

# Oil-Price Shocks: Beyond Standard Aggregate Demand/Aggregate Supply Analysis

S. Kirk Elwood

*Abstract:* The author explores the problems of portraying oil-price shocks using the aggregate demand/aggregate supply model. Although oil-price shocks are the most commonly cited examples of aggregate supply shocks, they violate the model's assumption of constant relative prices (as acknowledged by the label, "oil-price shocks"). The resulting problems are effectively masked in textbook presentations by implicitly assuming that the supply shocks occur in a closed economy. However, the typical discussion is glaringly inaccurate when discussing the effects of oil-price shocks on oil-rich countries. Thus, the cogency of the standard model's representation of oil-price shocks on open economies is compromised. A simple modification of the model that differentiates between production and absorption goods enables it to better reflect the effects of oil-price shocks on open economies.

Key words: aggregate demand/aggregate supply model, aggregate supply shocks, oil-price shocks

JEL codes: A22, E10

When presenting the concept of aggregate supply shocks, economists invariably refer to the oil-price shocks of the 1970s as examples. However, interpreting oil-price shocks in the aggregate demand/aggregate supply (AD/AS) framework is complicated because they affect oil-importing and oil-rich economies very differently. The typical AD/AS analysis simply notes that the increase in production costs caused by the increase in the price of the important input causes the AS curve to shift leftward and causes a reduction in output and, by implication, welfare.<sup>1</sup> Although this seems intuitively correct for an oil-importing country, it misses the obvious beneficial effects that higher oil prices have on oil-rich economies.

## OIL-PRICE SHOCKS AND THE VALUE OF OUTPUT

The failure of the standard AD/AS model to represent accurately the effects of oil-price shocks on oil-rich countries stems from the shocks' violation of the

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model's assumption of constant relative prices.<sup>2</sup> As long as a country trades with other countries, it will produce a different basket of goods than it consumes, or, more accurately, absorbs. If the price of its production goods rises or falls relative to the price of the goods it absorbs, then relative prices are obviously not constant. Of course, if the economy is closed, then absorption equals production and the relative prices necessarily remain unchanged, as assumed by the standard model.

For an economy with oil exports that constitute a significant fraction of its gross domestic product (GDP), the increase in the price of oil can greatly increase the value of its national production. This was true even for loyal members of OPEC during the 1970s when they sold fewer barrels of oil. For example, in the 1970s when the demand for oil was inelastic (e.g., Pindyck [1978] works with estimates of the long-run price elasticity of demand for oil ranging from  $-0.33$  to  $-0.90$ ), oil revenues rose following OPEC-led increases in the world price of oil.<sup>3</sup> Meanwhile, an oil-exporting economy's price level of the goods it absorbs does not rise to the same degree as the price of oil because oil (and substitute forms of energy) represents just one input in the production of those goods. Therefore, with the value of an oil exporter's production increasing by more than absorption prices, its budget constraint shifts out and provides for greater welfare.

This analysis suggests that output ( $Y$ ) is not as good a measure of welfare as is the level of consumption that  $Y$  affords, which would ideally be measured by deflating the nominal value of that output (or production) by an absorption price index, that is,  $P_{prod}Y/P_{abs}$ . Without estimating an absorption price index, this output measure could be approximated by deflating nominal GDP by a consumer price index, because consumption constitutes the lion's share of absorption.<sup>4</sup> Replacing  $Y$  with  $P_{prod}Y/P_{abs}$  as the variable on the horizontal axis of an AD/AS diagram enables a modified AD/AS analysis to capture more accurately the effect of a relative change in the price of oil, or any other good for which a country is a significant net exporter. The appropriate measure of prices on the vertical axis of this new model is  $P_{abs}$  because output is essentially being measured in terms of the absorption good.

With this new model, one effect of increased oil prices on an oil-rich country is an increase in  $P_{prod}Y/P_{abs}$ , thus shifting the modified AS out. This change in the relative price of production versus absorption goods is similar to a change in the terms of trade.<sup>5</sup> I refer to the movement in the modified AS curve resulting from a change in these relative prices as an *income effect*.

Although the above discussion identifies an income effect from oil-price shocks, it does not imply that the traditional explanation describing the effect of oil-price shocks is incorrect. Oil is an important input in an economy, and the increase in its price will cause less of it to be used, causing  $Y$  to fall accordingly. This *production cost* effect is appropriately represented in the standard AD/AS model as a leftward shift of the AS curve. The point I make in this article is that the production cost effect of oil-price shocks is not the whole story and that the income effect described above can counter and even reverse the welfare effects of such shocks for those countries with enough oil.

The income effect is also present for oil-importing countries. A large increase in the price of oil would cause the price of goods such as gasoline and fuel oil to

rise comparably, whereas the price of all other goods for which oil (or some substitute source of energy) is a less dominant input would rise by a smaller percentage. Because a price index for absorption would include the price of gasoline and fuel oil, it would rise more than the price of the production goods for an oil-importing country. Therefore, the income effect in this case would contract the budget constraint and lower the country's welfare. Consequently, both the income and production cost effects for a change in the price of oil move the modified AS curve in the same direction for oil-importing countries.

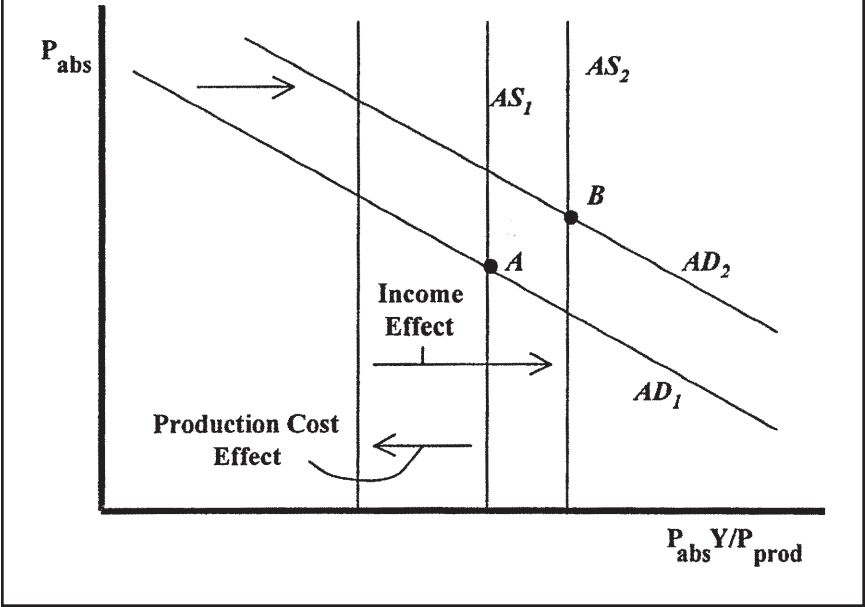
Interpreting the net effect of increasing oil prices on an oil-rich economy as an outward shift of the modified AS curve misses other important effects of the relative price change. If this new AS curve is shifting outward along a downward sloping AD curve for oil-rich countries, then domestic prices should be falling. It is odd to think that an *increase* in the price of an input could, by itself, bring about a *lower* absolute price level. Of course, the price levels of oil-exporting countries certainly did not fall as a result of the OPEC shocks of the 1970s. Therefore, recognizing the income effect of oil price changes on the modified AS curve is not enough by itself to enable the new model to represent the effect of oil-price shocks: it now fails to reflect accurately what happens to the price level. No shifting of the modified AS curve (either in the long run or the short run) alone can explain output and prices moving in the same direction, as is expected for oil-rich countries, after a change in the price of oil. Fortunately, reinterpreting AD so that it is consistent with the measure of welfare associated with the modified AS is sufficient to correct this problem.

Just as the output variable for the new AS curve is nominal GDP deflated by an absorption price index, the corresponding aggregate demand curve needs to be similarly modified. Specifically, an increase in the price of oil can significantly increase the real value of oil exports demanded by foreigners where the real value is defined again as the nominal value deflated by a domestic price index for absorption. This may be true even though the quantity of barrels exported has not changed much and, in the case of OPEC members during the oil shocks of the 1970s, may have fallen. The increase in the price of oil will cause the value of export demand to rise, and, therefore, the modified AD curve to shift right.<sup>6</sup>

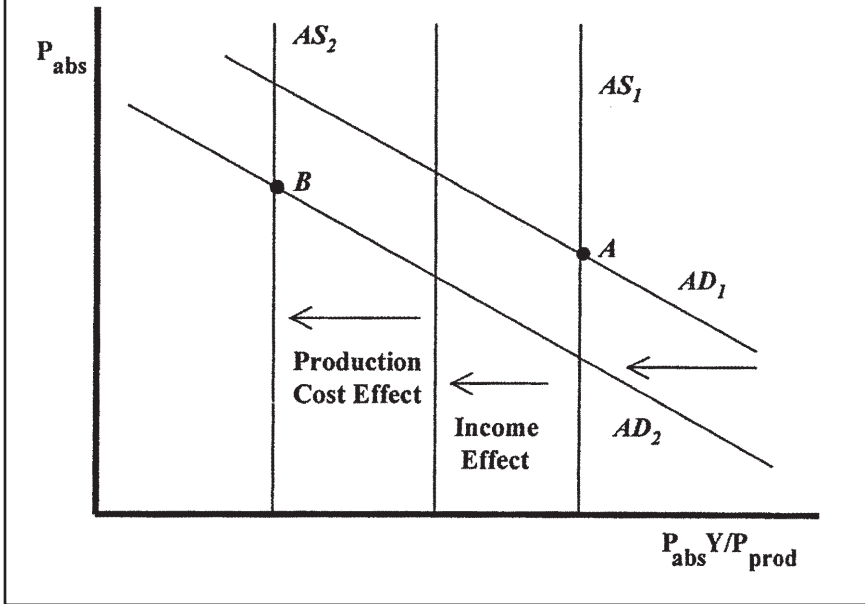
The long-run effect of an increase in the price of oil on an oil-rich economy is illustrated using the new model in Figure 1, with an initial equilibrium at point A.<sup>7</sup> The shift in the modified AS curve has its two components: the production cost effect shifting it to the left and the income effect shifting it to the right. The diagram represents the case in which the economy exports enough oil so that the income effect overpowers the production cost effect. These shifts along with the shift in the modified AD curve described above provide a new long-run equilibrium (point B) with a higher level of welfare, just as expected for oil-rich economies. Simply knowing that the AS and AD curves shift out leaves the effect on  $P_{abs}$  ambiguous. However, if one makes the reasonable assumption that the magnitude of the income effect of the oil-price shock on the modified AS curve is comparable in size to the shift of the modified AD curve, then  $P_{abs}$  will rise (Figure 1).

The effect of an increase in the price of oil on an oil-importing country is shown in Figure 2. In this case, both the production cost and income effects move

**FIGURE 1**  
The Effect of an Increase in the Price of Oil on an Oil-Rich Economy



**FIGURE 2**  
The Effect of an Increase in the Price of Oil on an Oil-Importing Economy



the modified AS curve in the same direction. The new AD curve shifts left as well because the ratio  $P_{prod}/P_{abs}$  is falling as the price of the imported oil rises; essentially, spending more on imported oil leaves less for expenditures on domestic production. Note that the diagram depicts the economy's welfare falling as a result of each of these shifts. If it is again assumed that the income effect on the new AS curve is similar in size to the shift in the modified AD curve, then the price level increases as shown.

## SUMMARY AND CONCLUSION

The standard representation of oil-price increases as leftward shifts of the AS curve in the AD/AS model seems reasonable provided one assumes the economy does not export significant amounts of oil. For residents of the United States, Japan, and most European countries, this assumption is intuitively uncontroversial. However, if one attempts to relate the effects of oil-price shocks on oil-rich countries, the same approach clearly fails. Can the analysis be credible for an oil-importing country when the same reasoning misrepresents what is going on in an oil-rich country?

I have suggested a way to portray oil-price shocks by modifying the AD/AS framework to differentiate between production and absorption goods. The resulting measure of welfare is in terms of the level of absorption that a country's output affords, just as it is in the standard AD/AS model when assuming a closed economy. With this new measure, an increase in the price of oil still precipitates the commonly described production cost effect on AS, but in addition, there is now an income effect on the modified AS curve and a shift of the modified AD curve as discussed above. The resulting AD/AS model provides explanations of the effects of oil-price shocks that are robust for both oil-importing and oil-rich countries. Thus, it provides a more generally cogent perspective on these shocks than standard AD/AS analysis.

The idea that a single event—such as a change in the price of oil—can directly affect both AD and AS is usually avoided by authors of economics textbooks. Even careful discussions of such cases risk misleading economics students in thinking that AD and AS are somehow interdependent.<sup>8</sup> The alternative to acknowledging that oil-price shocks have an income effect on AS and influence AD is to rely on the closed-economy assumption. Most students obviously do not detect this pedagogical slight-of-hand, but some note the inapplicability of the model in the case of oil-rich economies. It would seem wise for those who teach economics to be prepared to provide a reasonable explanation for the inquisitive student.

## NOTES

1. Providing only this cost-push interpretation of oil-price shocks within the AD/AS framework is almost universal among both intermediate macroeconomics textbooks (e.g., Blanchard 1997, 333; Dornbusch, Fischer, and Startz 1998, 113–15; Mankiw 1997, 243) as well as introductory texts (e.g., Case and Fair 1999, 301; Hall and Lieberman 1998, 345; Lipsey, Courant, and Ragan 1998, 546). Gwartney, Strump, and Sobel (2000, 254) are the exception in mentioning that changes in the price of imported resources will shift the AS curve.
2. The failure to meet the strong assumption also permits unorthodox features including positively

- sloped AD curves and negatively sloped AS curves (Podkaminer 1997–98).
3. Of course, the elasticity of demand for any single country's oil would be much larger.
  4. This discussion assumes the consumer price index is an accurate measure of consumer prices for welfare purposes. To the extent that it overstates or understates the cost of living, it would bias the measure of real output accordingly.
  5. In the extreme case where a country exports all of its production and imports all of its absorption, the change in  $P_{\text{prod}}/P_{\text{abs}}$  would be a change in the terms of trade. Barro (1997) provides parallel analysis of how terms-of-trade shocks affect a country's current account.
  6. Note that with  $P_{\text{abs}}$  as the variable on the vertical axis, the modified model retains the wealth/Pigou effect, the interest/Keynes effect, and the international explanation for the downward sloping nature of the AD curve.
  7. It is easily shown that the following analysis is also robust to SR analysis that employs upward sloping AS curves.
  8. Although the theoretical independence of the AD and AS curves has been questioned (e.g., see Barro 1994; Colander 1995; and Fields and Hart 1990), textbook authors normally do not complicate their presentation by discussing this literature.

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