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

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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

Chart 1
U.S. Monthly Average Imported Real Crude Oil Price
1974 - 2016 (U.S. dollars per barrel)
Big Terms of Trade Swings also for Alberta, Saskatchewan & Newfoundland

Terms of trade are defined as the ratio between the index of export prices and the index of import prices.
Little Change in TOT for Oil Consuming Provinces
[7/10 & 84% of population]

Chart 2b
Terms of Trade 1981-2014
Ontario, Quebec, Manitoba, NB, NS, PEI, BC & Canada
CANSIM Table 384-0038
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 \( \Delta TOT \) in Aus, Canada and Norway
The Method:
The Index of Economic Well Being
# Index of Economic Well-Being

<table>
<thead>
<tr>
<th>Concept</th>
<th>Present</th>
<th>Future</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heterogeneity of individual citizens</td>
<td>[C] Distribution of potential consumption—income</td>
<td>[D] Security of future incomes</td>
</tr>
<tr>
<td></td>
<td>inequality and poverty</td>
<td></td>
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</tbody>
</table>

\[\text{IEWB} = \beta_1 (\text{Current Average Consumption}) + \beta_2 (\text{Total Societal Wealth}) + \beta_3 (\text{Index of Equality}) + \beta_4 (\text{Index of Economic Security})\]

Subject to: \(\beta_1 + \beta_2 + \beta_3 + \beta_4 = 1\)
Going beyond GDP: IEWB components

• IEWB (Index of Economic Well Being) =

  • $\beta_1$ (Private Consumption flows, gov.t exp., unpaid work, family size) +

  • $\beta_2$ (Wealth: physical, R&D, natural res, human K, env., net int.l posit) +

  • $\beta_3$ (Equality and poverty) +

  • $\beta_4$ (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 = $\sum_t \left( \frac{P_t Q_t - C_t}{(1+r)^t} \right)$

    • assume relative prices and discount rate constant (though one can simulate a range)

• Per Canadian – tangible non-oil sands wealth = $192,000 \text{ Cdn in 2008}$
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

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

• $C(u,p,d) \rightarrow V(p,y,d)$ 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 $\Delta i_t$ denote the log difference in a component of economic well-being between dates $t$ and $t-1$.
• $\Delta y_t$ 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

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

$$= \alpha \ s_T (s_{ct}^x - s_{ct}^m)$$

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

$S_{x,m}^T = \text{shares of commodities and non-commodities in exports (imports)}$

$\alpha$ = 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 $\alpha$ describing the relation between GDI and each well-being component. While $s_T, s_{x,m}^T$ are directly observ., $\alpha$ (for the cons component = marginal propensity to consume from income) is not.
Results
Summary results: accounting approach using OECD stats to assess impact of $\Delta p$ on $\Delta i$

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

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

<table>
<thead>
<tr>
<th>Country</th>
<th>Trade Share of GDP</th>
<th>Commodities Share of Exports</th>
<th>Commodities Share of Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>0.19</td>
<td>0.48</td>
<td>0.08</td>
</tr>
<tr>
<td>Canada</td>
<td>0.31</td>
<td>0.17</td>
<td>0.09</td>
</tr>
<tr>
<td>Norway</td>
<td>0.36</td>
<td>0.45</td>
<td>0.06</td>
</tr>
<tr>
<td>Germany</td>
<td>0.28</td>
<td>0.03</td>
<td>0.11</td>
</tr>
</tbody>
</table>
The Econometric Approach

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

- short run \((\beta_s, \gamma_s)\) “transitory” effects and
- long run “permanent” effects \((\beta/\theta, \gamma/\theta)\)
- \(i = \) 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 ($\gamma/\theta$) 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