Speculation without oil stockpiling as a signature: a dynamic perspective

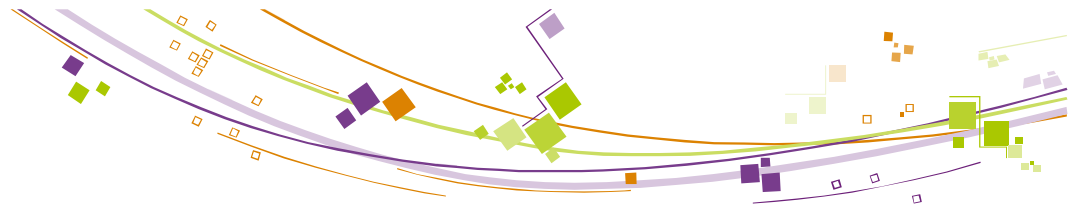## (let's get back to basic economic analysis)

Denis Babusiaux and Axel Pierru

Marchés organisés

Contrat à terme WTI créé sur le NYMEX en 1978

10 ans plus tard, volume de transaction ensemble marchés organisés ~ production mondiale

400 Mb/j en 2003

→ Triplement entre 2004 et 2008 à 15 fois la production mondiale

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Gré à gré (OTC)
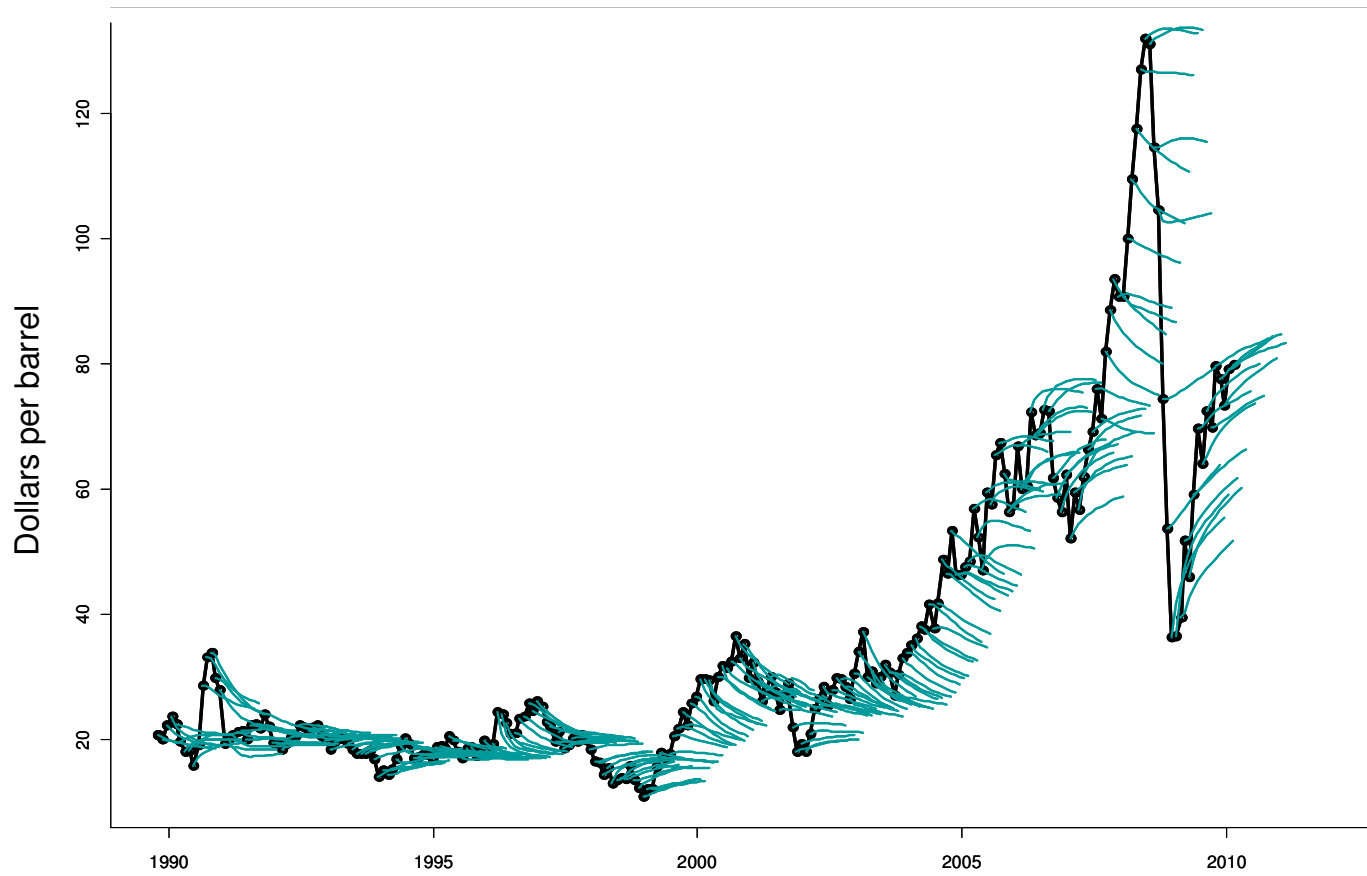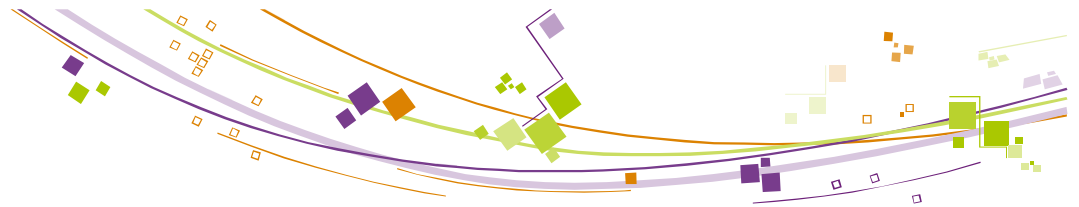
3 à 5 fois les volumes traités sur les marchés organisés, soit 35 (rapport J.-M. Chevalier) à 50 fois le volume physique.
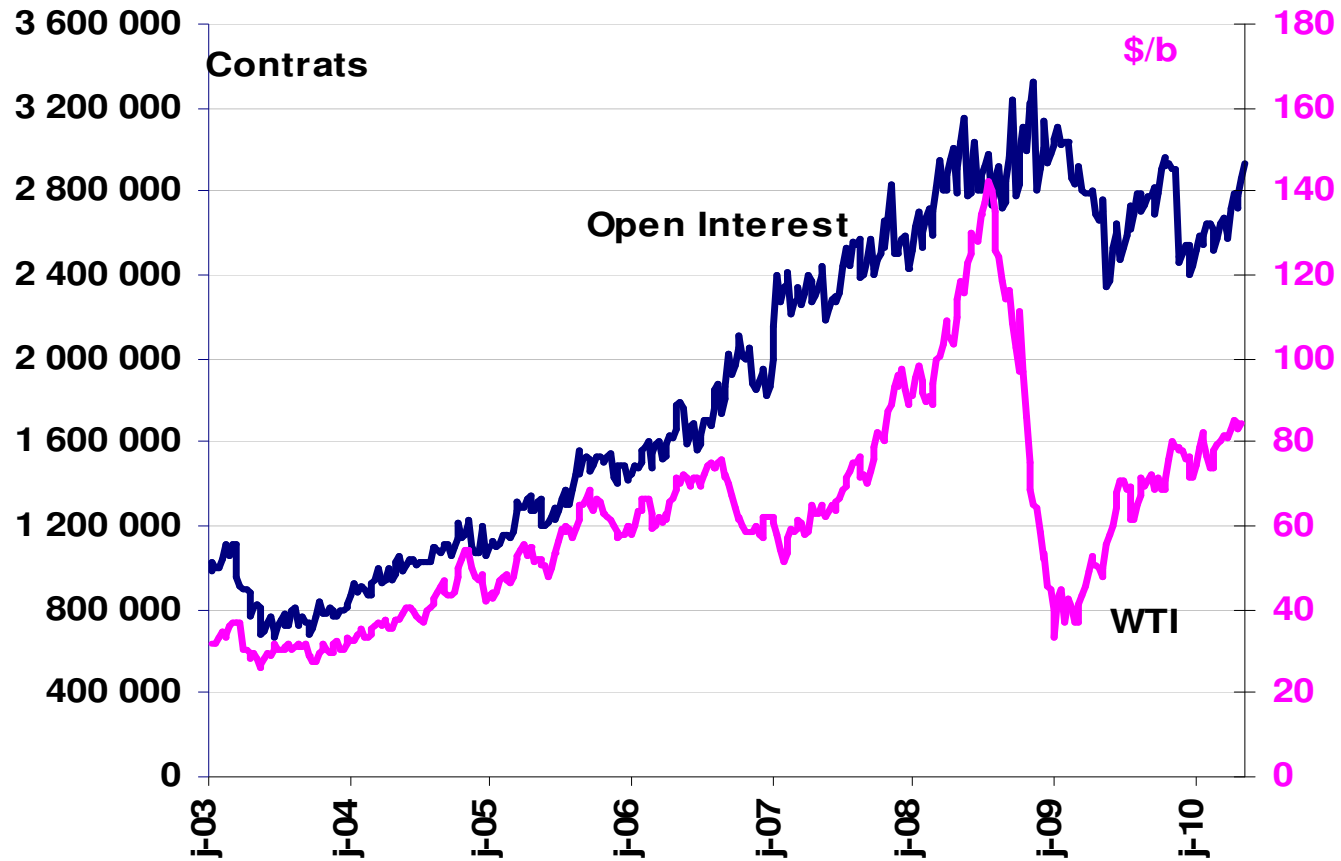
Mal connus …

Source : Société Générale

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The crude oil price

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Open interest in WTI on Nymex (all maturities)

Source: G. Maisonnier (Panorama IFP, 2010)

Open interest is the total of all futures and/or option contracts entered into and not yet offset by a transaction, by delivery, by exercise, etc. The aggregate of all long open interest is equal to the aggregate of all short open interest.

A possible (?) scenario of the role played by speculation in 2007-2008

In the wake of the sub-prime crisis (July 2007), Investors were then expecting the dollar to depreciate and inflation to rise (with a fall in interest rates and an injection of liquidity into the banking system). To hedge against these two risks, investors bought huge amounts of commodity futures contracts.
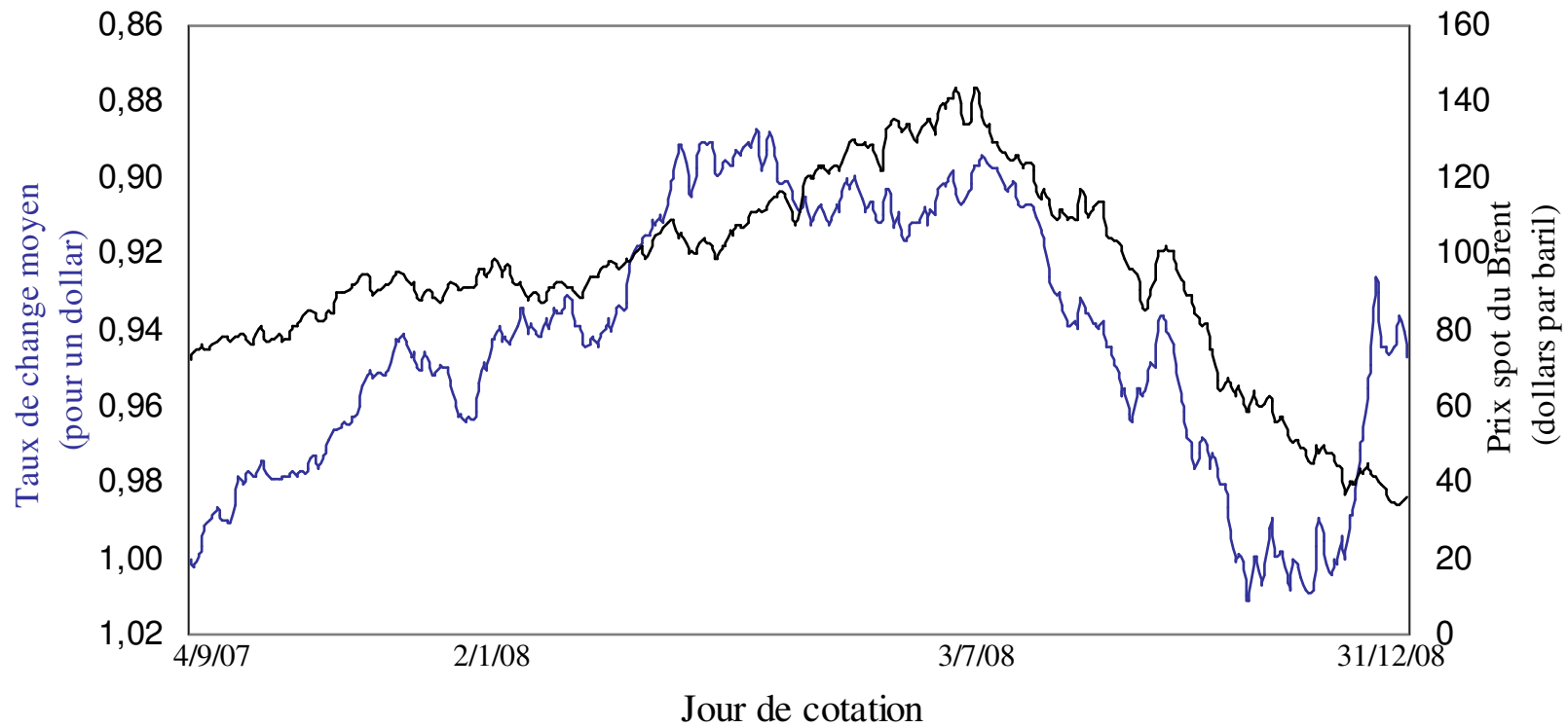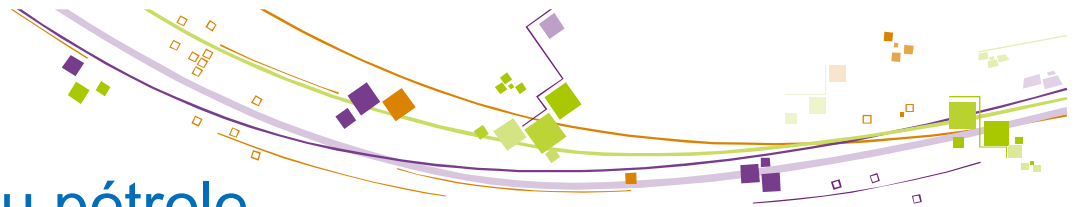
Other possible motivations for these purchases of futures contracts have also been put forward: wish to diversify portfolios of assets whose value is only partially correlated with commodity prices (for many analysts oil has emerged as a new financial asset class), intention to speculate on Chinese economic growth, etc.

➡ S&P GSCI Spot index gains 85% between July 2007 and July 2008
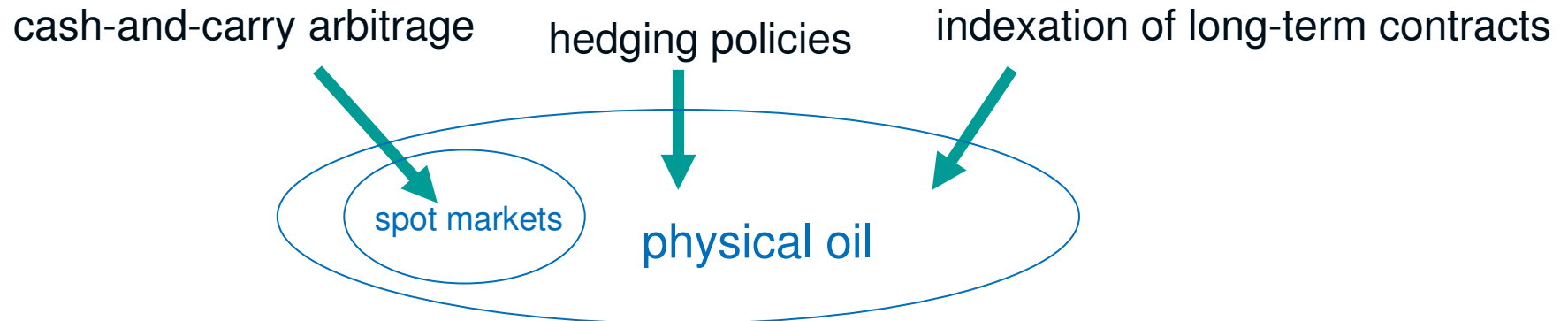
In July 2008, the sub-prime crisis proved more serious than expected and, above all, revealed itself to be global. Investors were faced with a risk of deflation (linked to the imminent recession) and a strengthening of the dollar (owing to risk aversion among investors who, amidst a worldwide recession, withdrew to dollar-denominated assets). Furthermore, a shift in market fundamentals, linked to the recession, took place. Confronted by a complete change in inflation- and dollar-related risks, investors closed their positions en masse, leading to a fall in commodity prices.

➡ S&P GSCI Spot index looses 65% between July 2008 and January 2009

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Valeur du dollar et prix du pétrole

But price of physical oil (only) matters ...

cash-and-carry arbitrage   hedging policies   indexation of long-term contracts

spot markets

physical oil

→ Prices of futures and forward contracts are closely related. Getting oil through physical settlement of a forward contract – as this occurs in practice - then means paying this oil at a futures price.

→ When - for instance - an airline buys futures contracts to lock in the price of the fuel it will use in the future, it will eventually have paid this fuel at a futures price (even if these contracts are cash-settled and physical fuel is finally bought on the spot market).

→ National companies of Saudi Arabia, Kuwait and Iran use futures prices for sales to Europe (and, until 2009, to the USA)

→ Analogy with the theory of contestable markets: commercial transactions are carried out directly on the basis of a smooth forward curve (of which the spot price would just be an extremity), with futures prices forming a dominant psychological reference in traders' behaviour ...

Changes in futures prices would therefore "spontaneously" reflect in the price of physical oil

However, oil is a consumer good whose price, at economic equilibrium, is set where physical supply meets demand ...

Oil stock, variable of adjustment between financial and economic equilibriums
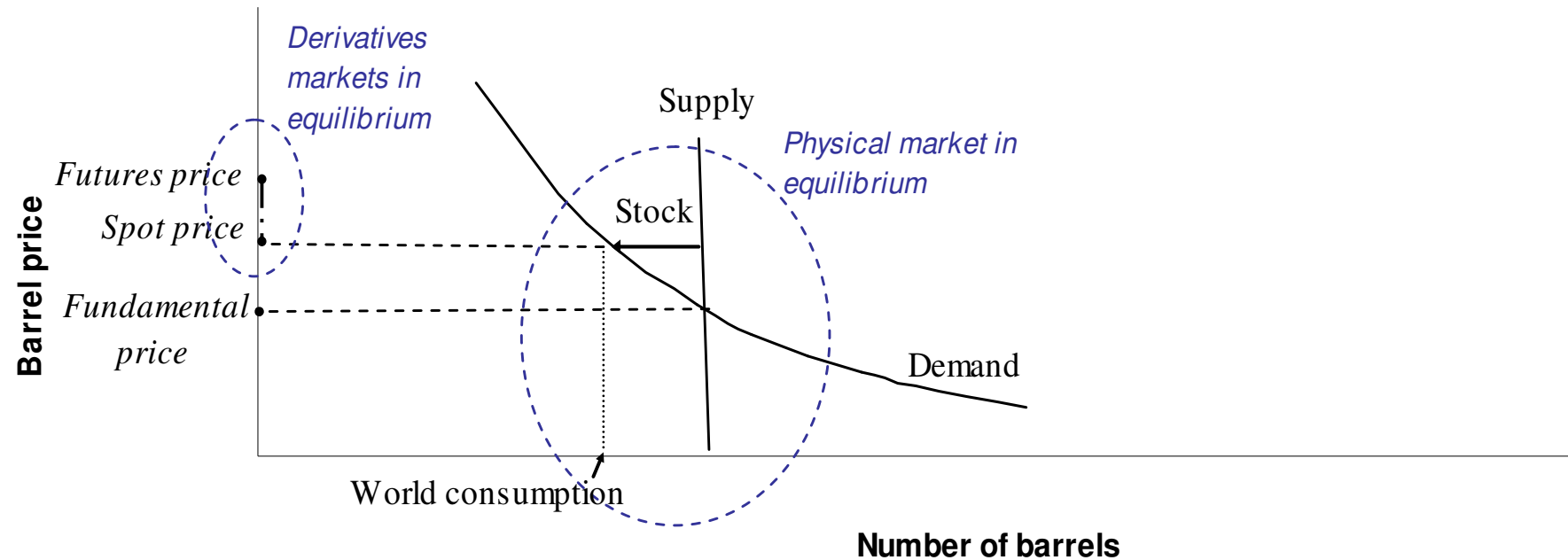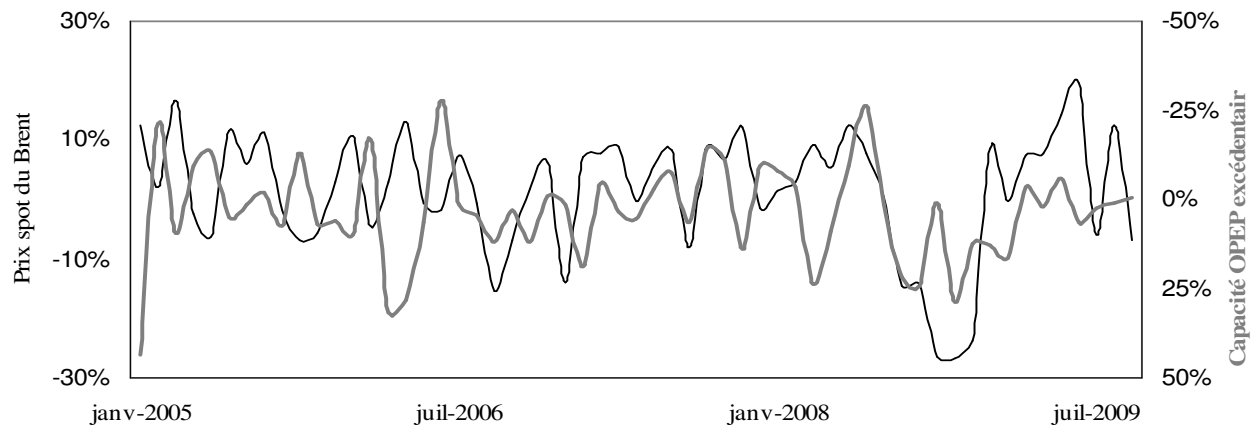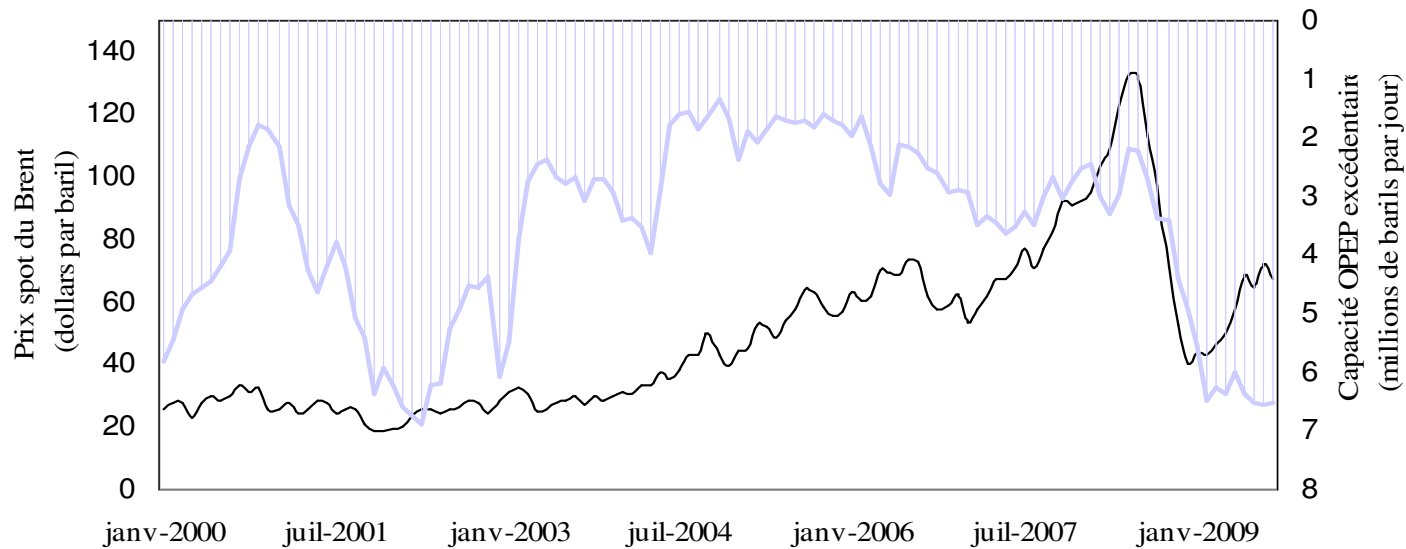

→ Oil storage, necessary signature of speculation

→ a continued - and not just temporary - increase in inventories for the price of physical oil to remain above the level justified by market fundamentals.
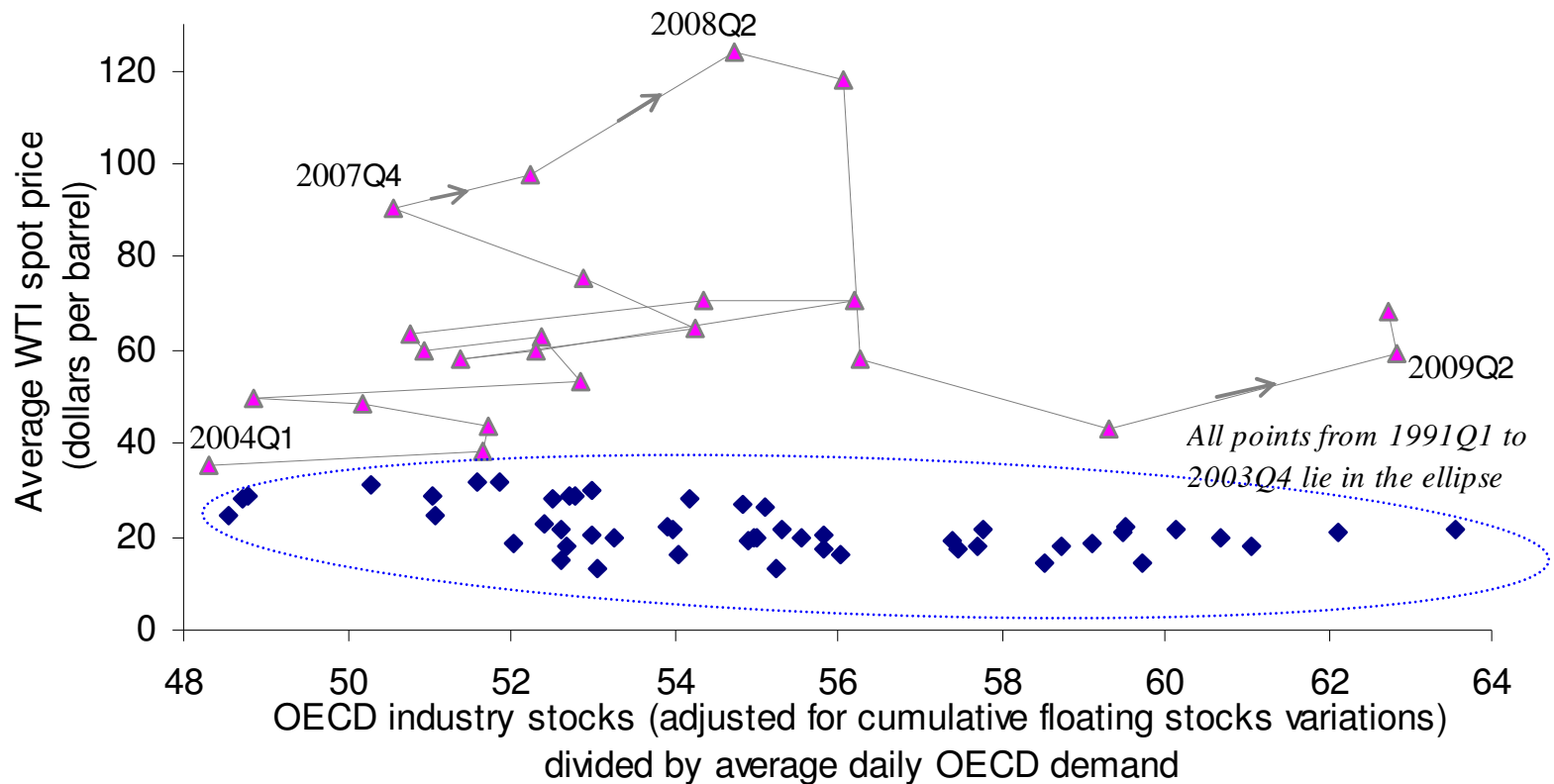
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Note: difficult to distinguish from supply fundamentals ...

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Krugman (2009): "last year I was skeptical about claims that speculation was central to the price rise", "this time, however, oil inventories are bulging ... the signature of large-scale speculation is clearly visible".

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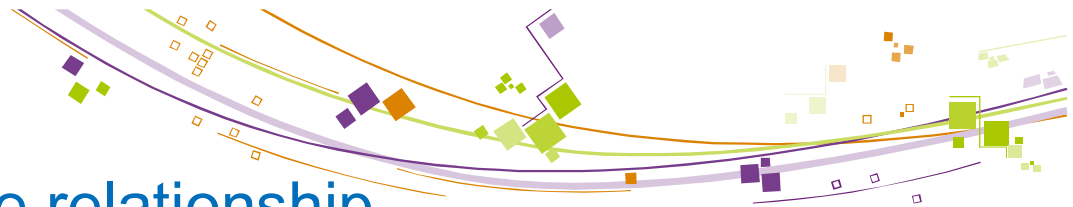
Change in the stock/price relationship

→ The historical downward-sloping price-inventory relationship seems to vanish after 2003. From 2004 on, during certain periods, points go in the opposite direction, such that higher inventories may be associated with higher prices

→ This downward-sloping price-inventory relationship was in line with the standard financial view in futures-pricing models: for instance, Schwartz (1997): "when inventories of the commodity decrease, the spot price should increase since the commodity is scarce ... , and vice versa when inventories increase."

→ To draw definite conclusions is however difficult:

- data on inventories are not comprehensive and sometimes differ between agencies,

- stockpiling as a signature should be assessed on a world basis, and not at the OECD scale only (e.g., Chinese stocks),

- until 2008, this shift in price-inventory relationships could be interpreted as the industry's response to the decrease in OPEC spare capacity (i.e., a shift of stock risk management down the crude supply chain to refiners).
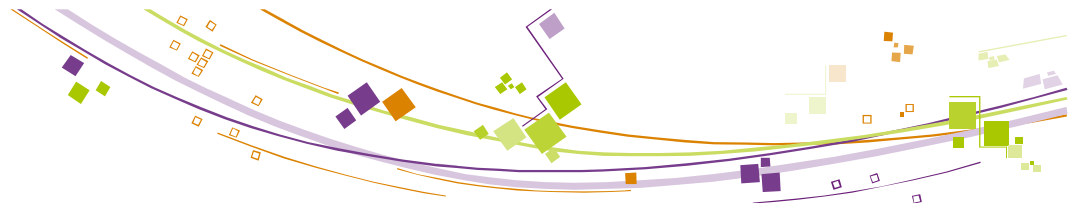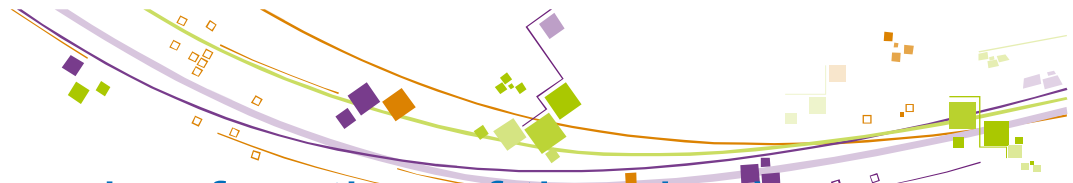
Chinese Stocks (crude oil, diesel and gasoline)
source: OGP

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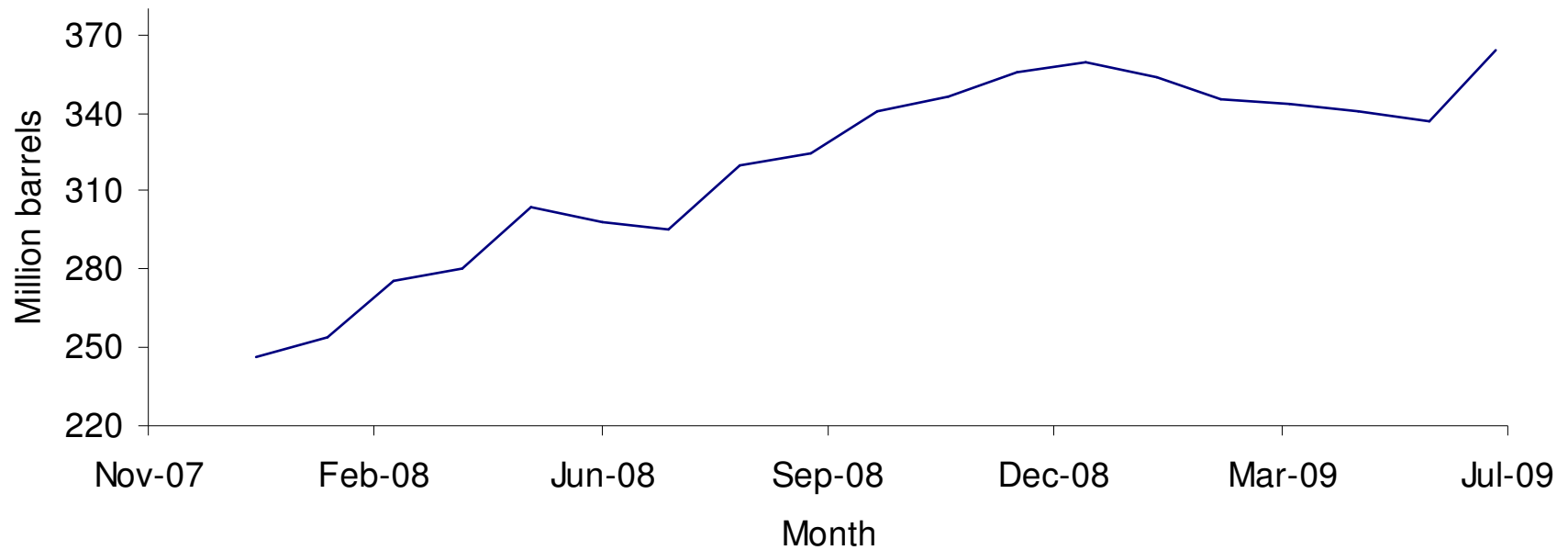
Price elasticity of oil demand: a function of time horizon

→ Price elasticity in the short run: -5% (?), in the long run -20% / -30% (?)

→ The demand curve plays a key role in the standard economic analysis. However, the graphic representation of a demand curve only makes sense if we consider a given time horizon (corresponding to the short run, for example).

And in the very short run?

The scenario of an oil-demand gradually adjusting to a speculative price leads us to define price-elasticity as an increasing function of the time horizon considered.

Short- and long-run elasticities can then be used to calibrate this function.

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Let's assume that in $t = 0$ because of speculation: $P \longrightarrow P + \Delta P$ (permanently)

$-\dfrac{\Delta P}{P} q_0 \varepsilon_s$

$\dfrac{\Delta p}{p} q_0 \varepsilon_l$

$q(t)$
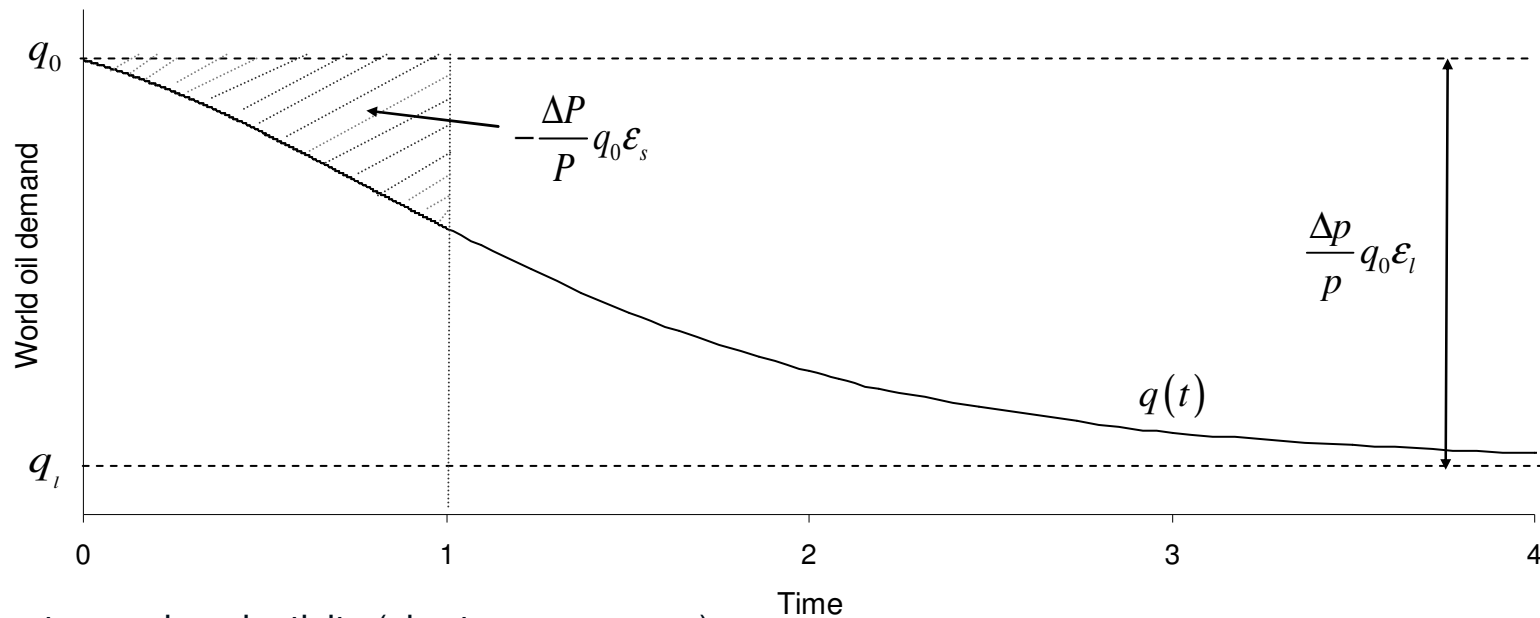
ε_s: short-run price elasticity (short run: one year)
ε_l: long-run price elasticity of oil demand

$q(0) = q_0$

avec:

$\displaystyle\int_0^1 q(s)\,ds = q_0\left(1 + \varepsilon_s \dfrac{\Delta p}{p}\right)$

$\dfrac{dq}{dt}(t) \leq 0$

$\displaystyle\lim_{t \to \infty} q(t) = q_0\left(1 + \varepsilon_l \dfrac{\Delta p}{p}\right)$

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→ Due to the gradual reduction in demand, the elasticity observed depends on the time horizon considered, with elasticity increasing the further the horizon in question.

Let us define $\varepsilon(t)$ as the elasticity given by the reduction in demand observed between dates 0 and t:

$$\varepsilon(t) = \frac{\displaystyle\int_0^t q(s)\,ds - tq_0}{tq_0} \frac{P}{\Delta p}$$

with: $\quad \lim_{t \to \infty} \varepsilon(t) = \varepsilon_l \quad \varepsilon(1) = \varepsilon_s \quad \lim_{t \to 0} \varepsilon(t) = 0$

With supply (production) unchanged, that which is not consumed is, by definition, stored. The average volume of oil stocks accumulated during the period $[0, t]$ is:
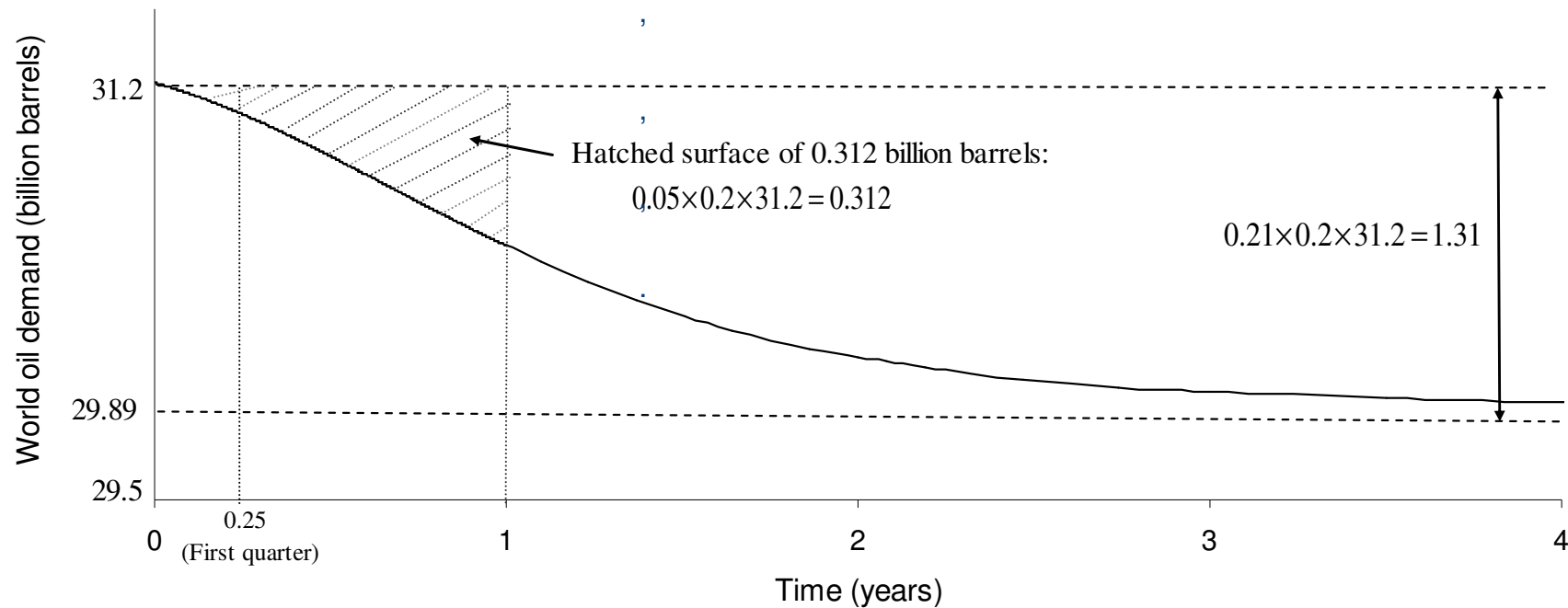
$$\frac{tq_0 - \displaystyle\int_0^t q(s)\,ds}{t} = -\varepsilon(t)\,q_0 \frac{\Delta P}{P}$$
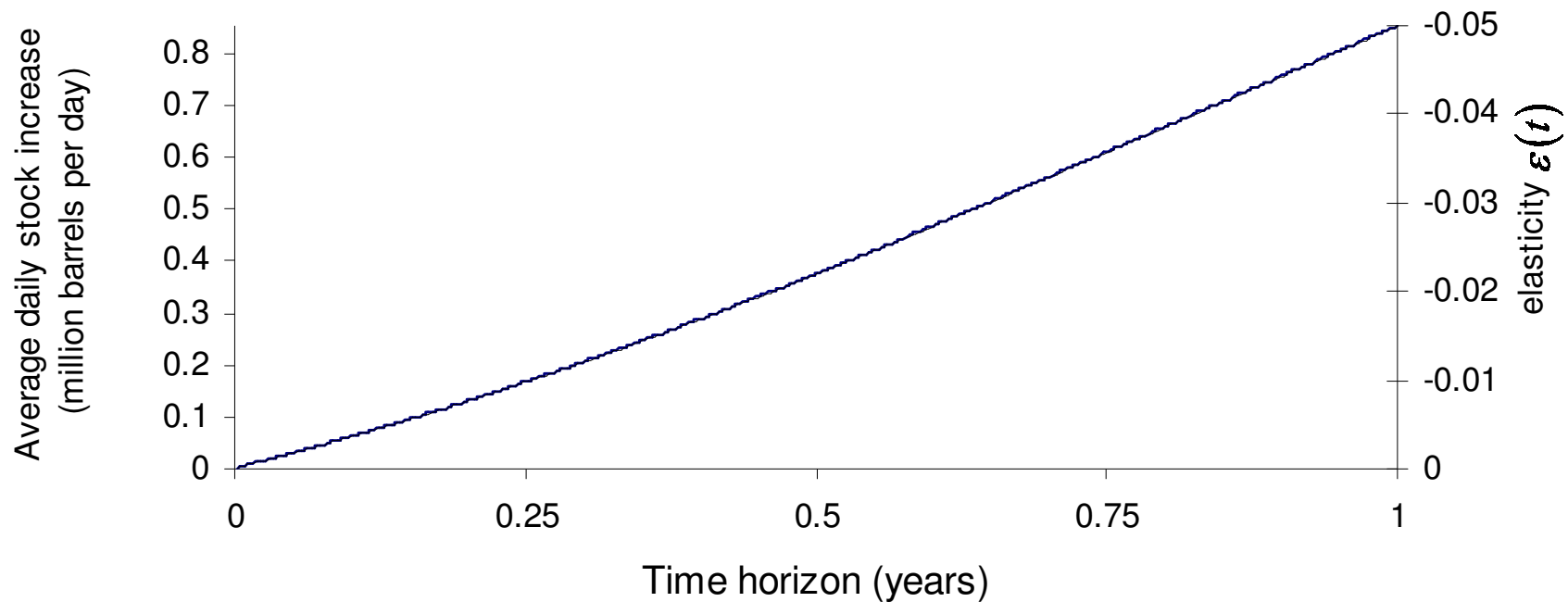
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Illustration: calibration to a Gompertz curve

Adjustment of oil demand to a price 20% higher than that justified by market fundamentals, according to a Gompertz curve.

$$q(t) = q_0 - (q_0 - q_l) \frac{e^{a(1-e^{-bt})} - 1}{e^a - 1}$$

with parameters: $q_0 = 31.2$ $q_l = 29.89$ $a = 2.54$ $b = 1.436$

Hatched surface of 0.312 billion barrels:

$0.05 \times 0.2 \times 31.2 = 0.312$

$0.21 \times 0.2 \times 31.2 = 1.31$

World oil demand (billion barrels)

- 31.2
- 29.89
- 29.5

0 — 0.25 (First quarter) — 1 — 2 — 3 — 4

Time (years)

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Illustration: calibration to a Gompertz curve (2)

The average daily increase in stocks is just 0.17 million barrels during the first quarter, whereas it is 0.85 million barrels during the first year.

Illustration: calibration to a logistic curve

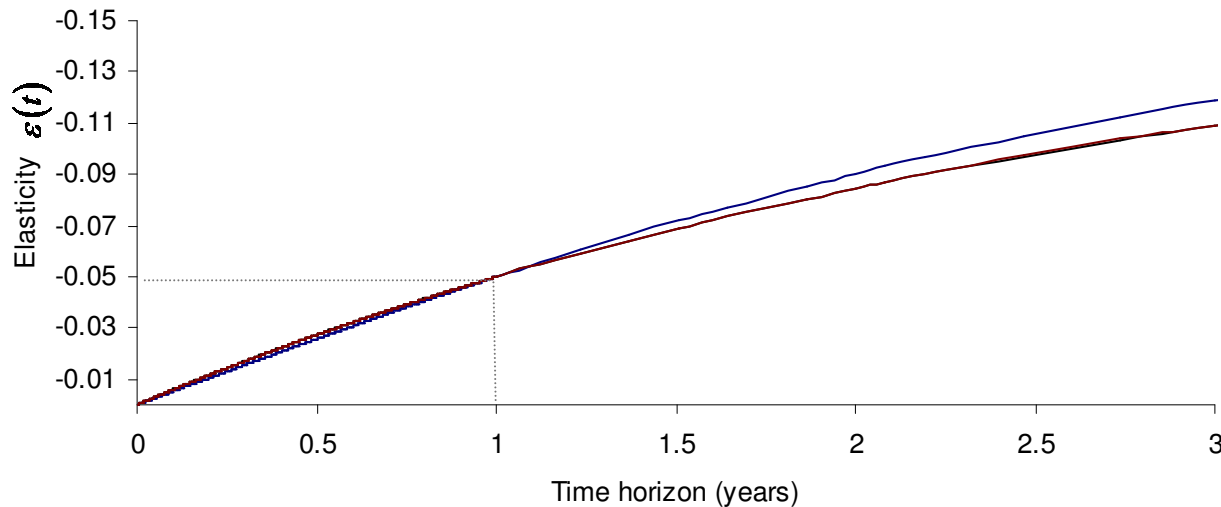$$q_0 = 31.2, \varepsilon_s = -0.05, \varepsilon_l = -0.21, \frac{\Delta P}{P} = 0.2$$

$$q(t) = q_0 - (q_0 - q_l)\frac{1-e^{-rt}}{1+ce^{-rt}}$$

an exponential adjustment $(c=0, r=0.57)$

a hyperbolic tangent $(c=1, r=0.99)$

a classic logistic curve $(c=-0.042, r=0.55)$

$$\longrightarrow \quad \varepsilon(t) = \left(1 + \frac{c+1}{rct}\ln\left(\frac{1+ce^{-rt}}{1+c}\right)\right)\varepsilon_l$$

$\longrightarrow$ For the first quarter, the average daily increase in stocks is between 220,000 and 245,000 barrels only (depending on the reaction of demand considered), while in all scenarios this average daily increase amounts to 855,000 barrels over the first year.

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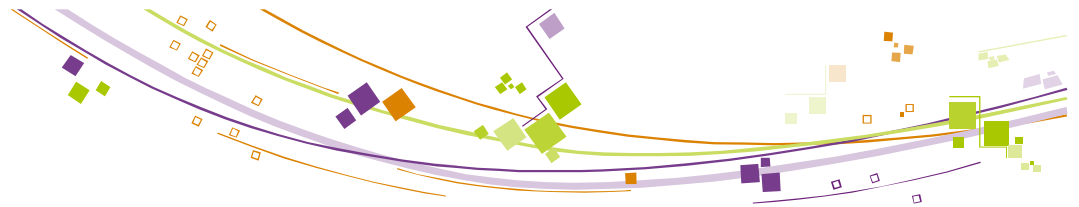
Conclusions

→ The traditional argument of a self-fulfilling bubble is often presented as: "when anticipating a price increase, storing a few barrels is enough to raise oil prices when short-run elasticity is small".

Adopting our approach, in the very short run the argument could be:

an exogenous rise in oil price reduces demand only slightly and therefore results in a negligible stocking.

→ The very low very-short-run elasticity emphasized by our approach, with an oil demand unresponsive to price changes, is consistent with the observed high short-term price volatility.

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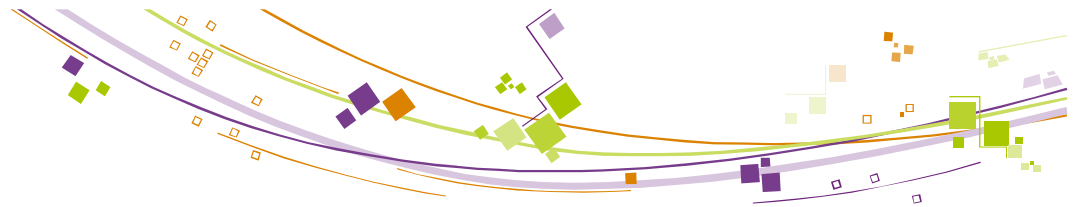
Merci de votre attention ....

Pierru, A., Babusiaux, D., 2010. Speculation without oil stockpiling as a signature: a dynamic perspective. MIT CEEPR WP 10-004.