Ansgar Belke and Daniel Gros

A Simple Model of an Oil Based Global Savings Glut

The "China Factor" and the OPEC Cartel

#128

Ruhr Economic Papers

UNIVERSITÄT DUISBURG ESSEN

Ruhr Economic Papers

Published by

Ruhr-Universität Bochum (RUB), Department of Economics
Universitätsstr. 150, 44801 Bochum, Germany

Technische Universität Dortmund, Department of Economic and Social Sciences
Vogelpothsweg 87, 44227 Dortmund, Germany

Universität Duisburg-Essen, Department of Economics
Universitätsstraße 12, 45117 Essen, Germany

Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI)
Hohenzollernstr. 1/3, 45128 Essen, Germany

Ruhr Economic Papers #128

Responsible Editor: Volker Clausen

ISSN 1864-4872 (online) – ISBN 978-3-86788-140-1

Ruhr Economic Papers

#128

Ansgar Belke and Daniel Gros

A Simple Model of an Oil Based Global Savings Glut

The "China Factor" and the OPEC Cartel

Bibliografische Information der Deutschen Nationalbibliothek
Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.d-nb.de abrufbar.

ISSN 1864-4872 (online)
ISBN 978-3-86788-140-1

Ansgar Belke and Daniel Gros*

A Simple Model of an Oil Based Global Savings Glut – The "China Factor" and the OPEC Cartel

Abstract
The purpose of this contribution is to illustrate the mechanism by which higher oil prices might lead to lower interest rates in the context of a simple model that takes into account the global external savings equilibrium. The simple model has interesting implications for how one views the huge US current account deficit and how the emergence of China's savings surplus and oil supply shocks impact the global economy. We show that the new equilibrium is located at a lower interest rate but also at a lower income level than without the China effect. Moreover, we argue that the lower real interest rates resulting from excess OPEC savings have facilitated the adjustment to the subprime crisis

JEL Classification: E21, E43, F32, Q43

Keywords: China factor, current account adjustment, interest rate, oil prices, saving glut

July 2009

---

* Ansgar Belke, University of Duisburg-Essen, Essen, and IZA Bonn; Daniel Gros, Centre for European Policy Studies (CEPS), Brussels. – We are grateful for valuable comments to Marianne Haug and participants in the international conference on "The Global Financial Crisis and the Reform of the Financial Regulatory Framework", School of Finance, Central University of Finance and Economics, and German Development Institute (DIE), May 7-8 in Beijing, and the International Conference on India and China's Role in International Trade and Finance and Global Economic Governance, ICRIER and IMF, December 6–7, 2007, Delhi. – All correspondence to Ansgar Belke, University of Duisburg-Essen, Department of Economics, 45177 Essen, Germany, e-mail: ansgar.belke@uni-due.de.

1. Introduction

The price of crude oil is discussed almost daily in the financial press and its evolution poses acute problems for policy makers everywhere. The oil price being still low in 2001, the next six years saw a steady increase that tripled the price by the middle of 2007. Later that year, the path of oil prices steepened sharply, sending the price to an all-time high on July 3, 2008, only to be followed by an even more spectacular price collapse (Hamilton 2008, p. 1). Around the turn-of-year 2008/09, the oil price has started to rebound.

It is also well known that oil producers have reaped enormous windfall profits from record oil prices. However, what is less well known and less widely reported is that oil producers also tend to save a sizeable proportion of their gains (Higgins, Klitgaard and Lerman 2006, IMF 2006, p. 75). This fact has one clear implication: an increase in the oil price will lead to an increase in the global supply of savings, and hence, at least potentially, also to lower interest rates. That savings from oil producers can have an important impact on the global supply of savings is clear from the raw numbers.

For the year 2007 it was expected that the OPEC group of countries should have a current account surplus of around 300 to 400 billion USD, which corresponded to about one half of the US deficit and represented a large share of the total sum of current account surpluses, and hence also of the total amount of external savings which is available globally.[1] The Saudi Arabian current account position, for instance, moved from being broadly in balance around the turn of the century to running a surplus worth more than 30% of GDP in 2008. If there were any hint that the rise in oil prices might not prove durable, it would make sense to save some of these gains (Broadbent and Daly 2009). Later on we will argue that the reason for the emergence of this surplus is quite simple: ever-rising oil prices transfer wealth from oil-consuming countries to oil-producing countries, and oil-producing countries have a higher propensity to save out of current income.

---

[1] For more details see, for instance, Gros, Mayer and Ubide (2006), pp. 40-62.

Table 1 - *Current account balances, 2001-2009 ($ billions)*

	2001	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
US	- 384.701	-461.271	-523.413	-624.999	-728.994	-788.115	-731.214	-673.266	-393.25
Japan	87.794	112.607	136.238	172.07	165.69	170.437	210.967	157.079	76.363
Euro area	6.612	47.825	42.951	116.968	40.947	31.526	20.439	-95.506	-133.769
UK	-30.386	-28.009	-29.92	-46.161	-59.511	-82.975	-80.722	-45.392	-40.73
CEECs	-10.439	-16.924	-28.998	-48.61	-54.734	-82.52	-122.079	-142.193	-59.366
Emerging and developing economies	46.639	83.19	151.271	226.086	447.763	630.632	633.403	714.44	262.438
China	17.405	35.422	45.875	68.659	160.818	253.268	371.833	440.011	496.569
CIS*	33	30.3	35.7	63.5	87.5	96.2	70.9	108.7	0.6
Middle East	40.442	29.893	57.466	97.073	201.345	252.868	254.112	341.62	-10.155
Western Hemisphere	-53.902	-16.185	9,30	22.051	35.502	47.673	13.376	-28.293	-77.252
Asian NICs	48	55.7	81	83.5	80.2	90	103.6	76.2	91
Developing Asia	36.613	64.757	82.423	89.276	162.277	282.38	406.466	422.377	481.328

Source: IMF (2009), World Economic Outlook Database.

* Mongolia, which is not a member of the Commonwealth of Independent States, is included in this group for reasons of geography and similarities in economic structure. Data for 2009 are based on IMF forecasts.

Table 1 summarizes changes in current accounts corresponding to changes in savings and investment balances. The current account position of emerging and developing countries improved by almost $670 billion between 2001 and 2008, while the current account position of the other countries/regions listed in the table deteriorated by some $500 billion. Within the latter group, the current account position of Japan rose until 2007 while that of the euro area deteriorated from 2004 on. Thus, increases in the current account surpluses of emerging and developing countries and Japan financed to a large degree the increase in the current account deficits of other countries.

In general, the savings glut in the emerging world was in large part a result of policies that emerging market economies put in place when the global economy started to recover from the 2000-01 recession (Bernanke 2005 and 2007).[2] Since it was spurred by monetary and fiscal stimulus in the US, some call it the liquidity glut. The rise in the international supply of savings from emerging market economies (EMEs) combined with a fall in investment in OECD countries pushed real interest rates to record lows. The deflation scare that emerged from the combination of the bursting of the stock market bubble, the shocks that ensued from the corporate scandals and geopolitical events, combined with the entering of China and India into the world trading system, provoked in response a policy of aggressive lowering of nominal and real interest rates. An initial savings glut thus became a liquidity glut.

China adopted policies that increased Chinese savings and restrained investment to try to keep the renminbi's large real depreciation after 2002 – a depreciation that reflected the dollar's depreciation – from leading to an unwanted rise in inflation. The governments of the oil-exporting economies opted to save most oil windfall – at least initially (Higgins, Klitgaard and Lerman 2006). Those policies intersected with distorted incentives in the US and European financial sector – the incentives that made private banks and shadow banks willing to take on the risk of lending to ever-more indebted

---

[2] The argument posits that an oversupply of savings - particularly in Emerging Asia - helped to generate a US current account deficit as the savings had to flow somewhere, and the US was the willing recipient of the savings.

households (a risk that most emerging market central banks didn't want to take) to lay the foundation for trouble.

Seen on the whole, thus, savings rates rose substantially in the emerging world from 2002 to 2007, although it is quite unusual for Asia and the oil exporters to show large surpluses at the same time.[3] The main reason for the rise in emerging Asia's savings is simple: China's GDP rose relative to world GDP, and China's savings rate rose relative to China's GDP. The result was a very large increase in the aggregate savings of the emerging world – especially after 2003. The rise in the combined surplus of Asia and the oil exporters that followed the Asian crisis was around 0.5% of world GDP. The post 2003 "China boom" pushed the combined savings rate of the oil exporters and emerging Asia up another 1% of world GDP. The net result was that the global economy prior to the crisis was characterized both by high levels of both savings and investment in Asia and the oil exporters and by high levels of consumption and low levels of savings in the US. Moreover, the major advanced economies began to run large current account deficits (see Broadbent and Daly 2009, Figure 6).

The purpose of this contribution is to illustrate the mechanism by which *higher oil prices might lead to lower interest rates* in the context of a simple model that takes into account the global external savings equilibrium. The simple model has interesting implications for how one views the huge US current account deficit and how the emergence of China's savings surplus and oil supply shocks impact the global economy. Moreover, we will argue that the lower real interest rates resulting from excess OPEC savings should have facilitated the adjustment to the subprime crisis.

The paper proceeds as follows. In section 2, the theoretical model is derived. For this purpose we have a closer look at the relationship between the price of oil and world output and the world supply of savings. But before we continue by deriving the world savings equilibrium in section 2.4, we check what could motivate oil exporters to save a large fraction of their current income. Section 3 contains some illustrations of the 'sos'

---

[3] See, for instance, Bernanke (2005). In 1998, the fall in oil prices helped Asia and hurt the oil exporters; in 2000 the rise in oil prices helped the oil exporters and hurt Asia. And way back in 1980, Asia ran a deficit that helped offset the oil exporters' surplus.

(savings-oil-savings) curve as the global savings balance condition and section 4 presents some comparative statics with respect to two types of shocks: the emergence of China and an oil supply shock. In section 5, we arrive at some policy conclusions.

2. The model

The basic building blocks of the model are quite simple. First, we derive the relationship between the price of oil and world output. Second, we illustrate the world supply of savings. Third, we solve for the global equilibrium savings.

2.1 The relationship between the price of oil and world output

We start with the oil market and in particular with the *demand for oil*. It is assumed here that growth in world income and production leads, ceteris paribus, to an equi-proportional increase in the demand for oil and that the price elasticity of demand is rather low.

Denoting income (in oil consuming countries) by the variable y and oil demand by the variable q the *demand for oil* can be written as:

(1) $q_d = y\, p^{-\varepsilon}$ with $\varepsilon < 1$,

where the variable p stands for the price of oil.[4] The elasticity of demand with respect to the price of oil, denoted by ε, is assumed to be low, and in any case smaller than one, as confirmed by many studies. Global demand for OPEC oil is sluggish due to the slow dynamics in demand[5] and non-OPEC supplies.

In terms of the determinants of demand, Hamilton (2008), p. 1, notes that the price elasticity of demand is challenging to measure but appears to be quite low and to have decreased in the most recent data. The income elasticity is easier to estimate, and is near unity for many countries. Anyway, most studies of the oil market find a long-term price elasticity of demand of between 0.1 and 0.3 (Gately 2004, Gately and Huntington

[4] Strictly speaking, our variable y denotes the deviation from the “normal“ growth path.

[5] Energy and in particular oil demand depends on appliances, their number and their technical efficiency. This existing stock of appliances limits short run adjustments to behavioral adaptations and implies that time constants of many years if not decades (e.g. thermal efficiency of buildings) characterize long run adjustments. See Wirl (2009), p. 5.

2002). For instance, Dahl (1993) and Cooper (2003) arrive at long-run demand elasticities for crude oil of -0.2 to -0.3. Hamilton (2008) comes up with an estimate of the intermediate-run price elasticity of oil demand of 0.26. Hence, in section 3 where we will illustrate the 'sos' (savings-oil-savings) curve we feel legitimized to assume a parameter value of $\varepsilon = 0.25$.

The second element of the description of the oil market relates the price of oil to its supply. Here the crucial assumption is that, in the short run, the *oil supply* is very inelastic, especially if producers operate close to capacity, so that the market clearing price must grow at an increasing rate as demand nears the available supply.[6] This seemed to represent the situation as of end-2007 when the price was close to 100 USD per barrel as oil stocks fell to a historical low. The following (standard) functional form was chosen in order to keep the algebra simple:

(2) $q^s = q_0 \, p^\zeta$ with $\zeta < 0.5$,

where ζ denotes the elasticity of supply and the shift parameter q_0 represents any other influences on the supply and, hence, the price for oil, as for example expressed by a political risk premium. The parameter ζ might become zero, especially if one considers oil as an exhaustible resource. In the latter case, the Hotelling rule applies, according to which the price of oil increases at the interest rate and the supply is constant (see Hotelling 1931 and section 2.3 of this paper).

Setting supply equal to demand yields a simple *relationship between the price of oil*, p, *and world output*, y:

(3) $p = (y/q_0)^\theta$, with $\theta \equiv 1/(\zeta + \varepsilon) > 1$ if $\varepsilon < 1$ and $\zeta = 0$.

---

[6] The supply side faces substantial lead times for new oil fields, pipelines, alternative energy carriers, new power plants, etc. that limit short run expansions of output. There are enormous lead times between the initial discovery of a new oil reservoir and the time at which the new oil is actually being delivered to a refinery to use. These lags mean that, in the absence of significant excess production capacity, the short-run price elasticity of oil supply is also very low, another factor contributing to the potential price implications of supply disruptions (analyzed by us in section 4). See Hamilton (2008), p. 25, and Wirl (2009), p. 5.

Note that in this case $\zeta = 0$ is a sufficient, but not a necessary condition for $\theta \equiv 1/(\zeta + \varepsilon) > 1$ to hold.[7] Let us now derive the world supply of savings.

2.2 The supply of savings

The next building block describes the *supply of savings* by the two main country blocks within the world economy: the oil consuming economies (as proxied, for instance, by the US which displays the highest variation or, more generally, the OECD countries and, more recently, China) and the oil suppliers representing mainly the OPEC countries.

Modeling the supply of (external) savings by the *oil producing countries* (OPEC) is straightforward. As mentioned above, OPEC member countries tend to save a certain fraction of their oil revenues. Thus, we have:

$$(4) \quad s_{OPEC} = \gamma pq = \gamma y^{\theta(1+\zeta)} q_0^{\theta(\varepsilon-1)} \text{ with } 0 < \gamma < 1$$

This simple form reflects the fact that in OPEC countries domestic financial markets are underdeveloped. In these countries it is essentially the government which determines the use of oil revenues and, thus, also how much is saved. Fiscal policy is key here. OPEC revenues are equal to the product of the price of oil (as expressed by eq. (3)) and the quantity of oil supplied (for instance, eq. (2) solved for the equilibrium oil price). The fraction saved, denoted by γ, is constant and, as already stated, exogenously determined by governments. As a stylized fact, it can be observed from the raw data that the savings rates of the oil producers vary sharply with the oil price (Gros, Mayer and Ubide 2006, p. 63).

The advice of the international financial institutions like, for instance, the International Monetary Fund (IMF) to oil producers is to save about half of their windfall gains from higher oil prices. If the oil price stays around $90 a barrel, oil producers will

---

[7] "In other words, it is the confluence of demand and supply factors that determines the effects of shocks to the oil market" (Dvir and Rogoff 2009, p. 34).

increase their current account surpluses by \$200bn-\$300bn a year.[8] However, in some cases, the strategy of some sovereign wealth funds more or less corresponds with the restriction $\gamma = 1$. Interest rates therefore do not play, de facto, a major role in determining OPEC savings. However, it is a different question what role interest rates should play in the perspective of inter-temporal optimization of consumption paths.

Modeling the supply of savings, i.e. net external savings, by *oil consuming countries* (here, the US or, more generally, the OECD countries and, eventually, China) turns out to be more conventional.[9] The savings supply depends on income and the real interest rate (i):

(5) $s_{OECD} = s_0 - \delta y + \varphi i$

where s_0 represents an exogenous shift factor.[10] This could, for example, be the result of a housing bubble which leads to a lower savings rate - for instance via a perceived wealth effect and housing equity extraction, as was popular until the start of the credit crisis in the US. But this shift could also be *the 'China' factor*, i.e. the emergence of a huge external current account surplus in China, where financial markets are much less developed and thus interest rates might have little impact on savings and investment decisions. It is implicitly assumed here that OECD consumers do not increase their savings in response to higher oil prices. This assumption could be easily modified (Kilian 2007, p. 9), but our essential results would not be affected as long as the propensity to save of OPEC is higher than that of the OECD.

---

[8] See Higgins, Klitgaard and Lerman (2006). The question will then be: who is willing and able to run corresponding deficits? Apart from the US, there are only two regions large enough to contemplate a shift in the external position of this order of magnitude: the euro area and Asia (Japan and China).

[9] As an aside, one might note that there is indeed a marked difference between the EU and the US in terms of oil consumption: the US has been responsible for almost one-quarter of the global increase in oil consumption from 1994 to 2004, against less than 10% for the EU. See Gros, Mayer and Ubide (2006), p. 60.

[10] Equation (5) represents a reduced form many people think about. Without loss of generality but also without changing the character of our results, it could have been explicitly derived by the NOEM three equations block.

2.3 Oil prices and OPEC savings

Before we continue by deriving the world savings equilibrium in section 2.4, we investigate what could motivate oil exporters to save a large fraction γ of their current income (see eq. (4)). One often cited reason is uncertainty about future prices (and hence incomes). Thus, the marginal propensity to consume may be very low in the short run. This might be partially the case because future prices exist only for at most five years.

Moreover, the international financial institutions (IFIs) have been urging governments of oil-producing countries to build up stabilisation funds, advice that has been at least partially taken. This implies that governments are saving a substantial part of the windfalls that accrue to them in the form of higher royalties in order to raise national savings (Higgins, Klitgaard and Lerman 2006). These two mechanisms, both of which are based on the uncertainty surrounding future oil prices, are fundamentally very similar.

However, there is another, simpler explanation why OPEC savings rates have increased: available reserves might now be much closer to exhaustion. This would explain why observed savings rates increase over time.

Consider a country with a finite amount of oil, Q, which has already been found and where the investment in extraction has already been undertaken. Denoting extraction in period t by q_t it is clear that with $\sum q_t = Q$ the sum of production over time can just exhaust reserves. Assuming that the lowest cost pattern of extraction is just to run production at current levels, extraction will just be a constant and will last for Q/q = m years, where m is the variable called usually years of supply.

OPEC's inhabitants have access to international capital markets. For them, the problem is thus to find a consumption path which maximizes their utility under the constraint that the present value of consumption equals the present value of oil production.

The latter can be easily calculated given that production is constant for m years and then falls to zero:

$$(6) \quad Pv = q \sum^{m} p_t(1+i)^{-t}$$

Where Pv is the present value of oil revenues and p_t denotes the price of oil in terms of the consumption good.

For any individual oil producer the future price path is exogenous. There is some discussion in the literature on exhaustible resources whether prices should increase over time at the rate of interest or at a rate equal to the difference between the interest rate and extraction costs (see, for instance, Akram 2009). Here it is just assumed that prices are expected to increase at the rate r.

The present value of the resource is then equal to:

(7) $Pv = qp_0 \sum^m [(1+r)/(1+i)]^t$

The consumption side is also straightforward: with infinitely lived consumers and the interest rate equal to the rate of time preference the optimal consumption plan is to keep consumption, denoted by c, constant, equal to the interest earnings on the present value:

(8) $C = i\, Pv$

It follows that the savings rate of an OPEC country can be written as:

(9) $S = (qp_0 - c)/qp_0 = 1 - i \sum^m [((1+r)/(1+i)]^t$

For the special case (Hotelling 1931) that r = i (the price of oil keeps increasing at the rate of interest) this collapses to:

(10) $S = 1 - im.$

This expression shows immediately that the lower m the higher will be the saving rate. In practical terms this means that a country where oil can last (at current production) only twenty years will save much more out of current (oil) revenues than a country where oil is going to last much longer.

This simple mechanism suggests that the current high savings rates of OPEC countries might constitute a signal that the producers themselves do not expect their reserves to last much longer. There is considerable uncertainty about the size of the actual 'recoverable' reserves in places like Saudi Arabia and other Middle Eastern producers. If governments and consumers in these countries are consistently sticking to their high savings rates, this might suggest that maybe their reserves are lower than often assumed.[11]

2.4 Global equilibrium savings – the role of the oil price

Global equilibrium requires that external savings of the OPEC countries s_{OPEC} equals dis-savings of oil consumers s_{OECD}. Combining eqs. (4) and (5) and multiplying the LHS with (-1) implies:

$$(11) \qquad -\gamma pq = s_0 - \delta y + \varphi i$$

Inserting now the equilibrium conditions from the oil market (eqs. (1) to (3)) leads to the following relationship between income and the interest rate:

$$(12) \qquad \varphi i = -s_0 + \delta y - \gamma\, y^{\theta(1+\zeta)}\, q_0^{\theta(\varepsilon-1)}$$

Hence, one is able to explain Ben Bernanke's global saving glut at least partially endogenously by the increase in oil prices. The latter is one of the diverse forces which have created a significant increase in the global supply of saving which helps to explain both the increase in the US current account deficit and the relatively low level of long-term interest rates in the world today, i.e. mid-of-2003 to mid-of-2008. Equation (12) reveals the relationship between income and the interest rate that maintains the *equilibrium on the global market for external savings* (and the market for oil). It is apparent that for the case of $\gamma = 0$ (that is when OPEC has a marginal propensity to save its oil revenues equal to zero) this relationship becomes conventional: higher income level leads to higher interest rates. However, with γ being positive, the sign of the relationship between income and the interest rate could change: a higher income could lead to lower interest rates. This at first sight surprising result has a simple explanation: as demand nears available supply, prices increase and hence savings of OPEC increase as

---

[11] There are many views (Matt Simmons' 2005 Twilight in the Desert being the most prominent) that argue that the supply curve is kinked so that the years of plentiful and inexpensive oil supplies are over and that the future holds a much more difficult and expensive search for new sources of oil capacity. If one considers, in addition, that the likely sources of new capacity are in the areas of the world where geopolitical risk is higher, the view that supply will be available at the same conditions as in the past has to be qualified to a large extent.

well. This mechanism might well describe the situation over the last few years when higher global growth (especially higher growth in the largest oil consumer country, the US) was not accompanied by higher interest rates. Part of the solution to the 'conundrum' of low long-term interest rates might thus be found in the reaction of OPEC (and of most other oil producing nations) to higher oil prices.

A simple calculation can show that the magnitudes involved are significant. Around 50 billion barrels a day are produced by countries that are not themselves big consumers. An oil price increase of \$30 a barrel (e.g. from \$30 to \$60/barrel) implies a transfer to these producers of about \$1.5 billion per day, or around \$550 billion per annum. If about one-half of this amount is initially saved, the increase in the oil price observed over the last year and a half is equivalent to a negative demand shock of about \$250 billion for the oil-consuming countries. This alone would be equivalent to a drop in the investment ratio in both the US and the euro area of over 1% of GDP. Under reasonable assumptions, an oil shock could thus have a significant impact on the global savings-investment balance (Gros, Mayer and Ubide 2006, pp. 50f.).

3. Illustrations – The 'sos' curve as the global savings balance condition

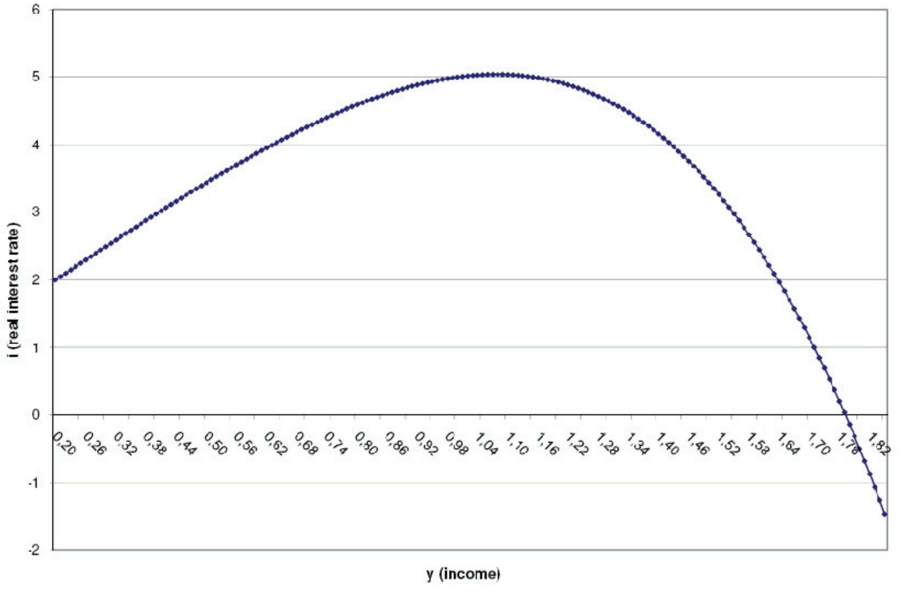
Figure 1 below provides an illustration of the shape of the *global savings balance condition* - without loss of generality - for a particular numerical combination ($\varphi = 1$, $-s_0 = 1$, $\delta = 5$, $\gamma = 1$, $\theta(1+\zeta) = 4 \Rightarrow \zeta = 0$ and $\theta(\varepsilon-1) = -3 \Rightarrow \varepsilon = 0.25$). Justifications of our parameter choice can be drawn from the preceding analysis.[12] For instance, we feel legitimized to set $\gamma = 1$, since, according to section 2.2, the strategy of some sovereign wealth funds more or less corresponds with the restriction $\gamma = 1$. Moreover, we choose $\zeta = 0$, since oil is an exhaustible resource for which, according to section 2.2 the Hotelling rule applies. Finally, we set $\varepsilon = 0.25$, since, as a stylized fact, the elasticity of demand with respect to the price of oil is low.

The curve representing the global savings balance condition in the interest rate-income space is strictly concave and it is henceforth called the 'sos' curve (savings-oil-savings).

[12] We choose $\varphi = 1$ just for simplicity reasons. Changes in the parameter values of φ do not alter our main results.

It relates a specific real interest rate on the ordinate to that level of income on the abscissa which - given the specific real interest rate - satisfies the global savings balance (Figure 1).

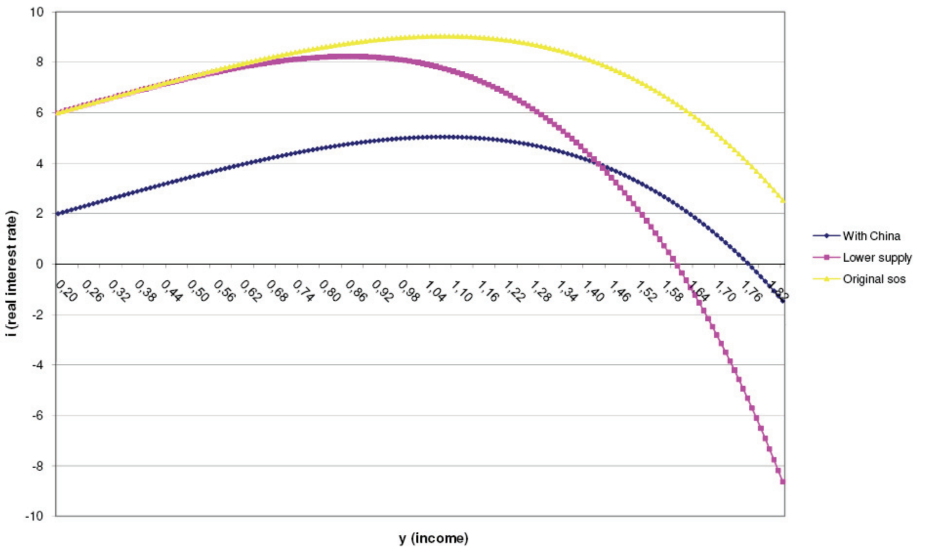
Figure 1 - *The global savings equilibrium (with China)*



In Figure 1 we have derived the original version of the 'sos' curve. However, the location of the 'sos' curve is determined by a number of shocks. On the one hand, the *'China' factor*, i.e. the emergence of China's huge external savings surplus, might cause an increase of s_0 (in our numerical example the parameter s_0 increases from -5 to -1). Because the shift factor amounts to $-s_0$ in eq. (12), taking the China effect into account is equivalent to a parallel downward shift of the 'sos' curve in Figure 2.

On the other hand, one could model the impact of a *negative oil supply shock*, i.e. lower supply, onto the location of the 'sos' curve. In our case, the shift parameter q_0 shrinks from 1 to 0.8. As a result, a negative supply shock (a fall in q_0) would tend to move the 'sos' curve lower, but at an increasing rate ($\theta(\varepsilon-1) = -3$ according to eq. (12) and our numerical simulation values (Figure 2).

Figure 2 - *The global savings equilibrium (with China): lower supply*



Note: The parameter s_0 takes a value of -1 when the 'sos' curve includes the China factor and a value of -5 in case of the original 'sos' curve. In case of the lower supply 'sos' curve, the shift parameter q_0 shrinks from 1 to 0.8.

Equation (12) represents just the combinations of world GDP and interest rates that satisfy the global savings equilibrium. In order to close the model we use a *standard IS equation* which links (again valid mainly for OECD countries) demand to interest rates in a simple and standard way:

(13) $$y = f - \omega^{-1} i,$$

where f is again an arbitrary shift factor. It could represent fiscal policy, or again, the impact of housing markets on consumption demand. The parameter ω represents the semi-elasticity of demand to the interest rate. It might be higher in the US than in other OECD countries and zero in China, where, according to section 2.2, financial markets are much less developed and thus interest rates might have little impact on investment demand.

Putting the last two equations (12) and (13) together gives the level of income determined by the global equilibrium in both the oil market and the market for external savings:

(14) $\varphi\omega(f\text{-}y) = - s_0 + \delta y - \gamma y^{\theta(1+\zeta)} q_0^{\theta(\varepsilon-1)}$. y =
$(\varphi\omega + \delta)^{-1} [\varphi\omega f + s_0 + \gamma y^{\theta(1+\zeta)} q_0^{\theta(\varepsilon-1)}]$.

Given the non-linearity in the oil market this equation cannot be solved explicitly for y, but it can be simplified to:

(15) $y = (\varphi\omega + \delta)^{-1} [\varphi\omega f + s_0 + \gamma y^{\theta(1+\zeta)} q_0^{\theta(\varepsilon-1)}]$.

In general, this equation might have *two solutions*: one at low GDP (and low oil prices) and another one at a high GDP level and high oil prices. The latter would be accompanied by lower interest rates.

Graphically, the equilibrium is determined by the intersection between the (linear) IS curve and the (non-linear) global savings equilibrium condition (see Figure 3 below). Given that the IS curve is linear and that the global savings equilibrium relationship is strictly concave, there will always exist *two points of intersection* (or none if the IS curve is too high; in this case no equilibrium exists). Which of the two combinations of y and i which both satisfy the IS curve (demand within OECD countries) and the global savings balance will materialize in the market?

The answer is suggested by the dynamics that are inherent in a system with two market determined prices (the price of crude oil and the interest rate) and a slower moving variable, namely output, and thus also employment in OECD countries. The system will thus always be on the global savings balance line, but maybe temporarily off the IS curve.

At any point *above* the IS curve the interest rate is higher than would be warranted by the level of output, hence output will start to decline. This implies that the system will tend to move leftwards on the 'sos' line. The opposite will apply for combinations of i and y *below* the IS line. This implies that *only the equilibrium with the lower oil price is stable*. On points on the 'sos' line to the right of the equilibrium with the higher oil price, world GDP will tend to accelerate driving the oil price ever higher (and global excess savings ever larger).Hence, we are in need to consider only *one equilibrium*. A closer look at the comparative statics of the model in the following section will contribute to a deeper understanding of these issues.

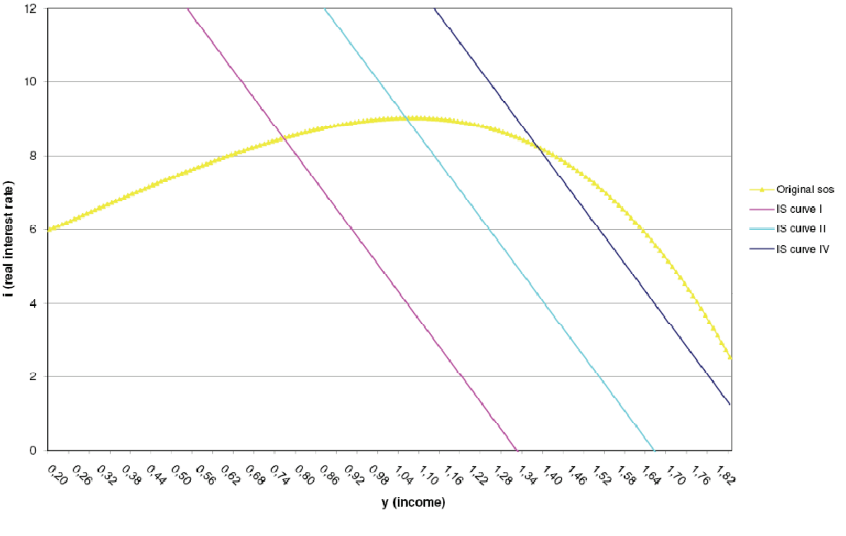
4. Comparative statics

Given our complete and closed model specification, we can now perform the usual *comparative static exercises* to determine how the system consisting of the 'sos' equation (eq. (12)) and the IS curve (eq. (13)) *reacts on different shocks*. For illustration purposes we also need a particular numerical parameterization of the IS-curve. For the purpose of illustration, we set ω = 15 and let ωf vary in a range from 15 to 29.

The first point to note is that any *shift in the 'sos' curve* displaces the equilibrium along the *given* IS curve, with the standard implication that an increase in income is associated with lower interest rates. However, when the IS curve shifts, the sign of the relationship between changes in income and the interest rate *depends on where the IS curve intersects the 'sos' curve* (Figure 3).

Consider, for example, a shift to the right of the IS curve (e.g. the numerical realization of ωf in eq. (13) is raised from 20 to 25 and then to 29) which might reflect an increase in OECD housing prices which leads to higher consumption demand).

Figure 3 - *The global savings equilibrium and shifts in the IS curve*



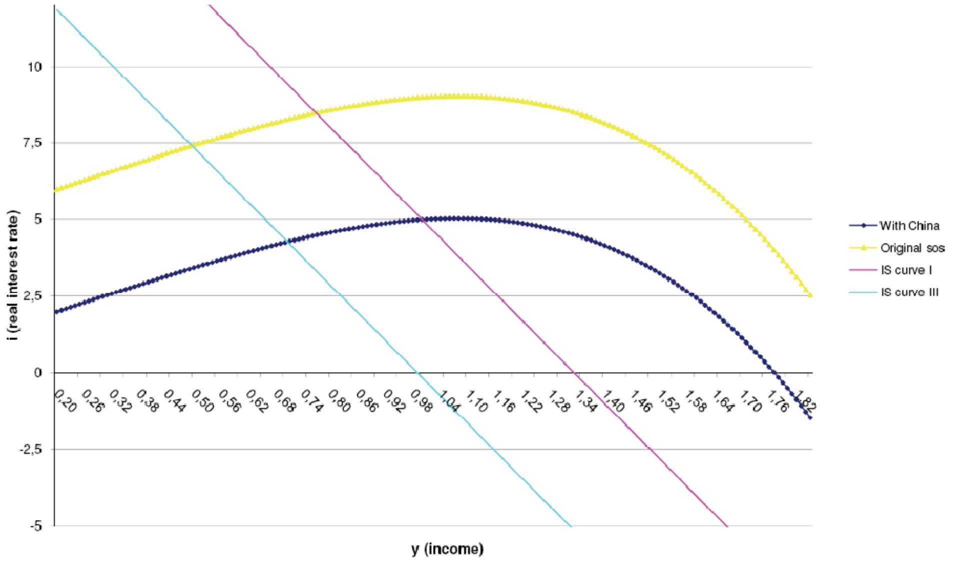
Note: IS curve I: 20-15y; IS curve II: i=25-15y; IS curve IV: 29-15y.

Note that these kinds of shift *do not necessarily lead to higher interest rates*. In this case income could go up, but interest rates could well fall if the intersection of the IS and 'sos' curve is located to the right of the maximum of the 'sos' curve. This might represent what happened when the US economy started to recover in 2004/5, but long-term interest rates stayed very low. By this, our considerations might contribute to solve the so-called interest rate conundrum according to which it proves difficult to attribute the long-term interest rate declines solely to glacially increasing globalization (Greenspan 2005). This aspect of our model fits the facts particularly well because a large part of the counterpart to the increasing US current account deficit came from OPEC surpluses until about 2004/5. The current account surplus of China had still been quite small (and also did not vary much) until about that time.

But how does the emergence of China's savings surplus impact the global economy? This important question is addressed in Figure 4. For this purpose, let us analyze the China effect alone and turn first to the 'sos' curve. As already derived in Figure 2, the 'China' factor leads to a parallel downward shift of the 'sos' curve. What is more, the IS curve shifts to the left, from IS curve I to IS curve III, because ω and, hence, also the product ωf which represents the constant of the IS curve equation becomes smaller if China is included. Again, this is because the parameter ω represents the elasticity of demand to the interest rate which – as explained further above - might be zero in China. As a result, the new equilibrium is located at a *lower interest rate* but also at a *lower GDP rate* than without the China effect.

What does the emergence of an increase in the supply of global savings imply for instance for the EU? The increased supply of savings should keep interest rates low, but this does not require any particular policy reaction assuming it is properly recognized by the ECB. The very large current account surplus of China is a relatively recent phenomenon, and it is not going to increase without limits. Once it stabilizes Chinese imports will increase in line with exports. China will thus not have a deflationary impact on the global economy forever (Belke and Gros 2007).

Figure 4 - *The global savings equilibrium: the China effect alone*

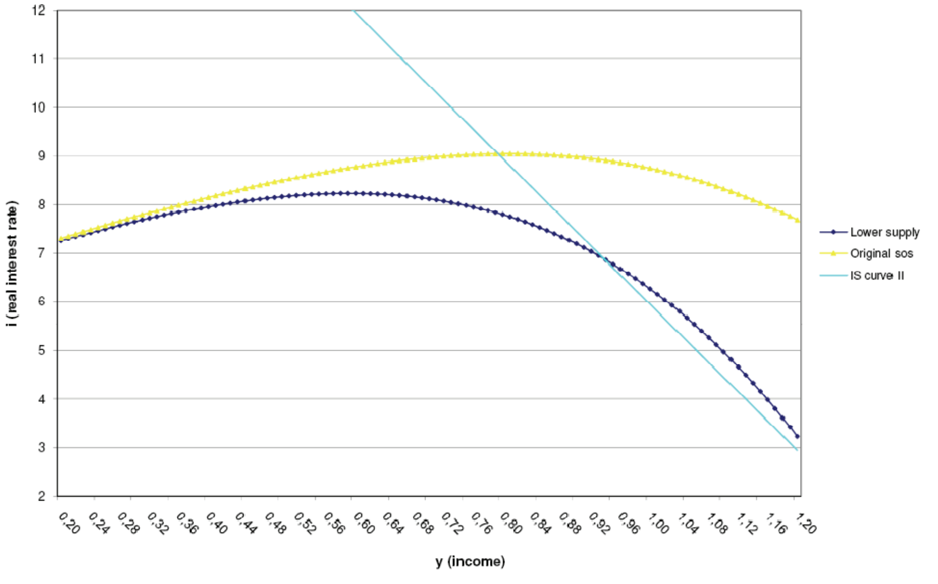


Note: IS curve I: i = 20-15y; IS curve III: I = 15-15y. Hence, the realization of the product ωf is diminished by 5 once the China factor is taken into account. The parameter s_0 takes a value of -1 when the 'sos' curve includes the China factor and a value of -5 in case of the original 'sos' curve.

Let us now finally analyze the impact of a negative supply shock on the global savings equilibrium. Rising oil prices signal the increased scarcity of energy which is a basic input to production. Hence, rising oil prices can be indicative of a classic supply-side shock that reduces potential output, as in Rasche and Tatom (1977 and 1981) and Brown and Yücel (1999). Consequently, the level of GDP is lowered.

A negative supply shock (a fall in q_0) would tend to move the 'sos' curve lower, but at an increasing rate ($\theta(\varepsilon-1)$ according to eq. (12)). With an unchanged IS curve this would then lead to a combination of *higher oil prices*, but also to higher income level in the OECD because of *lower interest rates* which stimulate domestic demand in the OECD region and to higher current account imbalances (higher OECD deficit and higher OPEC savings).

Figure 5 - *The global savings equilibrium: negative supply shock*



5. Policy conclusions

The simple model used here was just meant to illustrate a general idea, which should hold up in more sophisticated models such as, for instance, the New Open Economy Macro model as well. Our main result is that, provided oil prices stay high, an ex ante saving surplus in which surplus countries offer more savings than needed by deficit countries emerges. That should lead to lower global real interest rates (and/or higher asset prices – depending on the way petrodollars are recycled). Hence, the incipient excess of global saving over investment puts downward pressure on real interest rates which supports investment demand in oil importers and weakens incentives to save in oil exporters (IMF 2006, p. 81).

The purpose of this contribution was to illustrate the mechanism by which higher oil prices might lead to lower interest rates in the context of a simple model that takes into account the global external savings equilibrium. The simple model has proven to come up with interesting implications for how one views the huge US current account deficit and how the emergence of China's savings surplus and oil supply shocks impact on the global economy. Our paper implicitly even makes the argument that high oil prices may have just saved the world economy from the intensifying credit squeeze for a while. At least this view was valid until oil prices started to decline in mid-2008. But how so?

The global economy has been hit by two shocks: the subprime lending crisis and *high oil prices*. The latter have faded into the background as prices have stabilized near record levels around the turn-of-year 2007/08. But it would be a mistake to underestimate their importance at that time. The recent surge in oil prices has made a rebalancing of the global economy more difficult, but it might in fact have facilitated the adjustment to the "subprime" credit crisis.

The core of the issue is simple: oil producers tend to save about half of their windfall gains from higher oil prices. If, for instance at the turn-of-year 2007/08 the oil price would have stayed around $90 a barrel, oil producers would have increased their current account surpluses by $200bn-$300bn a year. However, the question in such a scenario always is: who is willing and able to run the corresponding deficits? Apart from the US, there are only two regions large enough to contemplate a shift in the external position of this order of magnitude: the euro area and Asia (Japan and China).

The euro area would have no problem running a current account deficit of $200bn-$300bn (at exchange rates prevailing around the turn-of-year 2007/08, $300bn would amount to €200bn, or about 2.5 per cent of euro area gross domestic product). In an ideal world this could be achieved if domestic demand remained strong in the face of a strong euro. It seems, however, that domestic demand in the euro area is already weakening and is unresponsive to efforts to influence it with either monetary or fiscal policy.

Asia, especially China, has until recently been determined to continue export-led growth (already preparing itself for the next post-crisis export boom). The Chinese authorities will not be able to defer a substantial appreciation of the renminbi for ever. A real appreciation is already happening via higher inflation in China, but this is a relatively slow process. It may take years before Chinese policymakers throw in the towel. Meanwhile, the most that can be expected is a reduction in the pace of increase of its current account surplus.

This prognosis implies, provided oil prices stay high, an *ex ante* savings surplus in which surplus countries offer more savings than needed by deficit countries. That should lead to lower global real interest rates. The rates of Treasury bills in the US prevailing at the turn-of-year 2008/09 were widely interpreted as a signal that recession has become more likely. However, it was just *a natural consequence of the petro-savings glut*. Factoring in petro-savings can also explain why the expectation that a fall in the dollar will lead to higher interest rates has not been fulfilled: as the dollar falls, oil prices increase and the oil based savings glut depresses interest rates worldwide.

Moreover, countries in OPEC, the oil exporters' cartel, are likely to invest at least part of their surpluses in US equities, as a proxy for the global market, thus sustaining the US stock market (witness the 2007 private deal between Citibank and Abu Dhabi). This has tended to mitigate the adjustment in US consumption as lower housing prices were offset by lower interest rates and sustained asset values outside the housing sector.

Since the elasticity of domestic demand with respect to interest rates is higher in the US, the counterpart to rising OPEC surpluses should come again from the US, rather than the euro area (or Asia, where, according to section 2.2, interest rates have little influence on consumption). Thus, other factors apart, from this point of view growth had the potential to remain stronger in the US than in the euro area, which apparently had and still has difficulties compensating for the loss of its export markets with stronger domestic demand.

Seen on the whole, the lower real interest rates resulting from excess OPEC savings should have facilitated the adjustment to the subprime crisis. This is because excess savings from the oil exporters keep real interest rates low and push asset prices back up. In other words, the oil producing nations have generated far more income than they spend and thus have excess savings. The excess savings will be lent out to or used to buy assets from countries willing to live beyond their means, i.e., to run a current account deficit. Since the world economy has been weighed down once again by tightening credit conditions that have emerged from the subprime mess, this injection of excess savings has provided the needed infusion of funding to keep the world economy going. But why is our analysis still relevant today although oil prices have come down significantly in the meantime and are only moderately increasing again?

A first argument is that the next bubble is already looming on the horizon and the pattern described in the paper can reproduce itself. For instance, it is far from unrealistic that the current level of global excess liquidity will sooner or later again feed into higher oil and other asset prices after the velocity of money will have increased again. At least, exactly this is implied by the debate about the role of commodity (and especially oil) prices in setting monetary policy among economists which took place over the last three decades (Angell, 1992). For instance, Barsky and Kilian (2002) demonstrate that monetary fluctuations contribute to trace the historical pattern of the movements of prices of oil and other commodities (see also Frankel 2008, and Hamilton 2008a, pp. 42ff.).

Second, the issues addressed and modeled in the paper could be analysed just in the opposite direction with signs reversed for a scenario of relatively low oil prices as, for instance, prevailing since the midst of 2008. We leave this task for further research.

References

Akram Q.F. (2009), Commodity Prices, Interest Rates and the Dollar, forthcoming in: *Energy Economics*.

Angell, W. D. (1992), Commodity Prices and Monetary Policy: What Have We Learned?, *Cato Journal* 12, pp. 185-192.

Barsky, R. B., Kilian, L. (2002), Do We Really Know that Oil Caused the Great Stagflation? A Monetary Alternative, in: Bernanke, B., Rogoff, K. (eds.), *NBER Macroeconomics Annual* May, pp. 137-183.

Belke, A., Gros, D. (2007), *China and India - Long-term Implications for the EU*, Paper presented at the International Conference on India and China's Role in International Trade and Finance and Global Economic Governance, ICRIER and IMF, December 6-7, Delhi.

Bernanke, B. (2005), *The Global Saving Glut and the U.S. Current Account Deficit*, Homer Jones Lecture, St. Louis, Missouri, April 14.

Bernanke, B. (2007), *Global Imbalances: Recent Developments and Prospects*, Bundesbank Lecture, Berlin.

Broadbent, B., Daly, K. (2009): *The Savings Glut, the Return on Capital and the Rise in Risk Aversion*, Global Economics Paper 185, Goldman Sachs Global Economics – Commodities and Strategy Research, New York et al.

Brown, S.P.A., Yücel, M.K. (1999), Oil Prices and U.S. Aggregate Economic Activity: A Question of Neutrality, *Economic and Financial Review*, Federal Reserve Bank of Dallas, Second Quarter, pp. 16-23.

Cooper, J.C.B. (2003), Price Elasticity of Demand for Crude Oil: Estimates for 23 Countries, *OPEC Review* 27(1), pp. 1-8.

Dahl, C.A. (1993), A Survey of Oil Demand Elasticities for Developing Countries, *OPEC Review* 17, pp. 399-419.

Dvir, E., Rogoff, K.S. (2009), Three Epochs of Oil, NBER Working Paper 14927, National Bureau of Economic Research, Cambridge/MA.

Frankel, J. (2008), *The Effect of Monetary Policy on Real Commodity Prices*, in: John Campbell (ed.), Asset Prices and Monetary Policy, University of Chicago Press, pp. 291-327.

Gately, D. (2004), OPEC's Incentives for Faster Output Growth, *Energy Journal* 25, pp. 75-96.

Gately, D., Huntington, H. (2002), The Asymmetric Effects of Changes in Price and Income on Energy and Oil Demand, *Energy Journal* 23(1), pp. 19-55.

Greenspan, A. (2005), *Testimony before the Committee on Financial Services*, U.S. House of Representatives, February 17.

Gros, D., Mayer, T., Ubide, A. (2006), *A World Out of Balance?*, Special Report of the CEPS Macroeconomic Policy Group, Centre for European Policy Studies (CEPS), Brussels.

Hamilton, J.D. (2008), *Understanding Crude Oil Prices*, Department of Economics, University of California, San Diego, December 6.

Hamilton, J.D. (2008a), *Causes and Consequences of the Oil Shock of 2007-08*, NBER Working Paper 15002, National Bureau of Economic Research, Cambridge/MA.

Higgins, M., Klitgaard, T., Lerman, R. (2006), Recycling Petrodollars, *Current Issues in Economics and Finance* 12(9), Federal Reserve Bank of New York, December.

Hotelling, H. (1931), The Economics of Exhaustible Resources, *Journal of Political Economy* 39(2), pp. 137-75.

IMF (2006), World Economic Outlook, Chapter II, *Oil Prices and Global Imbalances*, International Monetary Fund, Washington/DC, April, pp. 71-95.

Rasche, R.H., Tatom, J.A. (1977), The Effects of the New Energy Regime on Economic Capacity, Production and Prices, *Economic Review*, Federal Reserve Bank of St. Louis 59(4), pp. 2-12.

Rasche, R.H., Tatom, J.A. (1981), Energy Price Shocks, Aggregate Supply and Monetary Policy: the Theory and International Evidence, *Carnegie-Rochester Conference Series on Public Policy* 14, pp. 9-93.

Simmons, M.R. (2005), *Twilight in the Desert - The Coming Saudi Oil Shock and the World Economy*, New Jersey: John Wiley & Sons.

Wirl, F. (2009), OPEC as a Political and Economical Entity, forthcoming in: *European Journal of Political Economy*.