

# The Consumption Terms of Trade and Commodity Prices\*

Martin Berka<sup>†</sup>                      Mario J. Crucini<sup>‡§</sup>  
Massey University    Vanderbilt University and NBER

June 2009

## 1 Introduction

The goal of this paper is to study the *consumption terms of trade* and compare it to the *production terms of trade*. By the consumption terms of trade we mean the relative prices that consumers face in their home market for the basket of goods they export relative to the basket of goods that they import. By the production terms of trade, we mean the relative prices that producers face when making decisions about what to produce. If producer

---

\*

<sup>†</sup>Martin Berka, Department of Commerce, Massey University, POBox 102 904, NSMC, Auckland, New Zealand. Phone +64 9 414 0800 ext 9474. Email: m.berka@massey.ac.nz.

<sup>‡</sup>Mario J. Crucini, Department of Economics, Vanderbilt University; VU Station B #351819, 2301 Vanderbilt Place, Nashville, TN 37235-1819. Phone: (615)-322-7357, Fax: (615) 343-8495. mario.j.crucini@vanderbilt.edu

<sup>§</sup>Mario Crucini gratefully acknowledges the financial support of the National Science Foundation (SES-0524868).

and consumer prices are the same, the consumption and production terms of trade are equal, a common *terms of trade* faced by both consumers and producers. Improvements in the terms of trade motivate domestic producers to shift resources toward the production of exports and away from imports, with consumption shifting in the opposite direction. When the terms of trade in consumption differs from the terms of trade in production, the consumption, production and trade balance implications are altered in fundamental ways. Yet before these implications can be understood, we need to know how much the consumption and production terms of trade differ and understand the sources of those differences.

While it is certainly possible for incomplete pass-through of exchange rate and import price movements to retail prices to result in divergences in the consumption and production terms of trade, no studies that we are aware of make this link.<sup>1</sup> Pass-through traces the ripples of a foreign price change or exchange rate movement through to import prices and on up the chain to final consumer prices. In contrast, what we are interested in is a relative price, the price of exports relative to imports. Unless export prices in local currency are fixed, exchange rate pass-through to import prices is only part of the story.

The analysis begins with the study of retail price inflation and price level

---

<sup>1</sup>Perhaps the closest measure is an effective multilateral real exchange rate. As far as we know, these constructs weight aggregate CPI data with bilateral aggregated trade shares as weights. We use micro-prices at the retail level and weight them with their corresponding weights in trade.

inflation for the world as a whole. This is accomplished by averaging U.S. dollar prices of individual goods and services across as many cities as available in the Economist Intelligence Unit retail price survey, the source of our consumer price data. The standard deviations of these commodity-level inflation rates range from a low of 3.7% to a high of 11%; the median is about 5%. Averaging these global price inflation rates across goods and services provides the world inflation estimate. Our estimate has a correlation of 0.88 with the OECD, U.S. dollar world inflation rate. This is surprising given the EIU sample typically comprises one city per country and a different consumption basket than official estimates and reassuring in the sense that the estimate appears not to be systematically biased by these differences. Next, a variance decomposition of world inflation is performed where the contribution of each good's inflation to aggregate world inflation is estimated. Prices with relatively high variation and positive comovement with other prices in the basket will contribute more to aggregate inflation variability for the same reasons that high beta stocks contribute more than their portfolio weight to the variance of a stock price index. Individual items are found to contribute vastly different amounts to price level variability. Some of the usual suspects show up at the upper end of the distribution, such as fuels, but individual food items often display annual changes not unlike that of fuel. Basically, the differences we see in world price volatility and world inflation are similar to that at the national level where food and energy prices are more volatile than the typical item found in the consumption basket.

The world price series at the microeconomic level form the basis of our computations of the *consumption terms of trade*. Using micro-data on trade flows we construct import and export price indices by weighting world prices (constructed from the EIU micro-data) by national import and export trade shares. The ratio of the export price index to the import price index is our terms of trade estimate. Admittedly, using a single set of goods prices comes at the cost of missing deviations from the LOP documented in the literature. The benefit is a much more transparent picture of how moments of goods prices within the world price distribution translate into terms of trade fluctuations, given observed trade patterns.

We find that the consumption terms of trade is somewhat less volatile than the production terms of trade in levels. However, this difference is nil in growth rates, when we average across the panel of 38 countries we study. As is true of the production terms of trade, the variability of the consumption terms of trade differs considerably across countries, from a low of about 1% in Australia to a high of about 10% in Korea (in levels). Countries with high production terms of trade variability tend to have high consumption terms of trade variability in log-levels, but the cross-sectional correlation in growth rates is close to zero. The correlation of the two measures within a country averages 0.3 for log-levels and 0.4 for growth rates. The two measure, then, are conceptually and empirically distinct.

Decompositions of the aggregate consumption terms of trade into microeconomic sources of variation at the good level is telling. The bulk of the

variability for most countries in the sample is accounted for by oil, automobiles and medicine. The role of oil in the production terms of trade has been extensively documented and studied in the existing literature, the evidence here suggests that feature extends to the consumption level. The concentration of variance in so few items is a more novel finding, particularly the key roles of automobiles and medicine. Focusing on these three items we are able to account for much of the secular swing in the consumption terms of trade over the 1990 to 2005 period in our panel. Interesting, oil moves in an idiosyncratic fashion relative to other world prices, helping to distinguish its role beyond its asymmetric trade share internationally. Moreover the movements in key world prices allow us to classify 30 of the 38 countries into two groups, those with U-shaped terms of trade profiles (10 countries, 7 being oil exporters) and those with inverted U-shaped patterns (20 countries, all are oil importers). With few exceptions, patterns outside these two groups and subtle differences within the groups are elucidated by looking at the relative importance of oil, automobiles and medicine. Ireland, for example, experiences virtual continuous improvements in the consumption terms of trade due to the pull of medicine prices on the export side serving as effective counterweight to the drag of oil prices on the import side.

The analysis also reveals that the lack of diversification in trade, which has largely been the focus of terms of trade analysis in developing countries, is also relevant for industrialized countries. Apart from specialization per se, the other reason for this fragility is that the large number of goods in

which trade is roughly balanced creates a natural hedge against price variability at the world level in those goods, leaving the risks and terms of trade variability to be concentrated elsewhere in the distribution of goods. Isolating these sources of variation is virtually impossible without the variance decomposition developed here with the use of micro-price data.

## 2 A conceptual model

The focus is the evolution of commodity prices in U.S. dollars relative to the world price level, leads naturally to a theoretical framework emphasizing sectoral interactions over international interactions. The most tractable framework with a closed form equilibrium solution that links prices one to another over time is the equilibrium real business cycle model of Long and Plosser (1983). The solution for the evolution of equilibrium output levels across sectors in that model is:

$$y_t = \kappa + Ay_{t-1} + \eta_t \tag{1}$$

where,  $y_t$  is a column vector of the logarithm of outputs, with each sector's output being a row in the vector.  $A$  is the transpose of the input-output matrix and  $\eta_t$  is vector of sectoral productivity shocks.

The link between equilibrium prices and quantities is straightforward to establish in this model since each sectoral price is proportional to output:

$P_{i,t} = \gamma_i/Y_{i,t}$ .<sup>2</sup> Taking logs and substituting prices for quantities into equa-

---

<sup>2</sup>It is interesting to note that prices are inversely proportional to quantities as is true in the Cole and Obstfeld (1991), as they discuss in a subsection of their classic paper.

tion (1) gives a linear dynamic system in sectoral prices:

$$p_{t+1} = \alpha + Ap_t - \eta_{t+1} \quad (2)$$

with the innovation vector to prices the negative of the innovation to productivity.

Since, empirically, the prices in this vector are nominal we need to convert to relative prices. The LP model assumes preferences are log-additive, making the ideal domestic currency price index (also in logs):

$$p_t = \sum_{i=1}^M \theta_i p_{i,t} \quad (3)$$

where  $\theta_i$  are expenditure weights. The sectoral relative prices are thus,  $p_{i,t} - p_t$ .

The Long and Plosser model is a closed economy model, used here as a theoretical benchmark to organize our thinking about fluctuations in world relative prices.

To move from these international relative prices to the terms of trade, consider the constant-share terms of trade index, in logarithms:

$$q_{j,t} = p_{j,t}^x - p_{j,t}^m = \sum_i \gamma_{ij} p_{ij,t} - \sum_i \omega_{ij} p_{ij,t} . \quad (4)$$

where  $\gamma_{ij}$  are export shares and  $\omega_{ij}$  are imports shares satisfying,  $\sum_{i=1}^M \gamma_{ij} = \sum_{i=1}^M \omega_{ij} = 1$ .

Our maintained assumption is that the price of a particular good is the same whether it appears on the import or export side of the equation. As a

result, the terms of trade simplifies to:

$$q_{j,t} = \sum_{i=1}^M (\gamma_{ij} - \omega_{ij}) p_{i,t} \quad (5)$$

Note the strong implication of the assumption of common prices in all locations. The consumption terms of trade of each country is simply a different geometric weighted average of the same vector of prices. Put differently, the world price vector forms a common basis for determining all price indices and relative prices of interest.

Due to the fact that the number of prices used to construct our world inflation and national terms of trade estimates is very large, we use a variance decomposition inspired by the finance literature. The variance of the terms of trade becomes:

$$var(q_{jt}) = M^{-1} \sum_{i=1}^M (\gamma_{ij} - \omega_{ij}) cov(q_{j,t}, p_{i,t}) . \quad (6)$$

Dividing through by the variance of the terms of trade gives the variance decomposition:

$$1 = M^{-1} \sum_{i=1}^M \frac{(\gamma_{ij} - \omega_{ij}) cov(q_{j,t}, p_{i,t})}{var(q_{jt})} \quad (7)$$

$$= M^{-1} \sum_{i=1}^M (\gamma_{ij} - \omega_{ij}) \beta_{i,j} . \quad (8)$$

where  $\beta_{i,j}$  is the coefficient from a linear regression of an individual price series,  $p_{i,t}$ , on the aggregate terms of trade,  $q_{jt}$ . They have an interesting interpretation using the language of finance. The net trade shares represent net positions, or exposure to a particular commodity price variation. When



the net share is zero, but the trade shares are not, the country has perfectly hedged its risks in that commodity.<sup>3</sup> Since many net trade shares are close, if not identically zero, much of the international price risk is effectively hedged. When the country is specialized in the production of the good, the net trade share tends to be a large positive number, while goods in which the country has little in the way of domestic production, the net trade share is negative. In these cases, the price of the traded good influences the variance of the terms of trade in proportion to the net trade share and the covariance of the good's price with the terms of trade (as indicated in equation (7)).

Another way to express the beta coefficients is in terms of the relative standard deviation of the commodity price and the aggregate terms of trade and their correlation:

$$\beta_{i,j} = \frac{\sigma_i}{\sigma_j} \text{corr}(q_{j,t}, p_{i,t}) . \quad (9)$$

### 3 The data

The source of the price data is the Economist Intelligence Unit World-wide Survey of Retail Prices. The sample period runs from 1990 until 2005 and spans 123 cities and 301 goods and services. As these data have now been quite extensively used elsewhere, our description is brief.<sup>4</sup> The value of these data in this application is that the basket contains the same items in all

---

<sup>3</sup>Note, this hedge would be imperfect to the extent that the prices of import and exports are not equal, either due to LOP failure or heterogeneous composition, say due to different varieties in the good indexed by  $i$ .

<sup>4</sup>See for example, Crucini and Shintani (2008), Frankel, Parsley and Wei (2008) and Rogers (2008).

cities, which contrasts significantly with the practice of National Statistical Agencies where the focus is on the goods typically consumed at the destination. While one implication of this is that we may not match CPI inflation by location, an advantage is that we are not averaging prices of different goods across locations, which would not provide a meaningful estimate of commodity level inflation at the microeconomic level. The supplemental data include very disaggregated import and export shares and a detailed input-output table for the U.S. economy. The input-output data is considerably more aggregated than the micro-price data, while the trade data is more conformable.

In order to minimize the influence of any city price on a world price of any product, our price dataset utilizes only locations with at least 200 products. This restriction limits our sample to 82 cities, including 55 cities in 27 OECD countries and 27 non-OECD locations. These include 13 cities in the USA, 5 in Australia and Germany, 4 in Canada, 2 in each Japan, Spain, France, Italy, Switzerland and New Zealand. The non-OECD locations include 5 cities in 3 oil-exporting countries, 9 Asian and Latin-American countries each, and 3 African countries.

Products whose prices are used in the construction of our terms of trade measure account for 21.1% of the US CPI. Given that the consumption share of tradables in CPI is only 31.8%, our terms of trade account for 66% of the share of tradables in the consumption basket. In terms of CPI components, we cover 93% of clothing, 72% of alcoholic beverages, 70% of food at home,

61% of transportation goods, 40% of personal care products, 24% of household furnishings and 19% of recreation goods.

Our trade shares dataset uses UN Comtrade database to match the price data with 6-digit HS2002 import and export USD volumes for 2007. The sample includes members of the OECD, China, Brazil, Russia, India, several major oil exporting countries and Asian exporters. Among these countries, our categories on average cover 19% of imports and 18% of exports (we do not include re-exports or re-imports). The import coverage ratios reach up to 30% for Greece, but are as low as 6% for Singapore, which seems due to the paucity of electronic goods in the EIU survey. The export coverage ratios range between 3.5% for Singapore and 77% for Saudi Arabia.

## 4 World inflation

The good-level inflation estimates are inflation rates, in U.S. dollars, of a particular good,  $i$ ,  $\Delta p_{i,t}$ , averaged across all available cities in the EIU sample, indexed by  $j$ ,

$$\Delta p_{i,t} = N^{-1} \sum_{j=1}^N \Delta p_{ij,t} . \quad (10)$$

The number of locations varies somewhat across goods. We restrict the sample of locations to those with at least 200 price observations.

Aggregate world inflation (again, in the units of the numeraire currency, the U.S. dollar) is the average across commodities of these inflation rates,

$$\Delta p_t = M^{-1} \sum_{i=1}^M \Delta p_{i,t} . \quad (11)$$

The use of equal weights may be justified theoretically by the zero degree homogeneity of demand functions in which case the interpretation is that our aggregate price level is a numeraire, not a price index.

Figure 1 presents the inflation series for each of the 84 goods used to estimate world inflation while Figure 2 presents the aggregate inflation rate, the left-hand-side of the expression. The common inflation factor across goods is obvious from visual inspection of Figure 1, further confirmed by the fact that the median correlation of inflation at the good and aggregate level is a remarkable 0.92.

World inflation averages, 1.7%, from 1991 to 2005. Three years exhibit significant deflation, 1997 (-6.0%) and 2000 (-7.6%), while inflation was very high in 1994 (6.9%), 2003 (8.6%) and 2005 (6.8%). The correlation of this inflation measure with the estimate of OECD inflation in U.S. dollars is 0.88.

To more fully understand the role of individual prices in the evolution of the aggregate inflation rate we use the portfolio-inspired variance decomposition used by Crucini and Landry (2009) to study the microeconomic sources of aggregate real exchange rate variation. The variance of inflation may be expressed in terms of the covariance of aggregate inflation and good-level inflation:

$$var(\Delta p_t) = M^{-1} \sum_{i=1}^M cov(\Delta p_{i,t}, \Delta p_t) . \quad (12)$$

Dividing through by the variance of aggregate inflation gives the variance

decomposition of world inflation:

$$1 = M^{-1} \sum_{i=1}^M \beta_i . \quad (13)$$

The decomposition centers the distribution of the contributions of good-level inflation to aggregate inflation, the average beta, at unity. Goods with betas exceeding unity contribute more than the average good while goods with betas less than unity contribute less. Since beta can be negative, a commodity may reduce aggregate inflation variability. The interpretation is that adding such a price to the commodity basket will reduce the variance of the aggregate inflation rate. However, no prices in the sample have a negative covariance with the world inflation level, the lowest beta is 0.54.

The betas may also be expressed in terms of the relative standard deviation of commodity and aggregate inflation and their correlation:

$$\beta_i = \frac{\sigma_i}{\sigma} \text{corr}(\Delta p_{i,t}, \Delta p_t) \quad (14)$$

Figure 3, plots kernel density estimates relating to this decomposition. The upper-left chart is the kernel estimate of the standard deviation of inflation across goods, ranging from about 3.75% to about 8.68% (see also Table 1). There is considerable central tendency to commodity inflation at the level consistent with the standard deviation of aggregate inflation, 4.75%. The upper-right panel is the relative standard deviation, one component that influences how individual goods contribute to aggregate inflation variability. The values range from a low of 0.79 to a high of 1.83.

The lower-left panel is the estimated distribution of the betas, the distribution of the contributions of commodity level inflation to the variance of aggregate inflation. These average to 1 by construction, but vary considerably across goods, from a low of 0.56 for oil to a high of 1.45 for lettuce. It is surprising that oil contributes the least to world inflation variability by this metric. The conventional wisdom that oil is among the most variable prices is valid, even at the retail level: it ranks fourth among the 84 commodities in our inflation construct. What sets oil apart is that it has the lowest correlation with the aggregate inflation level of any commodity in our sample, at 0.35. As we noted above, good-level inflation rates have correlations with aggregate inflation above 0.6, the median is 0.92. The final chart is the correlation of commodity level inflation with the aggregate inflation rate.

## 5 The terms of trade

Recall, the *consumption terms of trade* is defined as:

$$q_{j,t} = \sum_{i=1}^{84} (\gamma_{ij} - \omega_{ij}) p_{i,t} . \quad (15)$$

We begin with an analysis of the stochastic properties of these terms of trade measures and comparisons with the production terms of trade.

Figure 4 and 5 presents a comparison of our estimate of the U.S. consumption terms of trade and the conventional production terms of trade as well as the import and export price indices used in the construction of each.

Because the official data is available quarterly but our retail price data is annual, we present a figure with the original official data as well as a version where we take quarterly averages to make them more comparable to our estimates. Each figure contains four charts, the left-most charts are the terms of trade, the differences between the two lines in the right-hand-charts, which contain the import and export price indices.

The U.S. consumption terms of trade displays a distinctive secular swing over from 1990 to 2005. This is true of 10 of the 12 cases for which we have both measures of the terms of trade (not shown). The most frequent pattern, found in 6 of 12 cases, Finland, France, Italy, Korea, Netherlands and the U.S. are quite similar in pattern to the evolution of the U.S. consumption terms of trade, inverted U-shapes, with terms of trade improvements followed by deterioration. Four are U-shaped patterns (Australia, Canada, Denmark and New Zealand), with the terms of trade deteriorating during the first half of the sample and then improving in the second half. Two exhibit virtual continuous improvement (Switzerland and United Kingdom). We will explore these striking similarities in the next section.

Turning to the production terms of trade, the relative price of exports to imports using prices at the border, the patterns share similarities and differences to the consumption terms of trade. The distinctive U-shapes and inverted U-shapes are largely gone. Denmark, the Netherlands, New Zealand, Switzerland and the United Kingdom show general terms of trade improvements. Canada and Australia maintain some of their original U-

shaped paths. Finland, Korea and Italy have deteriorating terms of trade over much of the sample. The picture for France is ambiguous, due to low variability. The United States has a somewhat inverted U-shape (see Figure 4 or 5), but the timing is different from what the consumption terms of trade shows.

Table 2 reports standard deviations of log-level and growth rates for both terms of trade measures, as well as their contemporaneous correlation. The production terms of trade tend to be more volatile than the consumption terms of trade, though this difference largely disappears in the move to growth rates, where the average standard deviation in the production terms of trade is 2.3, compared to 2.4 for the consumption terms of trade. Thus, the differences between the two is not merely a question of less volatile prices at the retail level than at the border. The two measures move weakly together in log-levels, where the correlation is about 0.3, on average, and somewhat more strongly in growth rates, where the correlation is 0.4, on average.

Since the production and consumption terms of trade are different conceptually, it is not clear that high correlation between them is to be expected. Moreover, the construction of the consumption terms of trade uses common international prices, while the terms of trade uses prices at the point of importation or exportation from the country in question. Given that deviations from the LOP have been widely documented in the literature, this is another source of difference between the two measures. The question we turn to next is: what is generating the trends and fluctuations in the consumption terms



of trade? As was noted earlier, there appear to be a few common secular trends shared by certain groups of countries. It will be interesting to see if those common features are driven by trade patterns and particular properties of a few key international prices, such as the price of oil.

## 5.1 Variance decomposition

Parallel to our inflation variance decomposition, the variance of a nation's terms of trade is computed as:

$$var(q_{j,t}) = M^{-1} \sum_{i=1}^M (\gamma_{ij} - \omega_{ij}) cov(q_{j,t}, p_{i,t}) . \quad (16)$$

Dividing both sides by the variance of the terms of trade, gives the desired variance decomposition:

$$1 = \sum_i^M (\gamma_{ij} - \omega_{ij}) \beta_{i,j} \quad (17)$$

with the betas are effectively the coefficients from a regression of the good-level price on the consumption terms of trade  $\beta_{i,j} = cov(q_{j,t}, p_{i,t}) / var(q_{j,t})$ .

Our analysis starts by pulling back to the broadest picture and pools all good and locations. Figure 6 plots two kernel density estimates, one for the net trade share and the other for the betas. These two distributions contain all of the elements needed to decompose the variance of the terms of trade.

The net trade shares lie almost exclusively between plus and minus 5%. Recall, these are normalized so that for each country within this distribution the sum of the import and export shares are each unity. However, oil has an absolute net trade share that averages about 40%, while various categories

of cars having an absolute net trade share that averages about 30%.. These are obviously outliers and outliers are key contributors to terms of trade movements due to the weighting of prices in terms of trade.

The beta distribution lies mostly between plus and minus 3, with strong central tendency toward the mean of about 0.25. Since the contribution to variance is the product of the net trade share and beta, values in the tail of the distribution are what tend to determine the terms of trade. To see this more clearly, it is productive to look to the details of the distribution of products of the net import share and beta:  $(\gamma_{ij} - \omega_{ij})\beta_{i,j}$ .

Figure 7 plots the contributions to variance, the product of the net trade share and beta, for each commodity and country in our sample. Since there are 84 commodities and 38 countries, there are 3,192 values plotted in this figure. The upper panel orders the contributions by commodity and the lower panel orders the contributions by country. In the upper panel, the vertical red lines mark the variance contributions by good with points between the lines denoting country-specific variance contribution for that good. In the lower panel, the vertical red lines mark variance contribution by country with points between the lines denoting good-specific variance contributions for that country. The variance contributions organized by country will sum to unity within each interval by construction.

The clusters of extreme values in the upper chart are commodities that contribute considerably more to terms of trade variation than is typical. The largest contribution comes from oil, where the mean contribution across

countries is about 0.6. In other words, oil alone accounts for about 60% of the variation in the terms of trade when we average across our 38 nations. Figure 8 focuses on the variance contributions of the seven most important items in terms of contribution to consumption terms of trade variance. In order of ascending importance, they are: pullovers; boneless beef; luxury, compact and large cars; medicine and oil. Medicine account for about 12% of terms of trade variation, the three automobile categories are comparable at 11%, while pullovers and boneless beef account for about 2% each. To place these items in perspective, the next 20 items account for the same percentage as medicine. It should be kept in mind that the composition of influences differs across countries, which is masked by the cross-country averaging discussed above. The cross-country differences in the contribution of each of these key commodities is evident in the variation between the segments of Figure 8.

## 5.2 Goods prices and the terms of trade

Based on the variance contributions discovered in variance analysis (and displayed in Figure 8), we focus in on the prices of key goods: oil, automobiles and medicine, items deemed to be most influential in the evolution of the aggregate consumption terms of trade.

Figure 9 plots the U.S. dollar prices of these five goods. Two features of these data are worth emphasizing. The first is that oil prices have a large idiosyncratic component while the other four series track each other very closely. This is consistent with the earlier decomposition of the variance of

world inflation: the median correlation of good-level and aggregate inflation is 0.92, while the correlation of oil inflation with world inflation is a mere 0.35. This is what we see in this sub-sample, with the non-oil goods tending to track the inflationary trend and oil diverging, for the first two-thirds of the sample at least (also, the correlations quoted above are growth rates while the plot is log-levels).

The second striking feature of Figure 9 is that oil prices are not much more variable than the typical commodity price in these data. This is a reflection of two facets of our analysis. First, the fact that we use prices paid by final consumers rather than prices determined in commodity exchanges such as the Chicago Board of Trade. Thus our ‘oil’ price is a retail fuel price, not the price of a barrel of crude petroleum. The former is much less volatile than the latter at annual frequencies, in most time periods. Second, we use micro-data which highlights the fact the retail prices do move around a great deal and the aggregate CPI index tends to obscure this by averaging away much of the idiosyncratic variation. Thus retail prices are much more volatile than the price level, which is what is most familiar to us.

The distinctive paths of these prices along with their dominate contribution to the terms of trade variance for the median country, already documented, suggests a convenient link between the aggregate consumption terms of trade and a few key prices. In a nutshell, we will expect countries with net positive exposure to oil (net exporters) to have an inverted U-shaped terms of trade path, following the path of oil’s price while those with a net negative

exposure in oil and positive exposure in medicine or automobiles will have a U-shaped pattern, following the evolution of these other prices.

To document this as clearly as possible we build up the terms of trade in stages, beginning with the oil terms of trade, then adding medicine, then automobiles and finally, everything else, to arrive at the aggregate consumption terms of trade. Figures 10 through 13 present precisely this information for each of the 38 countries in our sample. Figure 10 focuses on the eight oil exporters in our panel: Canada, Denmark, Mexico, Norway, Russia, Saudi Arabia, United Arab Emirates and the United Kingdom. Figures 11 to 13 focus on the thirty oil importers.

The terms of trade for oil is, by definition, just the path of oil prices at the retail level (with 1990 = 0, the base year), scaled by the net trade share in fuel.<sup>5</sup> Thus, the dashed red lines in all figures are either perfectly positively correlated with the world price of oil (for net exporters) or perfectly negatively correlated with the world price of oil (for net importers). In other words: if this was the complete picture, net exporters would experience a secular decline in their terms of trade followed by a secular rise, due to oil's price movements – a U-shaped pattern. For net importers, we would see an inverted U-shaped terms of trade profile. Moreover, the red dashed lines (oil terms of trade) and the solid black lines (overall terms of trade), would be the same.

---

<sup>5</sup>The net fuel share is zero for Hong Kong, Iceland and Luxembourg. Thus, for these three the oil terms of trade is constant, reflecting a perfect hedge.

While, this is, of course an over-simplification, it is the case that oil dominates the secular movements in almost every case, with net exporters of oil having U-shaped terms of trade (Figure 10) and net importers of oil tending toward an inverted U-shaped terms of trade (Figures 11 to 13). The pattern among net importers of oil is more complex than this stylized pattern, partly because their trade patterns are more complex on both the export and import side. Oil exporters, in contrast tend to be concentrated on the export side and less concentrated on the import side. For them, complexity lies on the import side, for the most part.

In most of the oil importing countries, the terms of trade in oil is the lower envelope of the other terms of trade constructs. In other words, oil is both the most rapidly improving and the most rapidly deteriorating ingredient in their the terms of trade. What prevents the overall terms of trade from behaving similarly is that other items are fueling improvements at the same time oil is sapping the fuel.

One of the clearest examples of this is Ireland (Figure 12) oil prices contribute to terms of trade deterioration over the last third of the sample, but this is completely swamped by the improvements in the terms of trade in medicine. Moreover, during the first third of the sample medicine and oil are reinforcing terms of trade improvements. While it is also apparent that automobiles are a drag on Ireland's terms of trade that is more significant than oil (comparing the green and blue dashed lines of Figure 12), medicine is sufficient to keep the Irish terms of trade rising on trend for much of the

period. Korea is an even clearer case in point as a major oil importer and automobile exporter, only two lines are visible, medicine and other goods play no role. Automobile price increases buoyed Korea's terms of trade until the last third of the sample when oil prices rose relative to automobile prices. Israel is a case where oil is important as a terms of trade drag, but automobiles and medicine are not helpful in accounting for the terms of trade, here exploration of the sources of variation would need to go beyond the three on which we have focused.

### **5.3 Discussion**

Our findings regarding the importance of oil are reminiscent of the analysis of Backus and Crucini (2000), who documented the extraordinary extent to which oil dominated the variation in the terms of trade of major industrialized countries from the 1970's to the middle of the 1980's. The thrust of their analysis was to show how business cycle comovement evolved as the importance of oil shocks relative to total factor productivity shocks changed across historical periods and affected importers differently than exporters.

Figure 14 displays the quarterly data used in their paper along with the relative price of oil in U.S. terms. By the latter, we mean the U.S. dollar spot price of crude petroleum divided by the U.S. consumer price index. In the figure, the oil price is normalized so that its standard deviation matches the standard deviation of the average of the terms of trade across the countries in the sample (the lower-right chart displays this average terms of trade

variable).

The standard deviation of the average terms of trade for this group is about 5.5%, while the standard deviation of the relative price of oil is an amazing 74%. Japan has the highest terms of trade variation at 21%, while Switzerland's is the most stable at 3.6%. Differencing both the terms of trade and the relative price of oil leave the basic implication unchanged, oil plays a large role, mostly because it has enormous variation relative to the terms of trade. The ratio of standard deviation of oil to the terms of trade, in levels or growth rates, is upwards of 10.

We view our preliminary findings as pointing to a broader role for a small set of goods to dominate a nation's terms of trade variation than was previously thought. Uncovering this feature of the data would have been daunting without the novel variance decomposition employed here. The fact that oil dominates in a broad cross-section is consistent with prior work on oil and the terms of trade. The notion that individual items other than oil may dominate within the cross-section of countries is novel. Moreover, it also suggests the value of organizing countries on the basis of their net export shares along a broader swath of the commodity space than oil and the few additional items focused upon here. It would also be interesting to consider how the influential set has evolved over time and across countries, analogous to how oil's role has been historically punctuated. Unlike oil and other commodities where comparative advantage is largely endow, manufacturers and increasingly services play a large role in trade and are likely to be more



geographically footloose.

The empirical differences between the consumption and production terms of trade are compelling, though it is too earlier in the research program to say how they relate to the broader literature on markups and distribution costs. If the consumption terms of trade is fundamentally different than the production terms of trade, the trade balance adjustment process on the demand and supply side needs to be elaborated. The common use of one elasticity to relate prices to the trade balance condition is likely muddling consumption and production elasticities and two relative prices (the consumption and production terms of trade) rather than one.

Our results are subject to a number of important caveats. For one, the use of a common set of internationally prices to construct the consumption terms of trade. While this undoubtedly clarifies the sources of variation in our constructs, it seems productive to consider how deviations from the LOP alter the facts and their implications. Second, the Economist Intelligence Unit sample, while comprehensive, certainly does not cover the universe of consumption items and misses intermediate goods that are used by firms and not used by consumers. This combined with the need to reconcile final goods with trade shares, leads inevitably to some errors and omissions in prices and trade weights. The short sample also prevents us from back-casting our analysis before 1990, when the EIU survey was first developed. We hope to deal with some of these issues in future work, such as using the Penn World Table data to push the sample back in time. Much remains to be done.

## References

- [1] TBA.

Table 1. Inflation variance decomposition, 1990-2005

Moment	Mean	Median	Max	Min
$\sigma_i$	5.40	5.26	8.68	3.75
$\beta_i$	1.00	0.99	1.45	0.56
$\frac{\sigma_i}{\sigma}$	1.14	1.12	1.83	0.79
$corr(\Delta p_{i,t}, \Delta p_t)$	0.89	0.92	0.99	0.35

Table 2. Production and Consumption Terms of Trade, 1990-2005

	Log-levels			Growth rates		
	std(P)	std(C)	corr(P,C)	std(P)	std(C)	corr(P,C)
Australia	9.40	1.09	0.28	4.79	0.68	0.28
Canada	3.94	1.29	0.80	2.93	0.98	0.74
Denmark	2.67	2.03	0.17	0.95	1.58	0.43
Finland	3.51	4.04	0.46	2.52	3.11	0.30
France	1.21	3.17	0.07	1.36	2.60	0.38
Italy	2.92	3.24	-0.11	2.84	2.76	0.53
Korea	16.05	9.09	0.56	3.06	6.45	0.75
Netherlands	1.72	3.00	-0.32	0.58	3.09	0.31
New Zealand	4.31	2.95	0.00	2.79	1.91	0.26
Switzerland	3.41	3.10	0.57	2.34	1.23	0.19
United Kingdom	3.02	1.30	0.77	1.78	0.62	0.02
United States	2.27	4.16	0.22	1.72	3.43	0.71
Averages	4.54	3.21	0.29	2.30	2.37	0.41

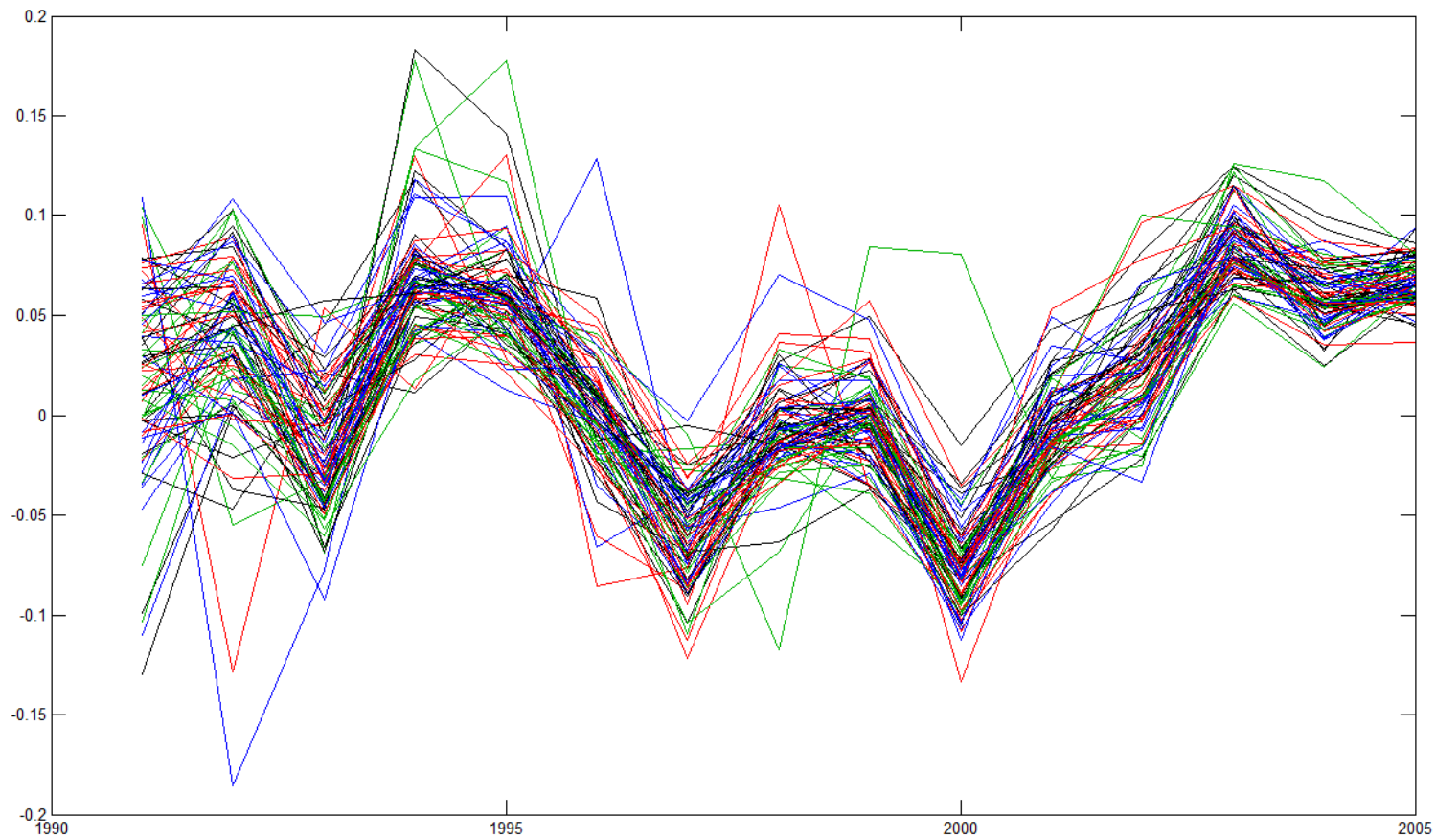


Figure 1. World inflation rates, by commodity

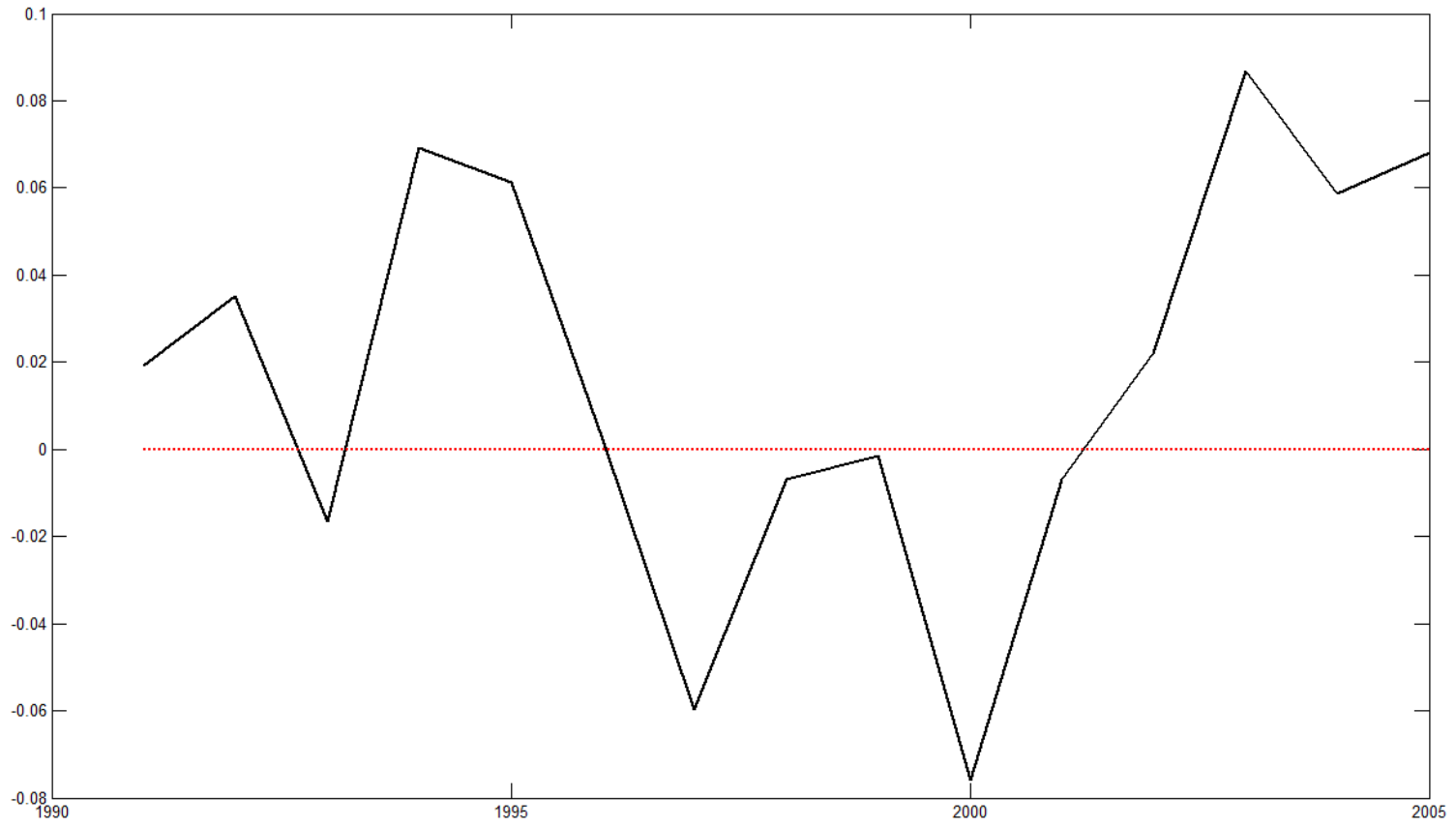


Figure 2. Average (across goods) world inflation.

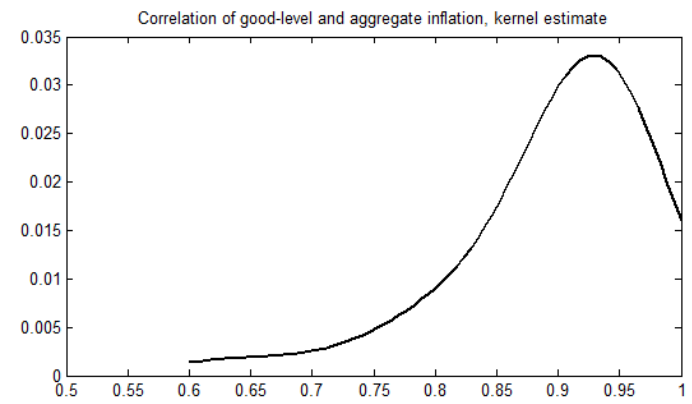
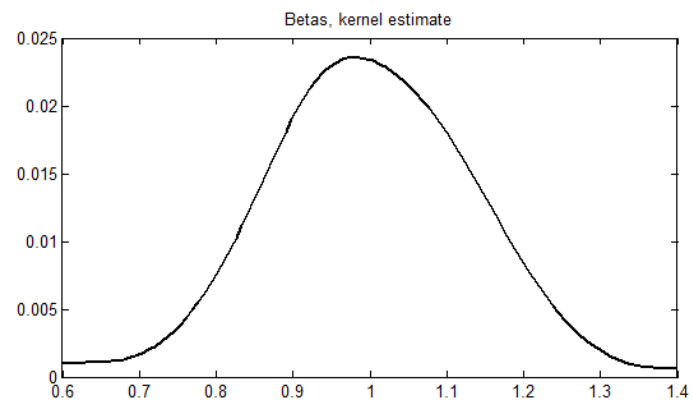
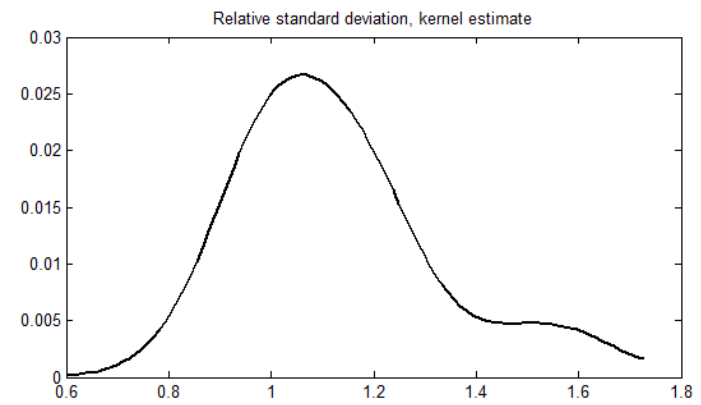
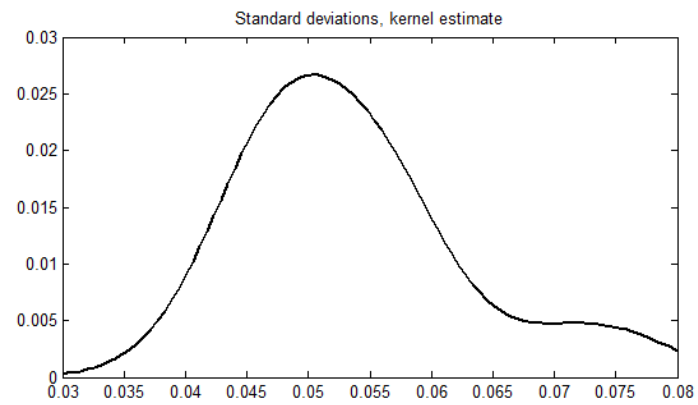


Figure 3. Variance decomposition of world inflation.

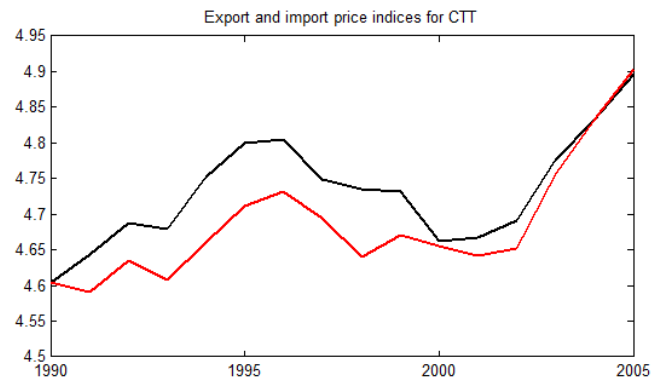
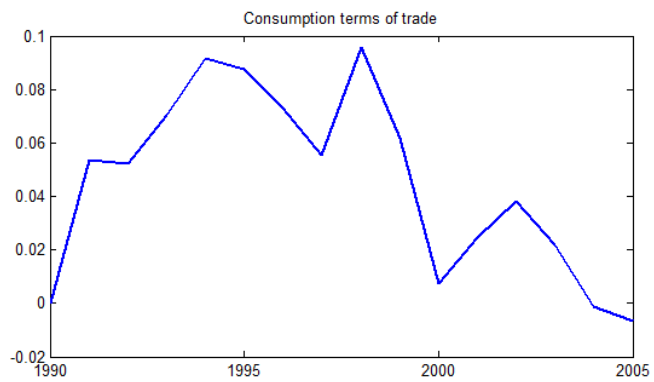
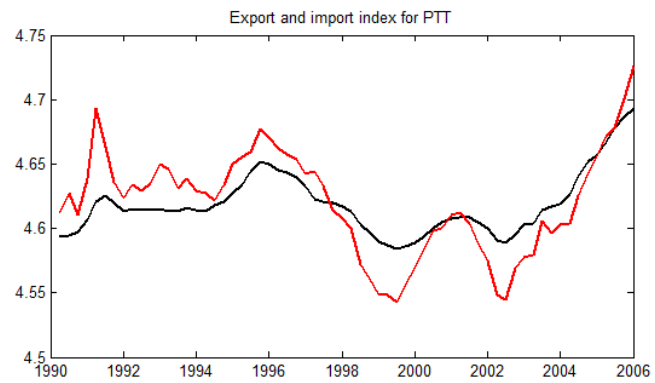
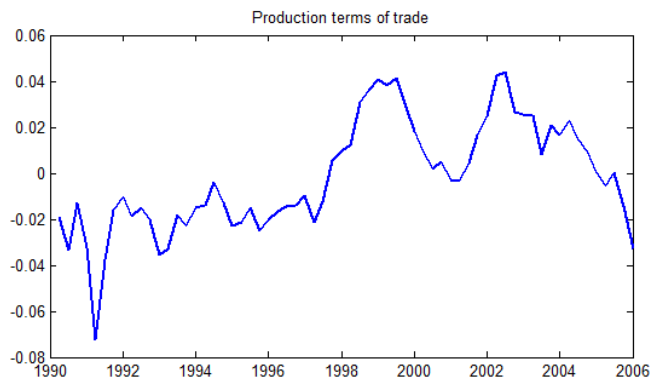


Figure 4. U.S. production terms of trade (quarterly) and consumption terms of trade (annually), 1990 to 2005.



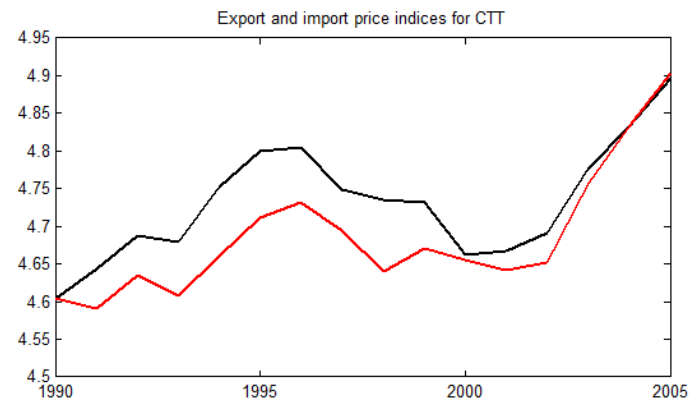
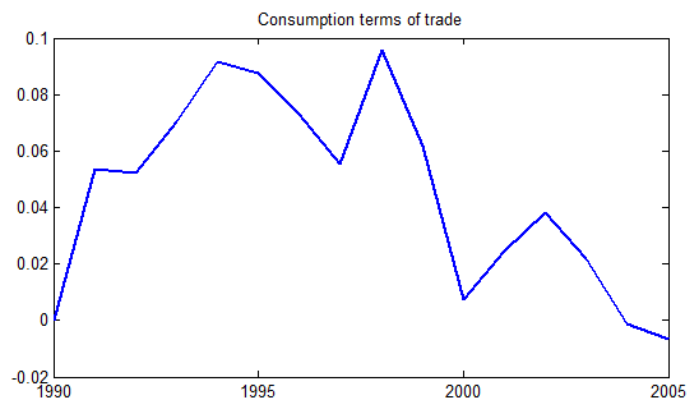
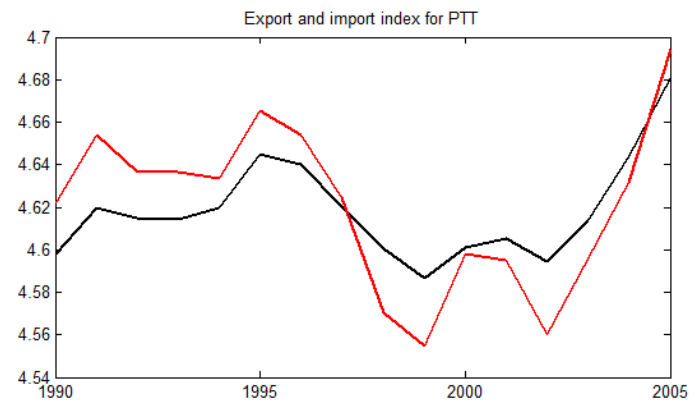
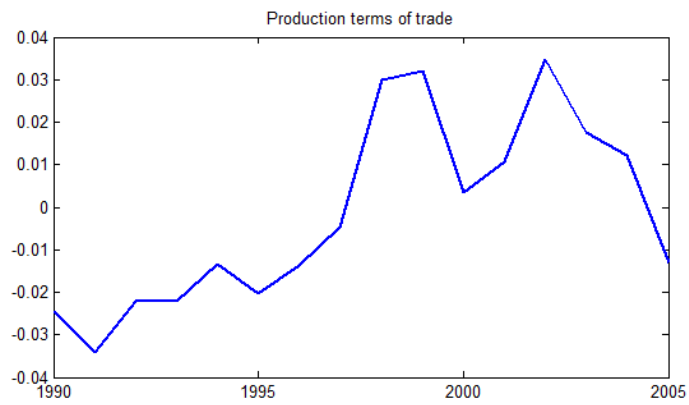


Figure 5. U.S. production terms of trade and consumption terms of trade, annually 1990 to 2005.

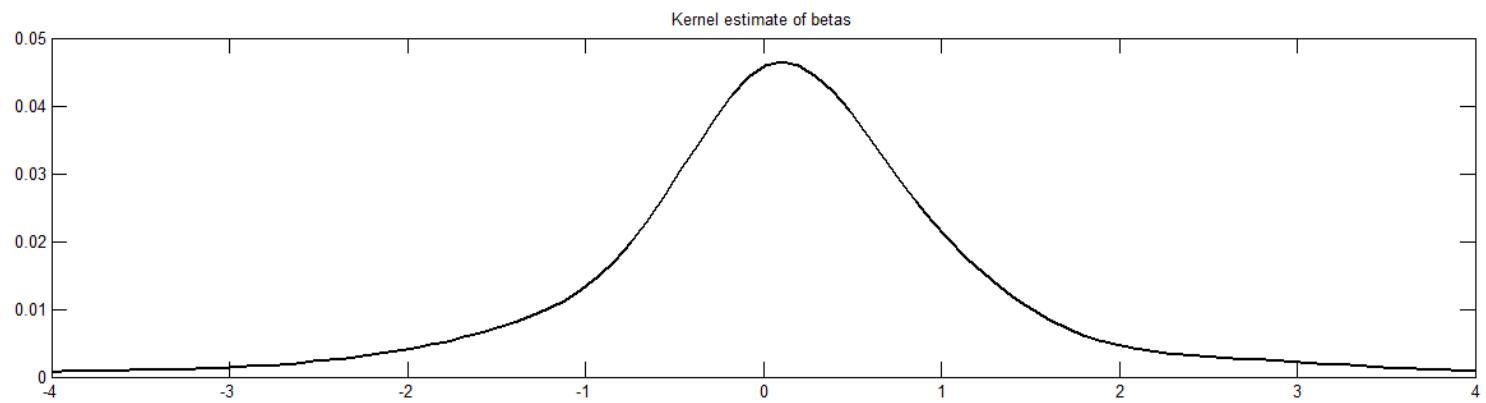
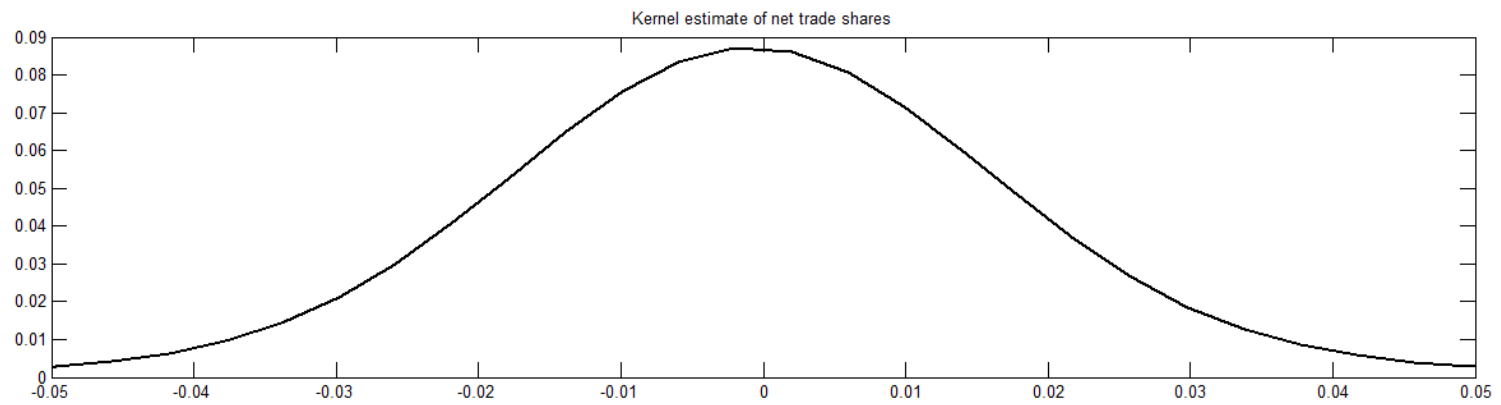


Figure 6. Kernel estimates of net share shares (top chart) and betas (bottom chart), pooling all goods and countries.

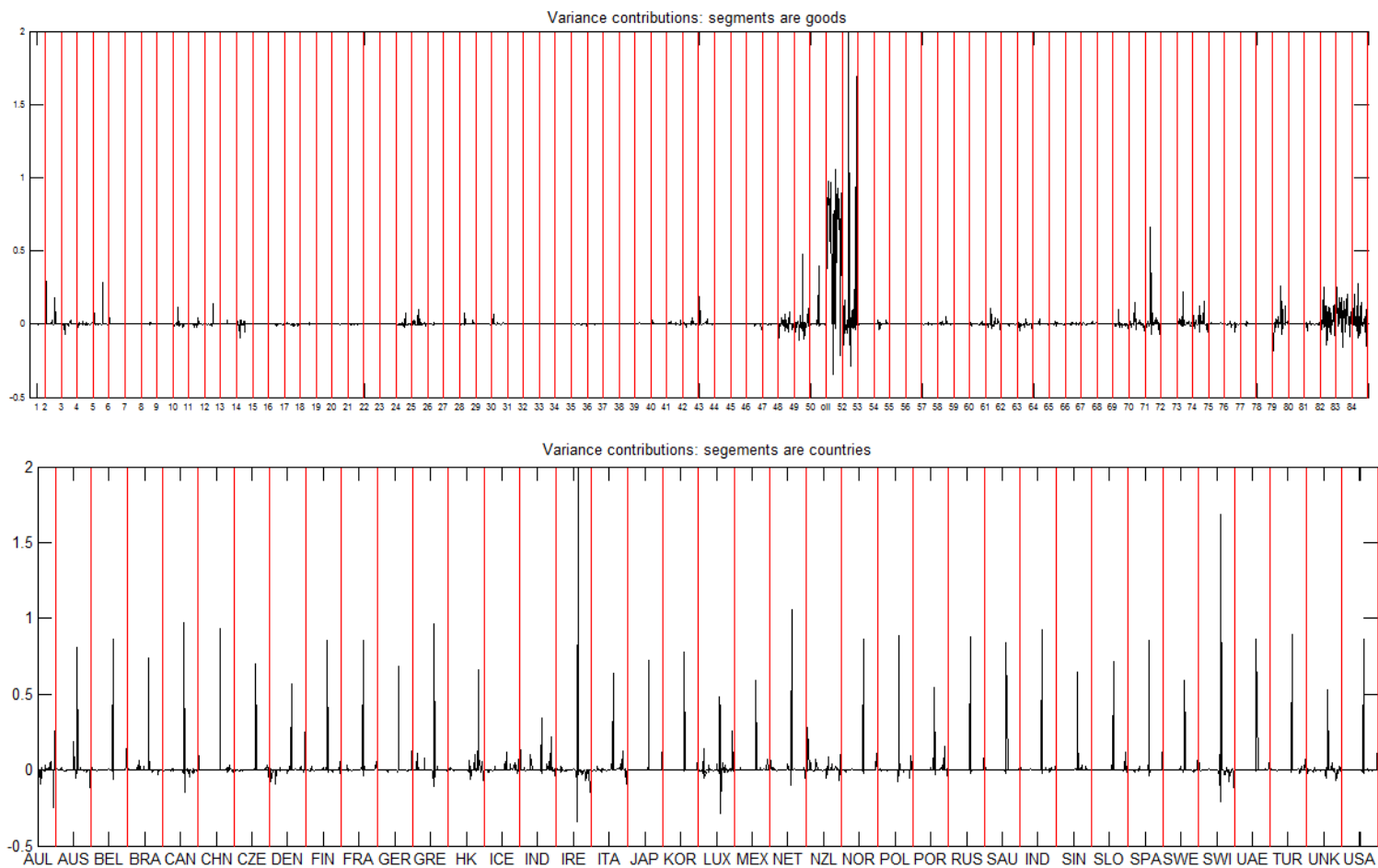


Figure 7. Contributions to terms of trade variation. Top chart orders contributions by good (1 to 84), with vertical segment marking goods. Bottom chart is the same information, but with vertical segments marking countries (as labelled).

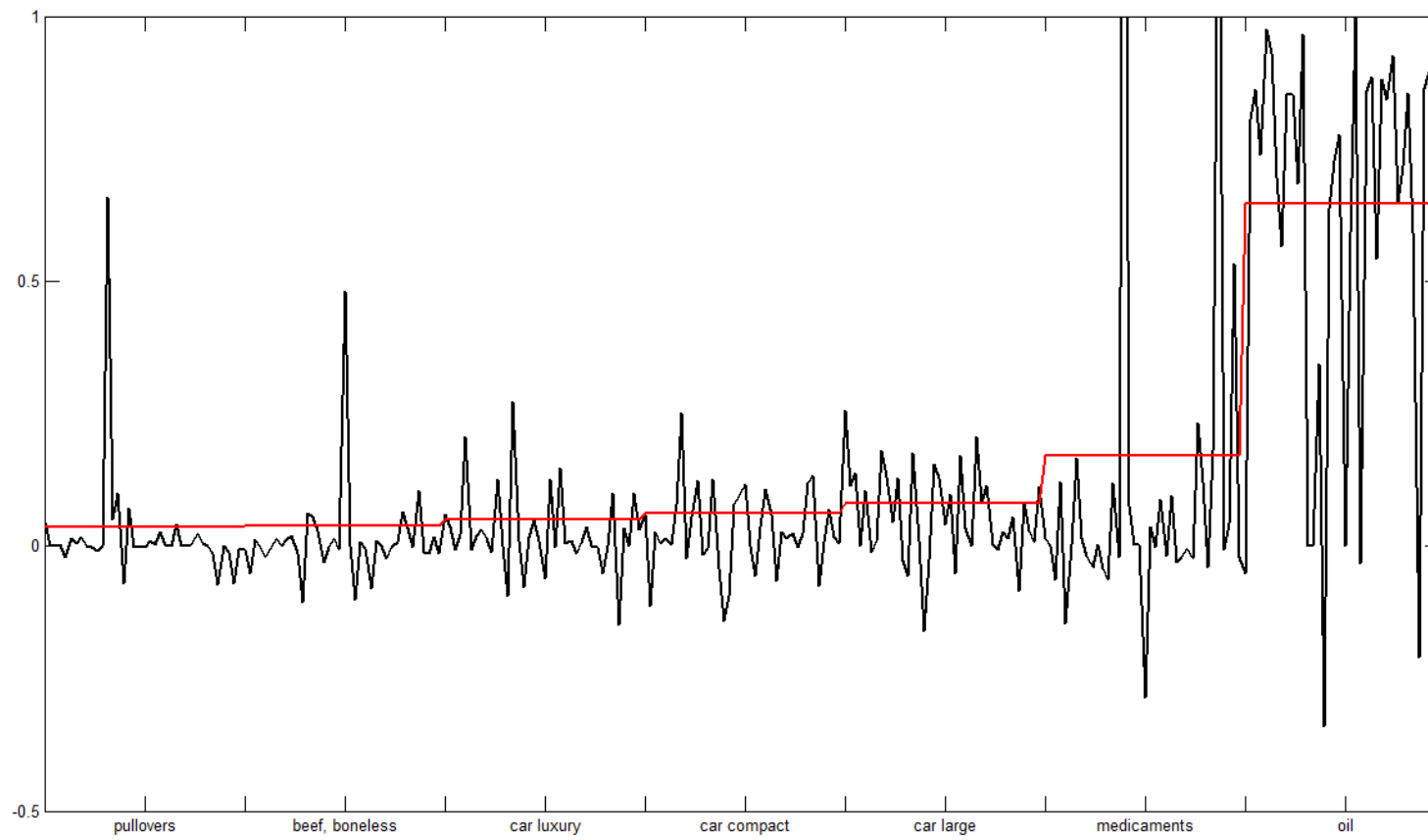


Figure 8. Contribution to terms of trade variance, ordered by commodity, seven most influential goods. Red line marks cross-country average variance contribution by good.

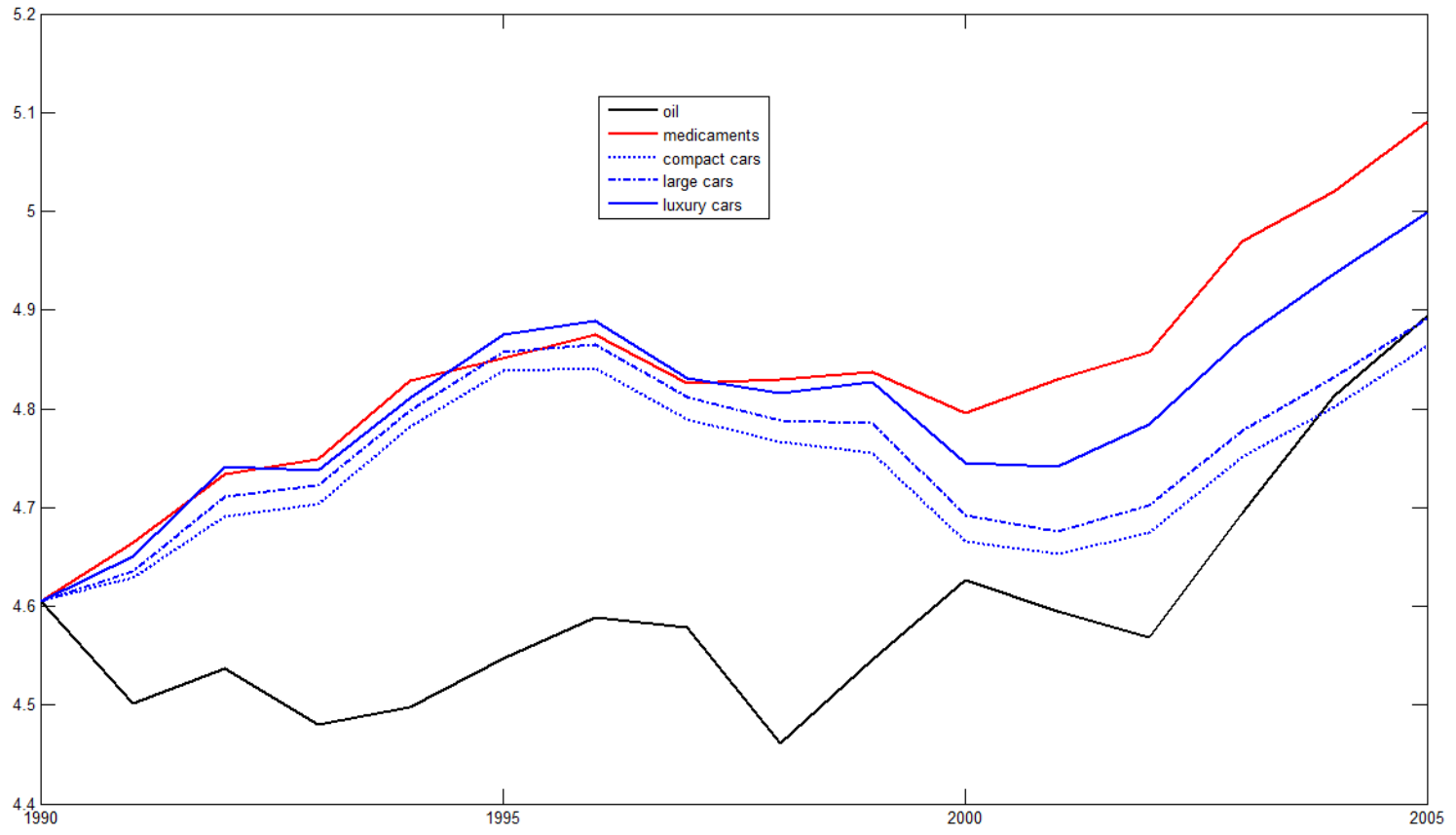


Figure 9. Nominal, U.S. dollar, price indices of key traded commodities.

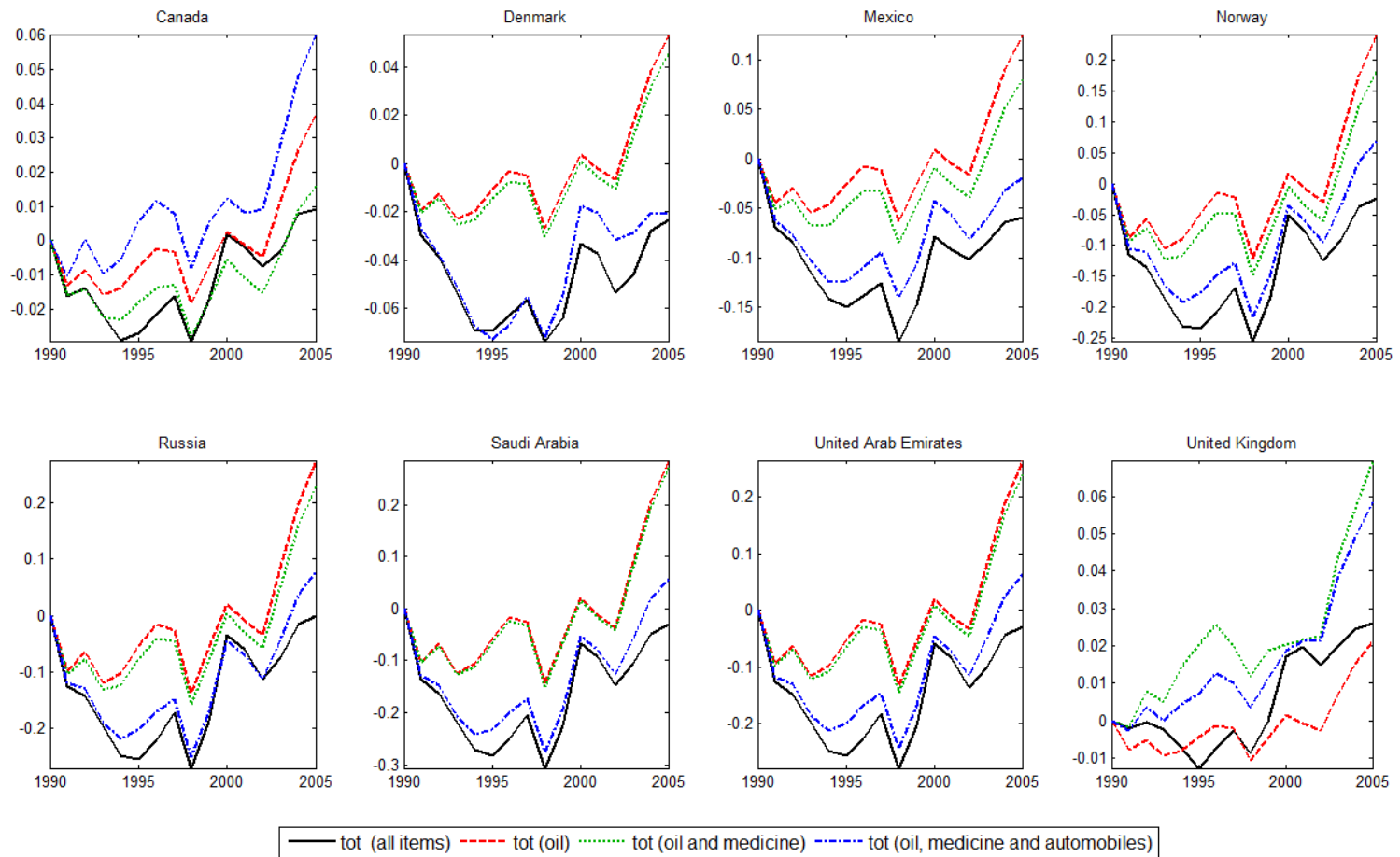


Figure 10. Oil exporters: consumption terms of trade decomposition

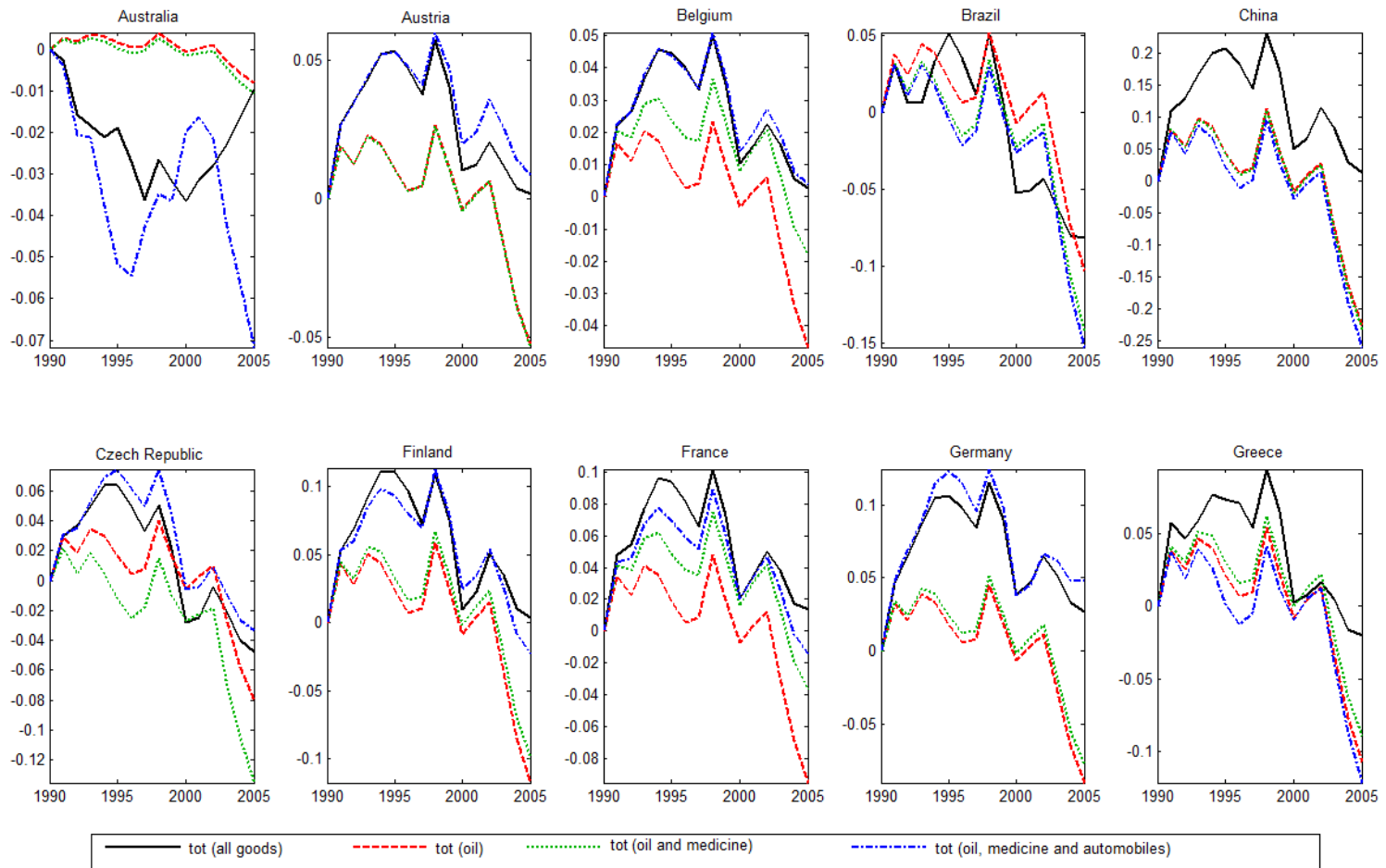


Figure 11. Oil importers: consumption terms of trade decomposition.

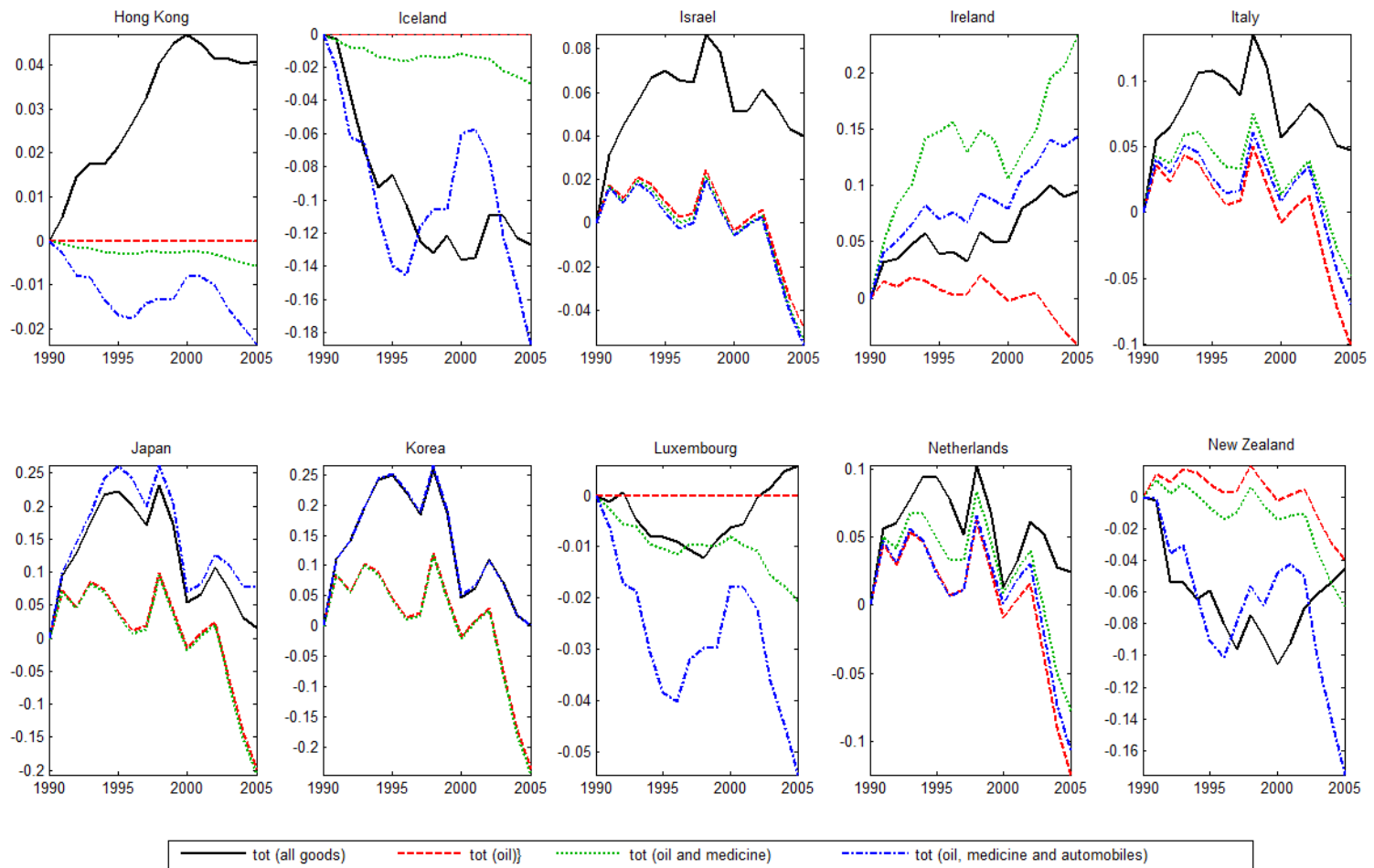


Figure 12. Oil importers: consumption terms of trade decomposition.



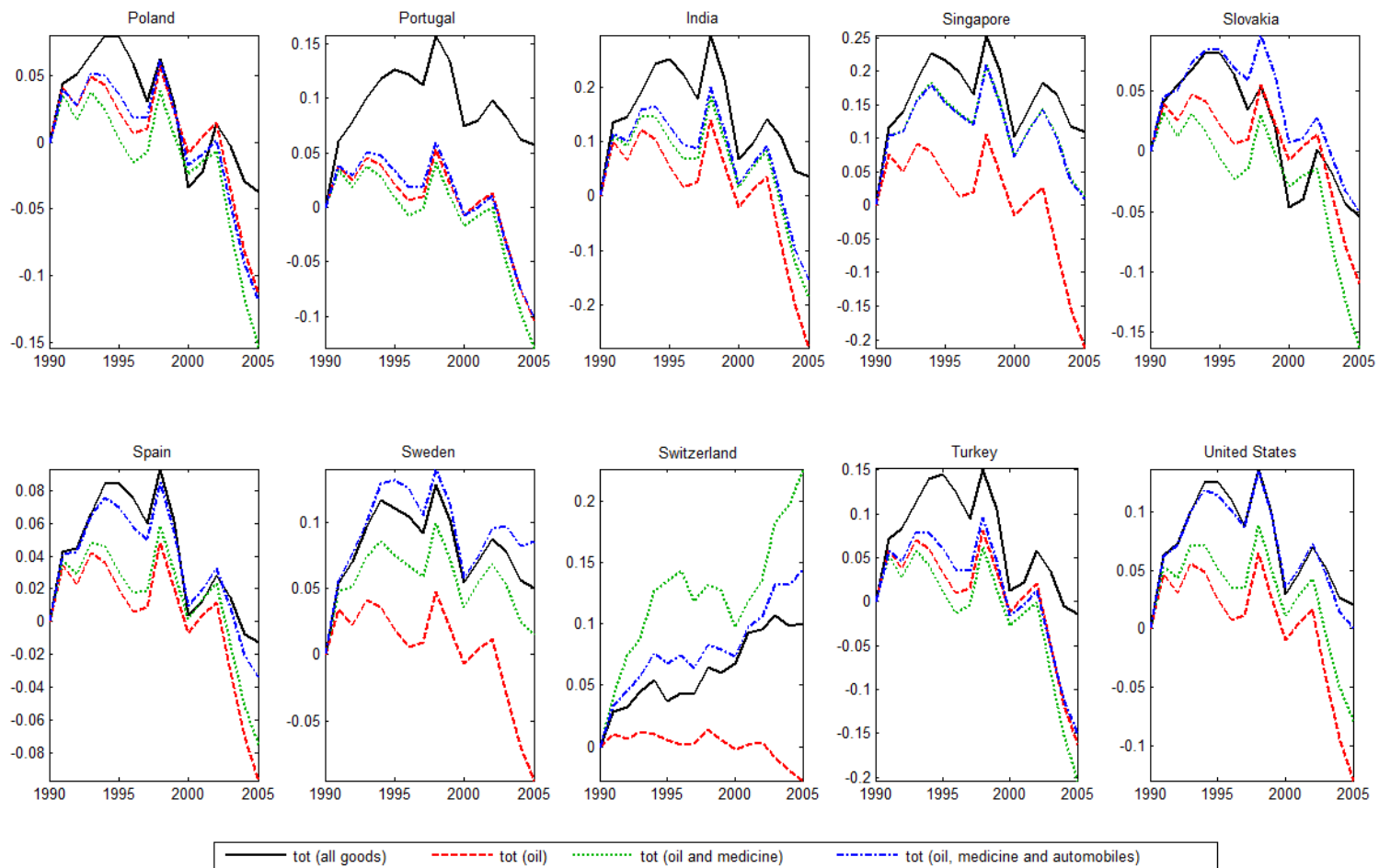


Figure 13. Oil importers: consumption terms of trade decomposition.

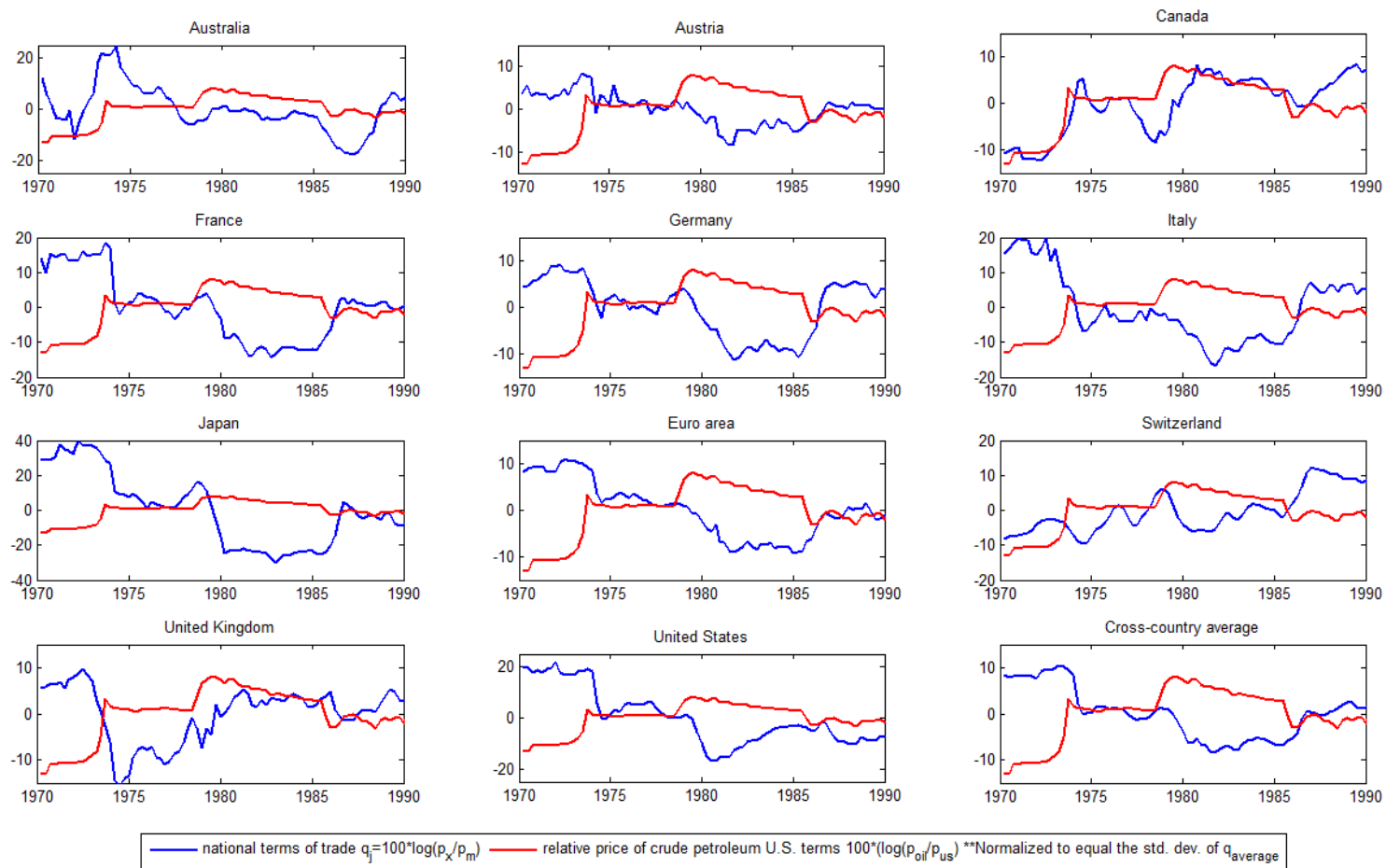


Figure 14. Historical national terms of trade for major industrialized nations and the relative price of oil in U.S. terms.