TAXATION OF INTERNATIONAL CAPITAL FLOWS,
THE INTERTEMPORAL TERMS OF TRADE AND THE REAL PRICE OF OIL:

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Helpful suggestions by Lars Svensson and comments by Ricardo Martin are gratefully acknowledged.
We analyze whether oil importing countries should tax interest payments to OPEC (raise the cost of borrowing from them) to exploit collective monopoly power in the world capital market.

We explicitly introduce the exhaustibility of oil and the Hotelling rule for OPEC pricing behaviour, OPEC sets the discounted future oil price equal to the current one (marginal extraction costs are assumed to be zero). It is shown that under those circumstances a tax on interest payments to OPEC is not necessarily welfare improving for Industria. Imposing such a tax is shown to lead to oil price increases, the negative welfare effects of which (for Industria) are more than offset the positive welfare effects of such a tax given the price of oil. A simple expression for the total effect on Industria's welfare of such a tax is derived, indicating that if future oil demand elasticities are sufficiently higher than current ones, a subsidy is called for rather than a tax. The intuition behind this result is explained using recent results on the structure of optimal tariffs in the presence of complementarities.
Section 1: Introduction

The large OPEC surpluses on Current Account during the seventies and the corresponding accumulation of financial claims in Western capital markets naturally lead to the question whether oil importers can exploit monopoly power in the world capital markets via standard optimal tariff arguments: should "Industria" tax interest payments made to OPEC? If the supply elasticity of net savings in Industria at the existing world rate of interest is larger than zero, such a tax will lower the world rate of interest, leading to welfare losses for the net creditor (OPEC) and gains for the net debtor (the rest of the world, "Industria" for short from now on). Another way of looking at the same thing is to note that OPEC surpluses now mean OPEC deficits and "Industria" surpluses tomorrow; but if Industria is a net exporter tomorrow it pays them to make future goods more expensive in terms of today's good: a higher discount factor (lower world interest rate) will lead to welfare gains for Industria. In a recent paper Marion and Svensson (1983) present this line of reasoning and argue, drawing the analogy with the standard optimal tariff argument, that such a tax would be unambiguously welfare improving for Industria.

In this paper we argue however that these results depend crucially on an asymmetry in asset market behavior for which no easy rationale can be found: Industria is supposed to arbitrage away any differences between the world rate of interest and the rate of return on physical capital by adjusting its investment program; by assumption however OPEC does not equalize the return on foreign capital and the rate of return on their domestic asset, oil in the ground, in despite of the fact that the exhaustibility of oil confers a
scarcity rent on oil kept in the ground for future use. In fact, Marion and Svensson assume an arbitrary exogenous sequence of oil prices over time and an infinite stock at OPEC's disposal. In what follows we show that an explicit incorporation of the exhaustibility of oil coupled with competitive pricing may reverse the positive welfare effects of such a tax on interest payments to OPEC by offsetting increases in the price of oil. Finally we draw on recent work on the structure of optimal tariffs in the presence of complementarity to explain the intuition behind this result.

Section 2

The framework used is the by now standard two period - two country- two-goods set up, with as main difference the explicit incorporation of the consequences of exhaustibility of one of the two goods, oil. Country 1 ("Industria") produces a final good using labour, capital and imported oil subject to a "well-behaved" concave production function. We shall represent the production side by a value added function

\[
R^i = \max \{ p^i X^i - q^i z^i \} = R(p^i, q^i; L^i, K^i) \quad i = 1, 2
\]

where \( p^i \) is the current period output price (set equal to one by choice of numeraire), \( q^i \) is the price of oil, \( X^i \) is gross output, \( z^i \) the amount of oil used and \( L^i \) and \( K^i \) the stock of labour and capital. The index "1" is a period index and takes the value 1 (today) or 2 (tomorrow). The derivatives

\footnote{The model used is similar in structure to the one used by Dixit (1981).}
of \lambda with respect to output (input) prices give the optimal supply of output (input use) given the relative price structure.

Industria's expenditure over time is described by an expenditure function derived from a well behaved twice differentiable concave utility function:

\[ E = \min \{ p_1 c_1 + \delta p_2 c_2 \} \]

subject to \( \hat{U}(c_1, c_2) > U \), yielding the expenditure function

\[ E = E(1, \delta, U) \]  

\( \delta \) represents the discount factor converting future values into their net present value equivalent, and equals the inverse of one plus the interest rate

\[ \delta = (1 + r)^{-1} \]

OPEC's expenditure is similarly described:

\[ E^* = E^*(1, \delta^*, U^*) \]

where the introduction of a different discount factor for OPEC anticipates the wedge between OPEC's and Industria's discount factor created by a tax rate on interest payments to OPEC:

\[ \delta = \delta^* - \tau \]
where \( \tau \) equals

\[
\tau = \frac{r - r^*}{(1+r)(1+r^*)} .
\]

\( r^* \) is the world market rate of interest that OPEC receives on its loans to industria, \( r \) is the tax-inclusive cost of such a loan to a borrower in industria. \( \tau \) equals the discounted value of tax payments per unit borrowed.

Investment demand for final goods by Industria is derived from value maximization of the firm:

\[
I = I(\delta, q_2)
\]

with

\[
\frac{\partial I}{\partial q_2} = - \frac{2R_Kq}{R_KK}
\]

\[
\frac{\partial I}{\partial \delta} = - \frac{2R_q}{R_KK} .
\]

We make a competitive oil pricing assumption for OPEC:

\[
q_1 = \delta^* q_2
\]

\[
= \frac{q}{q_1^*} .
\]

(7) implies that the rate of return on oil in the ground equals the world interest rate:

\[
\frac{q_2 - q_1}{q_1} = \frac{1}{\delta^*} - 1 = r^* .
\]
Monopoly pricing would lead to identical results if oil demand elasticities are the same across periods (Stiglitz (1976)). Notice that $\delta^*$ now has two mutually reinforcing effects on investment if oil and capital are strictly cooperative (i.e., if the cross-derivative of the production function with respect to capital and energy is strictly positive): for any given $q$ a higher $\delta^*$ means a lower oil price in the future in terms of future final goods which if capital and oil are cooperative will lead to more capital. On a priori grounds nothing can be said on the sign of the cross-derivative of the production function with respect to capital and energy (which equals minus the sign of $\frac{\partial R}{\partial qK}$). For simplicity we will henceforward assume zero cross-derivatives between capital and energy.

Taking all these building blocks together allows us to formulate the budget constraints and market clearing equations that constitute the model.

OPEC's budget constraint based on the assumption that it only produces oil and only consumes final goods indicates that the discounted value of expenditure should equal the value of their oil:

\begin{equation}
qS = E^*(1, \delta^*, U^*)
\end{equation}

with $S$ the total stock of oil available and $U^*$ the welfare level of OPEC.

Industria's constraint based on the assumption of no local oil production is

\begin{equation}
1R(1,q;K_1) + \delta^2R(1,q/\delta^*, K_1 + I) + \tau b_2 - I_1 = E(1,\delta, U)
\end{equation}

where $b_2$ equals Industria's period 2 trade surplus.
\( b_2 \) represents the revenue from the tax on interest payments to OPEC, which following standard assumptions in the trade literature on tariffs are handed out in lump sum fashion.

Substituting \( q_2 = q / \delta^* \) and \( \xi = \xi^* - \tau \) into (6) yields an expression for \( I \)

\[
(6a) \quad I = I(\xi^*, q; \tau) \quad \frac{\delta I}{\delta \xi^*} = -2R_{KK} \left( \frac{2R_K}{2R_{Kq}} q \right) \\
\frac{\delta I}{\delta q} = -2R_{KK} \frac{2R_K}{2R_{Kq}} \delta^* \\
\frac{\delta I}{\delta \tau} = 2R_{KK} \frac{2R_K}{2R_{Kq}}
\]

If \( \frac{2R_{Kq}}{R_K} = 0 \), \( \frac{\delta I}{\delta q} = 0 \), \( \frac{\delta I}{\delta \delta^*} > 0 \) and \( \frac{\delta I}{\delta \tau} = -\frac{\delta I}{\delta \delta^*} < 0 \).

Instead of having two oil market clearing conditions (for today and tomorrow), we have the Hotelling rule \( q_1 = \delta^* q_2 \) and the exhaustibility constraint which says that total oil use should not exceed the total supply:

\[
(10) \quad S + \frac{1}{p_1} R_1 + \frac{2}{p_2} R_2 = 0.
\]

The absence of extraction costs and the competitiveness assumption will ensure that (10) holds with equality.

The first period goods market clearing condition is

\[
(11) \quad \frac{1}{p_1} = \frac{E^*}{p_1} + \frac{E^*}{p_1} + I
\]
or total demand for consumption \((E_1^p + E^*_p)\) and investment \((I)\) purposes should equal total supply \(\sum_{p}^p\).

Second period goods market equilibrium is given by an expression similar to (11), but Walras' law makes it redundant.

Differentiating (8) yields us an expression for OPEC welfare \(U^*\):

\[
U^* = U(\delta, q) - E_{u} \frac{\partial U^*}{\partial q} = S
\]

Note that \(E_{u} \frac{\partial U^*}{\partial \delta^*}\) does not equal \(q_2 S_2 - E_{p2}^*\), OPEC's second period trade balance, as one might have expected; the term \(q_2 S_2\) cancels out once the effect of a change in the discount factor on the second period oil price \(q_2\) given \(q\) is taken into account.

A similar expression for Industria's welfare level \(U\) can be derived from (9), evaluated around \(\tau=0\):

\[
U = U(\delta, q) - E_{u} \frac{\partial U}{\partial q} = -S < 0
\]

\[
E_{u} \frac{\partial U}{\partial \delta^*} = (b_2 - \frac{2R}{q_2} q_{\delta^*})
\]

The dependence on \(q\) is straightforward. \(\frac{\partial U}{\partial \delta^*}\) incorporates two effects; one is simply the intertemporal terms of trade effect of a change in the discount factor (change in the world interest rate), \(E_{U}^{-1} b_2\), which is positive when a second period trade surplus is anticipated. The second term comes in via the
effect of \( \delta^* \) on \( q_2 \) given \( q \) and is positive. Note the absence of any direct effect of \( \tau \) on \( U \), any impact \( \tau \) has on Industria's welfare has to come via the price of oil or the world interest rate.

Using (12) and (13) and the oil and final goods market clearing conditions (10) and (11) we derive two schedules in \((q, \delta^*)\) space representing equilibrium in the world oil market (OM) and the period one market for final goods (GM1). (See Figures 1a, 1b).

**First OM:** A higher world interest rate (lower discount factor \( \delta^* \)) will, given the first period oil price \( q_1 \), lead to a higher second period oil price \( q_2 \), in order to equalise the rate of return on oil in the ground \(((q_2 - q_1)/q_1)\) with the world interest rate; this in turn will lead to excess supply in the oil market which necessitates a lower oil price in both periods or, in other words, a lower \( q \) to get back in equilibrium. All this implies an upward sloping OM schedule in \( q - \delta^* \) space

\[
\frac{\delta^* \cdot 2q_2}{q_2} = \frac{2R_2q_2/\delta^*}{Rq + \frac{2R_2q_2/\delta^*}{R}} > 0
\]

As long as our assumption of \( \frac{2R_2q_2}{q_1} = 0 \) holds no shift in OM will occur when \( \tau \) changes.

The locus describing first period goods market equilibrium (GM1) can be derived from (11):

\[
\frac{\delta^*}{\delta^*} \bigg|_{GM1} = \frac{(E_{p1p2} + E^*_p + I^*_p + (c_1 - c_1^*)E^*_p)}{(R_{p1}q + (c_1 - c_1^*)E^*_p)}
\]
Figure 1a, 1b: Equilibrium loci for the oil market (OM) and first period final goods market (GM1); dominant supply case (a) and dominant transfer case (b).

The numerator is always positive under the reasonable assumption of greater first period spending propensities in Industria than in OPEC ($c_1 > c_1^*$); the denominator can be either positive or negative, depending on whether the transfer effect of a higher oil price $((c_1 - c_1^*) E_{p2}^*)$ dominates the supply shock effect $R_{p1}^q$. Stability requires that GM1, when
positive, is steeper than OM (Figure 1.b). Under the usual assumption of dominant supply shock effects GM1 will slope upwards.

Imposing a tax on interest payments to OPEC will (given our assumption of \( R_{qK} = 0 \)) not affect the OM schedule. It will however raise the cost of borrowing in Industria for any given value \( \delta^* \) and \( q \) and so lead to less investment plus a substitution effect away from current towards future consumption of final goods. This will lead to excess supply in today's final goods markets and excess demand in tomorrow's market for final goods; to get back in equilibrium tomorrow's goods need to become more expensive in terms of today's goods or the discount factor \( \delta^* \) has to go up (a fall in the world interest rate). This was also found by Marion and Svensson (1983) who conclude that therefore, since Industria is a net debtor to OPEC, imposing such a tax is welfare improving for Industria. Figures 1a, 1b show however where that conclusion may go wrong. The higher discount factor (lower world interest rate) will induce a shift by OPEC out of foreign assets into their other asset, oil in the ground, until once again the rate of returns are equalized (Figure 2, move from B to C). This involves less production today and more tomorrow, indicating an increase in today's price \( q \) and a decrease in tomorrow's price \( q_2 \) (although not enough to offset the higher discount factor, so that the price of oil tomorrow discounted back to today still rises). See point C in Figure 2.
Figure 2: Effects of a tax on interest payments to OPEC on the price of oil and the world interest rate

The lower world interest rate makes Industria better off, but the increase in the price of oil it triggers leads to a welfare loss.

Another way of looking at it is that the tax on borrowing exploits monopoly power to improve tomorrow's terms of trade, and so increases Industria's welfare; it will however also deteriorate today's terms of trade and so reduce Industria's welfare. Since we have more than two commodities, giving rise to the possibility of complementarity, it cannot be excluded that the second effect dominates. Below we point out the analogy of this result.
with recent work indicating that with sufficient complementarity the optimal tariff vector may have negative elements (Feenstra (1983)).

The net welfare effect of the tax on Industria's interest payment to OPEC is therefore ambiguous:

\[
\frac{dU}{d\tau} = \frac{\partial U}{\partial \delta^*} \frac{\partial \delta^*}{\partial \tau} + \frac{\partial U}{\partial q} \frac{\partial q}{\partial \tau} \\
= \left( E_1 P_1 q_2 - \frac{2 R_k}{R_{KK}} \right)^{-1} x \\
\left\{ \left( b_2 - \frac{2 P_2}{q \overline{\delta^*}} \right) \left( \frac{1}{R_{KK}} q + \frac{2 R_1}{\overline{\delta^*}} \right) - 2 \frac{2 P_2}{\overline{\delta^*}} \right\}
\]

where $\Delta$ is the Jacobian of the system (stability requires $\Delta$ to be negative). If we define oil demand elasticities

\[
\epsilon_1 = q \frac{\partial z_1}{\partial q}
\]

with oil demand $z_1 = -\frac{1}{q_1}$, (16) can be simplified to get, after some manipulation:

\[
\gamma \frac{dU}{d\tau} = \left( \frac{\epsilon_1}{S_1} \frac{S_1}{S_2} - \frac{E_1}{E_{P_1}} \right) \left( \frac{E_2}{E_{P_2}} \right)
\]

$S_1$ and $S_2$ are oil production in period 1 and 2, while $E_1$ and $E_2$ equal OPEC expenditure today and the discounted value of its expenditure tomorrow (note that OPEC by assumption spends on Industria's goods only) respectively; $\gamma$ is a positive constant.
(17) indicates that when oil demand elasticities are constant over time \( \epsilon_1 = \epsilon_2 \) it will be optimal to subsidize rather than tax borrowing from OPEC if Industria's oil use is more tilted towards the future than OPEC's expenditure on Industria's goods \( S_1/S_2 < E^*/(E^*_b/E^*_p) \). This condition of course contradicts our starting assumption of large OPEC surpluses today. The other condition under which sign reversal of the optimal tax on borrowing may obtain is therefore of more interest: if future oil demand elasticities are sufficiently larger than current ones it is once again optimal to subsidize rather than tax borrowing from OPEC even if OPEC's expenditure is more tilted towards the future than our oil use:

\[
\frac{\epsilon_2}{\epsilon_1} > \frac{E^*_o}{E^*_p} \frac{S_1}{S_2} \Rightarrow \frac{dU}{d\tau} \bigg|_{\tau=0} < 0
\]

An intuitive explanation of why this result obtains in the presence of rational oil pricing by OPEC while it did not come out in the Marion/Svensson analysis with exogenous oil prices is available once we recognize the analogy of the problem considered here to the more general problem of welfare effects of tariffs in three (or more) goods models (see in particular Feenstra (1983)).

The Marion-Svensson analysis assumes fixed oil prices in terms of final goods; this allows Hicks-aggregation of oil and final goods within each period so that their model reduces to a two goods model (oil-and-final-goods
today and tomorrow). In a two-goods model there cannot be any complementarity; therefore the optimal tariff on future goods is positive, or, equivalently, borrowing from OPEC should be taxed.

In our case however oil prices are determined via the Hotelling rule

\[ q_1 = \delta^* q_2 \]

and the market clearing condition

\[ \frac{1}{q_2} \frac{d}{q_2} + \frac{2}{q_2} + S = 0 \]

this implies that the price of oil in terms of final goods can vary each period. On the other hand efficient oil pricing over time leads to equalization of the discounted price of future oil with the current price, allowing Hicks-aggregation of current and future oil into one Hicks-aggregate good oil. This implies that the model analyzed in this paper can be considered a special case of the three good model analyzed in Feenstra (1983): final goods today (the numeraire commodity), final goods tomorrow (with price in terms of the numeraire equal to \( \delta^* \)), and oil with price in terms of the numeraire \( q \).

Industria exports the two final goods and imports oil.

Feenstra (1983) shows that for that case a subsidy on one export good starting from free trade (the correct analogy with our set up) can be welfare improving for the exporter if the resulting terms of trade loss is more than offset by a terms of trade gain in the market for the import good. This is possible if the export good is sufficiently more complementary with the import good at home than it is abroad. The intuition is obvious: with sufficient complementarity the higher domestic price of the export good caused by the subsidy will lead to such a large fall in domestic demand for the import good (because it is complementary with the export good) that the terms

\[ T \]

This is ruled out in the two-goods case by the homogeneity of degree zero of net demand functions.
of trade there improve enough to offset the terms of trade loss on the export good. Similar results can be obtained for the fully optimal tariff vector (Feenstra (1983)).

This analysis explains the intuition behind condition (17), although it may be easier to see if it is rewritten slightly from the initial form:

\[
\frac{1}{q_1 q_1} \frac{\delta^*}{R} - \frac{E^*}{P_1 P_2} \times 0 \iff \frac{dU}{d\tau} \bigg|_{\tau=0} \times 0 .
\]

The role of the term \( E^* \) is straightforward: if \( E^* \) (future exports to OPEC) is large, future terms of trade gains due to a tax on borrowing will have a bigger positive welfare impact, so that tends towards a positive sign of \( \frac{dU}{d\tau} \bigg|_{\tau=0} \); of course the opposite holds for first period exports to OPEC, \( E^* \), since first period terms of trade will deteriorate if a small tax is put on.

The role of \( \frac{1}{q_1 q_1} \frac{\delta^*}{R} \frac{1}{q_2 q_2} \) is more subtle. Remember that what matters is whether future final goods are sufficiently complementary to the import good (oil) where "sufficiently" depends among other things on the ratio \( E^*/E^* \). Complementarity of oil with tomorrow's final goods implies that a higher foreign (\( \delta^* \)), but lower domestic (\( \delta \)) price of future goods in terms of the numeraire (today's final goods) will lead to an increased demand for oil and therefore to a terms of trade loss on that account. This effect should be strong enough to offset the terms of trade gain in the market for future final goods. To look at the complementarity issue, consider what happens to oil demand when a small tax \( \tau \) drives down the world interest rate \( r^* \) and so increases \( \delta^* \), the price of future goods. If OPEC does not respond by changing the price of oil in terms of the numeraire (current final goods,
i.e., if \( q_1 \) and \( \delta^* q_2 \) remained unchanged at value \( q \) oil will become cheaper in terms of future goods:

\[
\frac{\partial q_2}{\partial \delta^*} \bigg|_{q=q} = -\frac{q}{\delta^*} < 0
\]

Therefore oil demand tomorrow will go up, and the more so the larger \( \frac{q_2}{q_2} \). Of course more oil tomorrow means less oil today so that if tomorrow's increase in oil demand is met, excess demand for oil develops in period 1. This will lead to a price increase which will be larger, the smaller \( \frac{1_R}{q_1 q_1} \). Accordingly the tax induced terms of trade losses on oil account will be larger the smaller the quantity \( \frac{1_R}{q_1 q_1} \)

An alternative way of looking at the same thing is to consider what determines the size of the increase in the price of oil necessary to reduce demand for oil after a given increase in \( \delta^* \) has caused excess demand for oil: by differentiating the market clearing equation we get

\[
\frac{dq}{d\delta^*} = \frac{1}{1 + \left( \frac{1_R}{q_1 q_1} \delta^*/R q_2 q_2 \right)}
\]

so a low factor \( \frac{1_R}{q_1 q_1} \delta^*/R q_2 q_2 \) will lead to a large increase in \( q \) (and accordingly a large welfare loss on that account) for any given increase in \( \delta^* \).
Section 3: Conclusions

We analyze whether oil importing countries should tax interest payments to OPEC (raise the cost of borrowing from them) to exploit collective monopoly power in the world capital market. In a recent paper Marion and Svensson (1983) argue this case, following standard optimal tariff arguments, but ignoring exhaustibility of oil and its consequences for efficient oil pricing. In fact they assume exogenous oil prices in terms of final goods. Taking these factors into account is shown to potentially reverse this result.

In this paper we explicitly introduce the exhaustibility of oil and the Hotelling rule for OPEC pricing behaviour, OPEC sets the discounted future oil price equal to the current one (marginal extraction costs are assumed to be zero). It is shown that under those circumstances a tax on interest payments to OPEC is not necessarily welfare improving for Industria. Imposing such a tax is shown to lead to oil price increases, the negative welfare effects of which (for Industria) may more than offset the positive welfare effects of such a tax given the price of oil. A simple expression for the total effect on Industria's welfare of such a tax is derived, indicating that if future oil demand elasticities are sufficiently higher than current ones, a subsidy is called for rather than a tax. The intuition behind this result is explained using recent results on the structure of optimal tariffs in the presence of complementarities.
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