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The 'Asian Premium' and Dependency on Gulf Oil

Craig Parsons* and Jeffrey Brown**

Abstract

In the oil industry it is well known that Asian countries generally pay more, f.o.b., than Europe or the United States for the same quality oil leaving from the same Middle Eastern port. This paper first discusses the merits of potential explanations for the premium and provides a critique of recent research in the area. Next, it offers an alternative market segmented model that has the flexibility to incorporate a variety of hypotheses as to the cause of the premium. Last, the future of the premium and Gulf oil dependency is posited under three scenarios. Under a traditional price leadership model with lowered marginal costs and/or deregulation, a fall in Gulf market share is concomitant with a fall in the premium. Also, if local (Asian) supply is severely constrained and then relaxed, the premium and dependency ratio both will fall. However, in the event that marginal costs fall or deregulation occurs while Asian supply is still constrained, the premium and dependency ratio will not change whatsoever. Also, under alternative models of oligopolistic behavior, the effect on the premium and dependency ratio from any of these events is, in general, indeterminate.

Work in progress. Comments welcome.

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1. Introduction

With over a dozen major exporting nations shipping oil from every corner of the world (Saudi Arabia, Russia, Norway, Mexico, etc.) as well as numerous smaller exporters (Australia, Malaysia, etc.), crude oil is very much a global commodity.[1] In general, the prices of the various crude oil streams move in tandem across markets. Nonetheless, the market is less than a textbook version of perfect competition. For example, many oil producers are state-owned, and likewise some importers of crude oil (as well as refined petroleum products) are either state-run or regulated, especially in Asia.[2] Thus, incentives may not always be perfectly aligned with profit-maximization on the part of the suppliers or the consumers/importers. Intervention by the government on both ends of the market clearly leads to the possibility that political concerns are at least part of the buying and/or selling strategy. In addition, market shares and structure are not uniform across the globe. Some regions, such as Asia, are heavily dependent upon Middle Eastern oil while other countries and regions, such as the United States and Europe, have more alternatives. As a consequence, even without state intervention there is the potential for gaps in crude oil prices across markets. One well-known price gap is the so-called "Asian (price) premium."

If we look at Table 1, which depicts the average annual f.o.b. price differential between crude (Arab Light) destined for Europe, the U.S., and Asia, we can clearly see

[1] The authors would like to thank Professor Keiichi Koda for valuable comments and corrections made on an earlier draft which greatly improved the paper. Also thanks go to Yusuke Date and Shinya Suzuki for research assistance. All opinions and any remaining errors are the authors alone, however.

[2] There are a number of state-owned oil companies in Asia that play a prominent role in a variety of areas, including purchases of crude imports, e.g., Japan's soon to be dismantled JNOC, Korea's KNOC, China's CNPC, Sinopec, and CNOOC, and Taiwan's CPC, among others.

that oil destined for Asia is almost always priced higher. The average price differential over the 1996-2002 period was $1.43, a price markup of roughly six percent per ($25) barrel. Similarly, Soligo and Jaffe (2000) found that over the period 1990 to 1997, the premium was 83 cents when comparing crude oil destined for Asia and Europe, and 93 cents for crude oil destined for Asia versus the United States. It appears that not only is this premium persistent, but it may be on the rise.

Insert Table 1

As might be expected, the Asian premium is a pressing concern among the major oil importing nations in the region, e.g., Japan, South Korea, and increasingly China. Petroleum refiners are especially hard hit, as the premium generally contributes to lower profits in an industry that has experienced extremely slim margins in recent years (Ogawa, 2003). Also, rising dependence on Gulf oil has been a (political) concern, and calls to reduce that dependency ratio are on the rise.[3]

The premium receives a lot of attention among industry observers and in the industry press, but while there is a lot of discussion about potential 'solutions' to the premium, including calls for 'fairness' and 'cooperation' among producers and importers, theoretical analysis of the premium has—with the exception of Soligo and Jaffe (2000)—been quite limited.

In an effort to explore the Asian premium in depth, this paper proceeds as follows. Section 2 outlines three major hypotheses that are often used to explain the existence of the premium, namely: geo-political considerations, regulatory distortions, and market

[3] Naturally, Asian countries are not the only ones attempting to lower dependency on Gulf oil. The US has been debating the merits of opening up ANWR (Arctic National Wildlife Refuge) with much the same hopes, i.e. lower dependency and lower prices for oil in the US. The results here are, in general, applicable to this case as well.

segmentation/price discrimination; and delineates what can and cannot be said with certainty about each of these hypotheses. It also summarizes and critiques the most recent research in the area, which focuses primarily on the market segmentation/price discrimination hypothesis. In Section 3 we offer an alternative model which has the flexibility to incorporate multiple hypotheses. In Section 4 we discuss the implications of some likely scenarios within the context of the price leadership model with the added assumption that Asian oil supply is (severely) constrained. Section 5 concludes with a summary of the main findings and offers some predictions as to the future of the premium.

2. Possible Explanations for the Asian Premium

Geo-political considerations

In seeking to explain the Asian premium, one suggestion is that Saudi Arabia subsidizes oil exports to the United States and Europe to maintain a market presence for "political and commercial reasons" (Soligo and Jaffe, 2000). It is clear that offering oil to the U.S. at a discount ensures that Saudi Arabia will be prominent supplier in the U.S. market. Presumably Saudi Arabia and some of the other Gulf states feel that their presence in the U.S. market secures them a certain amount of protection and military insurance. Alternatively, they may feel that the U.S. may balk and threaten to withdraw military support if the prices set by the Gulf states' state-run suppliers are perceived to be 'too high.' Under either explanation, the U.S. may receive lower prices than countries like Japan or Korea, which have very little to offer militarily.

This argument is not wholly consistent, however. While it may seem to make sense for the U.S., does it also explain the price discount for Europe? One could argue that the Gulf states also have a strategic interest in currying favor with other military powers, in particular France and Britain, which have 'projective' military power as well as seats on the U.N. Security Council. However, one could extend the same logic to China, which also has a permanent seat on the Security Council. Yet China is among the countries that pay the Asian premium.

While this hypothesis may still be valid, the inherent complexity as well as lack of sufficient knowledge of any political intrigues make further analysis intractable and beyond the scope of this paper. Thus, this rationale will not be explored further.

Regulatory distortions

Horsnell (1997) argues that regulatory control has been, at least in part, responsible for the higher prices that Asian firms pay for oil. Historically, in East Asia procurement has often been conducted by either state-owned firms (e.g., China and Taiwan), or a small number of heavily regulated and closely monitored private firms (as is the case in Japan).

There are, of course, strong theoretical arguments one can make as to why a regulated or public corporation would be willing to pay more than private counterparts. Quite simply put, an employee in a state-owned or state-directed firm may have little or no incentive to push for changes in technology and/or suppliers to minimize costs—while a private purchaser does. Alternatively, this could reflect rigidity (bureaucratic or technical) to buying more low-sulfur oil, or even the political "premium" awarded to encourage a certain amount of Gulf oil (or a "penalty" for buying, say, Russian oil.).

One can imagine any number of simple public choice models where a procurer in a state-owned industry would have little incentive to switch suppliers. Also, with long standing relations between Gulf exporters and Asian purchasers, there is certainly the potential for rent-seeking efforts to maintain 'stable' oil supplies (at higher prices). These efforts are more likely to be successful when purchasing is guided by government bureaucrats.

It should be mentioned that deregulation has already occurred in some Asian energy markets for some goods and has resulted in significant declines in prices, for example, when Japan deregulated its oil product market in March 1996 (Nagaoka and Kimura, 1999). Also, distortions to the retail price of petroleum products, such as subsidies or programs aimed at smoothing price swings (e.g., the recently dismantled Administered Pricing Mechanism (APM) in India), are quite common in Asia. Because these programs insulate consumers from swings in the price of oil and in effect render consumers less price sensitive, they may contribute to the relatively high oil prices in Asia. Whether these regulations have an effect on the Asian premium, as Horsnell (1997) suggests, is difficult to say, but further consumer gains from deregulation in other energy markets seem likely.

Market segmentation/Price discrimination

The last, but by no means least likely, explanation for the Asian premium is that the Middle East producers have more pricing power in Asia. This is due to the fact that Gulf oil represents such a large portion of oil imports, coupled with the apparent ability to segment the U.S., Europe, and Asian markets (see Figures 1A, 1B, and 1C). The Middle

East's large market share in Asia is attributed mostly to geography and limited local reserves—Asia does not have as many alternative local or nearby supply sources as the U.S. or Europe. Transportation costs allow Middle East producers to segment the market, but it is also a key factor limiting the Asian premium because if the premium becomes too large, crude begins to move from other regions to Asia (e.g., West Africa). "Destination clauses" in Middle Eastern oil contracts, in which the buyer must state the ultimate location of delivery, further facilitates market segmentation.

Insert Figures 1A-1C here

This explanation of the Asian premium is perhaps the most appealing to economists and the easiest argument to formalize of the three. Also, a price discrimination model has been used to evaluate the premium in some detail before, and thus it deserves a more detailed discussion here.

The price discrimination model discussed below follows a fairly standard price leadership model where a homogeneous good is sold in two segmented markets. A general price leadership model applied to the world oil market is outlined in Griffin and Steele (1986), and used again in a segmented markets context in Soligo and Jaffe (2000) to examine the Asian premium. We follow these authors' notation and basic modeling assumptions here.

The basic premise behind the market-segmentation hypothesis of the Asian premium is as follows: given the standard assumptions necessary for price discrimination, namely the ability for the (monopolistic) producer to segment markets and prevent resale, as well as the existence of differing elasticities of demand among two or more markets, Saudi Arabia (and perhaps other Gulf OPEC members—Soligo and Jaffe focus on Saudi Arabia,

so we follow their example for now) can successfully charge different prices in the different markets. According to standard monopolistic pricing rules, the supplier will charge a higher price in the market in which it faces a lower price elasticity. However, an important difference between a textbook model of price discrimination by a monopolist and the Griffin and Steele model is that consumers' demand (and concordant elasticities) are not necessarily different *per se*, as is commonly the case in a segmented market (e.g., markets where student discounts are offered). Rather, the difference in the size of the market share occupied by the price leader drives the difference in elasticities.[4]

It follows quite logically and consistently that if Saudi Arabia (or OPEC, as is assumed in Griffin and Steele) has a larger market share, the elasticity for Saudi oil will be lower, and thus we will find the price to be higher. Quite simply, Saudi Arabia commands a larger market presence in the Asia than in Europe, and consequently the elasticity in Asia must be lower and the price must be higher, *ceteris paribus* (in particular, when assuming zero or constant marginal cost of production in Saudi Arabia), in Asia than in Europe.

While the price leadership model and the Soligo and Jaffe version of the model have much to offer in terms of understanding petroleum pricing behavior, we feel the assumptions are too rigid, and as such it asserts only one explanation for the premium, which may not be sufficient. Also, the prices and market shares implied by the model are extremely sensitive to the parameters and assumptions employed in the model. Lastly, it glosses over the *nature* of any difference in market shares, and in particular, the fact that Gulf oil has a larger market presence in Asia because of limited (constrained) local

[4] Or put alternatively, under the behavioral assumptions of the model and the values of various supply elasticities and given the data on actual market shares, it must be true that the demand elasticities fall when

alternatives. We address some of our concerns below, and later present an alternative oligopolistic model as well as a constrained price leadership model which may more accurately capture the salient features of the Asian market.

To get a sense of the sensitivity of such a model, a numerical example based on the Soligo and Jaffe paper is helpful. To begin, using the first row of data of Table 2 in Soligo and Jaffe which assumes an overall elasticity of demand of unity and an elasticity of supply of 0.5, we can impute elasticities of:

$$\varepsilon_{se} = 20 \cdot (1) + 19 \cdot (0.5) = 29.5$$

and

$$\varepsilon_{sfe} = 10 \cdot (1) + 9 \cdot (0.5) = 14.5$$

where ε_{se} is the elasticity of demand for Saudi oil in Europe and ε_{sfe} is the elasticity of demand for Saudi oil in the Far East.

Inserting these values into the ratio of Far East and European prices, as discussed in Soligo and Jaffe,

$$\frac{p_{sfe}}{p_{se}} = \frac{\left(1 - \frac{1}{\varepsilon_{se}}\right)}{\left(1 - \frac{1}{\varepsilon_{sfe}}\right)}$$

market shares rise.

we arrive at an imputed price ratio of 0.9661/0.9310 or 1.038.[5]

Thus, as Soligo and Jaffe suggest, a lower limit for the Asian premium might be 3.8 percent, which seems like a reasonable ball-park figure. Utilizing alternative demand and supply elasticities produces an upper bound of 23 percent for the premium.

While the theory behind the market segmentation model is well grounded, as Griffin and Steele point out, the imputed estimates of elasticities are *very* sensitive to the other parameters in the equations. In addition, there is somewhat of a tautological argument which may lead one to believe that the premium can be explained entirely by the larger market share. We will discuss each of these limitations in turn.

Huge price elasticities of demand

To begin, if we model Saudi Arabia as the price leader with only five or ten percent of a given market, the resulting implied demand elasticities for Saudi Arabian oil are enormous. In Soligo and Jaffe's first range of parameters (overall price elasticity of unity and non-Saudi supply elasticity of 0.5) we must believe that in Europe the price elasticity for Saudi oil is nearly 30, and in Asia a far less elastic (but still terribly elastic) 15. These are not reasonable parameters, and such magnitudes are not found in the literature on oil demand, or used for any good imported or otherwise. (In the original Griffin and Steele model, they posit the overall world demand for oil to be unity, which produces a more reasonable 2.5 demand elasticity for OPEC—which they assume controlled half of non-communist oil sales in the 1980s.)

[5] Apparently the elasticity terms were transposed in the original Soligo and Jaffe paper, but their final calculations in Table 2, do not (mis-) incorporate this error.

Extreme sensitivity to market share assumptions

As one might expect from the previous criticism, the price leadership model depends very much on market shares. Suppose, for example, that instead of Saudi Arabia, we assumed that the core OPEC Gulf states were a well-coordinated cartel (in much the same way Griffin and Steele do in their original example) that acts as price discriminating leader in both markets. Under this assumption, the market-share for Europe and the Asian markets would be approximately 30 percent and 80 percent, respectively.[6] Given the solidarity among these relatively close knit players within OPEC, as well as similarity in marginal costs, this is not an unrealistic assumption. In fact, this may be a more realistic assumption, more accurately capturing the Asia's dependence on Gulf states' oil, as well as Asia's limited alternatives.

Again using values of unity and 0.5 for the price elasticity of overall crude and the supply of non-Gulf OPEC oil, as was the case in an earlier example, we arrive at an imputed price ratio of 3.15 or a premium of 215 percent! This enormous premium would never arise, of course, because it is 'capped' to a large extent by potential arbitrage from other markets. Nevertheless, the potential premium would be very different from those calculated by Soligo and Jaffe for Saudi Arabia alone. This rather odd result poses a problem because it makes it difficult determine how much change must take place in the market (e.g., new sources of crude for Asia) to reduce or eliminate the premium. For example, if the true elasticities do, in fact, imply a premium of 215 percent which is only

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[6] Typically, approximately 30% of Western European imports come from the Gulf OPEC states: Saudi Arabia, Iran, Kuwait, Qatar, and UAE (Iraq may also be included in the group). For "East Asia" (Japan,

limited by the transportation cost differential on West African crude, then even an decrease from, say, 80 percent to 70 percent dependency would only reduce the premium to approximately 120 percent. Thus the transportation cost ceiling would still be binding and the premium would not fall.[7]

The point, of course, is not that the actual "potential" premium is so high or the demand for Saudi oil is so elastic. It is merely to point out the extreme sensitivity of the results to the parameters that are employed in the model—and thus the lack of confidence in the ability of the model to explain the size and relative changes in the magnitude of the premium under various circumstances. That is not to say that market segmentation does not explain a part (or even the majority) of the premium. As we will show in the next section, we do in fact feel segmentation is present and Gulf states' dominant market share does explain, at least in part, the premium. But with a model in which market shares (with the concomitant assumptions for the other elasticities) determine the elasticity for Saudi or Gulf oil, we can say little about other likely explanations for the premium. Moreover, we can say nothing about the *nature* of the higher market share, nor how it may change under alternative scenarios.

Extreme sensitivity to elasticities

One of the concerns in using the method described above, as pointed out by the authors, is that even when it is applied using a reasonable range of elasticities (e.g.,

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China, Taiwan and South Korea) the share of imports from the Gulf OPEC states generally exceeds 80 percent.

between 0 and 1), the implied premium can vary considerably. As a consequence, there is a danger of a sort of data mining with parameters to select those which roughly calibrate to the actual premium. One can certainly produce 'results' that are consistent with the observed premium, but this does not prove or disprove a particular theory. (See the next section for a brief discussion of some attempts to test competing theories of oil market behavior.) In a sense, this calculation is more like a computable general equilibrium (CGE) estimate than an actual verification that a particular model is appropriate. And CGEs, while very useful for simulating changes from a baseline, are not appropriate for testing a theory. One has to believe in the model assumptions *a priori.* And even then, the calibrations can produce dubious results (such as the very high elasticities for Saudi oil mentioned above.)

Market shares determining elasticities

The driving force behind the market segmentation story put forth by Griffin and Steele, Soligo and Jaffe and others is that "price discrimination was possible because the elasticity of demand for Saudi oil was different, the result of different market shares, in the two markets." (Soligo and Jaffe, 2000:130-131.)

This link between the market share and elasticities necessarily follows from the assumptions of the model. However, in our view, elasticities in the oil market may differ among Europe and Asia for a variety of other reasons. To be sure, one of the main reasons is that Europe has a number of supply options (e.g., the North Sea, Russia, the

[7] Of course this scenario is not quite that simple, as an increase in alternative suppliers implicitly alters the assumption about supply elasticities, with non-Saudi/non-Gulf oil to the Far East becoming more elastic as

Caspian Sea region, Africa, etc.), while Asia has considerably fewer options due to distance and a relatively limited regional supply base. Thus, we would naturally expect the premium to fall as alternative Russian supplies emerge (see Section 4 for this, among other, hypothetical scenarios).

Again, however, dominant market share by no means rules out other explanations for the premium. Thus, we need a more flexible model which incorporates the strengths of the price leadership, market segmentation model (in particular the potential for higher market share to command more pricing power as well the assumption of market segmentation), but one that also allows for other rationales for the premium.

3. An Alternative Model: Cournot Competition

We now introduce an alternative model which can encompass several possible explanations for the existence of the premium. But first, a brief discussion of previous oil modeling efforts is necessary.

The model presented in this section is not, of course, the only model of oil supply and demand. In fact, dozens of models have been developed to describe world oil market behavior. In addition, numerous attempts have been made to test which model fits the actual data best. This is a daunting task first tackled by Griffin (1985), Loderer (1985), and Griffin and Nielsen (1994), among many others.

Perhaps the most comprehensive test was recently done by Alhajji and Huettner (2000), in which they attempt to estimate aspects of supply and demand and test the suitability of the dominant firm model (with Saudi Arabia alone, OPEC, or an "OPEC

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well.

core" as the price leader), a simple Cournot model, and the competitive model. Alhajji and Huettner find that "Saudi Arabia as price leader" in a dominant firm model cannot be rejected while all other permutations of the other models can. This is important work and headed in the right direction.

However, we feel that no one particular model can be definitively accepted at the rejection of all others for the following reasons. First, while the empirical models presented above are important advances, the conclusions are far from robust. Alhajji and Huettner's work correctly estimates both supply and demand functions simultaneously for the oil industry (rather than only a supply function, which is typical in many previous studies), and relies upon those estimated parameters to accept or reject each of the theories. It is important to note, however, that the price elasticities of demand—especially for internationally traded goods—are subject to a notoriously wide range of estimates. Supply functions, and especially the costs used in estimating them, are even more challenging to measure and subject to considerable debate, especially in the oil industry. Thus, we are not yet convinced that the Cournot model (nor any other reasonable model) can, in general, be rejected.

Second, and perhaps more importantly, the research mentioned above is concerned with testing behavior in the world market, not a regional market such as Asia. As such, there is no allowance for price discrimination and market segmentation behavior at a regional level—and in fact it is ruled out. Thus, while this line of research may provide a decent assessment of world movements in oil prices, they can in no way explain the Asian premium, nor indeed the fact that Saudi f.o.b. prices are substantially different between the U.S., European, and Asian markets.

Of course, the Soligo and Jaffe model—a dominant firm model with segmented markets—is a reasonable alternative to the model below as it does offer an explanation for the premium. However, this model has not been statistically tested, and due to the reservations expressed in Section 2, we find no immediate reason that it should be the preferred model (except perhaps for its tractability.)

The Model

We begin by assuming only two segmented markets (Europe and Asia). While we use Europe and Asia as an example, the model could just as easily be used to examine the Asia-U.S. premium. In each market one local supplier competes with the Saudi-led Gulf OPEC members (for reasons of parsimony this is referred to as "Gulf OPEC").[8] Thus, Gulf OPEC is treated as one supplier, as are the local European suppliers. Gulf OPEC serves the Asian market as well and competes with local oil producers (such as China, Vietnam, Australia, Malaysia, etc.). While Gulf OPEC serves as a swing supplier to both regions, we assume that the local producers do not serve each other. That is to say, European oil is not sold to Asia and vice-versa, perhaps due to prohibitive transportation costs.[9]

Thus, both markets are characterized by a duopoly.[10] We assume, for ease of exposition, linear demand functions. As suggested by conventional wisdom, we will also assume the product provided by both firms in each market is differentiated (though Gulf

[8] By Gulf OPEC members we mean: Saudi Arabia, UAE, Qatar, Kuwait, Iran and Iraq (when exporting).
[9] This is a fairly realistic assumption. Only approximately four percent of Asian imports come from Europe/FSU and approximately 1 percent of European imports originate in Asia. This and other facts (see Soligo and Jaffe, 2000) support the hypothesis that the markets are segmentable.
[10] There is, of course, more than one Asian supplier and they most certainly do not act in unison. The restrictive assumption of duopoly (common in the trade literature) is admittedly a simplification which will

OPEC oil is assumed to be the same in both the EU and Asia) and that both markets are characterized by quantity (Cournot) competition.[11] We are not explicitly modeling Gulf OPEC as a price leader here, although capacity constraints on Asian suppliers (which will be discussed later) may produce results similar to that of a leadership type position.

Finally, we also assume linear cost curves, and thus constant marginal costs, for all producers. This probably characterizes Gulf states' production fairly well, though one may argue that non-Gulf states' marginal cost curves are more upward sloping. However, the key point is that the Gulf states' optimization condition is naturally $MR_e=MR_a=MC$, where the subscripts denote Europe and Asia respectively, and MC does not vary with respect to quantity. Thus, any changes in one market will not affect the optimal decision in the other.

Perhaps the most important feature—which is not explicitly modeled here for reasons discussed at the end of this section—is that the local (Asian) producers have an upper limit to the amount they can supply to their own market. And, as appears to be the case in Asia, this limit is binding.[12] (See Figure 2.) A constraint will, however, be introduced in the simpler model discussed in section 4.

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enable us to highlight various features of an oligopolistic model, and posit multiple explanations for price differentials across markets, however.

[11] Given the often large differences in composition of the various types of crude, we feel the assumption of homogeneity is too strict. While there is, of course, a very high degree of substitutability between different crudes, it is not infinitely elastic, especially in the short-run, nor would the elasticities be the same among three or more types of crude. We would rather allow the parameters in the model to differ and allow for various degrees of substitutability.

[12] Obviously, when regional prices are very high, purchasing from a distant supplier would become profitable. Asian importers sometimes purchase a portion of their oil from distant countries such as Gabon when arbitrage opportunities exist (due to shrinking crude price differentials and/or unusually low transport costs). Such imports have been growing in recent years, in part due to tighter product specifications and the need for more low-sulfur crude. (Gulf crude generally has a higher sulfur content.) This may have a significant arbitrage 'threat' value which mitigates a potentially larger premium. Thus we assume (similar to Soligo and Jaffe) that the premium is roughly capped by this transportation cost differential.

Insert Figure 2

The EU Market

Quantity demanded of Gulf OPEC and EU oil in the EU market is defined as follows:

$$p_{oe} = a - b_1 q_{oe} - c q_e \quad (1a)$$

$$p_e = a - c q_{oe} - b_2 q_e \quad (1b)$$

where q is the quantity produced (and sold), p is the price for each good, and where the subscripts "*oe*" and "*e*" delineate Gulf OPEC in Europe and European production, respectively. The remaining parameters capture the level and sensitivity of demand to own and other products.

Note that we have assumed the intercept to be the same for ease of exposition and "*c*" is identical in both equations to ensure the cross-price effects are symmetric, a requirement for well-behaved demand functions.[13]

The Asian Market

Similar demand functions exist in the Asian market, where although the functional form is identical, the parameters may differ across markets.

$$p_{oa} = \alpha - \beta_1 q_{oa} - \gamma q_a \tag{2a}$$

$$p_a = \alpha - \gamma q_{oa} - \beta_2 q_a \tag{2b}$$

That is to say, "a" in the European market may or may not equal "α" in the Asian market and so on. For now, let us assume that the marginal cost of production is equal to zero for Gulf OPEC. This does not qualitatively change the results, as we have assumed constant marginal costs.

The total revenue function (*TR*) for the European producer in Europe is:

$$TR_e = p_e q_e = (a - cq_{oe} - b_2 q_e) q_e \,. \tag{3a}$$

For Gulf OPEC, *TR* is:

$$TR_{oe} = p_{oe} q_{oe} = (a - b_1 q_{oe} - cq_e) q_{oe} \,. \tag{3b}$$

From the F.O.C. conditions (the best response functions for both 'firms') we can ultimately solve for the European producer's optimal quantity as:

$$q_e^* = \frac{a(c - 2b_1)}{c^2 - 4b_1 b_2} \,. \tag{4a}$$

[13] This set-up is a standard Cournot game, examples of which can be found in Singh and Vives (1984),

It follows that the quantity supplied by Gulf OPEC to Europe is:

$$q_{oe}^{*} = \frac{a(c-2b_2)}{c^2-4b_1b_2}. \qquad (4b)$$

Finally, the corresponding price of Gulf OPEC in Europe will be:

$$p_{oe}^{*} = \frac{ab_1(c-2b_2)}{c^2-4b_1b_2} \qquad (5)$$

with a similar (though not exactly the same, as the b_1 and b_2 terms' positions will be switched) expression for the price Europeans charge in Europe.

We can readily solve the unconstrained equilibrium in the Asian market as well, where:

$$q_{a}^{*} = \frac{\alpha(\gamma-2\beta_1)}{\gamma^2-4\beta_1\beta_2} \text{ and} \qquad (6a)$$

$$q_{oa}^{*} = \frac{\alpha(\gamma-2\beta_2)}{\gamma^2-4\beta_1\beta_2}. \qquad (6b)$$

The price charged by Gulf OPEC in Asia will be:

$$p_{oa}^{*} = \frac{\alpha\beta_1(\gamma-2\beta_2)}{\gamma^2-4\beta_1\beta_2} \qquad (7)$$

Varian (1992) and Shy (1995) *inter alia.*

and a similar expression for the Asian producers' price in Asia (not shown here).

Discussion of the model

As one can see, in a model where the assumptions of a homogeneous good, as well as a traditional price leader model are relaxed, a variety of possible explanations emerge. Let us assume that the European and Asian market demands are identical except for one parameter, b_1 (and its Asian analogue, β_1). All other parameters are identical. For example: $a=\alpha$, $c=\gamma$ and $b_2=\beta_2$. As shown in Singh and Vives (1984), in a linear model such as this, if the intercepts of both demand functions (in a single market) are identical, then $\frac{\gamma^2}{\beta_1\beta_2}$ expresses the degree of product differentiation. The closer this ratio is to unity, the greater the substitutability. By some algebraic manipulation of (5) and (7) one can see that if β_1 (for Asian demand of Gulf oil) is less than b_1 (European demand for Gulf oil), p_{oa} will be greater than p_{oe}. For plausible values, $\beta_1 < b_1$ also implies a lesser degree of substitutability between Asian and Gulf oil, than that between European and Gulf oil.[14]

Thus, to be sure, substitutability (or a lack thereof) does affect the premium when some market power is present. So, rather than the premium emerging due to a larger market share (as modeled by Soligo and Jaffe), it may be the differences in substitutability, or alternatively interpreted as "flexibility", which drive the price differential between markets and thus the higher market share. (The reader can confirm

[14] Reasonable values which meet stability and cross price effects would be $b_1=0.90$, while $b_2=\beta_2=\beta_1=1$, $c=\gamma=0.80$ and $a=\alpha=60$. The readers can in this way convince themselves of the above result. However, in doing so, one will also notice the degree of sensitivity of market shares and prices, both intra- and inter-market, to parameter choices.

that, in fact, the Asian market will have both a higher price and a larger share of the market supplied by the Gulf under such circumstances.) The reasons for the possible differences in flexibility are many and could include: general regulatory inflexibility; short-run technical constraints (e.g. Japan's existing refining infrastructure's bias towards high-sulfur content oil); other political constraints or administrative guidance; vested interests determined to preserve the status quo, etc.

Does a difference in flexibility/substitutability across markets have to be the only explanation for a higher Gulf OPEC market share in Asia? Of course not. Differences could exist in the demand for European and Asian oil itself. For example, consumption patterns of petroleum products are not the same in Europe and Asia, or for that matter in the U.S. These differences (such as the proclivity for Europeans to consume more diesel, the U.S. more gasoline, and the Japanese more kerosene) may drive the need for different crudes, which may in turn affect the demand parameters in the q_e and q_a equations. Differences in the quality of Asian and European crudes would be reflected in different substitutability with OPEC oil in each market.

And, of course, the overall level of demand matters. If we do not assume that $a=\alpha$ (additionally, there is no reason to believe that the intercepts for each separate demand curve within each market would be the same), very different market share and price outcomes can be produced.

Note that in these cases the premium and market share differentials come not from differences among suppliers, cost curves, or the like, but simply from differences in the nature of the demand. We have entirely ignored the cost side in this model. Certainly cost functions for North Sea oil will differ from the Gulf states, or Vietnamese oil, for

example. A more fully specified model taking this into account would offer still more explanations for both a higher market share and a higher premium in Asia.

The key point here is that the potential reasons for the differences in demand (and the associated elasticities) are many. It is not necessary—and in fact it would be quite challenging, if not impossible—to establish parameters for a model such as this. As illustrated in Section 2, calibration of these models may lead to 'data-mining' to find parameters that 'make the model work.'

The model when Asian supply is severely constrained

Ideally, the next step in developing the model would be to add the more realistic assumption that non-Gulf supply is not sufficient to meet all of the current Asian demand at any realistic price. That is to say, we would assume that Asian local supply is constrained at "reasonable" price levels. This is the most likely explanation for the premium, or at least explains the bulk of the premium and high Gulf dependency.

However, if we prefer a model with differentiated goods and some oligopolistic competition, perhaps as presented above, the effects become much more ambiguous. The ambiguity lies in the fact that if one (or more) of the firms is supply-constrained, there is typically no pure-strategy equilibrium to be found (Fellner, 1965). To produce an equilibrium one must assume the nature of the rationing mechanism, and this may be quite arbitrary unless one has very detailed knowledge of how the market functions. Furthermore, even in the case that some credible equilibrium is found, (at least) two problems remain. First, often the comparative statics are ambiguous. The reaction of both 'players' (whether to expand or contract output, for example) depends very much on

initial conditions and parameter values. Second, the equilibrium is, in general, only valid locally. For large constraints (as is likely the case of Asian supply), the equilibrium may not be defined, or at least will not hold for large changes in it. Thus, if we are to believe that a large constraint exists on Asian supplies, the effects of loosening that constraint to any large degree would be extremely hard to predict and sensitive to the numerous, restrictive assumptions that would have to be made.

A discussion of the literature on VERs (Harris, 1985; Krishna, 1989) in trade may help to illustrate the point. A VER (voluntary export restraint) such as those implemented against Japan in steel and autos in the 1980s is similar to the case we have here. With a VER, by government decree or threat of severe sanction, one 'firm' is restricted to a certain level of output/sales. The other firm is not constrained in any way. Though often modeled in Bertrand competition, the results often do not differ when other types of competitive behavior are formed (Harris, 1985).

This is not unlike the case here in which one 'firm' (local Asian oil firms) is constrained, while the Gulf states essentially are not. What the VER literature finds (after using admittedly arbitrary and often different rationing rules to achieve an equilibrium) is that the constrained equilibrium alters the strategic nature of interaction between the two firms. Often non-intuitive results are found. For example, as they restrict output of the foreign (exporting) firm, the domestic firm's output may rise or fall relative to some free trade equilibrium. Thus, it is not immediately clear that a relaxation of the constraints would cause both firms to increase output.

In the case of a constrained Asian oil supplier, it is not clear whether a relaxation of capacity constraints, (through new pipelines or new regional discoveries) will cause Gulf

oil to rise or fall in response. As in many things in economics, 'it depends'. To put it another way, in the event that more non-Gulf oil is brought to Asia through increased production and/delivery capacity (pipeline), we cannot say *a priori* whether Gulf states will find it more profitable to "fight back" with cheaper prices and more oil of their own, or restrict sales further and raise prices in response.[15] Thus, under such a constrained case, in an oligopolistic model we simply cannot predict whether the Gulf dependency or the premium will rise or fall.

In the event that Gulf states do increase ("fight back") in response to large increases local Asian capacity, the increase in local quantity must still be larger than any increase in Gulf oil for the dependency ratio to decrease. If this is not the case, the Gulf increases will still be a great boon to Asian consumers, but politically the "dependency" issue will remain. Of course, in the event Gulf oil acts as a strategic substitute in output, Gulf dependency will clearly fall as Gulf oil falls and local oil rises. Naturally, the Gulf states' supply is not small and therefore the direction and magnitude of any change will have very different implications for the dependency ratio.

Ultimately, what we would like to emphasize is that while the reality of limited local alternatives and its implications for price discrimination in segmented markets does offer the strongest and most plausible explanation for the high market share of Gulf oil in Asia as well as the premium, it does not rule out other explanations. That is, as shown in the above model, perhaps due to excessive regulatory burdens or other inflexibility resulting

[15] Though perhaps conventional wisdom holds the former view as evidenced by statements in the press such as, "Saudi Arabian Oil Minister Ali al-Naimi, who oversees the world's biggest oil reserves, may offer to cut prices to buyers in China, South Korea and Japan in the face of growing competition from Russia, traders said Friday," Subramaniyan, Bloomberg, c. April 2004. Even here, it is not clear how Gulf *output* would change, however.

in less substitutability, an Asian premium may exist regardless of local supply conditions. Thus, any regulatory intransigence is an additional layer of inflexibility and inefficiency (resulting in higher prices) on top of the more prominent explanation for the premium in Asia, namely, limited local supply. Thus, both deregulation and new sources of oil may reduce the premium, but in different ways, and with potentially different effects on the dependency ratio (and total quantity) in the region.

4. Three Likely Scenarios

In this section, we offer some predictions as to the impact of three events on the Asian premium and dependence on Middle East oil. While the future structure of oil demand and supply in Asia is far from predictable, three scenarios are often discussed in policy and media circles, namely: (1) new or expanding suppliers to the Asian market (Russia in particular); (2) changes in the regulatory and competitive environment among Asian importers and; (3) rapid demand growth which outpaces growth in Asian sources of supply.

We discuss each of these scenarios within the framework of a segmented price leadership model. However, we also allow for the possibility that the followers (Asian suppliers) may be constrained in output, and highlight the differences in final outcomes among the three scenarios with a non-constrained, price leadership environment. The price leadership model is not chosen because it is the preferred model, but rather because it can generate unambiguous results. As mentioned in the previous section, other oligopolistic models cannot be ruled out. However, as no equilibrium is well-defined in

the constrained case, confidently predicting the effects of any event becomes improbable. Thus, we would like to emphasize the fact that if a price leadership model is *not* the appropriate one, then the effects on the premium and dependency ratios are even less predictable than those presented below.

Figure 3 presents a price leadership model in graphical form similar to that presented in Griffin and Steele (1986) and many microeconomic textbooks. We have assumed that the marginal costs of the leader ("Gulf OPEC" acting in unison) are constant and lower than that of Asian suppliers', which is upward sloping. Again, we assume the markets are segmentable. We feel these assumptions are appropriate, though different assumptions of cost curves may result in outcomes different from those presented below.

For some cases, the model in equation form is more easily understand and thus we present it below. We assume that, for one of many possible reasons described above, the price in Asia is higher than that in Europe. Thus, a fall in the Asian price, *ceteris paribus*, implies a fall in the premium. The demand for Asian oil is expressed as:

$$D(p) = a - bp \tag{8}$$

and the cost function for the leader (Gulf=1) and followers (Asia=2) are:

$$C_1(y_1) = cy_1 \tag{9a}$$

and

$$C_2(y_2) = \frac{dy^2}{2} \tag{9b}$$

respectively.[16] Thus Gulf OPEC's marginal costs are constant and its supply curve is flat and the Asian followers' is upward sloping with a constant marginal cost. The *d* term is a

[16] This well-known model is identical to that found in Varian (1996) with the exception of the *d* term suggested by Professor Koda.

constant which we will use later to model decreases in red-tape regulation or perhaps delivery costs from newer, cheaper alternative sources.

Residual demand facing Gulf OPEC then becomes:

$$R(p) = D(p) - S(p) = a - bp - p = a - (b+1)p\,. \qquad (10)$$

Scenario 1: Increase in local (Asian) supply

Concerns over energy security among Asian consumers and a drive by Russian oil producers to push into the Asian market has led to discussion of the possibility of delivering Russian crude to Asia. One possibility is to link eastern Siberia's Angarsk with Nakhodka, a port city in Russia's Far East *via* a pipeline. Another possibility, which appears to have the upper hand because it is a much shorter route, is to link Angarsk with Daquing, the start of an oil pipeline network in China. Each of these pipelines would have to carry upwards of one million barrels per day (approximately 5% of Asia's current consumption) to be viable projects (Kyodo News Service, 2003). There is also talk of supplying up to one million barrels per day of Russian crude via the Trans-Israel pipeline, which would transport oil from the Mediterranean to the Red Sea (de Vreij, 2003).

If this increase is modeled such that marginal costs of non-Gulf oil to Asia fall, this would shift the supply curve of the "followers" to the right (see Figure 3) from S to S'. This, in turn, would alter the residual demand curve facing the leader such that the Gulf price of oil and local oil prices would fall (as the oil is considered homogeneous.) Thus, the premium (relative to Europe) would fall, local oil supply would increase and Gulf oil supply would fall, thus lowering dependency.

In terms of the equations the optimal price would be:

$$p = \frac{a}{2(b+1/d)} + \frac{c}{2} \tag{11}$$

and outputs would be

$$y_1 = \frac{a - c(b+1/d)}{2} \tag{12a}$$

and

$$y_2 = \frac{1}{d}\left[\frac{a}{2(b+1/d)} + \frac{c}{2}\right] \tag{12b}$$

for leader and follower, respectively.

A fall in *d* would reflect a decrease in marginal costs of Asian suppliers and a shift in the followers' supply curve to the right. One can see from equations 11, 12a, and 12b, a decrease in *d* implies a fall in price, a decrease in Gulf's oil and an increase in Asian oil. This scenario could also be viewed as a reduction in transportation costs (part of the MC) due to subsidies given by East Asian governments to construct pipelines. However, in this case, the costs of any subsidy (or infrastructure project) should be considered as well, and may very well be larger than any consumer gains from a lower Asian premium.

However, while shifting the supply curve is one way to model lower transportation and/or pipeline costs, this textbook case may not be appropriate for the actual situation where local Asian suppliers do not have sufficient capacity to supply their entire market (at a reasonable price.) Thus, we must consider the case in which Asian supply is effectively capped at some output. This scenario is also depicted in figure 3, where S_1 is the followers' supply curve when constrained by some limit in productive capacity. S_1 is

drawn so that it is 'just binding' with the standard price leadership outcome. S_2 represents a more constrained case.

When the follower's output is constrained to some level at or below that which would occur under a boundless supply curve, the residual demand curve facing the leader becomes D_1 rather than the standard unfettered case of D_o. (D_2 reflects the residual demand facing the leader if the constraint is the more severe case of S_2.) Thus, the residual demand simply becomes the total (Asian) demand curve shifted to the left by the amount the followers are restricted to, say amount $\bar{A}$.[17]

Again, in terms of the equations, a constraint on Asian supply would generate price and quantities as follows:

$$p^{\bar{A}} = \frac{(a - \bar{A}) + bc}{2b} \qquad (13)$$

and

$$y_1^{\bar{A}} = \frac{(a - \bar{A}) - bc}{2}\ ,\ y_2^{\bar{A}} = \bar{A} \qquad (14a \text{ and } 14b)$$

when the capacity constraint is binding.

Rather than (or perhaps, in addition to) shifting the Asian suppliers' supply curve to the right, we can model the increased local supply as a relaxation of the constraint from say, S_2 to S_1 . In this case, the price set by the leader does fall, thus lowering the premium. Also, Gulf quantity falls and Asian supply clearly rises thereby reducing the dependency ratio.

[17] Similar graphical (and mathematical) treatment can be found in Itoh and Ono (1982).

Thus, under this scenario, whether modeled as a shift in the supply curve or a relaxation of the constraint, the qualitative results are the same, i.e. the price/premium falls as does the dependency ratio. Thus far, it seems that conventional wisdom holds.

Scenario 2: Deregulation

This alternative scenario has results identical to that depicted in Figure 3 if we to believe there are no existing capacity constraints. We simply model the deregulation as a reduction of red-tape or other barriers to buying oil from Asian suppliers as a shift in the Asian supply curve to the right. This is reflected in a reduction in the parameter ***d.*** Thus, the premium falls as does the Gulf oil dependency, in accordance with conventional wisdom.

However, if we believe that deregulation occurs under an environment where local capacity constraints are binding, while benefits may be had, the results can look very different. While the unconstrained portion of the supply will shift from S to S', at binding levels of price and demand, supply still be constrained by either S_1 (or S_2). Therefore, when demand levels are in the binding range, a fall in costs due to deregulation will not change the price and quantity set by the leader, nor will the dependency ratio change.

If local Asian supply is constrained while Gulf oil is virtually unconstrained, then even if Asian countries have more flexibility in the source of their purchases, they simply cannot purchase any more locally. A model such as Soligo and Jaffe's implicitly assumes non-Gulf states can increase production to whatever extent necessary to meet demand. This is clearly not the case at present in Asia, at least when the premium operates

underneath the $.75-1.50/bbl transportation cost differential for oil bought from far away countries like Angola.

But, surely something must change if the local supply curve shifts, and indeed something does. The local Asian producer surplus will rise. However, as they are a price follower, and the leader did not find it optimal to change the price, none of these gains are passed on to the consumer! In the longer run, we may imagine that deregulation will have a broader effect on the local industry by encouraging entry of more firms, more exploration and perhaps a flattening or shifting out of the local supply curve. But in the short run, it will simply increase returns to existing producers.[18] This highlights the restrictive and perhaps unrealistic nature of the overly simplistic price leadership model. In another oligopolistic model, some or all of the cost-reduction may be passed on to the consumer, but this outcome is simply not an option given the competitive assumptions in a constrained price leadership model.

In summary, in this scenario we find, as did Soligo and Jaffe, that *if* Gulf market share falls, the premium will fall as well. However, the source of the fall in the market share is not assumed to be due to new supply sources, but rather deregulation or flexibility in purchasing. Thus, it is dangerous to dismiss the possible benefits of further deregulation in this industry, and to claim it will have no effect on market share and/or the premium. Importantly, however, if local constraints are binding, deregulation will have no effect on local prices or the dependency ratio, at least in the short run.

If the constraints are completely relaxed by massive new oil reserves nearby, the premium and dependency ratios would fall dramatically and any further deregulation

[18] Or, where government interference is large, gains would go to the relevant government agencies or other rent-seekers/stakeholders in the importing and/or refining industries.

savings could be passed on (at least partially) to the consumer. Interestingly, however, while the dependency ratio will fall, Gulf output to the region may actually increase, rather than decrease. If we compare the Gulf quantity under the severely constrained Q_2 with the unconstrained Gulf quantity of Q_o, we see that Q_2 is greater. However, under different cost assumptions (such as that characterized by S'_{GULF}), results may differ and Gulf quantity could stay the same or even increase rather than fall. Thus the leader "fights fire with fire" in response to the unfettered followers' supply. This is contrary to the above cases where Gulf output contracts. This highlights the ambiguity in even the relatively straightforward price leadership model when the followers are constrained. And, given the current projections, the constraint seems likely to remain for a long time.

Scenario 3: Rising dependence on Gulf oil due to growing demand

With rapid economic growth in Asia (especially China), growth in petroleum product consumption is far outpacing any increases in local supply. As a result, Asia's dependence on Gulf oil is growing.[19]

In the segmented price leadership model, this would obviously result in higher prices and thus an increase in the premium. This can be modeled in equations (11), (12a), and (12b) as an increase in *a*. Dependency will also rise as the increase in Gulf quantity will be larger than that of local supply given the assumptions laid out here.

[19] For example, Japan's dependency on Gulf oil rose to 85% as of spring 2004. And significant relief from the Caspian Sea seems unlikely. If Caspian Sea oil projections are reliable, they will provide up to 5% of *current* oil consumption in Asia. As China and South Korea are growing at up to 10% per year, continued Gulf dependency seems certain to remain in the future. Offsetting this has been Japan's stagnant growth, but that economy may be poised to rebound somewhat as well.

If local supply is constrained, all increases in quantity supplied would be provided by the Gulf states and the dependency ratio would rise even further than in the unconstrained case. The premium would also rise. This is scenario is not reflected in Figure 3, but can be confirmed graphically or *via* the equations quite easily.

Increased local alternatives and deregulation

Over the long run, it is possible that both the local constraint will be less binding or not binding at all, while deregulation and other marginal cost reducing policies come into effect. Relaxation of the constraint should allow a greater share of any deregulation or other cost-reduction savings to be passed along to the consumers. However, the likelihood that local Asian oil will not be constrained seems unlikely in the near future at least as long as China's rapid growth continues.

The effects under the price leadership model on prices, Gulf and Asian supply, and Gulf dependency are summarized in table 2. As we can see, some scenarios which reduce marginal costs of the Asian supply have no effect at all on prices or quantities when local output is constrained. Other scenarios result in lower prices, and increases in Asian output as well as a lower dependency ratio. This is consistent with the conventional wisdom that a lower premium does indeed coincide with a lower dependency ratio. Interestingly, the effect on Gulf output in the event the constraint is eliminated altogether may depend of the initial level of the constraint, as seen in cases 2b and 3c.

From some reports (as mentioned in footnote 14) the Gulf states seemed poised to respond to more Russian oil flowing east by lowering prices. But will Gulf states sell

more or sell less at lower prices? This is where conventional wisdom gives us little clue. Also, in a sense, it gives us a counterfactual to test the price leadership model.

Presumably the new Russian oil will not be enough to make the Asian local supply change from being constrained to becoming completely unconstrained. Thus, we can safely rule out the cases 2b and 3c in table 2. Cases 1 and 3b predict a fall in Gulf oil concomitant with their reduction in their prices. Thus, if we find that the Gulf actually increases it supply to the region as well as lowering prices, the price leadership model (constrained or not) fails to explain the behavior, and we must search for other models, perhaps more oligopolistic in nature. But even this counterfactual would be hard to test in practice as demand is rapidly increasing in the region (case 3d). This effect (rising prices and rising Gulf oil) would mask any effects one way or the other that may be due to new Russian oil.

5. Conclusions: Lessons and Limitations

If one believes the traditional price leadership model is appropriate, and that local capacity is unconstrained, then we can unequivocally say that any of the above mentioned scenarios—decreased marginal costs, deregulation which may allow more purchasing from non-Gulf states, or increased local capacity—would result in, *ceteris paribus*, a lower premium and lower Gulf dependency in East Asia.

However, if local supply is constrained, deregulation and/or lower marginal costs without meaningful increases locally may only mean higher profits for the local oil industry, but little or no change in the premium or dependency as the price leadership game remains unchanged.

Furthermore, if we believe that a different oligopolistic 'game' is being played, the results are far more ambiguous. There is no way to know *a priori* (barring strict and arbitrary assumptions) how the Gulf states, with their massive reserves, (or the Asian suppliers for that matter) will react. It is simply impossible to tell whether they will 'accommodate' with more oil at lower prices, be 'defensive' and reduce production and raise prices, etc. More empirical work on this question needs to be done. Thus, while under most scenarios it seems likely, it is too bold to assert that a "lower dependency (unequivocally) implies a lower premium" (or vice versa).

Also, while the reality of limited local alternatives (resulting in the dominant Gulf market share) seems the most plausible rationale, regulatory explanations cannot be entirely ruled out either. And the reasons need not be exclusive of one another. While the effects of deregulation in a constrained price leadership model on the premium may be negligible, it would be dangerous to dismiss the possible benefits in this less than laissez-faire industry. Also, it is clear that the price leadership model is not well-suited to capture efficiency gains likely to occur and indeed that have been occurring, both in the short run and the more dynamic long run. With the large role that regulatory bodies still play in Chinese, South Korean, Taiwanese, and Japanese oil markets, we feel that the premium may very well fall as these countries continue to deregulate. In our opinion, it is dangerous to rely only on one explanation for the premium and discount the others. The efficiency losses of excessive regulation may be large.

While Japan and China seem eager to secure new oil sources from Russia, and deregulation is moving forward throughout the region, the drop in the premium (if any) may be short-lived. The unconstrained case (i.e., if Asia finds substantial new oil

resources such that the constraint is no longer binding) is exceedingly unlikely in the near or even distant future. According to Jaffe and Manning (2000), new Central Asian oil will only account for 3-4% of the world's oil supply, and thus not be the 'bonanza' which will release Asia (or other countries) from their 'dependence' on Gulf oil. According to their predictions, Asia will continue to import more than 90% of their oil from the Persian Gulf by 2010.

With 2/3 of the world's proven reserves, the Gulf states can continue to be the relatively unconstrained swing seller and price discriminate in a market where demand outstrips local supply. Thus, to sustain a lower or non-existent Asian premium far into the future, further deregulation will play a role, but ultimately huge reserves must be brought on line which can reach Asia and act as a counterweight to Gulf states' market segmenting ability—a possibility which appears unlikely at this point.

The future for Asian oil prices overall may not be so bleak, however. While the premium (Asian vs. European and/or American oil) may persist, overall world oil prices may continue to fall in the foreseeable future. And with the price of oil falling from $23 to $8 in 1999, primarily due to politics rather than geology (Jaffe and Manning, 2000), fluctuations in the $2 premium may seem trivial.

References

Alhajji, A.F. and D. Huettner, 2000, OPEC and World Crude Oil Markets from 1973 to 1994: Cartel, Oligopoly, or Competitive?, The Energy Journal, 21(3), 31-60.

BP Statistical Review of World Energy, 2003.

de Vreiji, H., Russia Sidesteps Arab Oil, Oil and Gas Journal (on-line), July 18, 2003.

Fellner, W. 1965, Competition among the Few: Oligopoly and Similar Market Structures, (Reprint), (Augustus M. Kelley, New York.)

Griffin, J., 1985, OPEC Behavior: A Test of Alternative Hypotheses, American Economic Review, 75(5), 954-963.

Griffin, J. and W. Nielsen, 1994, The 1985-86 Oil Price Collapse and Afterwards: What does Game Theory Add?, Economic Inquiry, 17, 543-561.

Griffin, J. M. and H. Steele, 1986, Energy Economics and Policy, Second Edition (Academic Press, Orlando).

Harris, Richard, 1985, Why Voluntary Export Restraints are 'Voluntary,' Canadian Journal of Economics, 18(4), 799-809.

Horsnell, P., 1997, Oil in Asia: Markets, Trading, Refining, and Deregulation (Oxford University Press, Oxford).

Itoh, M. and Ono, Y., 1982, Tariffs, Quotas, and Market Structure, Quarterly Journal of Economics, 97(2), 295-305.

Jaffe, A. M. and R. A. Manning, 2000, The Shocks of a World of Cheap Oil, Foreign Affairs, 79(1), 16-29.

Krishna, Kala, 1989, Trade Restrictions as Facilitating Practices, Journal of International Economics, 26, 251-270.

Kyodo News Service, Tokyo, Japan, July 11, 2003.

Loderer, C., 1985, A Test of the OPEC Cartel Hypothesis: 1974-1983, Journal of Finance, 6(3), 991-1009.

Nagaoka, S. and F. Kimura, 1999, The Competitive Impact of International Trade: The Case of Import Liberalization of the Japanese Oil Product Market, Journal of the Japanese and International Economies, 13, 397-423.

Ogawa, Y., 2003, Proposals on Measures for Reducing Asian Premium of Crude Oil, The Institute of Energy Economics, Japan.

Shy, O., 1995, Industrial Organization: Theory and Applications (MIT Press, Cambridge).

Singh, N. and X. Vives, 1984, Price and Quantity Competition in a Differentiated Duopoly, Rand Journal of Economics, 15(4), 546-554..

Soligo, R. and A. M. Jaffe, 2000, A Note on Saudi Arabian Price Discrimination, The Energy Journal 21(1), 121-133.

Subrahmaniyan, Nesa, Saudis Eye Asian Price War with Russia, Bloomberg online feed, circa April 2004.

Varian, H. R., 1992, Microeconomic Analysis, 3rd edition (W. W. Norton and Company, New York).

Varian, H. R., 1996, Intermediate Microeconomics: A Modern Approach, 4th edition, (W.W. Norton and Company, New York.)

Table 1. Eastern Premium

Price differentials for Arab Light Crude (FOB)

	Asia - E.U.	Asia - U.S.
Average	$/bbl	$/bbl
1993	1.06	0.55
1994	1.03	1.07
1995	1.09	1.04
1996	0.52	0.52
1997	1.74	1.57
1998	1.03	1.04
1999	0.89	1.20
2000	0.88	0.44
2001	0.97	2.73
2002	1.73	1.55
1993-2002	**1.09**	**1.17**

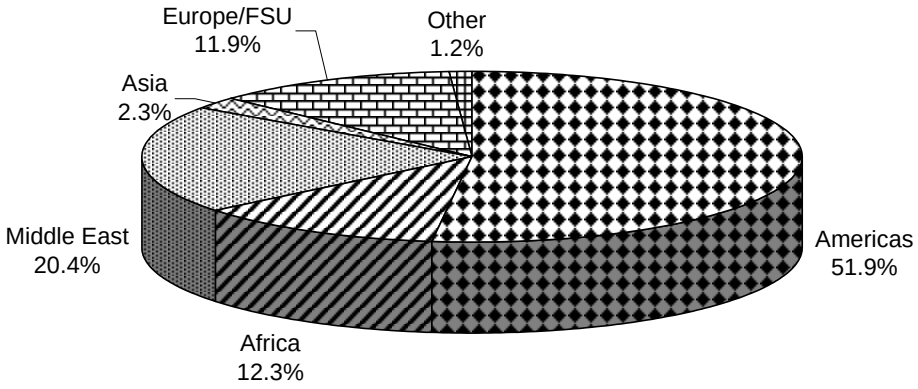
FACTS Inc. calculations

Table 2: Effects under Price Leadership Model (3 initial settings)

Initial Setting	Price	Q_{Gulf}	Q_{Asian}	Q_{Total}	Dependency
1. No constraint, with red tape					
Remove "red tape"; shift follower's supply	↓	↓	↑	↑	↓
2. Constraint (just binding) with red tape					
a. Remove "red tape"; shift follower's supply	Δ=0	Δ=0	Δ=0	Δ=0	Δ=0
b. Eliminate constraint	↑	↑	↑	↑	↓
3. Constraint (severe)					
a. Remove "red tape"; shift follower's supply	Δ=0	Δ=0	Δ=0	Δ=0	Δ=0
b. Relax constraint to "just binding"	↓	↓	↑	↑	↓
c. Eliminate constraint	↓	↓	↑	↑	↓
d. Increase in demand	↑	↑	Δ=0	↑	↑

Based upon assumptions in section 4 and Figure 3.

Figure 1A. Source of Crude Imports - U.S.



BP Statistical Review of World Energy 2003

Figure 1B. Source of Crude Imports - Europe

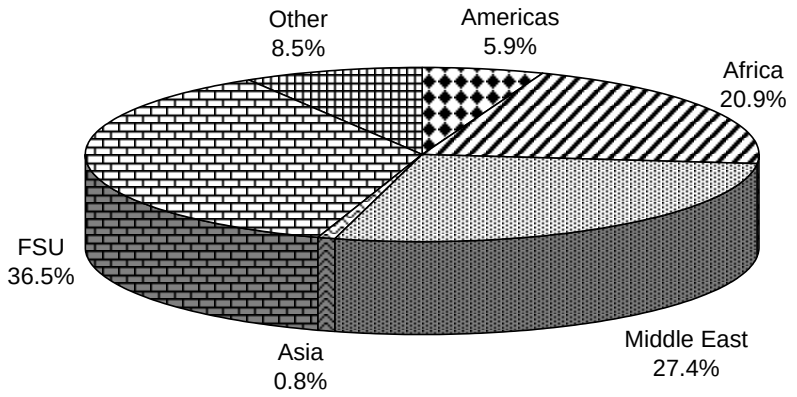


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Figure 1C. Source of Crude Imports - Asia

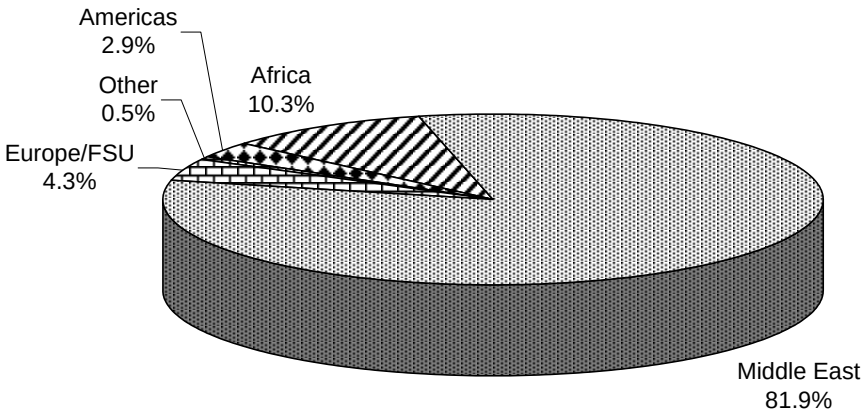

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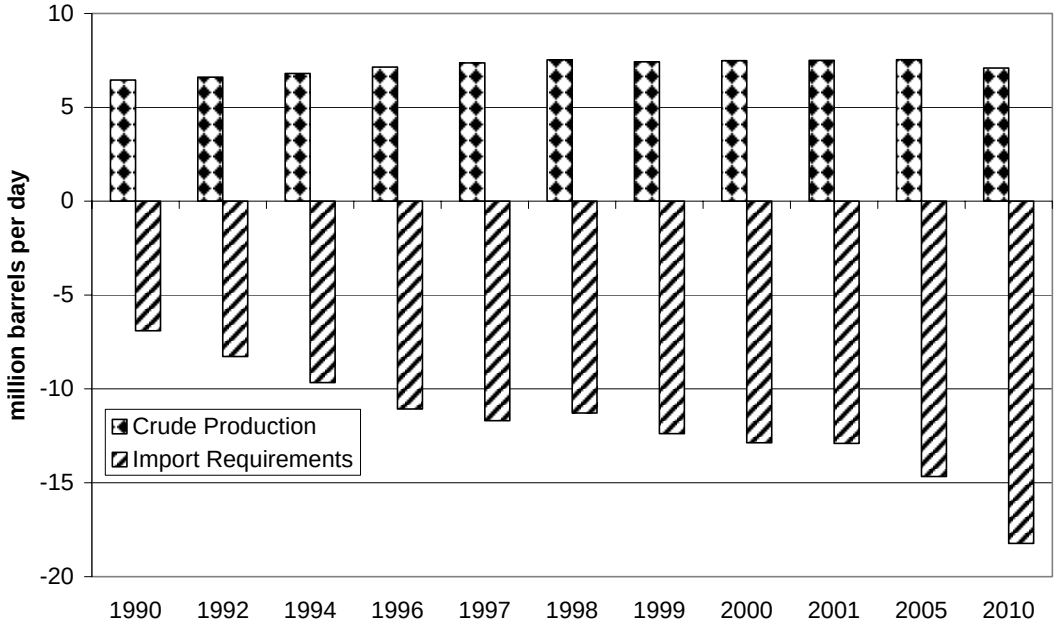
Figure 2. Historical and Projected Asia-Pacific Crude Production and Net Import Requirements (negative numbers denote imports), 1990-2010



East-West Center Projections

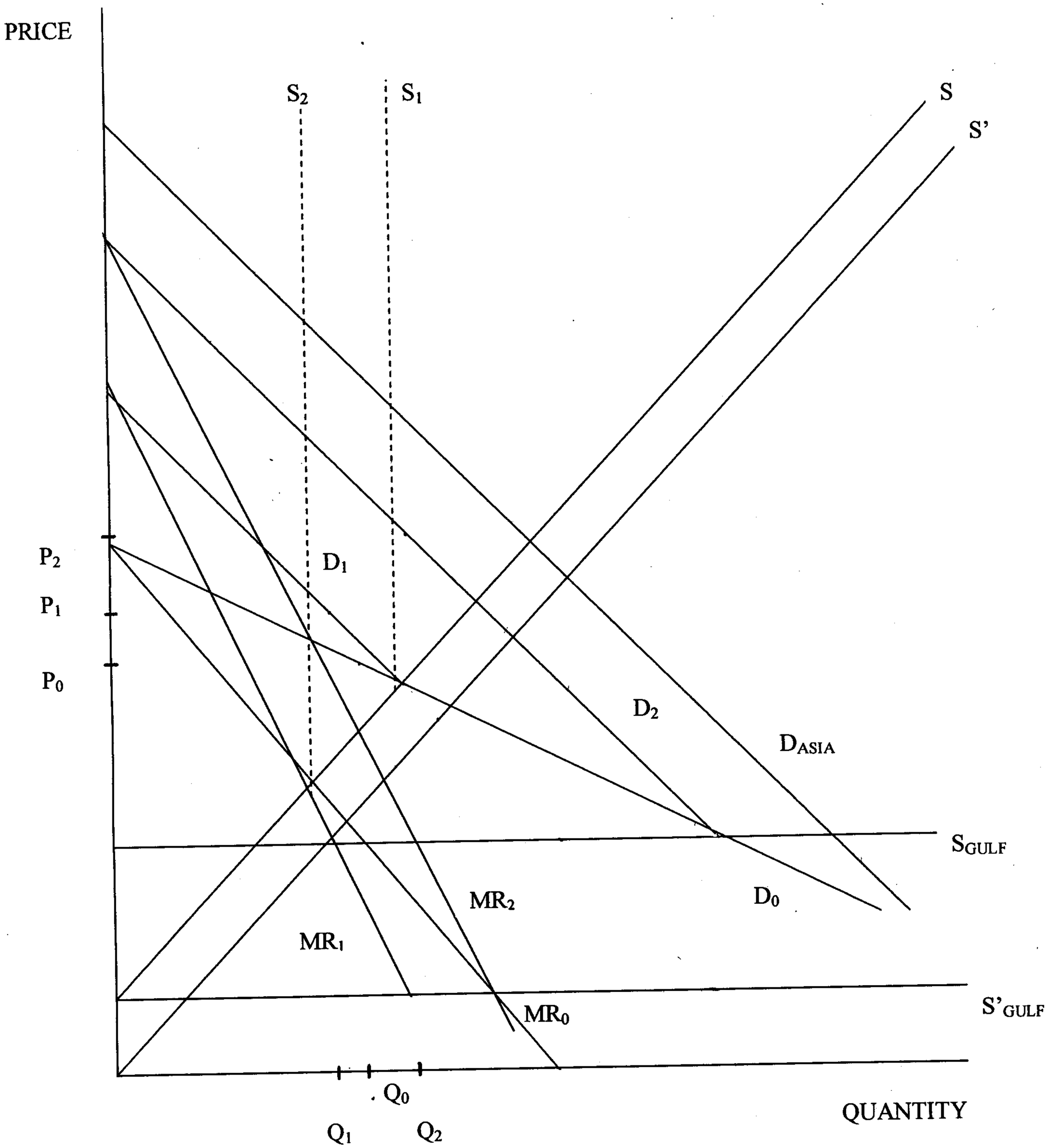


Figure 3: Price Leadership with Constraints and /or 'Red Tape'