**Forecasts for the Development of Economic Resources (Food and Energy)**

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## Preliminaries

For an economist the „measuring rod of money“, as it was famously called by PIGOU nearly a century ago, is the *ne plus ultra* of perfection. Economics is a quantitative science in two dimensions: money and time. For our topic we have to deal with the development of money measures for food and energy. The quantitative scenario of economics is, of course, a reduction of the vast complexity of problems to only these two dimensions, money and time, leaving out many other important aspects which the economist treats as mere side issues. “Money”, in our case, actually means: Let us just look at (money) prices of food and energy and let us try to forecast them over time. Forecasting is an attempt to think about a basically unknowable future development. What we usually do and in my case will do is to analyse how prices of food and energy have developed in the past and what those developments might tell us about the future.

Price developments as to food and energy are theoretically quite diverse, and their analysis will be – after these introductory reflections – the topic of respectively the second and the third part of my paper: Food is a renewable resource while large parts of energy supply, oil and also coal, are non-renewable resources. As renewable resource we shall analyse price and quantity of food, in particular price and quantity of the standard grains, wheat and rice, by the general economic techniques of demand and supply analysis. My questions will be e.g.: Did grain prices recently rise just because of bad harvests in important supplier countries? Or was it that higher incomes in previously poor economies caused higher food demand? Or even: did some important economies use durable types of food for accumulating wealth for hoarding – to put it bluntly: did major buyers speculate in food grains? Therefore the analysis will basically have to be a short- to medium-run analysis. For the non-renewable resources, especially for oil, on the other hand, there exists a well-developed particular theory: worked out at length since HOTELLING 1931 and then a

vast number of specialized economic articles since 1974. Here we have to deal with a mainly long-run analysis, the analysis of recurring oil booms.

The programme speaks of inflation as a, or even the, particular topic of my talk: But this will no longer do. Typically an inflationary spell precedes an economic slump or a depression. We are now in the midst of the beginning of a deep World Depression; and then stagnant prices or even deflation, i.e. falling prices, are the order of the day. According to the US Ministry of Labor, prices are now already in full decline in the USA. Consumer prices declined there by 1 per cent during the month of October. Oil prices have been falling from a level of 147 US-$ per barrel of brent oil early in the summer of this year to – at the time of writing (Friday, Nov.21) – merely one third of the price quoted, i.e. 48.30 US-$. Likewise, wheat and rice prices are no longer rising.

To be precise, inflation is actually defined as a longer-run rise of a suitable average of prices. Thus, by definition, a rise of particular prices, like those of oil or grains, as such does not cause inflation; or at least causes it only very briefly, as long as other prices are sticky and do not decline. It is, however, quite usual and thus “normal” (for economists) that prices generally develop with different speeds and even in opposite directions, some up and some down.

Food Prices, in particular Grain Prices

At the end of 2007 and during the first half of 2008 prices of important grains, like wheat and rice, rose to a level about 50 p.c. higher than prices a little earlier. There were reasons for this both on the supply and on the demand side.

Let us start with the demand side: In the highly developed countries of the world, and remember they comprise only a small part of the world population, but well over one half of world income, in those developed countries food demand is already nearly satiated. There, the income elasticity for food is perhaps 0.2, which means that if per capita incomes double, food quantity demanded only increases by 20 per cent. But even this demand increase is largely for higher qualities of food and not for higher quantities, and for food processing services rather than for foodstuffs themselves.

The demand for cereals is completely stagnant: It has zero income elasticity. But for the poor countries of South East and South Asia food demand is more income-elastic and that is true even for grains. And incomes there have risen by leaps and bounds and especially so since the beginning of this century, since the year 2000. In China with its population of 1.3 billion, the rapid increase in incomes has already been of somewhat longer standing than in other Asian countries: by now it has lasted more than 15 years. There, per capita incomes have increased about fourfold, i.e. they double every seven years. India with 1.1 billion people as yet has not witnessed such explosive income growth nor has it been growing as long as China; nonetheless it now registers considerable growth, viz. of about two thirds of the Chinese rate. Thus grain demand in South East and South Asia has noticeably increased and tends to surpass such increases of supply as are due to productivity increases. China, in particular, by now has turned into a grain importer – in normal years. That is partly due to the communist tradition of developing industry more quickly and to the relative neglect of agriculture, one instance being the flooding of wide tracts of agricultural land in the course of power dam construction.

Increase in grain demand in still poor South East and South Asia is to some extent not for direct, but for indirect grain consumption: Meat demand is much more income elastic than that for grain; and livestock is partly fed on grain. China especially favours the consumption of chicken and duck. And both ducks and chickens are mostly fed on grain (wherever things take their natural course). In addition, of course, the production of alcoholic beverages relies on grains to some extent.

Both wheat and rice are fairly durable. May I remind you that a certain type of wheat, recovered from the tombs of ancient Egyptians, was still consumable and was even made to germinate. It is presently cultivated under the name of *Kamut*. Thus one suspects that in particular the Chinese, desperate to find any asset in which to accumulate real capital from huge savings, have recently hoarded grain, which would explain its temporarily high demand and part of the price rise.

The problems on the demand side for basic foodstuffs pale, however, in comparison to those on the supply side. First there have been droughts in major wheat supplying countries, reducing their output. There has been drought in Southern Australia for

three years now, which has caused a cut-off of irrigation for wheat growing purposes and thus a serious decline in production. Production levels in the US-American Midwest have also been lowered because of drought. (The opposite, flooding and inundation due to storms, has not had any noticeable effects on the production of grains. Too wet a climate is, at present, not a major reason for harvest failures, as it had been in North Western Europe in the legendary seasons of 1310 and 1311, when it rained, e.g. in England, nearly continuously for an entire year.) Likewise, rice production has also markedly declined recently in parts of South East Asia because of drought.

But declines in production due to unfavourable weather conditions are not the only problem. Secondly, and on balance perhaps more importantly, there is quite a bit of reallocation taking place: agricultural areas where food has been grown traditionally are now being used and/or earmarked for growing – renewable – substitutes for man's hydrocarbon resources, accumulated in the paleontological past, but by now dangerously repleted. Until quite recently, there tended to be (seen worldwide) a slight surplus of total grain production, with relative prices moderately falling – in a secular decline. But lately the production of bio-ethanol has become all the rage. In many cases such production is as yet far from efficient, and much of that production is even stimulated by public subsidies. As has been shown in a past symposium of the KIÖS really efficient production of vegetable matter for fuelling purposes can only be achieved by the production of sugar cane in tropical Brazil, which has the further advantage that it does not diminish the production of food grains, for cane and grain grow in different zones.

On the other hand, the relatively rapid switch to bio-ethanol production, e.g. from rape-seed as in Central Europe, has sharply reduced grain production: Altogether. the slight world grain surplus has lately turned into a marked scarcity of grain, compounded by unfavourable climate shocks. As the most basic foodstuffs all types of grain have a low price elasticity, memorably estimated already as then being about 0.3 in Britain by Gregory King in the early 1690s: A ten per cent grain supply shortage in then still very poor England caused the prices of grain to shoot up by about one third. Thus a relatively mild decline in world grain production for food due to the use of considerable areas for producing the raw materials for fuel,

compounded by present climatic disturbances, has increased grain prices by about 50 per cent and has thus led to acute food shortages, even famine, in many less developed countries. It cannot be denied that the thirst of motor cars for oil has entailed hunger among significant parts of humanity.

As in terms of economics nothing is a perfect good all round, so nothing is an unmitigated evil for everyone, either: In the last year or two the strong rise in grain prices has markedly increased the incomes of many agriculturalists – not so much, of course, of those mainly engaged in livestock production, because for them grain is an input that has become dearer.

What is the future price development of basic food stuffs likely to be? There will be, as has always been the case so far, a tendency towards price decline due to the constant increase in the productivity of agricultural production. Prices of basic food stuffs have risen and subsidies for the production of bio-ethanol are likely to decline: Thus production of basic foodstuffs will probably increase again in a movement opposite to the present one. The recent droughts are likely to have been out of the ordinary, in part. So altogether one may expect that the present excessive prices of grains will be partly reversed.

To be partly reversed, but only partly so: Important new uses have been found for agricultural soils in fuel production and such uses will not be completely reversed, especially in view of the fact that in the very long run there will be an upward trend of fuel prices. Poor parts of the world in Asia which have become much richer will further consume more food. World population has peaked in terms of its rate of increase, but the level of population and thus the number of consumers of basic foods is still going to rise somewhat. Recent droughts, I have pointed out, have partly been unusual, but, on the other hand, climate forecasts have consistently shown that the probability of weather extremes is increasing, i.e. of droughts in parts of the world important for grain production. Add to this the increased likelihood of destructive floods, and climatic changes as a whole become unfavourable to grain production.

The conclusion therefore is: Wheat and rice and all other grains and with them such other basic foodstuffs as may be substituted for them, as well as proteins that are

produced by using grain, like meat, are likely to remain at a relatively higher price level than up to now. Furthermore, it will be a moderately increasing price level. We are simply using the soil more intensively. In part we shall return to the relative price situation of the Middle Ages when grain prices were high, relative to other food prices. I have said that in terms of economics food price analysis is more or less a problem of the medium run, but it certainly does have long-run consequences.

## What Price Energy?

While the analysis of food prices is a general and secular problem of economics the analysis of energy prices, to which I now turn, is a very special problem and one that has been thoroughly analysed by economists. There were four so-called oil price "shocks" in recent history: the first one in 1973-74, the second in 1979-80, the third one around 1991 and the fourth from about 2005 to – especially – the first half of 2008. By now, it is over. The first oil price shock increased prices in terms of nominal US-dollars fourfold and the second, only six years later, again fourfold. Then prices were considered excessive. With ups and downs, they did – in real terms and in the long run – not surpass that level until the first half of 2008. By now, though, in real terms they are once more below the level of 1980.

The price jump of 1973-74 came as a shock to economists and caused a wave of analysis among large numbers of them. As the – then young – later Nobel Laureate Robert SOLOW, asked to give the famous Ely lecture, described it: "I was trotting down to the sea, minding my own business, when turning around I suddenly found out I was a lemming." The lecture had the telling title: "The Economic Resources and the Resources of Economics" (*AER, PP* 1974, pp.1 ff.). The central idea for the analysis of energy prices was being re-discovered in a well-known article by Harold HOTELLING of 1931. Analysis says the oil producer has the alternative of either producing oil now or leaving the oil in the ground for another year. In equilibrium these two possibilities have to be equal in price. In other words: leaving the oil in the ground has to bring the same return as extracting it and investing the net receipt of the oil, i.e. the oil price minus extraction cost, on the financial market for a year. Therefore the net price of oil over its extraction cost has to rise per year with the rate of interest received for financial investment.

Generalized, the Hotelling Rule says: The net price of non-renewable resources, i.e. the difference between the price and the extraction cost, will rise over time with the interest factor, i.e. multiplied with one plus the interest rate. And to what level will the price rise in each period? Once more the answer is easy: It will rise constantly to such a level that at the moment of exhaustion of the non-renewable resource in question it will have reached the price of its cheapest alternative or, as the technical term is, it will rise to the price of the "stop gap" technology. And what if the production costs of the same non-renewable resource from different natural sources are different? Then once more the answer is easy: First, the highest cost resources will be exhausted and then on and on until we come to the cheapest resource – i.e. cheapest in production. So it was expected that Saudi Arabian oil, which has the lowest extraction cost, would only be extracted last.

As you see, economists have a quite persuasive theory of the price development of exhaustible or, equivalently, non-renewable resources, and also of their close substitutes, e.g. oil and gas, a perfect theory following an easily explainable, well-defined differential equation. In practice, however, the price development of oil and its close substitutes was completely different; and that was so because the parameters of the model solution remained unknown, and also the side conditions of the relevant equation were changing decisively over time. To use a picture from biology: It was like forecasting natural selection in an environment that changed both very rapidly and also haphazardly back and forth.

First of all, the relevant rate of interest, at which the net price should rise, was actually not constant but, after 1970 (or after 1974, when the theory was redeveloped), changing strongly over time, so that theoretically the equilibrium oil price should have been rapidly jumping up and down – as it actually did, more or less. But if then you wished to calculate the level of the actual price it was not enough to know its rate of change, the changing interest rate; you also had to know the price of the likely alternative technology, the stop-gap technology at a far-off moment, a price which was also constantly changing with technological progress, the extent of which was again unforeseeable. And in order to calculate the rate of extraction over time one had to foresee the demand structure for oil, and once more this varied

greatly over time, depending both on the rate of growth of the developed world and on the rapidity of the rise of developing nations, i.e. of new oil consumers over time. Next, one had to know the rate of development of new oil substitutes over time. In particular, natural gas developed strongly, to an extent not foreseen originally; wind turbines and other “small fry” came in use as well. Finally, the cheapest oil producers did not find it to their best advantage to leave the oil in the ground for an uncertain future use, but actually dominated present supply.

Thus, the oil price did not develop smoothly over time as standard economic theory would have predicted, but developed in leaps and bounds, in terms of up to now four oil price booms – with about constant or even declining prices in between. And the first oil price shock of 1973-74 and especially the second one of 1979-80 actually changed human behaviour markedly.

The first change that happened was that heating of homes was throttled. Before then, Americans had heated their homes to some 25 C°; after that they went down to some 22 C°. One just dressed a little more in winter. By now this reduction of heating has worn down somewhat once more, and cars and public spaces – or e.g. Viennese street cars – are once more heated more than necessary.

The second oil price shock, that of 1979-80, was even more decisive: It is an important fact of human behaviour that the second time something occurs it generates quite different reactions from the first time – a fact, I am told, which may even be genetically ingrained in us: If in a certain place at a certain time of day we see a hare running that is a unique event of no importance for future forecasting. But if in that place and at that time of the day we see a hare run for the second time, we conclude that at that time and place a hare always runs, and we react accordingly. That was the reaction to the second shock: From then on, newly built houses were insulated much more efficiently, the windows of existing ones were improved, smaller cars were built and sold etc.

And importantly also new supplies of oil were developed: in Europe, British North Sea oil and Norwegian oil, also from the North Sea. Natural gas started to become an interesting resource. And in very recent years Russian oil, oil from a very inefficient

supplier with lots of leaks in the pipe lines, has surged forward. Quite a few inefficient oil suppliers can only produce profitably at fairly high oil prices of 50 or even 60 US dollars the barrel. The present price of 48 US $ is probably already below the level of profitability of Russia. Perhaps the decisive aspect is that after some relatively high price level has been reached, supply may increases strongly because inefficient producers come onto the market.

Actually, by the 1979-80 price rise OPEC had overestimated demand: Prices then tended to fall and, above all, OPEC soon only supplied about one quarter of world oil demand, losing its dominant position: So many other oil suppliers came forward. The 1991 oil price rise was largely due to the fact that Iraq oil virtually dropped out of supply, Iraq being allowed to supply only a limited amount. In the second Iraq war once more the hope of the USA was dashed that, if victorious, they would gain access to large oil reserves. This, together with the sharp rise in incomes in South East and South Asia and the consequent increase in the use of motor vehicles there, caused the fourth oil price boom which has just ended. The third and fourth booms were due to particular circumstances basically independent of OPEC strategy.

How will the oil price develop in the future? We are now faced with a Great World Depression which can easily last a decade or even longer: Witness the Japanese stagnation that started in 1990 and has lasted up to now, without finding an end for close on two decades. In the near future oil prices will therefore continue to decline due to reduced demand, i.e. because of less car driving. Furthermore, since around 1980, proven oil reserves, reckoned in years of foreseeable oil demand, have constantly increased, not declined. Therefore, in contrast to food prices and in spite of the fact that oil is an exhaustible resource, oil and with it all other energy prices will first fall somewhat due to World Depression, the first one since more than 75 years; then they will stay at about the same level, possibly interrupted by certain small booms because of special circumstances. While standard theory says that the net price of oil over its extraction cost will increase over time, actually, quite to the contrary, at present it is the extraction cost which sets the price. Eventually, of course, energy prices will have to rise as more and more energy resources become exhausted. But that time is likely to be far off, the time of your – and not my – grandchildren’s maturity.

So I conclude: Food prices will rise modestly already in the near future, energy prices, as averages over time, however, only in the distant future. With energy the opening up of new resources is limiting price, while food demand surpasses the cheapening tendencies of technological progress.