MULTINATIONAL OLIGOPOLY IN POOR COUNTRIES:

HOW EAST AFRICA GOT ITS PETROLEUM REFINERIES*

by

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ABSTRACT

We claim here that the major institutional features of direct foreign
investment (i.e., that large multinational firms operate in "imperfect" mar-
kets) have implications for the nature and conditions under which direct
investments are made and lead to a suggested methodology for studying specific
cases. Some of these implications for import-substitutiong manufacturing
investments in poor countries are briefly described, followed by a demonstra-
tion that this approach facilitates explanation of direct foreign investment
behavior in one sample industry, petroleum refining, and, in particular,
explains oil refinery investments in East Africa. Finally, the inefficiency
of LDC policies to use foreign investment to obtain oil refinery investments
in the 1960s is discussed in the light of realistic alternatives, again
using the East African refineries as cases in point.

RÉSUMÉ

Notre propos dans ce livre est de montrer que le cadre institutionnel
des invéstissements directs à l'étranger (c'est-a-dire le fait que les grandes
entreprises multinationales éfféctuent leurs operations dans des marchés
"imparfaits") influence la nature et les conditions dans lesquelles sont
réalisés ces invéstissements. Cette constatation nous amène à suggérer une
méthodologie pour l'étude de cas particuliers. Puis nous discutons l'influence
de ce cadre institutionnel sur les invéstissements industriels dans les pays
pauvres (ces invéstissements substituant une production nationale à des
importations) et la démonstration est donnée que cette approche facilite
l'éxplication du phénomène des investissements étrangers dans une industrie
en particulier, le raffinage du pétrole en Afrique orientale. Enfin
à la lumière de politiques altérnatives réalistes, nous étudions l'innéficacité
des politiques des pays en voie de développement quant à l'utilisation des in-
véstissements étrangers pour le développement de raffineries de pétrole de
1960 a 70 en nous basant, de nouveau, sur l'éxemple de l'Afrique orientale.

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How should one study direct foreign investment behavior in poor
countries? Can one be guided by research prescriptions following from
neoclassical price theory; e.g., determine what behavior maximized present value
and check if data are consistent with this behavior? As students of actual
industry behavior can attest, this guide is of rather limited practical use; e.g.,

> Maximum present value is not a number to be read from a price-
> cost table; it is the evaluation of an uncertain future and
> reasonable men will differ on what strategy will best pro-
> mote it (Adelman 1970, p. 140).

In short, the theory need not be determinant, especially when the poli-
tical and economic environment places relatively few restraints on a firm's
potential activities.

On the other hand, one may take an approach to analysis that makes explicit
use of the major institutional features of direct investment: the investing firms
are usually multinational, often vertically-integrated giants (Vernon 1971,
chapter 1) which habitually operate in "imperfect" markets (Hymer 1970). Indeed,
these factors have certain implications for the nature and conditions under
which direct investments will be made and for an approach to studying specific
industry cases.[1] The purpose of this paper is first to describe briefly some
of these implications for manufacturing investments made in poor countries to
supply the local markets and then to demonstrate these implications by an
analysis of foreign oil refining investment, in particular, in the East African
countries of Kenya and Tanzania. Finally, the desirability of these investments
from the host-country viewpoints, in contrast to realistic alternatives, will be
discussed.

I. Theoretical Perspective

The *multinational* aspect of the foreign investing firms implies, by definition,
that they will be operating in a number of markets, while the size of the firms
contrasted with the size of typical underdeveloped-country markets suggests
that at least the LDC markets will be oligopolistic in structure. If one now
grants that the political-economic structures of underdeveloped countries are
reasonably similar and that LDCs are reasonably aware of each other, then one
may conclude that general forces acting to change the status quo in one of
these markets are also likely to be active, with whatever lag, in the other
markets as well. The point here is simply that if such forces create a problem
for the multinational firm in one market, they are also likely to create
similar problems in other markets.

A solution tried by a firm in the first instance, if "successful", is likely
to be used again as subsequent instances of the problem arise. Solutions which
do not "work" may be dropped (how fast depending on the firm's "learning"

abilities). In any event, after a number of instances one may expect the firms to evolve a set of policies for handling these problems, the set being applied almost routinely as new instances of the problems arise in new areas (or are predicted to arise soon). The policies themselves may cover a broad range of issues from, say, the variety of products or the extent of value added in any contemplated local manufacturing facility to, say, the conditions under which joint ventures with local partners will be acceptable to, say, the propriety of bribing public officials, and so on.

This discussion suggests that one should be able to observe patterns of investing behavior by the multinationals from which one could infer their investment policies and perhaps predict their actions in future situations of the same sort. One should not expect every firm to have a completely ideosyncratic set of policies. Indeed, the nature of the situations themselves will partly determine the policies so that different firms which are, say, established marketers of a certain product in certain LDCs may have a similar set of policies for handling the threat of a new entrant. Similarly, different firms in the role of new entrant may have similar policies in their target markets if the easiest means of entry is the same in each.

II. International Oil Industry Strategies for Refinery Investment

The refinery investment behavior of the international oil industry since the Second World War illustrates the preceding argument.[2] Since the war there has been a marked shift in the distribution of oil refining capacity from the older export locations near large crude oil sources (e.g., the Middle East and the Caribbean) to import-substituting, market locations. Thus, for example, by 1955, 85% of Europe's oil imports came as crude oil to be refined locally, compared to only 25% in 1938 (Frankel and Newton 1959, p. 87). Although some of this crude was processed in refineries large enough to capture essentially all the substantial economies of scale, i.e., in the range of 100,000 barrels per day (b/d), much crude was also processed in higher cost, small refineries in the range of 20,000 to 40,000 b/d (*ibid.*, p. 89). The same phenomenon could be observed outside Europe, except that local-market size rarely warranted large refineries. By the mid-1950s both India and Cuba had three refineries each. By the mid-1960s there were refineries in various Central American and African countries. By 1969, 22 African countries refined oil, almost all of it imported.[3]

Looking closer at the host of refinery investments, one would begin to see certain regularities, e.g., leading one to divide the investments into two groups. The first would be those built by the "majors", i.e., the seven giants that had dominated the industry in the inter-war period (Royal Dutch/Shell, British Petroleum (BP), Standard Oil of New Jersey (Exxon), Standard Oil of California (Chevron), Texaco, Gulf and Mobil). The second group would be those refineries built by a burgeoning group of new entrants to the international industry since the war, known in the trade as the "newcomers."[4]

The refineries built by the newcomers were generally among the smaller ones and generally were located in oil-importing countries which protected local refining industries. Further investigation of the conditions surrounding these investments would suggest that they were often used as parts of marketing strategies, e.g., as "entry tickets" to break into markets long dominated by the majors.[5]

The majors, on the other hand, expanded their old export refineries, built large European ones for regional distribution and also built small, import-substituting refineries in protected markets. The implied strategy here appeared to consist of policies to supply their product markets at as low a cost to themselves as possible (consistent with the need for some risk-reducing dispersal of refining facilities) and policies to build small, local refineries whenever not doing so would cause loss of a market. Up through the mid-1950s this meant building a number of small, competing, inefficient refineries in the larger of the small markets. However, the majors were not insensitive to scale economies and, presumably, to the potential for market control from refining together in the smaller, protected markets. Thus, by the late 1950s they apparently had adopted policies for joint ownership of small refineries. Such policies were implicit, for example, in Turkey where Mobil, Caltex (a joint venture of Chevron and Texaco), Shell and BP together built a refinery.[6] Similar joint ventures were also to be the case in Kenya, in Senegal, in the Ivory Coast, and so on.

Focusing exclusively now on the small, oil-importing LDCs, one may construct what appears to be a typical scenario. It begins with one or more of the majors importing and marketing petroleum products. One then observes a rising national concern over the security of energy supplies, the foreign-exchange cost of oil products and the need for local industry. All of these lead to political interest in a local oil refinery. Although the extra cost of local refining can be passed on to consumers, the majors would rather not bother with building such small refineries, although, if pressure is exerted, they would build them as they did in France after 1928.

On the other hand, pressure is not really needed in many cases as there are now various newcomers afoot, willing to build local refineries as market "entry tickets." In other words, due to scale economies, it is virtually necessary for a single, small LDC oil refinery to produce almost all the oil products sold locally. A newcomer that succeeds in building the refinery not only gains the friendship of the host government, but all the present marketers are then forced to bring their crude oil to the newcomer's refinery for processing as a condition for staying in the market. It obviously becomes necessary for the established marketers to adopt cordial relations with the refiner, e.g., to cede him a share of the market.

One newcomer in particular developed this strategy to a high art, using it successfully all over Africa (i.e., in Morocco, Tunisia, Ghana, Zäire, Tanzania and Zambia). This firm, actually an agency of the Italian Government, was the Ente Nazionale Idrocarburi (ENI), marketing as Agip, under the colorful direction of Enrico Mattei.

Mattei made ENI into a multinational oil company in order to obtain countervailing power against the majors at home. The majors could have been forced to leave Italy after the war, but there was no other source besides the majors that could completely satisfy Italy's need for imported petroleum fuels.[7] A multinational ENI would not only raise the national spirits of post-fascist Italy and earn foreign exchange, but it would also force discounts from the majors on oil for Italy. In the meantime, ENI would also prospect overseas for its own oil.[8]

In its battle for a share of LDC oil products markets, ENI turned to advantage the fact that it was engaged in a struggle against the giant oil "cartel" and that, as a state agency itself, it was not opposed to forming joint refining ventures with host country governments, something the majors were then refusing to do.[9] In addition, making a virtue out of a necessity (i.e., having no crude of its own to sell), Mattei's Third World refineries would not be constrained to use the refinery-owner's crude, as was the case with refineries built by the majors. In those days when, as a popular industry maxim put it, only fools and affiliates (of the majors) paid posted (list) prices, this was potentially important.[10]

Thus, LDCs might get a better deal than they could from the majors in terms of the price of imported crude oil and in terms of refinery ownership, while ENI would get a market for Agip products, a protected refinery which the host government would have an interest in seeing make a profit and, not inconsequentially, a contract for ENI's refinery construction subsidiary, SNAM Progetti. In some cases ENI also obtained local concessions to hunt for crude oil.

Thus, for example, in Tunisia in 1960, Mattei beat out Exxon, Shell, Mobil, BP and a Belgian firm, Petrofina, which were competing with ENI for the right to build the one refinery. There Mattei won a refinery, a new marketing network and an oil-exploration concession until then reserved for Mobil.[11]

The ENI appeal may be seen from a speech Mattei gave when agreement was announced in Tunis:

> ENI does not operate according to the obsolete pattern of
> 19th century colonialist capitalism, but looks toward financial
> coparticipation and joint technical and commercial management
> in terms of perfect equality....We have not offered Tunis a
> foreign refinery on its native soil, but a pole of economic
> development...against economic Malthusianism and the choking
> regime created by the interests of monopolies and political
> oligarchies.[12]

In sum, it has been suggested here that perusal of a catalogue of international refinery investments since the war, especially in the Third World, would reveal patterns of investment behavior which could be explained by imputing investment strategies to the firms involved.[13] In this regard, we have claimed that ENI's refining investments may be interpreted in terms of a market-entry strategy and that the majors' investments (individually and collectively) may be interpreted in terms of a market-defense strategy. If this analysis is useful, it should help one to explain how specific investments were made. We thus consider East Africa which hosted two refineries in the 1960s, one, outside Mombasa, Kenya, opened in December 1963 and the other, outside Dar es Salaam, Tanzania, opened in June 1966.

III. The Attraction of the East African Market

In the late 1950s and early 1960s, the oil products market of the common market territories comprising British East Africa (Kenya, Uganda and Tanzania) was small and growing slowly. In 1958, total sales in the three territories were at the rate of only 22,500 b/d while by 1964 they had risen to only

29,500 b/d. Over this period sales grew by 4.5% in Kenya, 4.0% in Uganda and 5.6% in Tanzania.[14] In contrast, total world sales over the same period grew by 7.4%; Western European sales grew by 14.2%.[15] Nevertheless, this was a market in which the majors had been selling for a long time, in which new firms were beginning to market, and in which two refineries would soon be built as parts of market-oriented strategies.

That such interest was being expressed in a small, relatively undynamic market suggests that profits per barrel of products sold must have been very high or that market growth prospects were seen as very favorable. The former seemed especially to have been the case.

To see the source of the profits one needs to look at the source of East Africa's oil products. Thus, let us first consider Shell and BP or, more properly from 1928, the two acting together in this region through their joint marketing subsidiary, Consolidated Petroleum. We find BP in possession of large crude oil supplies and an efficient and very large refinery in southern Iran. Ships loaded with oil products regularly leave Abadan, Iran, travel out of the Persian Gulf, around Saudi Arabia, through the Suez Canal and on to Europe. Occasionally, instead of turning north at the Red Sea, one of the ships continues south along the eastern coast of Africa, delivering relatively small amounts of oil products at each stop along the way. Two of these stops are Mombasa, Kenya and Dar es Salaam, Tanganyika.

Similarly, consider Exxon and Mobil, or more properly until 1961, the two acting together east of Suez as Stanvac.[16] As early as 1929 they had six tanks in Mombasa harbor with a capacity of 3 million imperial gallons. By 1962 they would have 16 tanks with 14 million gallons capacity and would be assembling three others to add over 2 million gallons more. Their ships also come from the Middle East, from Saudi Arabia (although after 1954 they also owned a share of the Iranian oil). Their ships also stopped at a number of ports along the route in addition to Mombasa, e.g., at Dar es Salaam (from 1951), Mauritius (1957), Zanzibar (1957) and Madagascar (1959).[17]

Finally, there was Chevron and Texaco, or rather their joint venture, Caltex. They also had crude oil in the Middle East (and after 1954 owned part of the Iranian oil). They too marketed in East Africa and also held the large fuel supply contract with the East African railroads, newly converted to oil in the early 1950s.[18]

For all intents and purposes, these six major oil companies, operating through three subsidiaries, were the suppliers of oil products to East Africa in the 1950s. Consequently, as one industry insider put it,

> ...there was no competition at all except for that between the few established major oil companies and this, commerce being what it is, resulted in the maintenance of price levels and profit margins which were considerably higher than they were elsewhere -- even after allowing for the substantial cost of transport and handling incurred, coupled with the comparatively small turnover. It was said, not without some justification, that the poorer a country was, the higher were the prices it paid for its oil (Frankel 1966, p. 124).[19]

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Unfortunately, it has not appeared possible, with publicly available data at least, to estimate the actual profitability of oil product sales to East Africa. However, one can estimate profits of producing and refining oil in the Middle East based on average revenues per barrel, f.o.b. the Persian Gulf. This could serve as a lower-bound estimate of profits per barrel on output destined for "captive" markets such as East Africa; i.e., it would exclude profits on shipping and marketing.[20]

Table 1 presents an estimate of this lower bound for 1960 and Iranian oil. However, this estimate is a lower bound on the lower bound since in constructing the estimate it became necessary to assume that no profits were earned on refinery operations per se. In other words, it was assumed that the "gross refiner's margin" (i.e., the difference between the revenue earned from the products produced from a barrel of crude oil input and the price of that crude oil input) was composed entirely of costs and taxes. Ninety cents per barrel seems greatly in excess of actual refinery costs per barrel (including a cost of capital reflecting risk) and probably much in excess of refining costs plus refinery taxes to Iran.[21] In other words, the calculated gross refiner's margin undoubtably includes some profits.[22]

In any event, our lower-lower bound estimate is that, on a per-barrel basis, profits were very high indeed; i.e., they raised prices more than 35% over costs, including in the latter an allowance for risk which set the cost of capital at 20%. In other words, if the estimated profit per barrel in Table 1 had been zero, the producers of Iranian oil would have still been making a 20% return on their investment. As it turned out, our estimate is that they were making at least an extra $.69 per barrel on average which, for example, cost East Africa roughly $6.5 million at least in excess profits transfers to the oil companies in 1960 based on consumption volume.[23]

If the estimate here is that average profits had been high for oil companies selling to East Africa, it also seems likely that other oil firms with Middle Eastern crude oil should have expected high incremental profits from entering the East African market.[24] Indeed, we already found that six of the majors were selling oil to East Africa. In addition, it is no wonder that the large French firm, Compagnie Francaise des Petroles (CFP), with a share in Iraqi oil since the 1920s and a share in Iran since 1954, now would bring its "Total" brand to East Africa. It is also no wonder that soon after Stanvac was dissolved, with Exxon acquiring the Stanvac assets in East Africa, Mobil re-entered the market on its own in 1962-63, building terminals, depots and a chain of service stations.[25] Finally, it is no wonder that ENI too appeared in East Africa in 1960, establishing a subsidiary in Kenya to market Agip brand gasoline and fertilizers (Dechert 1963, p. 53).

In sum, although the East African market in the late 1950s and early 1960s was "thin" and growing slowly, there were substantial profits to be made from selling there. With increased competitive activity generally in the international industry in the 1950s, new marketers were eventually attracted to East Africa. By the mid-1960s, sales began growing faster than earlier, but marketers apparently expanded even faster. Thus, for example, in 1968 oil executives were heard to "complain that the market is overcrowded and that too many companies are chasing too small a market. The result, they say, is that they are all carrying excessive overheads on too small a base" (National Christian Council of Kenya 1968, p. 83).[26]

TABLE 1 --Profitability of Iranian oil products, 1960

	$/bbl
1. Revenue from sale of products obtained from a barrel of crude oil, f.o.b.	2.57
2. -gross refiner's margin	-.91
3. Price of barrel of crude, f.o.b.	1.66
4. -tax paid to Iran	-.80
5. -estimated operating cost (including pipe lines, etc.)	-.90
6. -estimated development cost (cost of capital at 20% per year)	-.08
7. Revenue/bbl in excess of average cost	.69

Sources: Lines 1 and 3 are from estimates by C. A. Heller, "Economics of Refining," in United Nations, Techniques of Petroleum Development, Proceedings of the U.N. Inter-regional Seminar on Techniques of Petroleum Development, 1962, (New York: United Nations, 1964), p. 201. Heller's values per ton were converted to volume equivalents using the conversion factor for Iranian crudes in Statistics Division, Petroleum Information Service, Glossary of Terms Used in Petroleum Industry and Conversion Tables, 2nd ed., (New Delhi: Petroleum Information Service, 1964), p. 138.

Line 4 is reported in M. A. Adelman, The World Petroleum Market, (Baltimore: Johns Hopkins University Press, 1972), p. 208.

Line 5 is a backcast to 1960 of the operating cost data for 1962-69 reported in Adelman, op. cit., p. 289 for the Iranian Consortium. The regression equation was log (cost/bbl) = 59.54 - .0299 (year) with R^2 = .86 (t = 8.52).

Line 6 is based on the methodology detailed in Adelman, op. cit., pp. 47-77. Within this context, I used Adelman's estimate of investment per initial daily barrel for the four largest Middle East producers (Iran Consortium, Iraq, Kuwait, Saudi Arabia) for 1959-60 of $154 (p. 63). This was converted to development cost per barrel using a "present barrel equivalent" (PBE) factor calculated as a weighted average of the factors Adelman used for the main components of capital cost (exploration and drilling, leasing equipment and pipe line-terminal costs), the weights being the proportion of investment per initial daily barrel in each component as given in Adelman's analysis (p. 320). The resultant PBE factor was 5.24. This factor incorporates the assumption of a 20% cost of capital (reflecting risk) plus a 1% rate of production decline for crude oil-related costs. The reason for not using Adelman's development cost estimates directly was that they were an average for 1963-69, a period of significantly declining costs in this area (e.g., see the discussion in Adelman, pp. 62-63). His estimate for development cost per barrel was $.047 which may be compared to my estimate with his data of $.081 for 1960.

The latter, of course, pertains to costs and profits from distribution activities. However, the continued and expanding presence of these marketers through the 1960s suggests that overall profits were still substantial or that expectations were high. In any event, to the firms involved, East Africa was apparently a good market to have a share in.

IV. How Kenya Got a Refinery

If the majors felt in the late 1950s that East Africa was a good market in which to sell, it was also one whose control they could lose. If the market remained open to all importers, newcomers might enter and underprice them. Or, some newcomer might answer to nationalist aspirations in any of the three countries, build a local refinery and perhaps thereby wrest control from them. As noted above, ENI's actual marketing entrance to East Africa would not be until 1960, but the handwriting was on the wall earlier; e.g., in 1958 ENI representatives had come to Kenya to make a "preliminary survey of market possibilities."[27]

In sum, East Africa appeared to promise a situation quite similar to what the majors had already faced in Europe and elsewhere. It would thus be an appropriate situation in which to apply the import-substitution policies of their refinery investment strategies, including trying to include their major "competitors" as partners. Indeed, from the viewpoint of the oil companies, by this time decisions to build such import-substitution refineries may have become almost routine.[28]

The benefits to the majors from applying their joint-venturing policies, in particular, were clear. First, given the economies of scale in refining it was desirable that the one refinery supply as large a market area as possible. Thus, it was desirable that the East African market area be defined to include, not only Kenya, Uganda and Tanzania, but also, at least temporarily, exports to other places within the region such as Rwanda, Burundi, western Zäire, Madasgascar, etc. If the prospective refinery supplied products to the major East African marketers, it would also thereby supply them to these other areas since these firms were also represented in the other markets. In the longer run, these exports might end as the principle of import-substitution refining spread to these other places, but by then demand in East Africa proper would have increased enough to maintain the refinery at full capacity.[29]

However, even more desirable than exports to peripheral markets was that all marketers in East Africa be required to refine at the one local refinery. Having them all be partners was one way to discourage them from establishing competing, excess refining capacity. On the other hand, too much should not be made of the scale economy savings from the size of the market served from one refinery. "Clubbing together" was a way to reduce costs in a given market area. However, as one executive said in an interview, the size of a national market is almost irrelevant in determining whether or not a refinery will be built there. If the host government wants a local refinery and if the country's development prospects are reasonable, then someone will build it, either to preserve his market position in the country or as an entry ticket to the market.

The second major benefit from a joint refinery was its potential for
being a market control mechanism. Indeed, something of this sort seems
indicated by a stipulation in the agreement made in 1959 between Consolidated
Petroleum (Shell/BP) and the Government of Kenya Colony in which exclusive
refinery construction rights were granted to Consolidated. The agreement
stipulated that processing rights be guaranteed to all "established
marketers" (and not necessarily to others), whether or not owning equity in
the refinery.[30] The approved list would consist of Shell/BP, Exxon, Mobil,
Caltex and CFP.[31]

As one industry executive put it in an interview, the purpose of the
restriction was to keep out "fly-by-night" operators, not "real" companies. This
could be interpreted as an attempt to prevent market disruption from foreign
"dumping" of excess oil on the East African market at "fire-sale" prices. On
the other hand, given that an actual arm's-length market in crude oil was
developing at this time as newcomers and majors sold crude to new independent
refining companies, one may make a less sanguine reading of the executive's
comment. Rather than fear dumping, perhaps the majors feared more competitively
priced oil would enter the region. East Africa was in possession of a significant
group of resident entrepreneurs, some having built substantial commercial,
agricultural and industrial empires. With cheaper crude oil available on the
world market and a refinery in Mombasa required to refine oil for all comers,
the temptation to enter the local market might have been substantial.

Indeed, it is not necessary to state the argument quite so hypothetically.
For example, one may note the formation of a new oil products distributor in
Kenya in 1959, the Kenya Oil Co., Ltd., registered in the names of two
Kenyan Europeans.[32] Also, as has already been noted, ENI had come to East
Africa in 1960 and was thus not an established marketer in 1959. In 1961,

> BP and Shell refused [to agree] to refine ENI crude at their
> Mombasa refinery [which was not yet in operation] and ENI was
> refused permission either to refine or to import refinery
> products. The Italian Ministry of Foreign Affairs charged that
> a discriminatory attitude had been shown.[33]

Nevertheless, by the time the Mombasa refinery came on stream in December 1963,
this problem had been resolved, perhaps because ENI had by then won the right
to establish Tanzania's refinery, thus obtaining some countervailing power
in the region, or perhaps as a result of a general truce that ENI and the
majors had recently worked out in Europe.

With respect to this issue of market control, it is also relevant to note
again that the East African situation was not different from that in other parts
of Africa and that the response planned by the majors elsewhere was also
correspondingly similar. Thus, they were not only planning to refine locally
in the east, but also in Nigeria, in Ghana, etc. Viewing the African refining
"problem" on a continent-wide level, it is easy to see how costs could be
reduced and mutuality of interest made more secure if the majors could
agree to divide up among themselves the responsibility for building and operating
the refineries in the various necessary locations. Indeed, one industry
executive has admitted that, since in most African countries only one
refinery would be allowed by the governments, the majors achieved an understanding

among themselves as to which of them it would be in each country; i.e., they
agreed which one would "lead" in refinery project proposals in different
countries (Shell in Kenya, BP in Nigeria, Stanvac in Ghana, etc). The
"leader" was supposed to win the right to build a refinery. It would then
be in a position to process the oil of the other majors in exchange for the
same privilege at their refineries in the other countries.[34]

In the East African case, there was even a clause in the original
agreement between Consolidated and Kenya Colony, inserted "by requirement of the
Kenya Government,"[35] that the refinery be open to equity participation by the
other "established marketers" in East Africa. This clause was certainly not
forced on Shell/BP as they preferred their competitors to be on the "inside", as I
was told, rather than risk having them possibly decide in the future to
build a competing refinery. Similarly, their major competitors also showed a
desire to be on the inside: for access to inside information (e.g., on competitors'
planned refinery runs), to get priority access to use of the refinery for
supplying their regional export markets, and for public relations reasons (i.e.,
in order to be able to say, "we are local, not foreign importers"). Thus, the
original two partners, Shell and BP, took on two others in 1964, Exxon and
Caltex. Management, however, was left to Shell.

In sum, the discussion thus far seems to indicate that in the Mombasa
refinery the majors clearly were using their joint-venture policy for small-
market refineries. By "clubbing" together in East Africa they reduced the
cost to themselves of import-substitution refining and established a mechanism
that could be used for allocating market shares. This allowed them to make
the most out of the need, which arose out of their market-defense strategies,
to build a local refinery.

That the market-defense strategies were themselves being used may be
further suggested by the majors' choice of a refinery location and their timing of
the investment. In terms of costs, a refinery for East Africa required a
coastal location nearest to the biggest market area. A coastal location was
needed because a significant part of the refinery output by weight would be
exported (principally, heavy bunker fuel which was largely returned to the
Persian Gulf, but also a general run of products exported to southern
Tanganyika, Zanzibar and other Indian Ocean islands). Thus, since the crude oil
itself would be imported, any inland location would have been very inefficient.
This meant locating the refinery in Mombasa, Kenya or in Tanga, in northern
Tanganyika, since Dar es Salaam, to the south, although itself a significant
market, was hundreds of miles from the large Kenya-Uganda-northern Tanganyika
market centers. Both Mombasa and Tanga were on a rail link to the market
centers of Arusha, Moshi, Nairobi, Kisumu, Jinja and Kampala. However,
perusal of a topographical map of East Africa, showing rail routes, would
indicate how inferior the Tanga location would be: to go from Tanga to Nairobi
one would have to climb the mountains to Moshi, return half-way to the coast
along the rail line to Mombasa, and then climb back up to Nairobi.

In addition, Mombasa would be a superior location to an oil refiner because,
being in Kenya, it was in the largest of the three East African territories. Thus,
if British East Africa, on gaining independence, decided to break up their common
market and erect trade barriers between themselves, the refiner would at least be in
the biggest piece of the market (also, land-locked Uganda, which was linked to the
sea by the rail line through Kenya, would likely continue as a customer).

But, Mombasa, being in Kenya, was in a very uncertain political environment in the late 1950s and early 1960s. Mau Mau had been put down by the British, but independence would come anyway. There was great uncertainty as to just what character the transition would take. In fear that non-Africans might be forced to leave in a hurry, the immigrant business community contracted activity to such an extent that from 1958 the economy stagnated and reported unemployment increased by nearly 50% over preceding years. Net European and Asian immigration ground to a halt and in 1961 became net emigration; and, there was capital flight (World Bank 1963, p. 43 and tables S.2, S.4, S.5 and S.8). From 1960 to 1963 the British prepared to grant independence to Kenya. Jomo Kenyatta was released from detention. African political parties were formed. The British press worried over the future of the European settlers who, for example, accounted for four-fifths of the exportable farm surplus in 1960.[36] They also worried about the ability of independent Kenyan Africans to maintain "law and order", let alone to achieve economic growth:

> The point about independence is that the majority of black
> Kenyans, relatively untouched by the European-built world,
> will now begin to suffer from a severe attack of rising expec-
> tations. Kenya's rulers will be hard put to keep their country
> from poverty, let alone to satisfy these demands.[37]

This, then, was the atmosphere (especially in 1962-63) in which Shell and BP built the Mombasa refinery. It would certainly appear that, had they felt themselves able to delay the actual commitment of funds for construction, they would have as did other foreign investors in Kenya at the time (Herman 1971, pp. 15-16 and table 6). As it was, the refinery came "on stream" in the same month that Kenya was granted independence, December 1963. That Shell and BP did not delay seems to indicate that these British firms did not share the concern of the rest of England over the investment climate or that, for competitive reasons, they felt the need to take the risk. The latter seems more likely.

V. How Tanzania Got a Refinery

Although the majors were able to build their Mombasa refinery without any apparent competition, quite a different situation arose two years later when the Tanzanian Government wanted a refinery built. On the side of the major marketers, Exxon, Shell and Caltex were reported in the press as "eager to get the contract,"[38] although one executive claimed in an interview that Caltex was slated to make the "leading" offer. Nevertheless, here Mattie's ENI provided stiff competition, including an offer of half ownership to the Tanzanian Government.

The strategies of ENI and the majors here seemed to be clear examples of their general strategies in such markets as discussed in Section II. If the majors won the agreement, they would have been in a position to maintain control of the market to be served by the Dar es Salaam refinery in the same way, discussed above, intended for the market served by the Mombasa refinery. If the majors lost it would signal the strong entry of ENI to Tanzania.

Indeed, after the agreement went to ENI, the majors expressed "considerable anxieties" that their marketing and distribution investments of $28 million would now be jeopardized.[39] However, ENI had obtained, not only an entry to Tanzania, but also, thereby, the likelihood of establishing cordial relations with the majors in Mombasa. It thus would not be frozen out of Kenya and Uganda due to inability to obtain or import oil products there as had been feared the year before.

In short, through its refinery, ENI successfully obtained a new market for its Agip products in East Africa. But, it also obtained a refinery construction contract and a new refinery to operate. With this to hold, ENI would now go on to expand its market share and to obtain additional large construction and operation contracts in the region. The latter may have fallen to ENI at least partly because, through the Dar refinery, it became a familiar name in the region and was linked with a government popular in African political circles.[40]

Thus, ENI found itself well placed when, after the disintegration of the Federation of Rhodesia and Nyasaland and the unilateral declaration of independence by Rhodesia, Zambia looked north to Tanzania for economic and political relations in the mid-1960s. The first result was a $47 million oil products pipeline, opened in 1968, stretching 1,060 miles from Dar es Salaam to N'dola in Zambia. Although the pipline is owned by the Tazama Pipeline Company, Ltd., a joint venture of the Tanzanian and Zambian Governments, it was build by ENI and is operated by them under a 15 year contract which began in July 1968.[41] In obtaining the pipeline contract, ENI beat out two competitors, a Japanese firm and a British firm with large interests in Rhodesia and Zambia (Lonrho).[42]

The pipeline transports products refined at Dar es Salaam, but in the 1970s it is to transport crude oil. This brings us to the second big project falling to ENI, a refinery at N'dola. In 1970 ENI signed a "$32 million contract to build a 22,000 b/d refinery, new product outlets and a motel in Zambia....British and French interests reportedly lost out in the competition for the refinery."[43]

Thus, ENI's construction business may have benefitted from the parent firm's success in obtaining the Dar refinery. So too did Agip, ENI's oil products marketing business. From no sales in Tanzania before 1961, Agip grew to 20% of the market by 1970.[44] This success may have been partly due to a public relations advantage in the private marketplace arising from partnership with the Government in refining. However, as important in a country with a large and rapidly-growing state sector, such as Tanzania, was Agip's ability to capitalize on its political relations with the Government.

This is well illustrated by more recent events in Tanzania. On March 4, 1970, the Government announced that it was acquiring a half-interest in two oil product distributors: Agip (Tanzania) Ltd., and Shell and BP Tanzania, Ltd.[45] In addition, the Government decided not to form partnerships with the other distributors thereby making them foreign competitors of a government corporation in an economy with much state buying and an atmosphere highly-charged with nationalism and anti-imperialism.

Now, although the Tanzania Government has strong ideological grounds for wanting to extend the public sector into oil distribution (as it has into wholesale and retail trade and rental housing), it was in fact not the originator of this joint marketing venture. Indeed, had the Government originated the idea, it probably would not have selected only two of the marketers for acquisition, nor would it have stopped at half ownership.

Also, Shell/BP was not the originator of the plan, although they would be a beneficiary of it, becoming one of the acquired firms. By the late 1960s, Shell was very willing to form joint ventures with host-country governments as the need arose, but it nevertheless preferred "solo" ventures when possible. As one executive put it, Shell's "practice in this had been pragmatic and we have

no inhibition in principle to undertaking such joint ventures" (Chandler 1971, p. 219). Thus, when the need arose in Tanzania, Shell had no policy inhibition to offering the Government a 50% share in its long-standing marketing venture, which in 1969 had a turnover of approximately $11.2 million, net of duty and sales taxes.[46]

The need arose in Tanzania because Agip had independently started negotiations with the Government to give it a 50% share in Agip's marketing business, as admitted by the General Manager of Agip (Tanzania) Ltd., C. E. Borrazzi.[47] However, this was not just a local subsidiary's response to unique Tanzanian conditions, but an instance of a general marketing strategy at Agip. As Giuseppe Bartolotta, Managing Director of Agip said when the final agreements were signed, Agip was aware

> ...that it is possible to operate in Africa only if the coun-
> tries concerned play an active part on the industrial and
> commercial side, which has so far been handled almost en-
> tirely by foreign interests.
> [Thus, Agip has a joint venture policy which] aims at
> *giving* the African countries, where it works, the option of
> partnership [emphasis added].[48]

Agip certainly had much to gain from instigating such an offer in Tanzania. Agip would know that Shell, on learning of the proposal and having no policy objection to joint ventures, would quickly see the importance of also offering a partnership to the Government. The others would be more reluctant and hesitate. It would thus only remain to convince the Tanzanians not to enter partnerships with the remaining distributors.

Interestingly enough, almost exactly the same pattern occurred about six months earlier in Zambia.

> In October 1969, the Zambian state-owned Industrial Develop-
> ment Corporation (INDECO) accepted an offer from Shell-BP and
> ENI oil marketing organizations to take up 51% of their
> shares respectively. Turnover of Shell-BP in Zambia is $27.6
> million per year, representing about half of the Zambian mar-
> ket. INDECO will not open further offers of similar share-
> holding in local oil companies (*World Petroleum Report* 1970,
> p. 100).

The net effect of these joint ventures in marketing appears to be to have tied up the markets supplied from the Dar es Salaam refinery. With ENI and the Governments of Tanzania and Zambia running the refineries and pipeline, and with Shell/BP, ENI and the Governments jointly dominating the marketing of oil products, control of the markets would seem assured. The long run position of the other oil companies would thus appear bleak here.

VI. An Evaluation of the East African Refinery Investments

It seems reasonable to conclude at this point that the East African refineries were built as instances of an oligopolistic "game", played for shares of oil products markets in Africa and elsewhere. In each case the game

was prompted and at least partly shaped by the actual or expected host-country government's interest in having a local, import-substituting oil refinery built. However, we should also ask whether there were "better" ways for these countries to obtain their refineries than through this oligopolistic game process. That is, whatever the level of net benefits actually received from the multinational company refineries, were realistic opportunities thereby foregone for higher benefits or lower costs? In short, how efficient were the East African decisions to develop domestic oil refining industries using multinational companies?

In beginning an answer, one may first note that the Mombasa refinery was originally built to serve the entire East African market (plus some peripheral areas such as the Seychelles, Rwanda, part of western Zaïre, etc). As a result it was large enough so that, as one executive interviewed noted, continued processing at the majors' large Persian Gulf refineries was "only marginally more attractive in terms of unit costs."[49] Thus, unlike many import-substitution investments, the Kenya refinery did not really need, nor did it get, special tariff protection. Domestically refined oil products paid the same excise tax as the tariff paid by imports (EACSO 1965, p. 39). Indeed, as Table 2 shows, ex-refinery prices in Mombasa (before excise taxes) exhibited a generally downward trend, as was the case also in the international market generally in the 1960s up to the Suez Canal closing in 1967 (Adelman 1972, chapter 6).

On the other hand, one may also ask whether prices could have been set even lower. That is, were more than "normal" profits being earned at the prices actually in effect? The answer is suggested by Table 3 which estimates what profits would be had the price and output patterns of 1965, 1966 or 1969 alternatively been typical of prices and outputs over the life of the refinery (20 years).[50]

The table shows the amount by which revenue per barrel exceeded cost per barrel assuming a cost of capital of 15%. Oil company executives had indicated in interviews that their minimum rate of return on LDC refineries, such as the one in Kenya, was between 10 and 15%. Thus, 15% was used for the calculation. Since the refinery was wholly financed by the parent firms with both equity contributions and intra-company loans, this 15% was taken as the rate of return to total investment, i.e., to equity plus debt. For reasons detailed in Appendix Section A.2, the rate of interest on debt was put at 9% per year. Since the refinery was financed with one-third equity and two-thirds debt, the 15% return to total investment implied a 27% return to the equity investment itself.

Granting this cost of capital, Table 3 indicates that, under 1965 or 1969 prices, revenue per barrel would be considerably in excess of "cost" (defined to include this minimum rate of return); i.e., prices (before excise taxes) would have been over 12% higher than the "supply price."[51] But perhaps more dramatically, well over one-third of the value added in refining would be "excess" profits under these price and output patterns. In total amounts, this meant about $3.9 million per year under 1965 conditions or about $5.7 million under 1969 conditions were "unnecessary" profits, implying an unnecessary after-tax transfer from East Africa to the refinery owners of about $2.4 million per year under 1965 conditions or about $3.4 million under 1969 conditions.

TABLE 2—Calculated oil product prices at Mombasa (shs./litre)[a]

	1962	1964	1965	1966	1967	1969
LPG[b]	.503	.456	.369	.155	.127	.312
gasoline	.170	.160	.166	.165	.161	.183
kerosene[c]	.197	.190	.190	.187	.183	.183
gas oil	.159	.137	.134	.134	.135	.134
diesel fuel	.179	.177	.171	.170	.157	.169
fuel oil	.095	.094	.091	.092	.095	.083
bitumen	.307	.323	.306	.212	.223	.104
export residue	-	.088	.087	.071	.086	.085

[a]Calculated prices are unit values for home consumption from import data, except for export residue prices which are unit export values, f.o.b. Total home consumption data continued to be shown in trade statistics after the refinery began operations because imports and domestic output were stored in the same tanks in Mombasa harbor and any separate estimate of retained imports, the usual meaning of home consumption in trade statistics, would have been essentially arbitrary. Conversions from weight to volume were made using standard conversion factors.

[b]Liquid petroleum gas.

[c]Includes jet fuel.

Sources: East African Common Services Organization (from 1967, East African Community), East African Customs and Excise, *Annual Trade Reports of Tanzania, Uganda and Kenya,* (Mombasa: Commissioner of Customs and Excise).

TABLE 3—Estimated unit profits from the Mombasa refinery ($/bbl)

Year for which price and output data taken as typical	1965	1966	1969
Revenue per barrel of crude	$2.73	$2.39	$2.76
—operating cost	-.22	-.22	-.19
—capital charge	-.29	-.29	-.29
—cost of crude (c.i.f. Mombasa)	-1.93	-1.93	-1.92
Revenue per barrel in excess of average cost	$ .29	-$ .05	$ .36
Excess revenue per barrel as a percent of average cost	11.9	-	15.0
Excess revenue per barrel as a percent of gross refiner's margin	36.25	-	42.86

Source: Appendix

In sum, if these conditions were representative, the benefits of local refining to East Africa could have been increased substantially by reductions in oil product prices (before excise taxes) of over 12%. On the other hand, the Government of Kenya, as host of the refinery, could have appropriated all such benefits for Kenya by "negotiating" a profits tax surcharge to absorb the excess profits.[52]

On the other hand, if the price and output pattern of 1966 would have been typical, there would not even have been enough revenue to cover the "full" cost. However, one important aspect of 1966 that is relevant here is that in June of that year the second East African refinery came "on stream". The Mombasa refinery continued to operate near full capacity (see Appendix section A.3) and product prices in general continued to hold firm at Mombasa except for the price of the "export residue" which fell 18% (see again Table 2). This, more than anything else, seems to have been the cause of the 12% fall in average revenue per barrel, essentially enough to eliminate the "excess" profits.

The export residue consists of heavy, residual fuel oils, used, for example, for ships' bunkers. The residue is necessarily produced in excess of local needs by most small refineries and therefore is generally exported to neighboring ports or to large export refineries for further processing. With the Dar es Salaam refinery on stream in 1966, the local supply of bunker fuel was increased, presumably causing the observed fall in price. However, with the closing of the Suez Canal in 1967 and thus increased sea traffic around Africa, the demand for bunker fuel increased. So did prices received, as can been seen in Table 2.

In sum, 1966 was not a typical year and thus our conclusions about a missed opportunity for lower oil product prices or higher tax revenues appears to hold. Nevertheless, even with the Suez Canal closed, 1966 could have been the first in a series of bad years at Mombasa. With the Tanzanian refinery coming on stream, oil refining capacity in East Africa far exceeded demand. The resultant excess capacity would most likely have had to be shared by both refineries, raising costs at each. Fortunately for East Africa, however, the slack was taken up by new exports to Zambia due to the Rhodesian Emergency. Thus, for example, by 1968 Tanzanian petroleum product exports to Zambia accounted for at least 50% by weight of Tanzania's imports of crude oil, while in 1969 they accounted for at least two-thirds of her crude imports.[53]

In short, if not for the Suez Canal closing and the Rhodesian Emergency, there would have been substantial excess refining capacity in East Africa as a result of the Tanzanian refinery and hence considerably higher refining costs.[54] This being the case, one must ask whether Tanzania made an inappropriate decision when it sought to obtain an oil refinery of its own in the early 1960s.

The answer, given that the Mombasa refinery was being built by and for the major, multinational oil companies, seems to be that no mistake was made. First, on a narrow cost basis, the Tanzanians may have realized that the excess cost of idle capacity and small scale at Dar es Salaam could possibly be offset by savings on the cost of crude oil, since independent buyers of crude were paying less than the transfer prices the majors charged their refining affiliates.[55] Second, although the Tanzanians strongly favored strengthening East African unity on political and economic levels, which should have discouraged a separate Dar refinery, they feared even more a complete dependence on capitalist, multinational

firms, seen to be agents of imperialism.[56] However, acknowledging the reality
of underdevelopment, this did not mean that Tanzania opposed any role for
foreign firms in East Africa. It did mean, though, requiring a larger domestic
role in running the industry than Kenya had settled for.[57] In short, Tanzania
took advantage of an opportunity to obtain an ideologically-preferred refinery
at a cost not necessarily higher than that of continued importing from Kenya.

Our discussion in this section thus far has attempted to critically
evaluate the two East African refineries as built. However, our analysis would
be incomplete if we did not also discuss whether superior, realistic alternatives
were bypassed. From the preceding it should be clear that in terms of refining
costs per se, it would have been most efficient to supply all of East Africa's
oil product needs for the 1960s using a single refinery located at Mombasa. In
terms of the cost of crude oil, it would have been best for the refinery to be
an independent purchaser of crude, free to buy from whichever firms offered
the best terms. Finally, we may also add that refining technology had become
standardized enough by 1960 so that there was an active international construction
industry that built refineries on contract.[58] It would seem that technical
managers could also be had on contract.

In other words, it seems that a single, independent, domestic refining
company for East Africa was feasible technically and in terms of cost. It also
seems that it would have been feasible financially, although a privately-owned
domestic refinery would have probably begun operations a few years after
the actual refinery did. That is, after 1964, when the private "investment
climate" improved following Kenya's peaceful transition to political independence,
resident capitalists would doubtless have found the refinery an attractive
investment. Even with crude oil charged to the refinery at full prices and
products priced at import parity, the refinery was a highly profitable investment
as we saw in Table 3. Table 4 gives a further indication of this by
showing the rates of return that could have been earned under the price and
output structures of 1965, 1969 and even 1966. It is assumed in the first part
of the table that the refining company could have raised two-thirds of its
capital from long-term debt at 9% interest (see Appendix section A.2 for how
this interest rate was chosen). In the second part of the table, debt
capital accounts for half the total in order to present a case without
such extensive leveraging. It will be noted that in only one case is the
return to equity less than 20% and in most cases it is considerably higher.[59]
Rates of return such as these would undoubtably have appeared attractive to
members of the considerable group of experienced, resident entrepreneurs
(mainly from Kenya and Uganda), especially if, say, the Kenya Government
was providing some backing.

The incremental advantages of such a domestic, private refinery over
the multinational-company refineries could have been twofold. First, the
domestic refinery could have reduced the foreign-exchange cost of oil products
more than the multinationals did, especially through the use of cheaper crude.
Second, the domestic refinery could have increased the economic surplus
available for domestic investment (assuming prices were unchanged) through
domestic ownership of the profits.

On the other hand, as is always the case in capitalist enterprise, the
distribution of refinery benefits would have been highly inequitable. In this case
the inequity would not only have been between economic classes, but also between

TABLE 4—Estimated rates of return for a Mombasa refinery (percent)

Year for which price and output data taken as typical	1965	1966	1969
Under debt/equity ratio of 2			
Return to equity	56.6	21.0	62.2
Return to debt	9.0	9.0	9.0
Return to total investment	24.9	13.0	26.7
Under debt/equity ratio of 1			
Return to equity	43.8	17.5	48.3
Return to debt	9.0	9.0	9.0
Return to total investment	26.4	13.3	28.7

Source: Appendix

racial groups (the resident entrepreneurs generally being non-African) and between the three East African countries. The question thus arises whether there was yet a superior, practical institutional alternative to the private refining company just hypothesized, one which would retain the latter's benefits but also provide an improved distribution of those benefits.

One such alternative was a refining company, still located in Mombasa, but jointly owned, operated and financed by the three East African governments. Indeed, there was even public foreign aid for such ventures, although not from the international aid agencies of the capitalist world (Tanzer 1969, chapter 8). That is, aid was available from one of the world's original oil exporting regions, south-eastern Europe and the USSR; e.g., the Soviet Union built Ethiopia's refinery and trained the Ethiopians to run it themselves.[60] Alternately, international oil companies themselves were providing technical and financial assistance for refineries as part of supply contracts for discounted crude oil (Adelman 1972, appendix 6-E).

In addition, in East Africa there was more than just a precedent for joint public ventures of the three countries; there was also an organizational structure within which to place the venture. That is, it seems that an East African oil refining company could have been included with the railroads, rivers and harbors, posts and telecommunications companies already within the East African Common Services Organization (later to become part of the East African Community). The distribution of benefits from refining would then have become part of the political process used for distributing the benefits in general from East African economic integration.[61] Certainly, with better-distributed benefits from an efficient, jointly-owned Mombasa refinery, Tanzania would have been less likely to press for a second, less efficient refinery of its own.

VII. Conclusion

The analysis of the East African oil refining industry here has tried to bring out two main points. First, the two refineries built by multinational oil

companies were examples of investments made according to strategies evolved by the companies in their search for effective ways to operate in the political and economic environment of the 1950s and 1960s. Second, whatever the level of benefits East Africa actually obtained from these foreign-owned refineries (some of which were fortuitous), greater benefits could have been obtained had a single domestic refinery been built instead, an alternative which seems definitely to have been within East Africa's capabilities in the 1960s.

Thus, our initial theoretical approach has led to an analysis of the conditions underlying direct foreign investment in oil refining in small markets, which, in turn, led to expectations that those conditions would be operative in a specific case study. The analysis of East Africa indicates that they were. Reversing the direction of the argument, one may expect that the conclusions about the relative "inefficiency" of using multinational firms as the source for a local oil refinery in East Africa would, in turn, generally apply to the group of other cases in which similar conditions underlay the refinery investments. That is, there is no reason to believe that East Africa was unique in any sense crucial to the conclusion about the relatively high cost of direct foreign refinery investment. The investments were made by multinational firms with expectations of (or in order to defend) high profits in an international industry which, in the 1950s and 1960s, could be characterized by rapidly increasing oil supplies, more standardized technology and easier conditions of entry. Under these conditions, it seems that, for LDCs in general, multinational oil industry refinery investment was neither necessary nor efficient.

APPENDIX. Estimating the Profitability of Refining in Kenya

The purpose of this appendix is to discuss how Tables 3 and 4 of the text were constructed.

A.1 Revenue per Barrel of Crude

The Kenya Government publishes statistics on the output of petroleum products and the throughput of crude oil at the Mombasa refinery each year (e.g., Kenya 1970a, Table 111). Using the calculated prices shown in Table 2, total revenue and thus revenue per barrel of crude input was found.[62] Conversions to dollars were made throughout at the official exchange rate.

A.2 Capital Charges per Barrel of Crude

The methodology used here closely follows that of M. A. Adelman (1972, pp. 371-74). In order to determine the capital charge per barrel in Table 3, we need an amount per barrel that will cover interest expense, debt repayment and income taxes, plus leave enough profits over to provide a rate of return to equity equal to the firm's cost of equity capital. The calculation is done by finding the "annual capital charge" (acc) which satisfies these conditions and then converting this to a capital charge per barrel. The acc will equal the sum of the annual interest expense, debt repayment, corporate taxes and the "annual equity return" (aer). The latter is the amount which must be paid each year for the life of the refinery so that its present value, discounted at the cost of equity capital, equals the amount of equity investment.

The cost of the refinery was K£6 million, with paid in equity of £2 million, the rest being intra-company loans (National Christian Council of Kenya 1968, p. 79; verified by investors). With the overall rate of return set to 15% as discussed in the text, setting the interest rate for the debt sets the required return to equity capital; i.e., the overall rate of return is a weighted average of the return to equity and debt, the weights being the proportions of the investment financed by equity and debt.

For intra-company loans, as used in financing the Kenya refinery, the interest rate charged is purely an accounting convention. However, if we assume the head office acts like an investment bank, we may assign an interest rate based on external market rates. Since Shell/BP is British, yields on long-term (20 year) debentures and loan stocks in Britain were investigated. Yields generally rose from an estimated 6% in 1963 to 8.4% in 1968 and 10.3% in 1969 (Herman 1974, pp. 300-301). Thus, in order to err on the high side, 9% was chosen as the interest rate for our calculations. This, in turn, implied a required return to equity capital of 27%.

For the calculations in Table 4, in which the return to equity capital is the dependent variable (see Section A.5 below), it was also necessary to assign an interest rate to the local debt capital variable. Rates obtaining in Kenya in the mid-1960s were thus relevant. Commercial bank rates in Kenya were between 7 and 9%, the former for "first-class customers" (IMF 1969, p. 193). Since a local oil refinery would have been such a customer, it would have had access to bank capital costing 7% (which could be rolled over as necessary). On the other hand, additional sources of debt capital would have been needed such as, say, some form of government-backed bonds. In this regard, yields on long-term Kenya Government securities (over 10 years) were relevant. Yields dropped after independence from a temporary high of 9.1% in mid-1964 to 7.5% at mid-1966, falling further to 7% by the middle of the following year, holding fairly steady thereafter; the average for 1964-67 was thus roughly 8% (Central Bank of Kenya 1969, p. 53). It seems that a government-guaranteed bond issue could have been floated by a local refining company at something above these rates, e.g., at 10% from 1965. In addition, less costly loan capital would undoubtably also be obtainable from government development banks such as the Development Finance Company of Kenya. Finally, outside sources of subsidized debt capital were also potentially available, such as the Commonwealth Development Corporation or, if Ismaili investors were involved, the Aga Khan's, Industrial Promotion Services. With all these and yet other sources of debt financing available, it is hard to estimate what the average interest rate for a financial package for an independent refinery should have been. The rate chosen for the calculations was 9%; in light of the above, it did not seem unduly unrealistic.

Other factors which entered into the capital charge calculations were profits taxes, depreciation rates and debt repayment. The Kenya tax on corporate income was raised at independence from 27.5% to 37.5% (later raised to 40%). The post-independence rate was used in the calculations as the refinery did not begin operations until then (the final increase of 0.5% point not affecting our results). Although Kenya allows accelerated depreciation for tax purposes and has a system of investment tax credits, these were ignored in the calculations. Rather, a straight-line depreciation over the life of the refinery (20 years) was assumed, thereby imparting a downward bias to estimated excess profits and rates of return.

It was also necessary to assume, in effect, that a non-interest-bearing sinking fund was established into which 1/20th of the debt was put each year. Interest payments on the debt were thus a constant amount per year. This overestimated the cost of the debt for bond or bank finance instruments (in the former, the borrower would invest his sinking fund in interest-bearing liquid assets, while in the latter, interest payments decrease as debt outstanding decreases). This implies that the rates of return in Table 4, where it is assumed that local investors would borrow from the local financial system, have a downward bias in addition to that noted above.

For the calculations of the profits from the refinery as built (Table 3), the implications of debt repayment are a bit more involved. That is, although one may expect East African investors using outside debt to maximize the term of the debt (given the interest rate), the opposite may be expected of foreign investors using intra-company debt. For firms using bank-type debt, one may show that the present value of the debt, when incurred, is lower (given the interest rate) the long is the period over which the debt is repaid (Herman 1974, pp. 297-99). Also, for investors who feared possible expropriation or capital loss in terms of international currencies resulting from some future Kenyan devaluation, local debt outstanding would serve as a useful hedge. However, for foreign investors using intra-company loans, quick repayment reduces parent-firm assets exposed to these risks. It also allows quick repatriation of early profits that might otherwise seem embarrasingly high. Thus, quick repayment may be expected for cases such as the Mombasa refinery as built.

In this case, the present value of the cost of intra-company debt incurred by the refinery subsidiary would be higher than that implicit in our calculations which assume repayment over 20 years. This tends to impart a downward bias to our capital charge estimate and thus an upward bias to our excess profit estimates. However, we may show that the maximum bias is small.

First, one may write the present value of the cost of debt as the present value of payments to the creditor minus the present value of corporate tax savings from interest expense. Shortening the repayment term raises the first term and lowers the second. The first term is the parent firm's asset at the same time as it is the subsidiary's liability. Increasing the value of that asset through quicker repayment at the original interest rate may be seen to be equivalent in present value terms to obtaining a higher interest rate on the original repayment terms. Given that our calculation requires a constant return to total investment, a higher effective interest rate on debt capital requires a lower return be paid to equity capital as its cost. It may be shown that, since this higher effective interest rate is not an actual extra interest expense which would affect the tax liability, there is no change in the capital charge on this account.[63]

The change in the second term in the present value of the cost of intra-company debt, however, does lead to a higher capital charge. That is, with quicker payback, interest is paid over fewer years and thus tax savings arising from interest expense are lower. The maximum loss of tax savings to the investor would occur if the total debt were repaid in the first year (a totally unrealistic option). In this case, the refinery's tax liability would be higher each year than in our calculations. The amount on $11.2 million of debt at 9% interest with a tax rate of 37.5% would have been $378,00 per year or $.03 per barrel for the 1965 and 1966 calculations in Table 3 and $.02/bbl for the 1969

calculation. If the debt were not all repaid in the first year, the average
per barrel tax increase would be smaller. In addition, against this source
of downward bias in the estimated capital charge for the refinery as built
must be set all the sources of upward bias discussed previously.

A.3 Operating Cost per Barrel of Crude

Operating costs were first estimated for full capacity operations with
cost-penalties for operating at less than full capacity then added on. Previously-
publishes, full-capacity operating cost estimates for simple, LDC refineries,
showing costs per ton graphically as a function of capacity output, were used
(Hubbard 1964, p. 218).

The cost of excess capacity was interpolated from estimates of the percent
by which average total costs rise over the costs at full capacity for LDC
refineries at different levels of idle capacity (Hagemans and Ingall 1962, p. 3).
Idle capacity was calculated to have been 8.7% for 1965, 8.3% for 1966 and 1.7% for
1969 (using calendar-days definition of capacity). The resultant percentage
additions to average costs at full capacity were 7.8% for 1965, 7.5% for 1966
and 1.5% for 1969. These extra charges were added to full capacity operating
cost ($.18/bbl) to give the operating cost estimates in Table 3 (also used in
deriving Table 4).

A.4 The Prices of Crude Oil

Crude oil prices were estimated from import data in the *Annual Trade Reports*.[64]
Import quantities were in units of weight which necessitated conversion to
volume. Because the weight of a barrel of crude differs by country of origin, i.e.,
since there are different specific gravities of different crudes, it was
necessary to convert crude imports by weight separately from each of the major
suppliers, using available average conversion factors for each supplying
country (Petroleum Information Service 1964, pp. 138-39).

A.5 The Rates of Return

To calculate the rates of return in Table 4, the excess revenue per barrel
for a given year and the capital charge estimate of Table 3 were added, giving
what might be called the economic surplus per barrel of crude. Multiplying this
by 40,000 b/d crude capacity and by 365 days yields the surplus in annual terms,
analogous to the annual capital charge (acc) in Section A.2. This acc allows
us to solve for the implied annual equity return (aer). The rate of return to
equity is then closely approximated by dividing this aer by the value of the
equity investment. Given the rate of return to debt capital (9%) and the
debt/equity ratio, one can finally calculate the overall implied rate of
return as well.

Footnotes

Robert Stern, Sidney Winter, Jr., and Robert W. Adams. In addition, a number of executives from firms involved in the cases discussed were very frank and helpful, including granting access to confidential company papers (all the estimates presented here, however, were derived from publicly available data). Some of my interviewees wished the cases to be disguised in the manner of management-training cases used in business schools, but this turned out not to be possible. As a compromise, however, it is possible simply not to mention names, as the analysis is based in all essentials on events and public statements, not on hearsay.

[1]For a general analysis based on these factors and others, stressing investments in LDCs, see Herman (1974).

[2]Since the "international oil industry" (conventionally defined to be the industry outside the U.S., Canada and the socialist countries) has long been dominated by seven firms, five of which are American, almost all refinery investment in the international industry is direct foreign investment. For two perspectives on the development of international oil, see Penrose (1968) and O'Connor (1962).

[3]These data are drawn from international enumerations of refineries as published annually in the last issue each year of *Oil and Gas Journal* under such titles as "World-Wide Refining" or "Survey of World Refining", etc.

[4]We are thus excluding from discussion here those refineries built by state agencies.

[5]How this strategy worked for one company in particular will be shown below.

[6]*Oil and Gas Journal* 57(December 28, 1959): 23.

[7]Although Mattei did manage to buy substantial quantities of Russian oil at discount prices (Votaw 1964, pp. 5, 36).

[8]The story of Mattei and ENI have been told in Dechert (1963), Frankel (1966), and Votaw (1964).

[9]Not only would Mattei's joint refineries appeal to nationalist feelings and thus help market Agip products in the private sector, but it would also help capture a market in the public sector.

[10]For an exhaustive analysis of crude oil price behavior since 1948, including a thorough enumeration of the discounts obtained by independent refiners, see Adelman (1972, chapters 5 and 6 and associated appendices). For a treatment stressing the implications for LDC refining, see Tanzer (1969).

[11]*Petroleum Week* 10(June 24, 1960): 104-105 and Indro Montanelli, "Enrico Mattei, the Man," *Atlas* 2(October 1961): 280 (translated from *Corriere della Sera* (Milan), August 29, 1961).

[12]As quoted in Dechert (1963, p. 89) from *Le Monde*, June 13, 1960.

[13]Confidence in these imputed strategies is enhanced if, in turn, they may be explained in terms of the requirements of a general theory of direct investment. Such, for example, is undertaken for the case at hand in Herman (1974, chapter 6).

[14]Calculated from data in American Petroleum Institute (1967, p. 325).

[15]Calculated from data in British Petroleum Company (1968).

[16]Stanvac was dissolved in a consent decree in a U.S. antitrust case against Exxon and Mobil ("How the Stanvac Split Stacks Up," *Petroleum Week* 11(November 25, 1960): 31-33).

[17]"Esso in East Africa," in *Industry in East Africa* (1962, p. 156).

[18]*East African Trade and Industry* 1 (July 1954): 15.

[19]The author was referring to Africa in general (excluding South Africa).

[20]Also, since discounts were then being given to independent buyers, as noted in Section II above, average revenues f.o.b. underestimate f.o.b. average revenues on undiscounted sales to East Africa.

[21]M. A. Adelman (1972, p. 381) presents estimates of average refining costs for European refineries for 1960-69, none of which were above $.37/bbl. He also reproduces European Coal and Steel Community (ECSC) estimates of refining costs for 160,000 b/d refineries processing two Middle-Eastern crudes. Both estimates were $.36/bbl. The ECSC also estimated costs for smaller refineries processing these crudes, the highest being $.61/bbl for a 40,000 b/d refinery processing Iraq-Arabian 35° crudes. Although Abadan was older than any of these, it did have a capacity of roughly one-half million barrels per day and so it is more than doubtful that refining costs at Abadan were more than two times refining costs in Europe (in spite of a higher cost of capital in Iran due to risk).

[22]Some of this refining-stage profit may have resulted from temporarily high prices that Abadan received at this time for bunker fuel (Adelman 1972, pp. 177-78), a product without much demand in Third World markets. Since such profits on bunker fuel would not be obtained on sales to East Africa, one should probably have adjusted the revenue per barrel figure in Table 1 downward. However, since it was not known by how much to adjust revenue downward, it was decided instead to adjust refining cost upward by assuming that all of the gross refiner's margin was cost.

In addition, we may note that as oil product prices and crude oil prices began their downward trend in 1957, the gross refiner's margin at Abadan also fell, e.g., from $7.84 per ton in 1957 to $6.65 per ton in 1960 (Heller 1964, p. 201). This suggests that whatever refinery profits were in 1960, they had been higher earlier, yet another reason for treating the profits estimate in Table 1 as a lower bound.

[23]In the years before 1960, when oil product prices were higher and taxes paid to crude-oil-producing countries were lower, the average profits per barrel of Middle Eastern oil sold to poor-country markets must have been simply awe-inspiring.

[24]That is, such a firm could assume that its entry to East Africa would, first, not affect prices received outside this small, dependent market and, second, would not necessarily even lead to lower prices in East Africa as the established majors generally eschewed price competition. Thus, the lower-bound

estimate of average revenue in Table 1 may be interpreted as a rough estimate of marginal revenue. In addition, if the long-run marginal cost of crude oil production in the Persian Gulf was upward sloping at this time, it was only slightly so for incremental output rates equal to the entire East African consumption (let alone an individual firm's market share). The conventional wisdom in the industry at this time was apparently that average costs were falling, although M. A. Adelman, for example, argues that this was not likely. Nevertheless, Adelman also argues that marginal crude oil production costs in the Persian Gulf would rise little to 1985 under even the most extreme assumptions, e.g., that no new reserves would be discovered (Adelman 1972, chapter 2). It thus seems reasonable to assume that long-run marginal crude oil production cost was not greater than long-run average cost. Similarly, long-run marginal costs of refining and transportation may be assumed no greater than long-run average costs since the latter were non-increasing (Hubbard 1964).

[25]On these new entrants, see *Foreign Commerce Weekly* 59 (March 31, 1958): 27, *Petroleum Week* 10(June 24, 1960): 104-105, *ibid.*, 11 (November 24, 1960): 31-33 and *Industry in East Africa* (1962, p. 151).

[26]Casual observations made in Kenya in 1971 suggests that this was still very much the case.

[27]*East African Trade and Industry* 7 (August 1960): 21.

[28]Also, although these refineries may have appeared as very large capital investments from LDC perspectives, they were not large outlays from company perspectives; e.g., the Kenya refinery, which was initially only a project of Shell and BP, accounted for only 1.5% of their 1960 investment expenditures (based on company investment data from Penrose (1968, pp. 102 and 111). On the other hand, when the refinery came "on stream", it accounted for 50% of the increase in Kenya's manufacturing output (calculated from manufacturing index data for 1964 in Kenya (1966, p. 45)).

[29]One executive interviewed also claimed that a regional refinery in East Africa was desirable per se on the basis of risk-reducing advantages from decentralizing refining facilities, previously concentrated in the Persian Gulf. Indeed, a refinery at Mombasa had apparently been discussed in the early 1950s; e.g., it was listed as one of a group of locations for market-oriented refineries in an article published in 1955 (Melamid 1955, p. 176). However, the concern over risk in the early 1950s had been prompted by the nationalization of Iran's oil in 1951 by a government that was subsequently deposed in a coup in 1953. The oil was returned to private, foreign hands in 1954 and, apparently, the need for a Mombasa refinery became less pressing for the time being. (For the story of the Iranian episode, see O'Connor (1962, chapters 23 and 24); for the role of the U.S. CIA in the coup, see Wise and Ross (1964, pp. 110-14).

[30]A copy of this agreement is on file at the Registrar of Companies, Nairobi, Kenya.

[31]CFP was considred an established marketer because in 1960 it took over the marketing organization of an international French firm that had just begun marketing in East Africa in 1958. This firm, Omnium Francais de Petrole, marketing as Ozo, was itself closely linked with CFO (i.e., CFP had been a major

supplier of crude to Ozo which, in turn, was a large shareholder in CFP).
Although only marketing for one year before the Kenya-Consolidated agreement, Ozo
had first come to East Africa in 1955 when it began an investment program
in distribution and retailing facilities (on Ozo and CFP, see *East African
Trade and Industry* 2 (August 1955):30 and 10 (June 1964): 29). We may thus
note that the rational for considering CFP an "established marketer" was fairly
strong, certainly much stronger that the rational for including Mobil which was
that Mobil had been Exxon's partner in Stanvac. Mobil's share in established-
marketer Stanvac had gone to Exxon when Stanvac was dissolved. Mobil thus
had to re-enter East Africa in the early 1960s with all new facilities. Nevertheless,
Mobil was given "established marketer" status by its fellow majors, Shell and BP.

[32]*East African Trade and Industry* 6 (July 1959): 31.

[33]Dechert (1963, pp. 67-68), citing *Platt's Oilgram*, October 23, 1961.

[34]Whether or not an actual conspiracy was in operation, the majors did not
win the right to build the refineries in all of these countries; e.g., ENI
beat them in Ghana.

[35]*Petroleum Week* 9 (September 25, 1959): 87.

[36]*Economist*, February 17, 1962, p. 605.

[37]*Ibid.*, April 14, 1962, p. 127.

[38]*Journal of Commerce*, May 21, 1962, p. 2.

[39]*Ibid*, May 25, 1962, p. 13.

[40]ENI's presence in Tanzania may have also helped it obtain an oil exploration
concession along the coast in 1969. However, perhaps too much should not be
made of this since "in 1965 Shell/BP relinquished its license in the same area
having spent £6 million over a 13 year period without success" (*World Petroleum
Report* 1970, p. 100).

[41]See *ibid.*, and Tanzania (1967, p. 40).

[42]*Africa Diary*, September 8-14, 1968, p. 4092, citing the *Standard* (Dar es
Salaam), and *ibid.*, April 4-10, 1966, p. 2810, citing the *East African Standard*
(Nairobi).

[43]*Oil and Gas Journal* 68 (February 23, 1970): 140.

[44]*Africa Diary*, April 30-May 6, 1970, p. 4939, citing the *Standard* (Dar
es Salaam).

[45]See "The East African Scene," *Petroleum Press Service* 37 (July 1970):
255-57, "Tiper Refinery", *Jenga* (Dar es Salaam) 8 (1971): 23, and *Africa Diary*,
March 26-April 1, 1970, p. 4892, citing the *Standard* (Dar es Salaam).

[46]Contained in a statement issued by Shell in Tanzania, reported in the
Standard (Dar es Salaam) as excerpted in *Africa Diary*, March 26-April 1, 1970, p. 4892.

[47] *Ibid.*

[48] Quoted in the *New York Times,* April 12, 1970, Section 3, p. 13.

[49] Although average costs of refining were higher at Mombasa than at Abadan, the cost of transporting crude oil was less than the cost of shipping "clean" products, thus partly offsetting the higher unit cost of refining.

[50] Although the refinery actually operated by charging oil marketers a fee for refining their crude oil imports, our calculations treat the refinery as if it purchased its own crude and sold the refined products to the marketers at import-parity prices. This seemed to provide a clearer picture of the profitability of refining operations per se as opposed to an estimation using refining fees which would be more relevant to how refining profits were allocated between the refinery affiliate and the distribution affiliates of the oil companies dominating East Africa.

Profit estimates were made using only the price and output data of 1965, 1966 and 1969 because the calculations rested on the treatment of a typical year's activities. Thus, 1964 was omitted because, being the first year of operations, there would be more down-time, etc., and thus higher operating costs (however, revenue per barrel and cost of crude per barrel were approximately the same in 1964 as in 1965 and 1969). Similarly, 1967 was omitted because it was felt that results were influenced by short-term effects of the Suez Canal closing which, it seems, accounted for the unusally high revenue per barrel obtained that year. The reason for omitting 1968 was simply that the requisite data on home consumption of oil products by 6-digit SITC categories was not included in the *Annual Trade Report,* as had been the case in the other years. Years subsequent to 1969 were not included because in 1969 capital expansions to the refinery were made (Kenya 1970, p. 87), and our purpose was to estimate the profitability of the original investment.

[51] The point here is not to argue that the "supply price" would have been the minimum necessary to call forth the investment; i.e., it was not relevant to the parent firms' actual decision making. Refining was here a stage in a vertically-integrated industry with transfer pricing between units. The perspective of the calculations is rather that of welfare economics from the East African point of view, taking input prices as data. Thus, "supply price" represents the "cost", including the return to entrepreneurship and risk and "waiting" which is considered "justified" under neoclassical theory. Returns to the firms above the supply price may thus be considered "neoclassical exploitation".

[52] In fact, the Kenya Government implemented a variant of the latter strategy when it acquired a 50% shareholding in the refining company in 1971 (*Daily Nation* (Nairobi), January 21, 1971).

[53] There were two reasons for stating the above proportions as lower bounds. First, oil products trade data intentionally overestimate re-exports and underestimate domestic exports as a conservative solution to the "identification" problem arising from the storage of imported oil products and domestic output in the same tanks in Dar es Salaam harbor (see any *Annual Trade Report* from 1966). Second, although the average weight per barrel of the aggregate of products refined from crude oil should weigh roughly the same as the

crude (more or less depending on whether light or heavy ends are used as refinery fuel), the average barrel of products shipped to Zambia weighed less. This was because some of the heaviest products, viz., bunker fuel, were not in high demand in Zambia.

[54]In addition, because the Dar refinery was approximately one-third the size of the one at Mombasa, it was a higher-cost plant to operate even at full capacity. Thus, the fees charged the oil marketers for having crude refined into products were roughly 50% higher at Dar than at Mombasa. However, oil product prices at Dar did not rise as a result, the oil companies apparently absorbing the extra cost through lower effective crude oil transfer prices (Herman 1974, pp. 257-58).

[55]Crude oil could be obtained on terms ranging from spot purchases to 20 year supply contracts, with provisions also available for transport and buy-back of the excess heavy fuel oils. The latter would solve the potentially difficult problem that an independent refiner could face in finding markets for the excess residual oils (interview with Kebede Akalewold, Managing Director, Ethiopian Petroleum, S.C., Addis Ababa, January 1971). For examples of the major terms of crude oil supply contracts, see Adelman (1972, appendices 5-A, 6-E, 6-G and 6-I).

[56]The importance of this point was impressed upon me by Mutsembi Manandu in comments on an earlier version of this paper.

[57]The development ideologies of Kenya and Tanzania have been set forth in Kenya (1965) and Nyerere (1968).

[58]For example, an independent British firm, Procon Ltd., was hired by Shell and BP to build the Kenya refinery (*Oil and Gas Journal* 62 (March 23, 1964): 67).

[59]It may be objected that had the refinery been built by an independent company, it would not have had the opportunity to supply the markets outside East Africa which were supplied in the early years from Mombasa. Indeed, the refinery might have been somewhat smaller and higher cost. Lack of experience might have raised an independent's operating costs further. And finally, had the refinery been built in the middle 1960s, instead of during a depression in the Kenya construction industry, it would have had a higher capital cost (one industry executive interviewed cited this factor as important to the financial success of the Mombasa refinery).
  Nevertheless, against these potential cost-increasing factors one can set the major potential cost-reducing factor of discounted crude oil prices. That is, since crude oil accounts for about 70% of the price of products, as can be seen from Table 3, a 20% reduction in the price of crude, ceteris paribus, approximately offsets a 50% increase in refining costs due to all the potential inefficiencies listed above.

[60]Interview with Ato Akalewold (see note 55).

[61]Perhaps the most simple solution would have been to transfer all refinery profits to the East African Development Bank for investment in the three countries according to formulas previously agreed upon.

[62]One exception to this was the use of calculated united values for domestic exports for LPG for the 1965 and 1966 calculations since most of the output was apparently exported. By 1969, however, the domestic market was apparently exported. By 1969, however, the domestic market was apparently absorbing considerably more of the LPG output and so home consumption unit values were used here instead (the 1965 unit export value for LPG was .320, while for 1966 it was .210).

[63]First, let "acc" be the annual capital charge, "aer" be the annual return to the equity investment, E; also, let i be the interest rate on debt capital, D. Let t be the corporate tax rate, "dep" be the depreciation charge and, finally, let n be the life of the investment. Then, the definition of the acc is

$$(1) \quad acc - aer + iD + \frac{D}{n} + t(acc - dep - iD),$$

which implies

$$(2) \quad acc = \frac{aer}{1 - t} + iD + \frac{D}{n(1 - t)} - \frac{t}{1 - t}dep.$$

Second, let r be the proportion of debt in total financing of the investment, i.e.,

$$(3) \quad r = \frac{D}{D + E},$$

which implies

$$(4) \quad E = (\frac{1 - r}{r})D.$$

Third, let us approximate the rate of return to equity by aer/E, which is close for a 20 year investment. Finally, the rate of return to total capital invested is fixed at 15%, which gives us

$$(5) \quad ri + (1 - r)\frac{aer}{E} = .15,$$

which, with equation $(4)_1$ yields

$$(6) \quad aer = (.15 - ri)\frac{D}{r}.$$

Substituting (6) into (2) and taking the derivative of acc with respect to i, we get

$$(7) \quad \frac{d(acc)}{di} = \frac{-tD}{(1 - t)}.$$

Thus, in general, if the interest rate rises, the acc (and thus the capital charge per barrel) falls due to the extra tax savings on the higher interest expense. However, if the interest rate rise is an "effective" rise not entailing an actually higher interest expense, then t in equation (7) is zero and thus (7) is itself zero.

[64]The prices shown in Table 3 for crude oil are revisions of estimates in Herman (1974, table 7.4) which contained an error.

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