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

Lars S. Osberg (Dalhousie University, Canada),
Andrew Sharpe, Jasmin Thomas, and Alexander Murray
(Centre for the Study of Living Standards, Canada)

Discussant: Federico Perali – University of Verona

34th IARIW General Conference
Dresden, Germany
August 21-27, 2016

Organization

- Commodity Price Volatility and Economic Well-Being in Rich Countries using available data on fourteen OECD nations over the period 1980 to 2014
- The Issue – Energy rather than food prices
- The Method
  - IEWB
  - Accounting type decomposition
  - Econometric approach
- Results Summary
- Discussion

The Issue

Big Swings in Terms of Trade (TOT): How much do they matter for Well-Being?

- Context
  - in 1976-2016 large swings in oil prices + unpredictable future trend
- With a special interest on
  - resource (oil&minerals) producing countries such as Canada, Australia, and Norway
    - (Russia and Brazil are not OECD countries)
  - in the swings of export rather than import prices – supply side interest

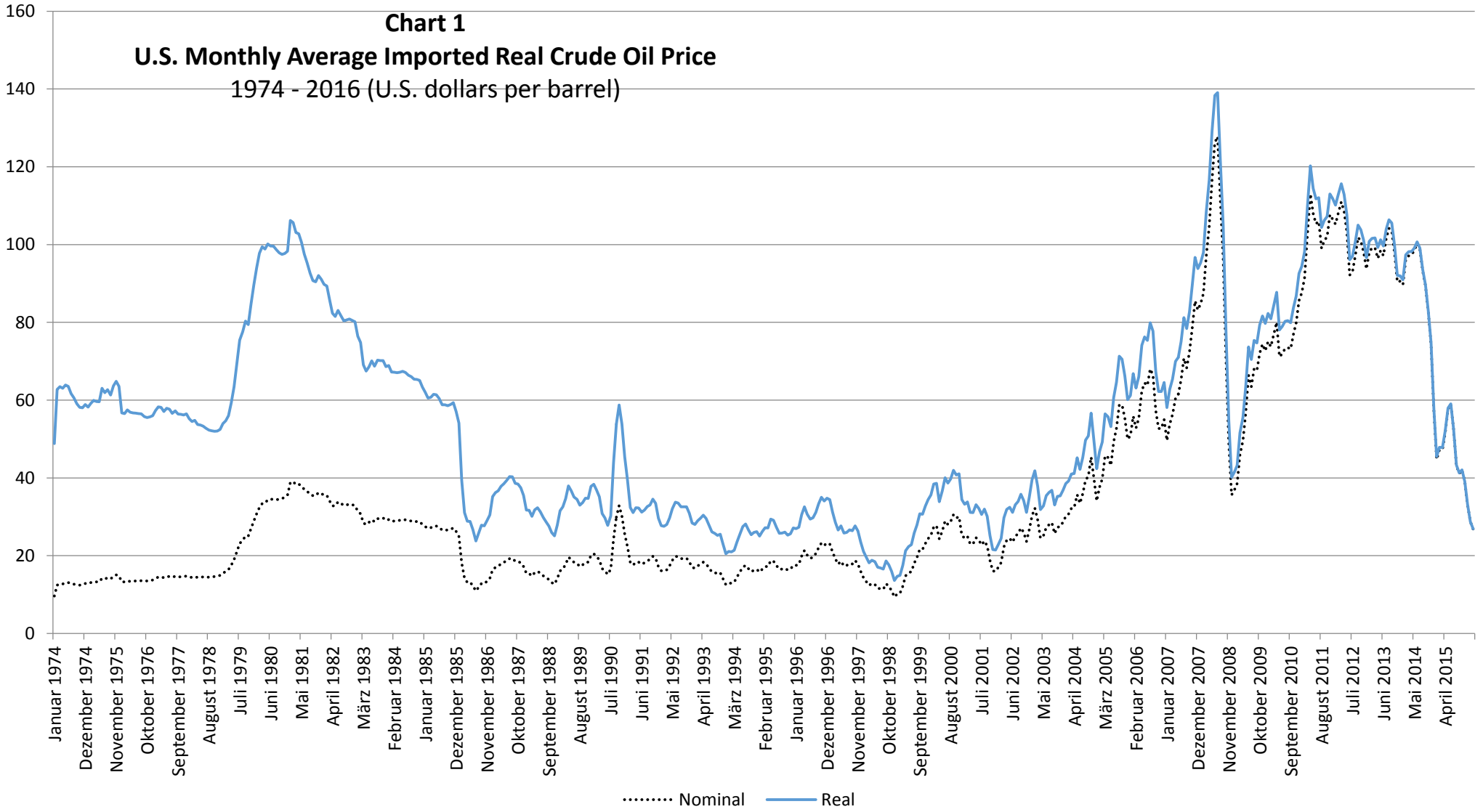
A ZOOM on Canada's Oil Producing Countries

- 7/10 provinces consume oil (84% pop.) – little TOT movement
  - IEWB method: Evaluate Wealth stocks at fixed base period prices
- Canada Oil Producers: Alberta, Saskatchewan, Newfoundland
  - big swings in TOT, driven by oil prices
  - Wealth estimates capitalize the value of the future consumption which asset stocks enable
  - Net Present Value of resource rents highly depend on expected future prices
  - Oil price: $88.50 in 2014 → $42.30 in 2016 => NPV oil sands rent ↓ by $210,000 per Albertan
    - Natural bitumen deposits are found in extremely large quantities esp. in Canada (owned by provinces)
  - Future oil price dominates wealth estimates for producing provinces, but not elsewhere

What future price of oil should one expect?

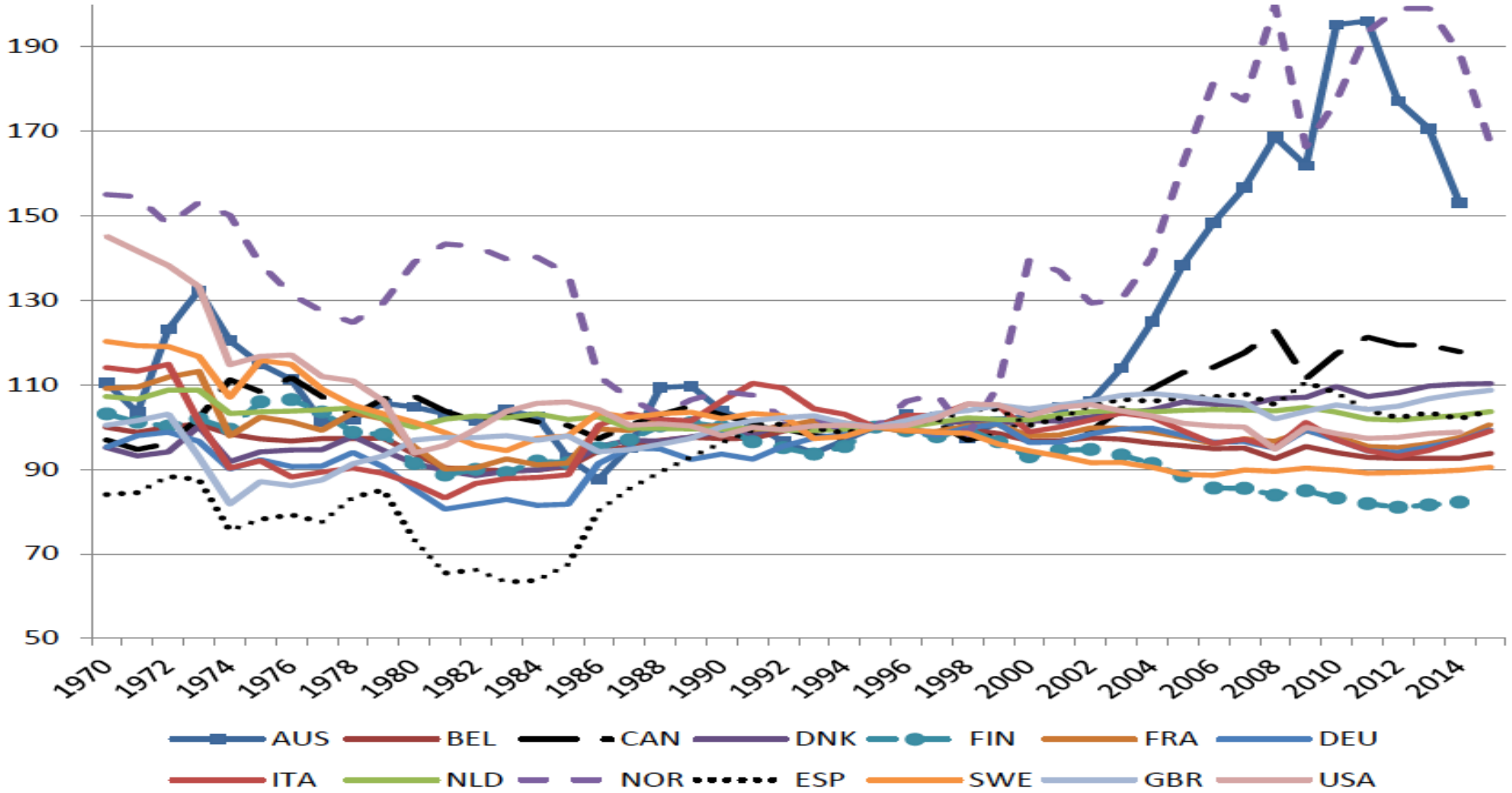
- Even best forecasts have been spectacularly unsuccessful
- Big swings of oil prices in past and possibility of an off oil future => real unpredictability
- Implication:
  - wealth of Alberta, Saskatchewan, Newfoundland is highly uncertain … and Norway, Australia as well

Real Price of Petroleum Energy: Short run Volatility + Huge Long Swings

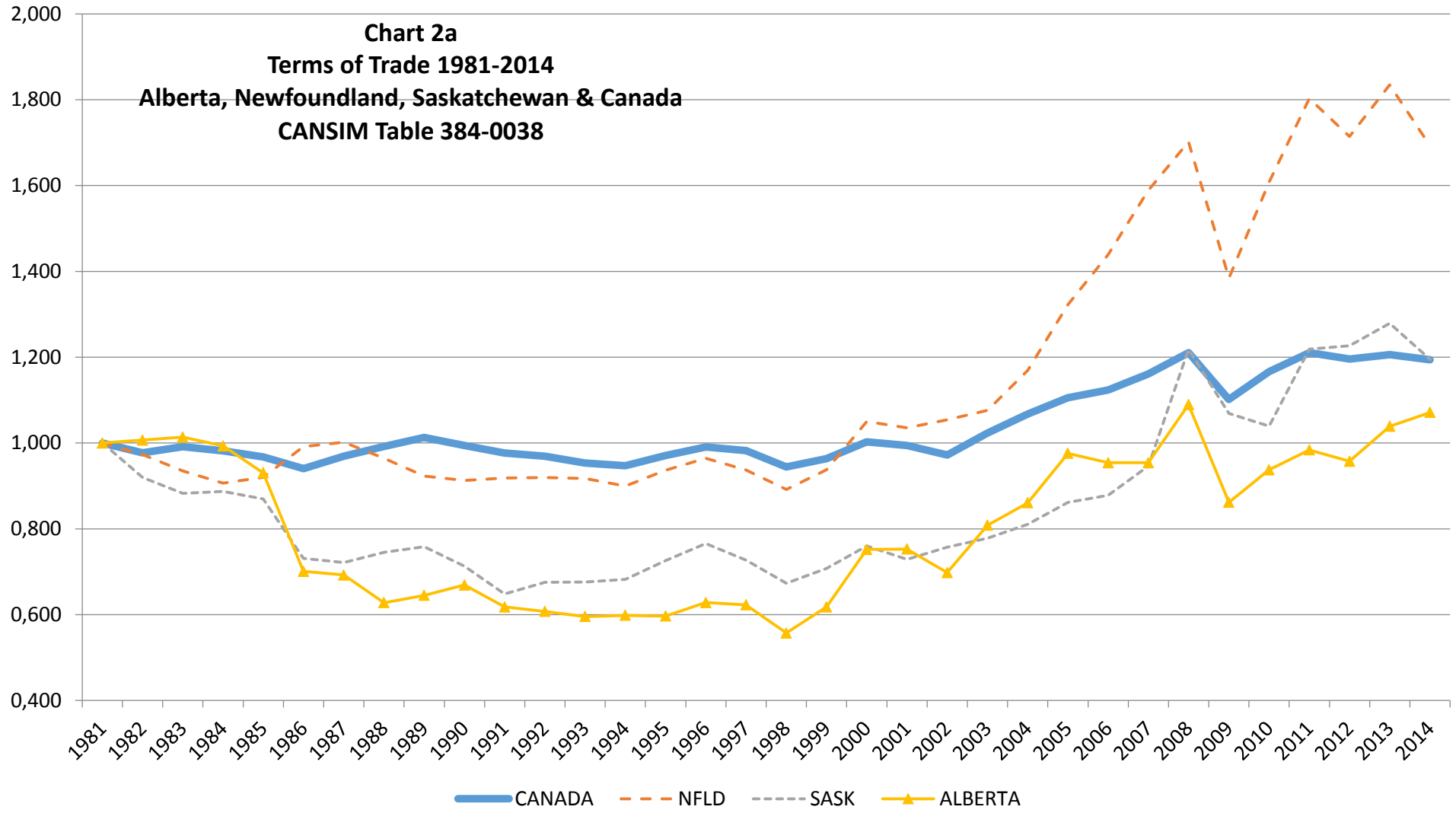


Terms of Trade

Selected OECD Countries, 1995 = 100, 1970-2015

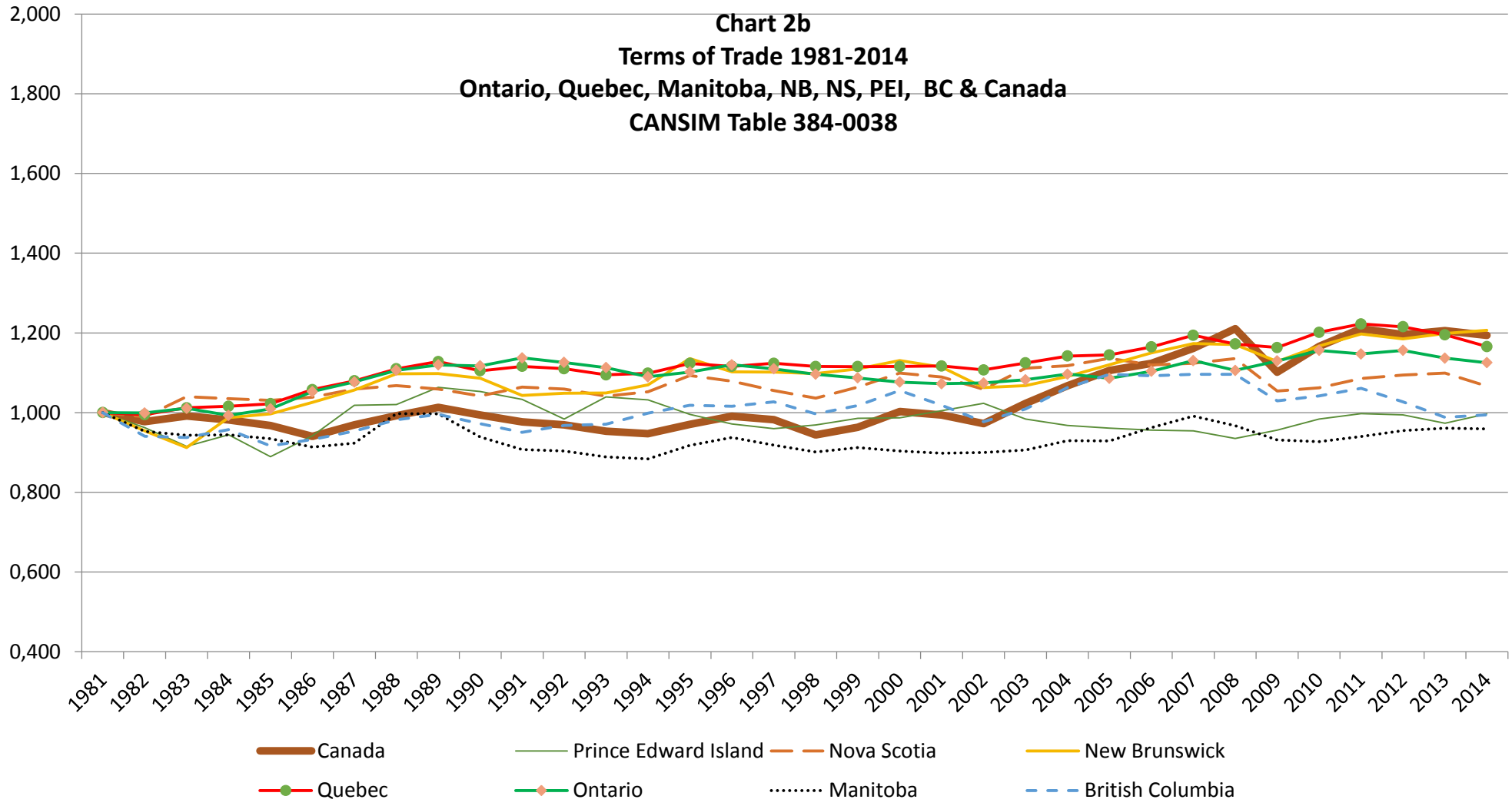


Big Terms of Trade Swings
also for Alberta, Saskatchewan & Newfoundland



Little Change in TOT for Oil Consuming Provinces

[7/10 & 84% of population]



Commodity PI and National TOT

TOT = export/import prices

$$\%\Delta TOT_t = \alpha + \beta(\%\Delta x_t)$$

x = energy price index

= all commodity index,

= oil price index

Annual data 1981-2014

Commodities & especially oil / energy prices strongly pos correlated with ΔTOT in Aus, Canada and Norway

	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

The Method:
The Index of Economic Well Being

Index 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] Security of future incomes

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

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

Going beyond GDP: IEWB components

- IEWB (Index of Economic Well Being) =
  - β_1 (Private Consumption flows, gov.t exp., unpaid work, family size) +
  - β_2 (Wealth: physical, R&D, natural res, human K, env., net int.l posit) +
  - β_3 (Equality and poverty) +
  - β_4 (Security: risk from unempl., illness, single-parent, pov. in old age)

with $\beta_1 + \beta_2 + \beta_3 + \beta_4 = 1$

Note: results are conditional on weighting schemes

How to measure "wealth" in IEWB ?

- "Wealth" = stock of productive assets accumulated in the past in order to enable consumption in the future
  - IEWB = market value of *physical capital* stock of buildings & machinery + estimated PV *human capital* stocks + R & D investment + ***natural*** **resource wealth** + environmental assets - degradation) + net foreign financial assets/liabilities
    - Present Value Assets = $\Sigma_t (P_t Q_t - C_t)/(1+r)^t$
      - assume relative prices and discount rate constant (though one can simulate a range)
    - Per Canadian – tangible non-oil sands wealth = $192,000 Cdn in 2008

BUT not plausible for Alberta, Saskatchewan & Newfoundland

- Large changes in Terms of Trade driven by changes in oil prices
- Natural resource wealth
  - large per capita (twice of wealth of avg Canadian) and highly volatile because dependent on future oil prices
  - Even the best oil price predictions have been spectacularly wrong
  - Wealth Component of IEWB therefore highly uncertain
- A problem of the real world for any well being index that values the future consumption of citizens

Per Capita Wealth

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%

Benes, Chauvet, Kamenik, Kumhof, Laxton, Mursula & Selody (2012)
"The Future of Oil: Geology versus Technology"
IMF Working Paper - Fig. 11

real 2011 US $ per barrel

(6.4 % CPI inflation 2011-16)

90% Confidence Interval

= $ 100 – $ 170 (2016)

= $ 120 – $ 240 (2021)

Actual US $ Spot Prices – West Texas

March 2016

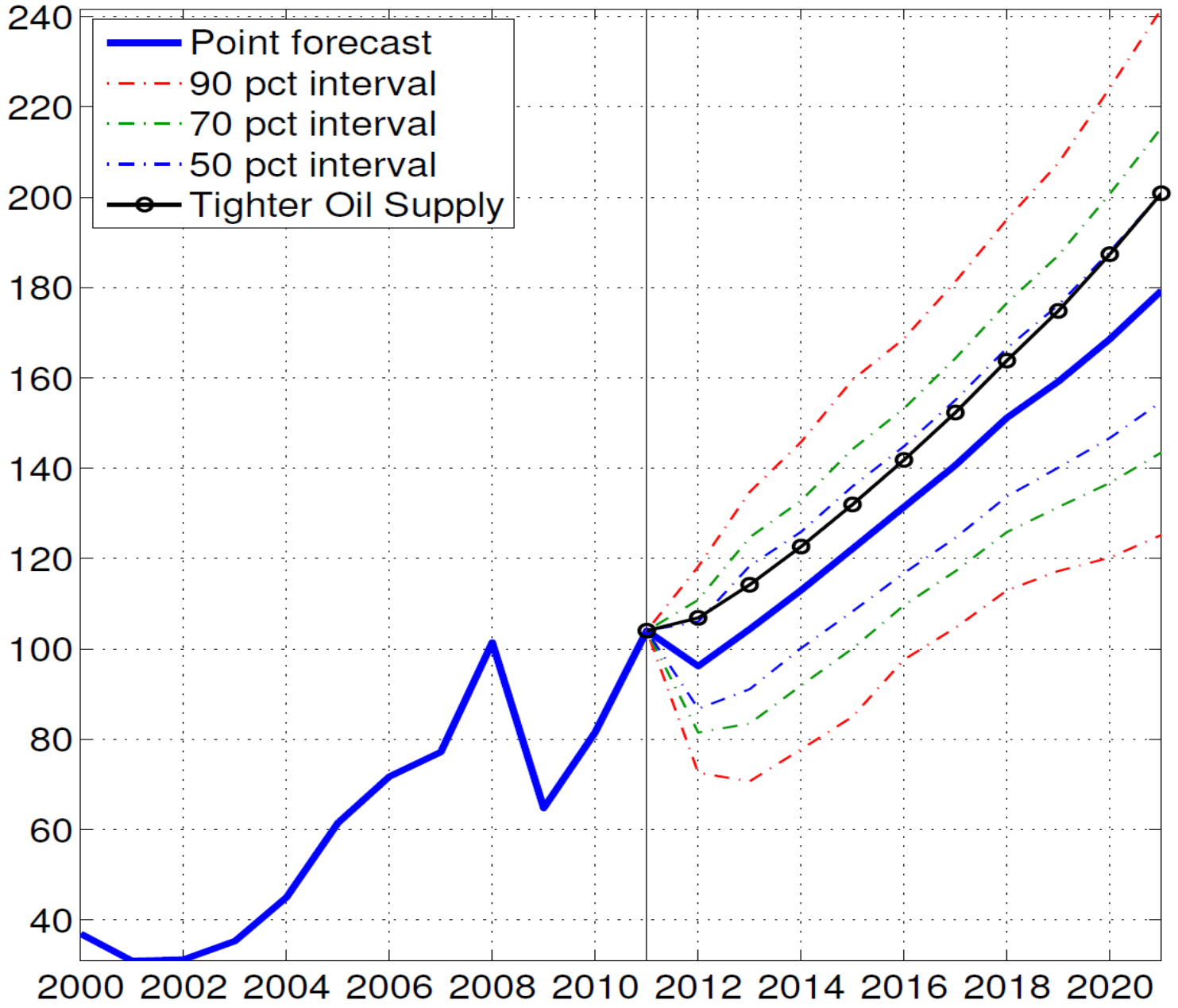
- $34.56 to $37.99

April 2016

- $34.30 to $46.03

May 2 – May 23, 2016

- $ 43.77 to $ 48.29



What future oil price should we expect?

- Year-to-date average price Western Canada Select = 30.15_{(Cdn)}$
  - Average processing costs = $31.40
  - If average processing costs are not covered, how many producers close?

- Is this a long swing in commodity price or a regime change?
- Expectations of low cost producers (Saudi Arabia) are crucial
  - Will public policy shift to decrease CO_2, technical change (e.g. solar, eco-engines) imply substantially decreased world oil demand post 2025?
  - If so, selling oil cheap now = better option than selling later for even less
  - Forward looking oil producing countries are big GREEN investors and GREEN JOB creators as a (oil price) risk coping strategy
- real uncertainty of future oil prices => uncertain present wealth

The Accounting Approach

- C(u,p,d) → V(p,y,d) Individual and Social well-being depend on p
- Real gross domestic income (GDI) measures the purchasing power of income generated by production activity in a country.
- Growth in real GDI = growth in real gross domestic product (GDP) + *trading gain* (or loss) that captures the effect of changes in relative prices
- Trading gain = *trade effect* + *real exchange rate effect*.
  - The magnitudes of these effects in part reflect the size of the international trade sector as a share of output.

Effects of Resource Prices and Trading Gains on Components of Economic Well-being

- Let Δi_t denote the log difference in a component of economic well-being between dates t and t-1.
- Δy_t be the log difference in per capita real GDI, and
- $\Delta i_t = f(\Delta y_t)$
- real per capita GDI growth can be decomposed as

$$\Delta y_t = \Delta GDP + s_T TOT + s_R RER \approx \Delta GDP + s_T TOT$$

A simple decomposition

$$\partial \Delta i_t / \partial \Delta p_{ct} = (\partial \Delta i_t / \partial \Delta y_t)(\partial \Delta y_t / \partial \Delta p_{ct}) = \boldsymbol{\alpha}\,(s_T\, \partial \Delta TOT_t / \partial \Delta p_{ct}) =$$

$$= \boldsymbol{\alpha}\; s_T\, (s^x_{ct} - s^m_{ct})$$

S_T = weight depending on the size of imports and exports as a share of GDP

$S^{x,m}_{ct}$ = shares of commodities and non-commodities in exports (imports)

α = elasticity of IEWB component growth with respect to real per capita GDI

- well-being is more sensitive to prices in countries with large trade sectors (i.e. a large s_T).
- 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 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. 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.
- Sensitivity of well-being to commodity prices depends on the elasticity $\boldsymbol{\alpha}$ describing the relation between GDI and each well-being component. While s_T, $S^{x,m}_{ct}$ are directly observ., $\boldsymbol{\alpha}$ (for the cons component = marginal propensity to consume from income) is not.

Results

Summary results: accounting approach using OECD stats to assess impact of Δ p on Δ i

- Growth of real GDI, GDP, trading gains (Average of Annual Growth Rates) and volatility (standard deviations in red) – 1980-2014

	GDI	GDP	Trading Gain	TOT growth as % GDI
Australia	3.43	3.17	0.24	7.1
	2.19	1.56	1.26	
Canada	2.56	2.45	0.10	3.8
	2.62	2.07	1.01	
Norway	3.03	2.57	0.44	14.5
	4.21	1.79	3.59	
Germany	1.73	1.71	0.02	1.2
	1.89	1.99	0.78	

Determinants of the Sensitivity of Well-being to Commodity Price Shocks – 1980-2014

	Trade Share of GDP	Commodities Share of Exports	Commodities Share of Imports
Australia	0.19	0.48	0.08
Canada	0.31	0.17	0.09
Norway	0.36	0.45	0.06
Germany	0.28	0.03	0.11

The Econometric Approach

$$i_t = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_s \boldsymbol{\Delta} \ln GDP_t + \boldsymbol{\gamma}_s \boldsymbol{\Delta} \ln TOT_t + \boldsymbol{\beta} \ln GDP_{t-1} + \boldsymbol{\gamma} \ln TOT_{t-1} + \boldsymbol{\theta}\, i_{t-1} + \boldsymbol{\varepsilon}_t$$

- short run (βs, γs) “transitory” effects and
- long run “permanent” effects (β/θ, γ/θ)
- i = current average consumption, equality in income distribution and economic security | GDP, TOT

Summary results: econometric approach

- Consumption
  - Negative results: GDP sign., TOT not sign. also for Australia, Norway and Canada (but for Germany), because consumption expenditures are a major component of GDP and the size of terms of trade fluctuations is generally small. The long run impacts (γ/θ) are negligible.
- Income equality
  - not sensitive to variations in resource prices because the effect of changes in resource prices on TOT and the distribution of employment, and the associated distribution of market income, is weak.
- Security
  - positively related to GDP as the prob. of unemployment enters the unemployment risk sub-component directly and unemployment is negatively related to GDP growth. Interestingly, among the three resource nations and Germany, only Canada shows a positive correlation of TOT and security. Long run impacts of TOT are generally insign.

Conclusions

- Norway, Australia and Canada's three oil producing provinces – Alberta, Saskatchewan and Newfoundland – have seen huge swings in TOT, largely driven by energy price changes.
- The TOT of the other countries examined (Belgium, Denmark, Finland, France, Germany, Italy, Nether, Spain, Sweden, U.K. and U.S.A.) and of Canada's seven other provinces are not related to resource price movements
  - Therefore, little impact on economic well-being.
- However, expectations of future resource prices matter enormously to the per capita natural resource **wealth** of the people living in producing areas such as Russia, Venezuela, or South-Sudan whose gov't revenue heavily depends (85%) on royalties from oil production... where also food price volatility matters too.

Discussion

Not only energy (coal, natural gas, oil), minerals, but also food … a more micro view

- Bellemare, Barrett, Just (The Welfare Impacts of Commodity Price Volatility: Evidence from Rural Ethiopia, AJAE 2014) ask:
  - How does commodity price volatility affect the welfare of rural households in developing countries, for whom hedging, insurance and consumption smoothing are often difficult?
  - When governments choose to intervene in order to stabilize commodity prices who gains the most?
- And conclude "Contrary to conventional wisdom, we find that the welfare gains from eliminating price volatility are increasing in household income, making food price stabilization a distributionally regressive policy."
- … what about energy price stabilization?
- … what are households' coping strategies in oil rich countries?

A typical general equilibrium question

- Partial approach via an accounting decomposition not sufficient to explain a story that is inherently a general equilibrium story
- Dutch disease: “external health and internal ailments”.
  - Since the discoveries of large gas resources in the 60’s, Dutch exports soared, but unemployment increased, investments tumbled, the Dutch currency overvalued (pre-Euro …) making other parts of the economy less competitive in international markets. Gas extraction was (and is) a relatively capital-intensive business, which generated few jobs. Interest rates were kept low and investments rushed out of the country thus limiting future economic potential.
- Russia, for example: oil-and-gas exports make up 70% of Russia’s annual exports and 52% of the federal budget. Unless commodity-rich countries use their fortunes to diversify their economies (and make them more green with fresh green jobs)—or can get their real exchange rate down—Dutch disease can still prove problematic.

A more “general” approach

- A classic – Jorgenson and Slesnick’s (1983, 1984) class of social welfare functions that combines the average level of household welfare with deviations of individual welfare levels from average. (Jorgenson and Schreyer, Measuring Individual Economic Well - Being and Social Welfare within the Framework of the System of National Accounts, IARIW - OECD Special Conference: “W(h)ither the SNA?”, Paris, 2015): a parametric ”general” IEWB that can naturally host the four dimensions analyzed here in a dynamic context
- The Social Cost-of-Living: Welfare Foundations and Estimation (Crossley and Pendakur, QSEP Research Report No. 407, 2006)