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World oil demand's shift toward faster growing and less price-responsive products and regions

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ABSTRACT

Using data for 1971–2008, we estimate the effects of changes in price and income on world oil demand, disaggregated by product – transport oil, fuel oil (residual and heating oil), and other oil – for six groups of countries. Most of the demand reductions since 1973–74 were due to fuel-switching away from fuel oil, especially in the OECD; in addition, the collapse of the Former Soviet Union (FSU) reduced their oil consumption substantially. Demand for transport and other oil was much less price-responsive, and has grown almost as rapidly as income, especially outside the OECD and FSU. World oil demand has shifted toward products and regions that are faster growing and less price-responsive. In contrast to projections to 2030 of declining per-capita demand for the world as a whole – by the U.S. Department of Energy (DOE), International Energy Agency (IEA) and OPEC – we project modest growth. Our projections for total world demand in 2030 are at least 20% higher than projections by those three institutions, using similar assumptions about income growth and oil prices, because we project rest-of-world growth that is consistent with historical patterns, in contrast to the dramatic slowdowns which they project.

1. Introduction

Two liters a day—that is what per-capita world oil demand has been for 40 years. Yet this constancy conceals dramatic changes. While per-capita demand in the OECD and the FSU have been reduced – primarily due to fuel-switching away from oil in electricity generation and space heating, and by economic collapse in the FSU – per-capita oil demand in the rest of the world has nearly tripled, to more than 1 L/day (Fig. 1). In addition, the rest of the world's population has grown much faster than in the OECD and FSU (1.85% v. 0.74% annually). As a result, the rest of the world's total oil consumption has grown *seven times faster* (4.4% annually, versus 0.6% in the OECD and FSU)—increasing from 14% of the world total in 1971, to 39% today. Strangely, however, recent projections by DOE, IEA, and OPEC project a sharp deceleration of per-capita oil demand growth through 2030 in the rest of the world—from 2.54% annually since 1971 to 0.6% annually (DOE) or 1% annually (IEA, OPEC).

The factors most responsible for reducing demand since 1971 cannot be repeated. Almost all the low-hanging fruit has now been picked; it cannot be picked again.

1. The OECD has already done the easy fuel-switching, away from oil used in electricity generation (residual oil) and space heating. This fuel substitution started after the two price jumps in the 1970s, continued in the 1980s and 1990s despite the oil price collapse, and accelerated after recent price increases. Fuel oil's share of total OECD oil has fallen from 44% in 1971 to 16% in 2008; OECD Fuel Oil's share of total world oil has fallen from 33% to 9%.
2. The economic collapse of the FSU reduced their oil consumption by 54% in the period 1990–1998: from 8.3 to 3.8 mbd. Residual oil use has been almost completely eliminated since 1990, declining steadily by about 7% annually; its product share went from 34% in 1990 to 13% by 2006.

If annual per-capita oil demand growth rates to 2030 were assumed to be held zero in the OECD, 1% in the FSU, and at its 1971–2008 historical rate (2.54% annually) in the rest of the world, total oil demand will be 138 million barrels per day (mbd) in 2030—about 30 mbd greater than what is projected by DOE, IEA, and OPEC. By 2030 the rest of the world's per-capita demand would be almost 2 L/day, and its share of total world demand would increase from 39% now to 58%.

Now that the OECD and FSU have almost exhausted their easy fuel-switching opportunities, it will be much more difficult to

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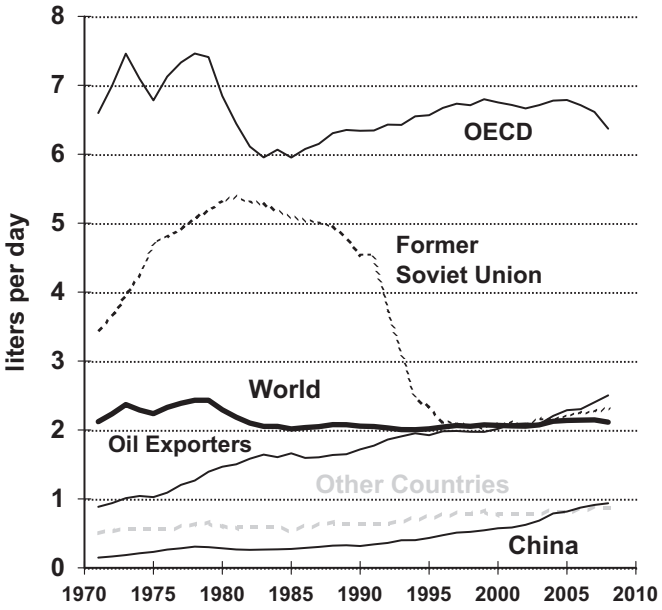

Fig. 1. Per-capita oil demand, 1971–2008 (L/day).

restrain oil demand growth in the future, while the rest of the world's economies and population continue to grow. To illustrate the difficulty of reducing demand, compare two decades in which the price of crude oil has quintupled: 1973–84 and 1998–2008. After the price increases of the 1970s, per-capita demand fell by 19% for the OECD and by 13% for the world as a whole. In the past decade, with oil price increases similar to those of the 1970s, per-capita demand fell only 3% in the OECD; worldwide it actually increased, by 4%.

The outline of this paper is as follows. We employ a model similar to that of Gately and Huntington (2002) to analyze oil demand disaggregated by product (transport oil, fuel oil, and other oil), for almost all countries of the world. In Section 2, we summarize how oil demand has changed over time and relative to income, by oil product and by country group. Section 3 describes the demand equations that we shall use, and Section 4 summarizes the econometric results, for each group of countries. We allow for the possibility that demand has responded asymmetrically to price increases and decreases, and find strong evidence for this in the OECD, especially for Fuel Oil. We also test for asymmetric demand response to *income* increases and decreases, and find evidence for this in the demand behavior of the Oil Exporters. Section 5 presents our demand projections and compares them with the long-term projections of IEA and DOE. Section 6 presents our conclusions. Appendix A describes the data sources.

2. Background

We examine world oil demand since 1971, disaggregated into three groups of oil products[1] (see Fig. 2):

- Transport Oil: Gasoline, Jet Fuel, Diesel (Light Fuel Oil used in transport)
- Fuel Oil: Residual Oil, Heating Oil (Light Fuel Oil not used in transport), Kerosene (non-Jet fuel)
- Other Oil: Feedstock (petrochemical inputs: Naphtha and Liquefied Petroleum Gases, LPG), non-feedstock LPG, and Miscellaneous

[1] See Downey (2009) for more details about oil products.

Note that only for the OECD does the IEA disaggregate Light Fuel Oil into Diesel Oil and Heating Oil. For non-OECD countries, the IEA does not disaggregate Diesel Oil and Heating Oil. As discussed at the end of this section, we disaggregate the non-OECD into five groups: Oil Exporters, FSU, China, Income Growers and Other Countries.

The OECD graph of Fig. 2 shows significant increases in levels of Transport Oil and Other Oil, and decreases in levels of Fuel Oil; oil product shares move in the same direction as the levels. The non-OECD graph of Fig. 2 shows increasing demand levels for almost all products; shares are increasing for Other Oil and decreasing for residual oil and kerosene.

The biggest reductions in oil demand have occurred in fuel-switchable uses of oil within the OECD, such as electricity generation and home heating: 7 mbd drop in fuel oil demand 1978–85, 2 mbd drop in 2003–2008. Within the non-OECD, similarly large reductions occurred after the economic collapse of the FSU; total oil demand fell by 5 mbd, from 8.7 mbd in 1989 to 3.7 mbd in 1999. Due to this FSU reduction, non-OECD demand remained relatively flat from 1988–1994; the FSU declines offset demand growth elsewhere.

Fig. 3 compares the growth of per-capita oil demand with per-capita income, for the OECD and Non-OECD since 1971. The scales are logarithmic, which facilitates growth-rate comparisons between oil growth and income growth. Movement parallel to the diagonal lines indicates equi-proportional growth in oil demand and income; steeper (less steep) movement indicates that oil is growing faster (slower) than income. Transport and other oil demand in both the OECD and non-OECD have grown almost as rapidly as income, despite two major increases in price. Were it not for reductions in Fuel Oil, Total Oil demand would have grown as rapidly as income, in both the OECD and non-OECD.

Substantial declines in OECD per-capita Total Oil have occurred only after major price increases: in 1973–74 and 1979–80, with a more moderate demand decline in 2004–08. The declines were due primarily to dramatic reductions in Fuel Oil demand. In contrast, non-OECD Total Oil has increased steadily since 1971, about as fast as income; the only substantial decline followed the FSU economic collapse in 1989.

An important aspect of OECD demand is that it did not respond symmetrically to price changes; the demand reductions following the price increases of the 1970s were not reversed by the price collapse of the 1980s. One interpretation of asymmetric price effects on demand is that the price shocks of 1973–74 and 1979–80 induced energy-saving technical change, which was not un-done when prices fell. Examples are irreversible efficiency improvements in vehicles and heating systems: see Walker–Wirl (1993) and Haas–Schipper (1998). Asymmetric price effects could also reflect fuel-switching that is not reversed by price cuts, as is evident in the demand for residual and heating oil.

Fig. 4 depicts graphs for price versus the OECD ratios of oil to gross domestic product (GDP) for the three product groups, each indexed to 1971=100. On the vertical axis, we see the 1973–80 price quintupling being almost completely reversed by 1986, to be followed by the 1998–2008 price quintupling. The OECD Fuel Oil/GDP ratio fell after the 1973–80 price increases (as did OECD Fuel Oil levels: see Fig. 2), and continued to fall even after price collapses in 1980–86 (due to delayed responses to the previous price increases): the demand reductions were not reversed when the price increase was reversed. The Fuel Oil/GDP ratio fell again when price increases again in 1998–2008, with the ratio by 2008 falling to only 17% of its 1971 level. It was good news for the OECD that these demand reductions were not reversed in the 1980s when the oil price increases of the 1970s were reversed. But the bad news is the OECD has picked almost all of fuel-switching's low-hanging fruit; it did not grow back, so it cannot be picked again.