal domestic demand from the OECD database. I chose to impose the Tornqvist relationship between the deflators P_t, P_{Dt}, P_{Xt} and P_{Mt} in order to ensure that the decomposition of the trading gain holds exactly. The deflators computed via the two approaches are almost perfectly correlated.

Appendix Chart 4: Trading Gains, Selected OECD Countries, Per Cent per Year, 1980-2014



Appendix Chart 5: Volatility of Trading Gains, Selected OECD Countries, 1980-2014



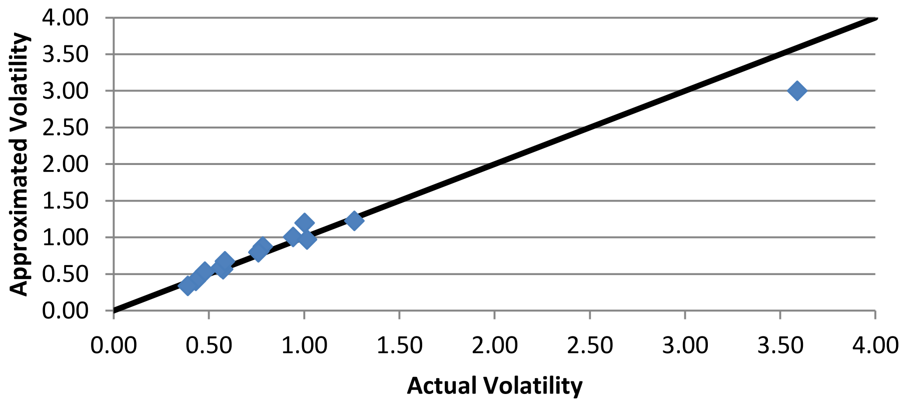
The growth rate of the trading gain is the sum of the terms of trade (TOT) effect and the real exchange rate (ER) effect. The final two columns of Appendix Table 1 show that shocks to the trading gain are dominated by the TOT effect. The average ER effect over the sample period is close to zero in every country, and the standard deviations are small. The TOT effect also exhibits a mean close to zero in each country, but with relatively large standard deviations. This means that nearly all the year-to-year volatility in the trading gain is attributable to TOT shocks.

The reason for this result is evident in the equation for the trading gain decomposition, given above. TOT changes are weighted by the average share of imports and exports in output, while ER changes are weighted by the share of net export in output. Since imports and exports are approximately in balance in most countries, the weight on ER shocks is small.

An implication of this result is that a reasonable approximation to the trading gain effect is given by the TOT effect itself. The ER effect is negligible. Under this approximation, the elasticity of trading gain growth with respect to TOT growth is given by the average share of exports and imports in output. This provides a quantitative measure of the degree to which TOT shocks feed through to GDI growth via the trading gain.

A way to assess the quality of this approximation is to compare the volatility of actual trading gains to the product of the average trade share and the volatility of TOT growth. Based on the discussion above, these two numbers should be similar.[50] InAppendix Chart 6, I plot actual trading gains volatility against the approximation for each country. As expected,

Appendix Chart 6: Actual and Approximated Volatility of Trading Gains, Selected OECD Countries, 1980-2014



the points are all close to the 45-degree line. This is a further illustration of the sense in which year-to-year variation in trading gains is dominated by changes in the terms of trade.

Appendix Table 4 provides a breakdown of the TOT effect into its components: the average trade share of GDP and the change in the terms of trade (i.e. the difference in the growth rates of export and import prices). The change in the TOT is further broken down into export price growth and import price growth.

Most of the countries have experiences secular increases in their average trade shares of GDP over time. This trend is a manifestation of the phenomenon of globalization in recent decades, and one of its effects is to increase the sensitivity of countries' GDI to TOT shocks. Across countries, there is substantial variation in the average trade share over the 1980-2014 period (Appendix Chart 7).

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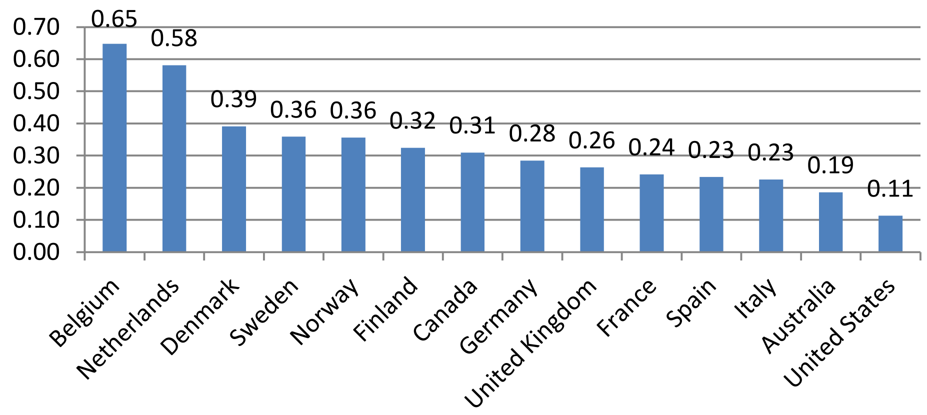
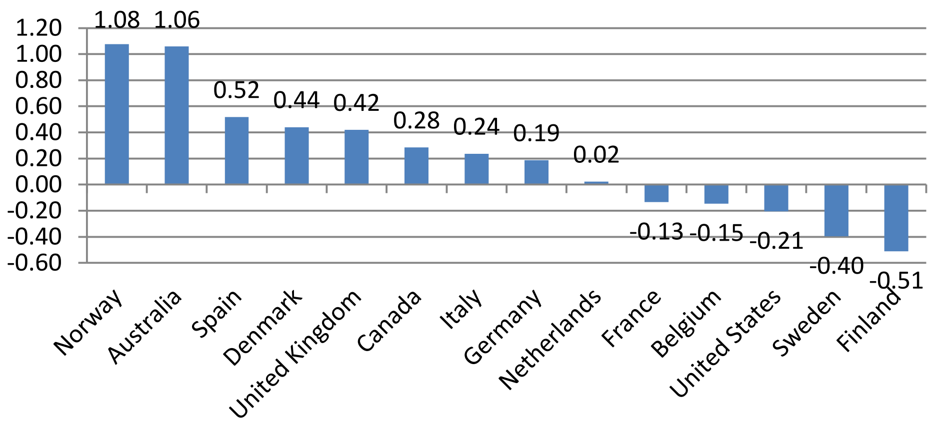
[50] The Kohli (2006) decomposition of the trading gain implies that trading gain growth $g_t \equiv \ln \frac{G_t}{G_{t-1}}$ is a weighted sum of TOT growth and RE growth, which I denote by τ_t and ρ_t, respectively. Ignoring time variation in the weights (which are based on trade shares and have relatively low volatility), one can write $g_t = \omega_T \tau_t + \omega_R \rho_t$. The variance of g_t is $Var(g_t) = \omega_T^2 Var(\tau_t) + \omega_R^2 Var(\rho_t) + 2\omega_T \omega_R Cov(\tau_t, \rho_t)$. Since both weights are less than one and ω_R is very close to zero, it is approximately true that $Var(g_t) = \omega_T^2 Var(\tau_t)$, and hence $StDev(g_t) = \omega_T \, StDev(\tau_t)$.Appendix Chart 6plots empirical measures of $StDev(g_t)$ against $\omega_T \, StDev(\tau_t)$ and shows that they are nearly the same.

Appendix Chart 7: Trade Share in GDP, Selected OECD Countries, 1980-2014



Appendix Chart 8: Growth of the Terms of Trade, Selected OECD Countries, Per Cent per Year, 1980-2014



The average annual growth rate of the TOT was small in most countries over the 1980-2014 period (Appendix Chart 8). The most substantial changes in TOT were in Norway and Australia, at 1.08 and 1.06 per cent per year, respectively. This was to be expected, given the importance of commodity exports in these countries. It is perhaps surprising that Canada's TOT grew by only 0.28 per cent per year over the period. This reflects the concentration of Canada's TOT gains in the latter part of the 1980-2014 period.

Appendix 4

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

Chart A4:5 Consumption Domain

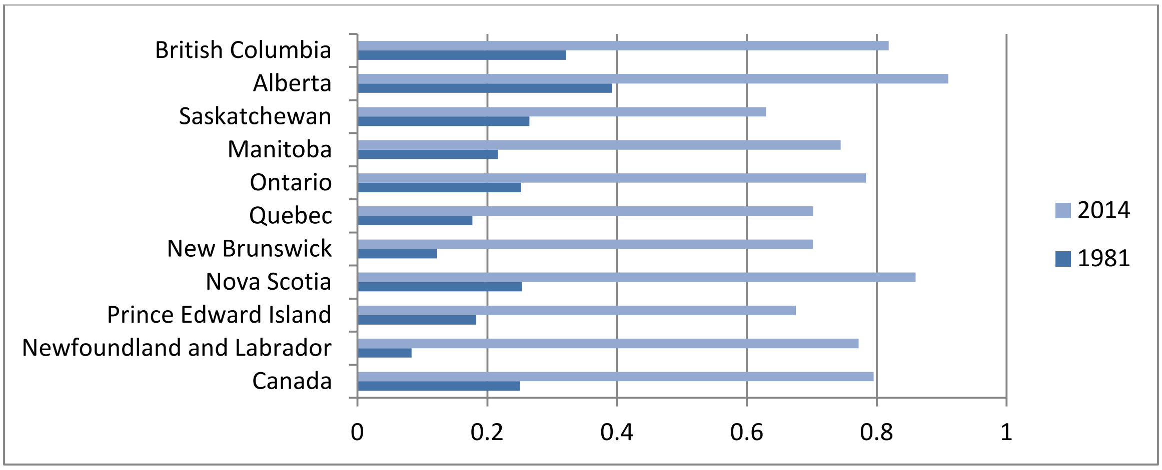


Chart A4:6 Wealth Domain

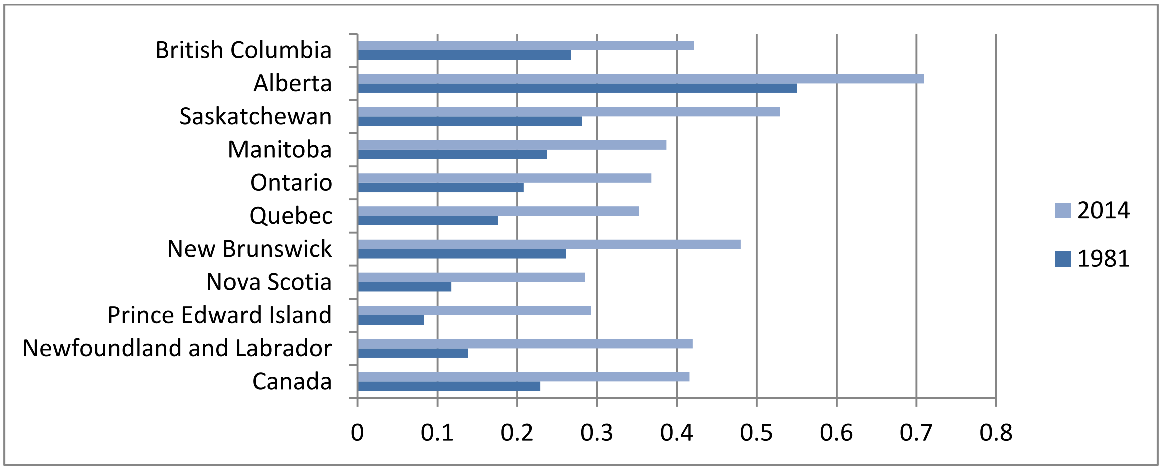


Chart A4:7 Equality Domain

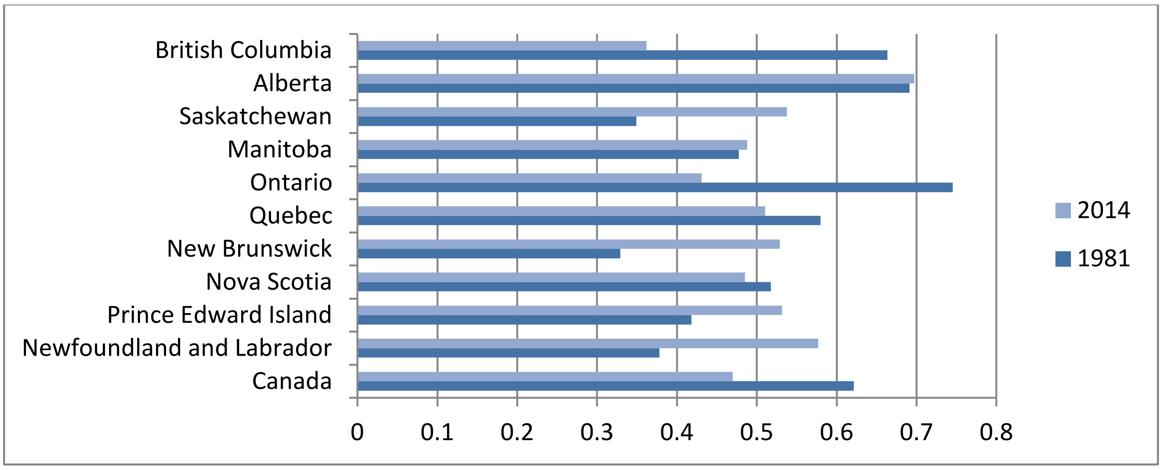


Chart A8:4 Security Domain

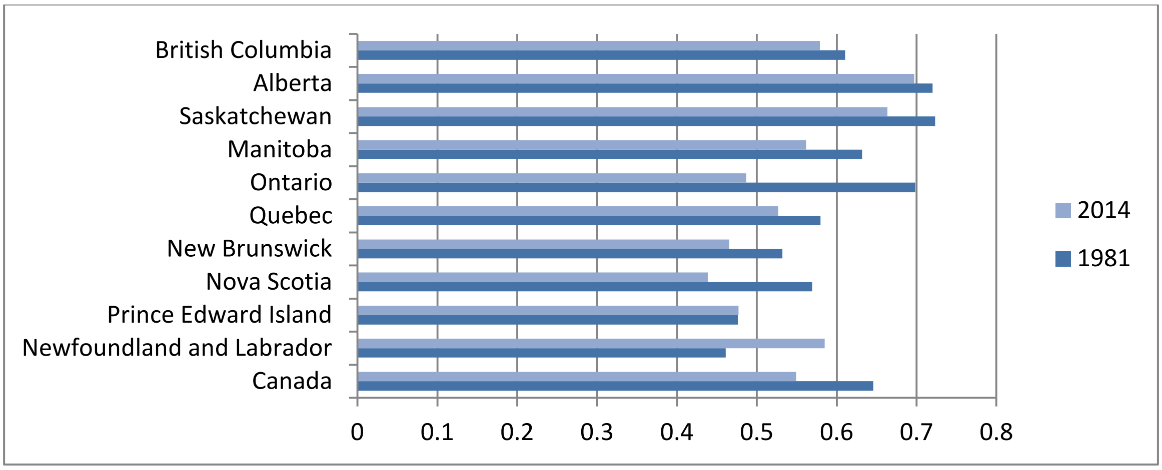
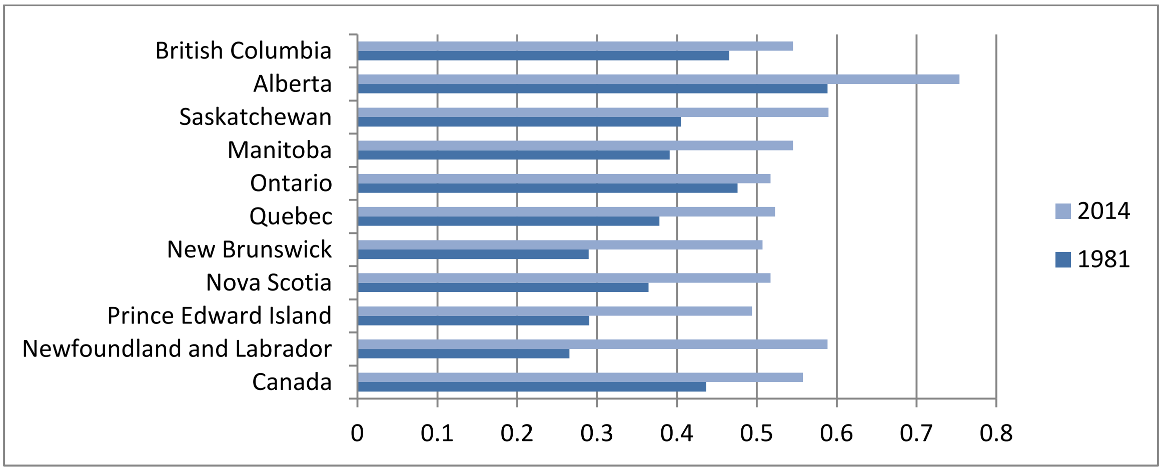


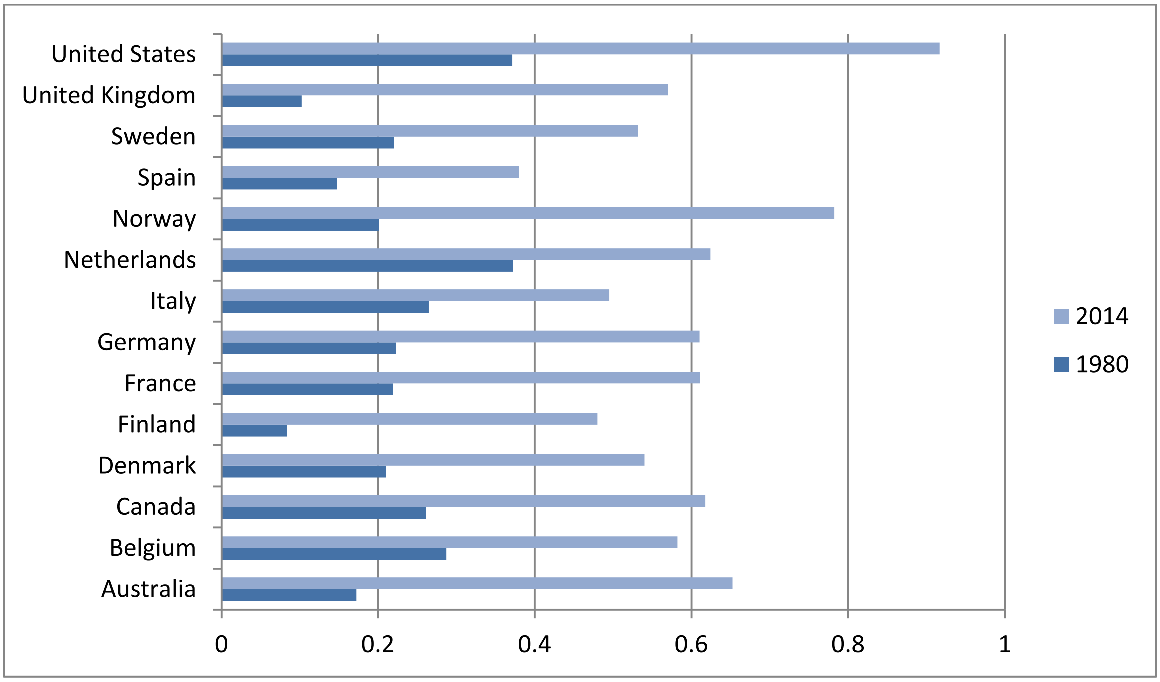
Chart A4:5 Overall IEWB



Appendix 5

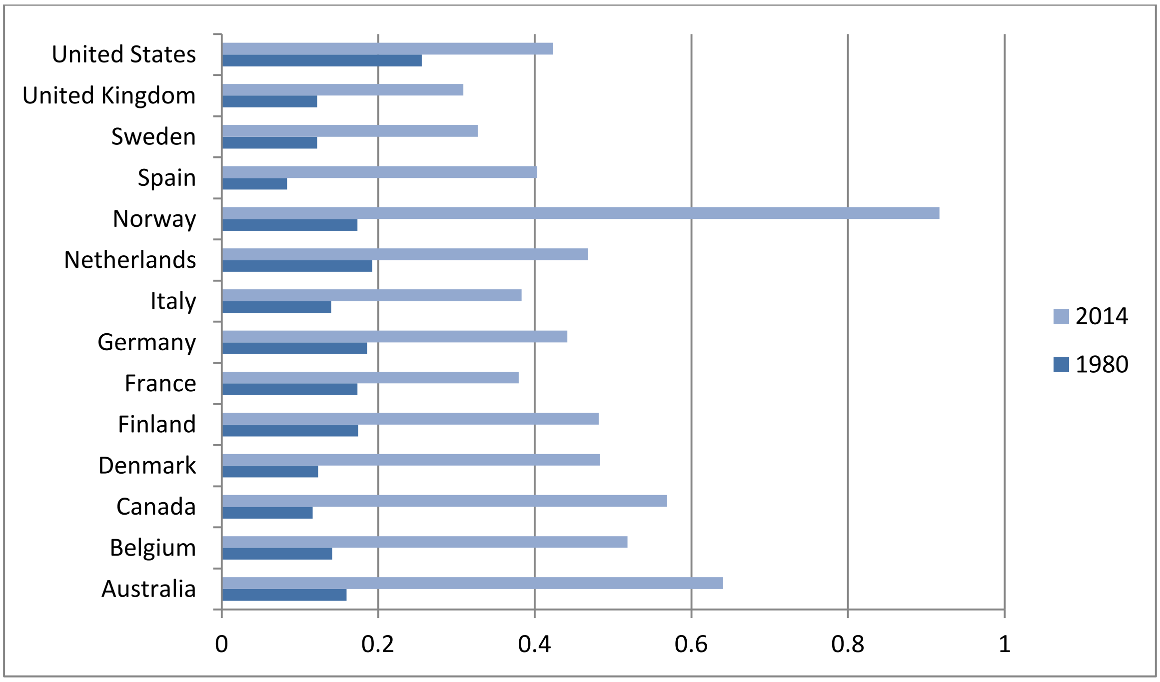
The Index of Economic Well-Being by Dimension and by Nation

Chart A5:1 Consumption Domain



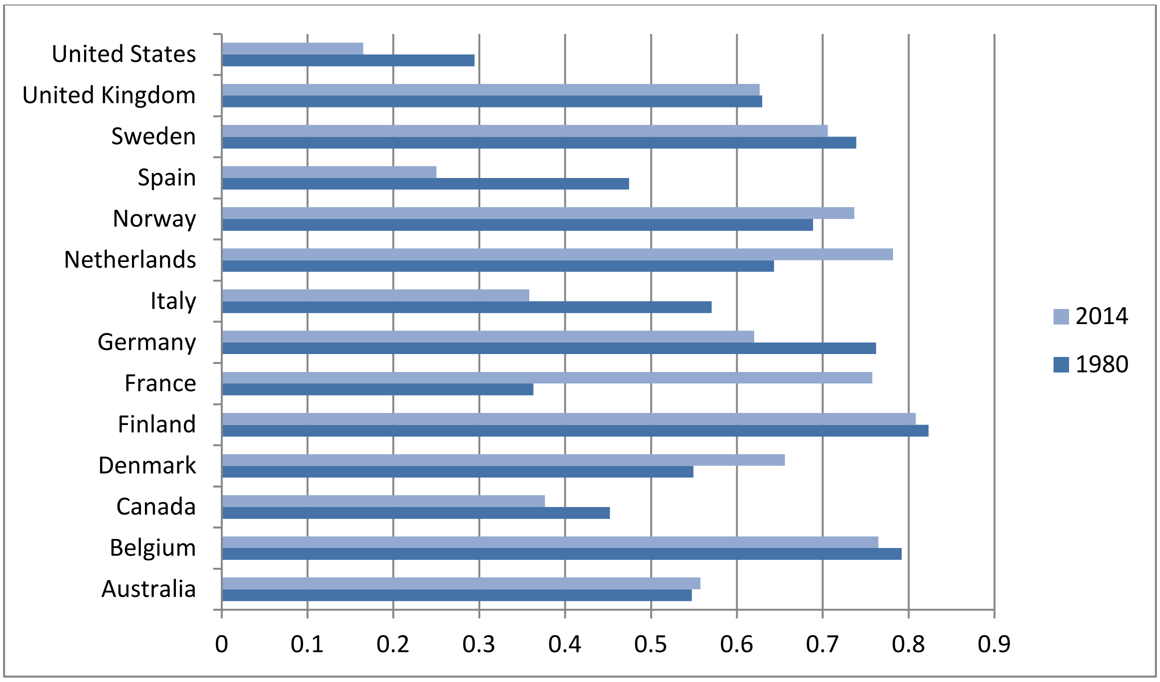
Source: CSLS IEWB OECD Database.

Chart A5:2 Wealth Domain



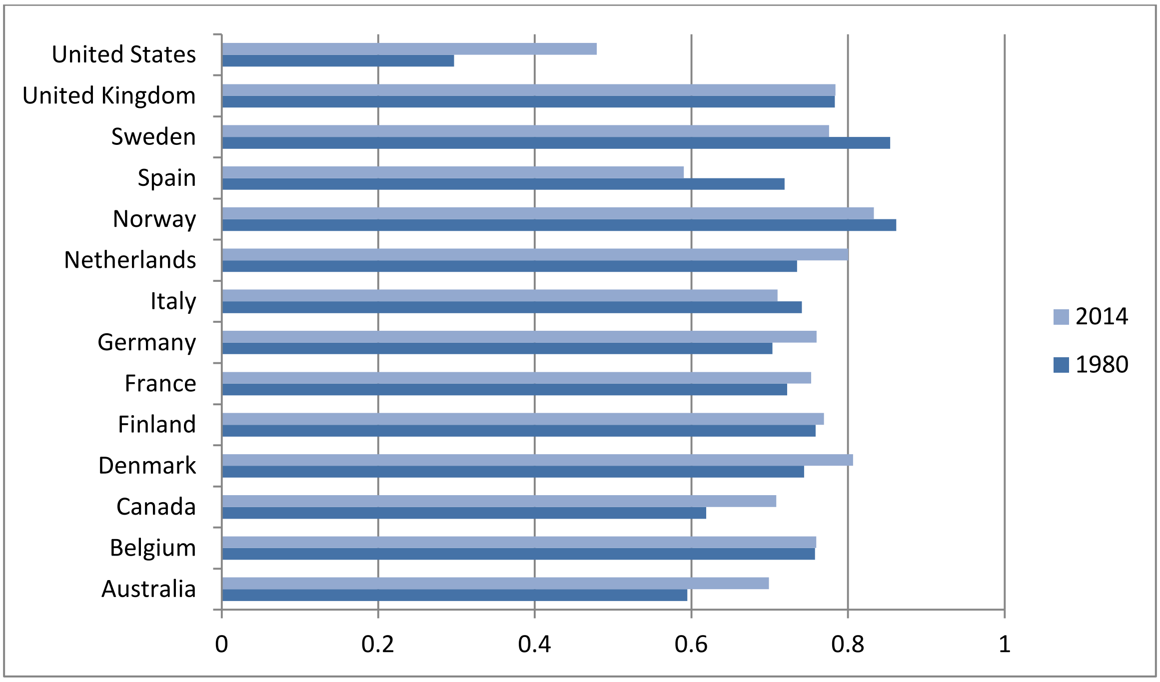
Source: CSLS IEWB OECD Database.

Chart A5:3 Equality Domain



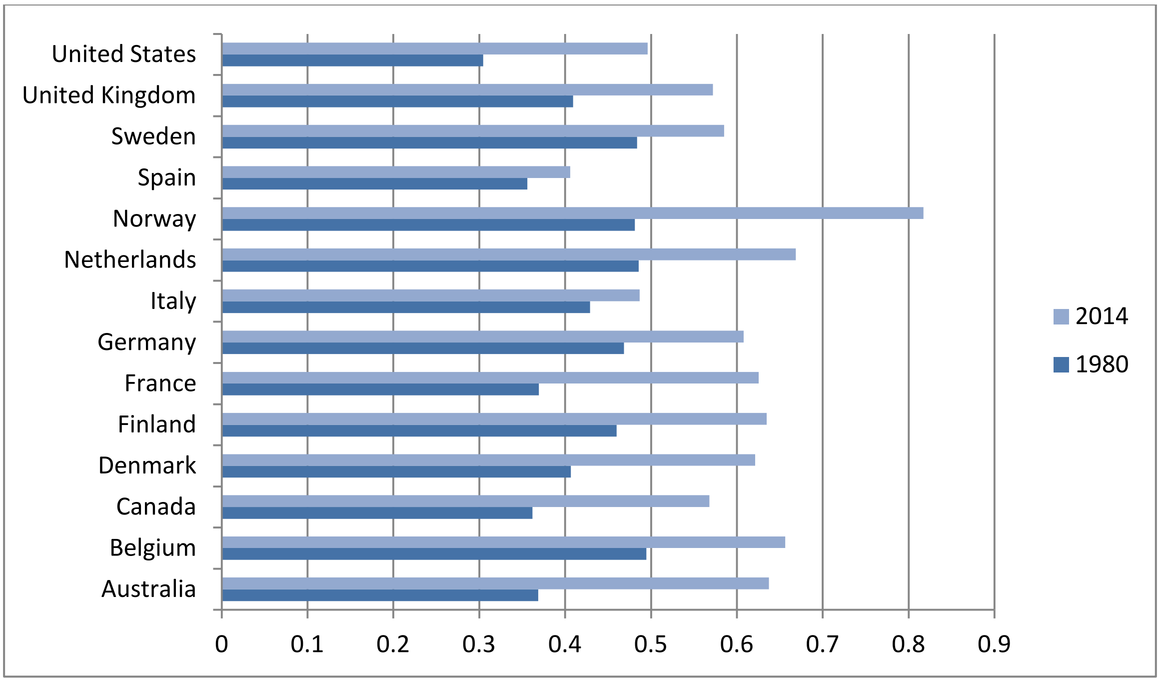
Source: CSLS IEWB OECD Database.

Chart A5:4 Security Domain



Source: CSLS IEWB OECD Database.

Chart A5:5 Overall IEWB



Source: CSLS IEWB OECD Database.