OIL PRICES AND THEIR EFFECT ON POTENTIAL OUTPUT

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Abstract

Oil prices have fluctuated considerably in the last few years, with major effects on the economy. This paper describes some of the mechanisms by which these fluctuations produce changes in the long-run growth of the economy. In particular, it analyses the effect on productivity, capital stock and structural unemployment. The analysis suggests that a (permanent) increase in oil prices can significantly reduce potential output. From an economic policy point of view, this effect may be more marked when competition in the product markets is low or when wage indexation is high; thus, reforms aiming to increase competition and improve wage-setting mechanisms help to reduce the negative effects of higher oil prices on long-run economic growth.

Keywords: oil price, potential output, production function.

JEL-Classification: O13, O47, J64.

CONTENTS

1 Introduction

Although oil prices in the international markets have diminished significantly in recent months to $40 per barrel, since the beginning of the new millennium they have followed an upward trend, amply exceeding the $100 per barrel barrier by mid-2008. Thus, the price of oil in real terms (that is, calculated in the currency of the country in question and subtracting the price level) surpassed the historical peaks reached in the first half of the 1980s in most importing countries. This behaviour can be expected to have had a significant impact on both aggregate demand and aggregate supply of the economy.

The channels that transform an increase in oil prices into a higher level of inflation and a reduction in the real demand of agents are well understood. By contrast, less is known of how this kind of shock impacts supply in the economy. This document seeks to describe some of the mechanisms affecting the aggregate supply of an oil importing country after a (permanent) change in the price of this raw material.

Before starting, it is important to clarify that the concept of aggregate supply we are going to use is the traditional definition of potential output, that is, the level of activity that can feasibly be reached without generating inflationary pressures. Furthermore, some simplifying assumptions are made. First, we do not delve into the reasons behind changes in oil prices. However, in the real world, the behaviour of the oil price, like that of any other product, can be the result of shocks to supply or demand (or both), and the impact on the economy can be very different depending on the initial cause of the price adjustment.[1] Second, the definition of oil price that is relevant for economic agents has to take into account the exchange rate[2] and oil-related indirect taxes.[3] This paper does not consider the impact of taxes and, although our analysis considers exchange rate, it does not take into account the effect of currency appreciation or depreciation on competitiveness, and, therefore, on potential output.[4]

Against this background, the paper describes three possible channels by which oil prices may influence the level of potential output (measured in terms of gross domestic product —GDP—). Thus the next section analyses, firstly, the effect on (estimated) productivity, secondly, the (optimal) capital stock, and, finally, the level of potential employment. The third section provides some simple empirical evidence on the prevalence of these channels in Europe and their quantitative impact. The last section sets out the main conclusions.

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1. For example, if the increase in oil prices is the result of strong oil demand by particular importing countries, these countries will demand not only oil but also other goods and services produced by other importing oil countries, which will also benefit from the increase in global demand. However, if the increase in oil prices is a result of lower oil supply (due, for example, to a strengthening of the OPEC's oligopolistic power or to a reassessment of oil reserves), all the oil importing countries will reduce their aggregate demand for goods and services, including imports; thus world trade will diminish and therefore the exports of oil importing countries will fall. When the increase in oil prices is due to speculative financial factors, the implications are more complicated.

2. This means that the oil price has to be measured in the currency of the importing country.

3. It is necessary to consider indirect taxes because most of them are specific (as opposed to ad-valorem taxes, like VAT). Thus they do not change when oil prices change and they therefore soften the impact of the shock in terms of the price borne by the final consumer.

4. It is interesting to highlight this last relationship, since sometimes it is argued that an increase in the dollar price of oil is less harmful if it happens at the same time as an appreciation of the currency of the oil importing country with respect to the dollar. However, this analysis does not consider that the appreciation worsens competitiveness of the country and therefore, its domestic production is more expensive and the foreign production cheaper, thus reducing GDP.

2 The effect of oil prices on the determinants of potential output

As said in the introduction, in order to analyse the effect of oil prices on the aggregate supply of the economy, this latter concept is taken as synonymous with potential output. Following tradition, potential output is defined as the level of production that can be reached by the economy using the available productive factors and existing technology without generating inflationary pressures. Therefore, potential output can be considered a good description of the supply side of the economy and thus a key variable for economic analysis and the design of economic policy.

From a theoretical perspective, potential output can be modelled by means of a production function relating the (real) GDP of the economy (Y) to the inputs used to generate it. Usually, two primary inputs are considered (capital —K— and labour —L—) and a third variable is included to capture the part of observed production that is not explained by the recorded utilisation levels of the primary inputs. This last "factor" is known as total factor productivity (TFP, denoted by the letter "A"). It proxies the technical efficiency with which the productive factors are used and its behaviour is related to technological progress. Mathematically, the productive process can be expressed as follows:

$$Y = A\,F(K,L) \qquad [1]$$

where F is a (production) function which is twice differentiable and homogeneous of degree 1. This last condition implies that the productive process exhibits constant returns to scale; meaning that if the primary input endowments increase in the same proportion, production also increases by that proportion. As a result, applying the Euler theorem to this expression gives:

$$\Delta y = \frac{F_K\,K}{Y}\,\Delta k + \frac{F_L\,L}{Y}\,\Delta l + \Delta a \qquad [2]$$

where the lower-case letters represent the natural log of the corresponding upper-case variables, Δ is the difference operator and F_I represents the partial derivative of the production function with respect to each primary input (that is, its marginal productivity). Assuming the existence of perfect competition in the input and product markets, profit optimisation first-order conditions imply that the marginal productivity of labour and capital will be equal to the real wage (W/P) and the real user cost of capital (CU/P), respectively. Therefore, [2] can be written as follows:

$$\Delta y = \left(1 - s_L\right)\Delta k + s_L\,\Delta l + \Delta a \qquad [3]$$

where s_L is the share of labour income in nominal production.

In this last expression, all the variables are observable apart from the TFP growth rate; therefore, it can be obtained as a residual. This means that, by construction, the production function will be exactly fulfilled.

However, in order to estimate the potential output of the economy it will be necessary to evaluate this equation at the potential level of each productive factor. Thus, starting with TFP, its potential level is usually proxied by filtering this residual input with a statistical procedure to eliminate its fluctuations at the business cycle frequency ($\Delta\bar{a}$). In the case of the capital stock, its potential level is traditionally equated to its observed value because, as it is the accumulation of an investment flow (with a depreciation rate which is not very large), it does not exhibit fluctuations at the business cycle frequency. Finally, the increase in potential employment ($\Delta\bar{l}$) is estimated by adding the growth rate of the (working-age) population (which should be filtered since, although the natural growth of population is not correlated with the cycle, migrant flows are), the potential participation rate (that is, the proportion of the working age population that is working or actively seeking a job — $\Delta\overline{pop}$ —) and, with a negative sign, the changes in the potential unemployment rate (proportion of participants in the labour market that do not find a job). This last variable is called the NAIRU and is defined as the level of the unemployment rate that does not generate inflationary pressures. Leaving aside socio-demographic elements, like the incorporation of women in the labour market, the potential participation rate should have a close negative relationship with the NAIRU, since individuals will be more reluctant to participate in that market when conditions are less favourable, that is, when the unemployment rate is higher.

Thus, to estimate the potential growth of the economy ($\Delta\bar{y}$) it suffices to replace the observed values in expression [3] by their potential counterparts:

$$\Delta\bar{y} = (1 - s_L)\,\Delta k + s_L\left[\Delta\overline{pop} + (\gamma - 1)\,\Delta NAIRU\right] + \Delta\bar{a} \qquad [4]$$

At both theoretical and empirical level, at least three channels have been identified through which oil prices influence potential growth: potential TFP, the capital stock and the NAIRU. The next three sections describe them.

2.1 Productivity

The first channel is the possible impact of oil prices on (measured) productivity. The difference between gross production and the value added of the economy serves to illustrate this mechanism. GDP can be obtained as the sum of the value added by firms and, in the National Accounts framework, it is estimated by subtracting intermediate consumption from gross production. Intermediate consumption includes imported crude oil and derivatives. Therefore, an increase in oil prices may mean that, even with the same capital and labour endowment, the share of production that remains in the oil importing country is lower. Higher oil prices are thus equivalent to a decrease in the productivity of the two primary inputs. Therefore, a similarity exists between an oil price shock and a TFP shock.

Algebraically (and assuming for the sake of simplicity that the only intermediate consumption is imported oil), the value added in nominal terms *(PY)* will be equal to nominal gross production ($P^Q Q$) minus imports of oil, also in nominal terms *($P^O O$):*

$$P\,Y \equiv P^Q\,Q - P^O\,O \qquad [5]$$

In real terms (that is, taking on board price changes), the estimation of GDP is slightly more complicated, as its deflator is not an observable variable. Thus, the National Accounts use a technique known as “double deflation”. This methodology consists, firstly, of obtaining the growth of gross production and oil imports in real terms; this is an easy task, since these prices are observable. Secondly, the real growth of oil imports, weighted by the share of this intermediate consumption in gross production (s^Q_O), is subtracted from real gross production growth:

$$\Delta y = \frac{\Delta q - s_O^Q \, \Delta o}{1 - s_O^Q} \qquad [6]$$

Using this definition, it can be shown that the value added deflator can be calculated as follows:

$$\Delta p = \frac{\Delta p^Q - s_O^Q \, \Delta p^O}{1 - s_O^Q} \qquad [7]$$

that is, it deducts oil prices from gross production prices.

From an economic perspective, modelling gross production is conceptually equivalent to GDP, except for the appearance of a new productive factor, namely oil (or intermediate consumption in more general frameworks). Therefore, using the same symbols, we can write:

$$Q = A^Q \, F^Q(K, L, O) \qquad [8]$$

Notice that neither gross production TFP nor the production function need be the same as the value added (GDP) function. In any case, imposing the same conditions as in the case of GDP (constant return to scale in the three inputs and perfect competition in factor and product markets), a very similar expression is obtained. Thus, the gross production growth rate is a weighted average of the productive factor growth rates (the weights being the share of each factor's cost in nominal gross production —s^Q_I—) plus TFP growth rate:

$$\Delta q = \left(1 - s_L^Q - s_O^Q\right) \Delta k + s_L^Q \, \Delta l + s_O^Q \, \Delta o + \Delta a^Q \qquad [9]$$

Thus, if expression [6] is substituted in [9], the following production function for GDP growth is obtained:

$$\begin{aligned} \Delta y &= \frac{1 - s_L^Q - s_O^Q}{1 - s_O^Q} \, \Delta k + \frac{s_L^Q}{1 - s_O^Q} \, \Delta l + \frac{1}{1 - s_O^Q} \, \Delta a^Q = \\ &\left(1 - s_L\right) \Delta k + s_L \, \Delta l + \frac{1}{1 - s_O^Q} \, \Delta a^Q \end{aligned} \qquad [10]$$

If this last equation is compared with that obtained in [3], it may be concluded that oil (and, therefore, its price) does not play any role in the determination of real GDP. However, it should be taken into account that the TFP growth rate in terms of GDP is equal to the TFP growth rate in terms of gross production divided by one minus the weight of oil costs in gross production, and this weight can change when oil prices change.

In particular, if, following an increase in real oil prices the relative demand for oil declines more than proportionally (that is, if the elasticity of substitution between oil and the other intermediate inputs is higher than one), the weight of the cost of oil in nominal gross production will diminish, thereby reducing TFP expressed in terms of GDP for a given gross production TFP. Conversely, if, following an increase in real oil prices the relative demand for oil declines less than proportionally (that is, if the elasticity of substitution between oil and the other intermediate inputs is lower than one), the weight of the cost of oil will rise, thereby increasing TFP in terms of GDP for a given gross production TFP.

2.2 Capital stock

The second productive factor that can be affected by changes in the relative price of oil is the capital stock of the economy. In the short term, an increase in the price of this raw material may push some production plants and equipment into obsolescence as they become unprofitable. This loss of profitability may arise because another less oil-intensive technology becomes available and/or because the products manufactured by them are oil intensive and demand thus declines.

However, to affect the potential output of the economy, oil prices have to have an impact on the long-term (equilibrium) capital stock. In this respect, Finn (2000) showed theoretically how, under certain conditions, a permanent increase in oil prices lowers the equilibrium level of the capital stock in the long term. The intuition for this outcome is that if energy is an essential complement of equipment goods needed to generate production services, the user cost of capital should include the price of oil and, therefore, be positively correlated with it. As a result, the optimal degree of utilisation of the capital stock will diminish, and, if the depreciation rate depends on the degree of utilisation, it will also decline. Therefore, for a given level of production, the investment and the capital stock should be lower.

Formally, the two assumptions that Finn (2000) relaxes to obtain these results are as follows. The first is that energy is an essential complement needed for the capital stock to be able to generate production services. Thus, capital utilisation *(U)* can only be increased if the amount of energy per unit of capital is also increased:

$$\Delta u = \frac{1}{v}\left(\Delta o - \Delta k\right) \qquad [11]$$

The second is that the depreciation rate of capital (δ) is variable, being positively correlated with the degree of capital utilisation:

$$\Delta \delta = \omega\, \Delta u \qquad [12]$$

If these two conditions are introduced in a standard profit optimisation problem of a representative firm where value added behaves according to a Cobb-Douglas production function, the arguments of which are employment and the level of capital stock used (that is, the product of capital stock and the degree of utilisation), it can be shown that the ratio of capital stock to GDP will depend negatively on a redefined user cost of capital. The redefinition consists of adding the real price of energy to the traditional user cost of capital (that is, the product of the relative price of investment goods and the real interest rate plus the depreciation rate). This additional term is due, on the one hand, to the dependence of the depreciation rate on the level of capital utilisation, and, through it, on energy intensity. Thus, an increase in the real price of energy will diminish energy intensity and capital utilisation and, therefore, lower depreciation; this means that the user cost of capital will decline, increasing the optimal capital stock for a given GDP. On the other hand, in order to obtain productive services from capital, it is strictly necessary to consume energy. Therefore the real price of energy will appear directly in the user cost of capital. In this case, an increase in the real price of energy will raise the user cost of capital, inducing a downward adjustment in the desired capital stock for any level of production. Finn (2000) shows that this second channel dominates the aggregate results, so there will be a negative relationship between a firm's optimal level of capital and the real price of energy for any production level and traditional user cost of capital.

However, these effects are difficult to isolate empirically, since, at aggregate level, capital stock is not directly observed. On the contrary, it is built by accumulating observed investment (from a given initial condition), using a specific depreciation rate. The problem is that, although the depreciation rate can vary over time (mainly due to changes in the capital stock composition), there is doubt as to whether it captures the degree of capital utilisation. Besides, there are no quantitative or qualitative statistics measuring the degree of capital utilisation for the whole economy. This makes it more feasible to test this assumption using data from investment. To do so, it has to be kept in mind that in the steady state, the investment-capital stock ratio should be equal to the depreciation rate (that is, in the steady state, investment only occurs to replace depreciated capital and maintain the level of production). This implies that if the capital stock depends negatively on the real price of oil for a given level of production and the traditional user cost of capital, this negative relationship will be even stronger in the case of investment, because when the real price of oil increases, depreciation declines and, therefore, less investment is necessary to replace the depreciated capital:

$$(i-k)=Ln(\delta)\Rightarrow(i-y)=-cu-\sigma\left(p^{O}-p\right) \qquad [13]$$

2.3 Employment

The third way in which oil prices can influence potential output is through potential employment. Here it should be considered that, as pointed out above, potential employment is usually estimated by applying an equilibrium unemployment rate (or NAIRU) to a measure of the population participating in the labour market. In particular, the first step in determining potential employment is to establish what part of the working-age population is potentially willing to participate actively in the labour market. From this group it would then be necessary to subtract those individuals who, as a result of labour market rigidities, could only be employed assuming a higher level of inflation. This result is then expressed as a percentage of the active population to give what is known as the NAIRU. Therefore, the NAIRU is the variable that balances the labour market.[5] Consequently, to test if the real oil price has an impact on the NAIRU, it is necessary to know if it shifts —and if so, in what direction— the labour demand and/or supply curves.

It has also been proposed that the part of the working-age population actively participating in the labour market may depend on the equilibrium unemployment rate. This is known as the discouragement effect. This effect is explained as follows: the unemployment

5. The intuition is that if the share of labour income demanded by workers is much higher than that which firms are able to pay, there will be a disequilibrium which will be adjusted through an increase in the unemployment rate.

rate of an economy can be understood as a rough approximation to the inverse of the probability of finding a job; thus, if it is permanently high there will be individuals who, although of working age, do not search for a job because ex-ante the probability of finding it is very low. In the same vein, when the unemployment rate is lower, hiring conditions for workers improve, increasing the possible reward from participating in the market.

Therefore it can generally be assumed that real oil prices can shift labour demand and supply, and this translates into changes in the equilibrium unemployment rate.

2.3.1 LABOUR DEMAND

Labour demand by firms can be estimated from the profit optimisation first-order conditions for this primary input. Thus, in its simpler version, employment will depend positively on the level of production to be reached and negatively on the real labour cost of hiring a worker, since higher wages imply the substitution of capital for labour. If it is assumed that, as usual, firms have some market power (that is, they have a certain ability to set the selling price of products), there appears a new determinant of labour demand: the mark-up of prices over marginal costs *(μ)*. The effect of mark-ups on employment is a consequence of imperfect competition in the product market. This imperfect competition raises equilibrium prices above those found in perfect competition, making for a lower quantity exchanged in the market and produced by the firm. In particular, if, for example, mark-ups widen, the firm gains market power; therefore, the optimal decision of the firm is to raise selling prices and reduce production to increase profits; thus, for a given real labour cost, it will hire a lower number of workers. In this context, if mark-ups increase when real oil prices are higher, employment demand will be lower for every wage and, therefore, the structural unemployment rate (the NAIRU) will tend to increase.

The conditions under which a relationship holds between mark-ups and oil prices are relatively easy to derive. For example, assuming that the gross production function of a representative firm (with market power) is of the Cobb-Douglas type with constant returns to scale in the two primary inputs (capital and employment) and in intermediate consumption, the profit maximisation first-order condition for employment implies:

$$\Delta l = -\Delta Ln(\mu) + \Delta q - \left(\Delta w - \Delta p^{Q}\right) \qquad [14]$$

Substituting in this expression real gross production and its deflator defined in [6] and [7], it is easy to check that, for a given GDP and real wage (defined in terms of the GDP deflator), employment will be higher when oil costs account for a higher share of nominal gross production (implying a lower mark-up of value-added prices on value-added marginal costs):

$$\Delta l = -\Delta Ln(\mu) + s_O^Q \, \Delta Ln\left(s_O^Q\right) + \Delta y - \left(\Delta w - \Delta p\right) \qquad [15]$$

Thus, as with TFP in terms of value added, if following an increase in the real oil price there is a more than proportional reduction in the relative demand for oil (that is, if the substitution elasticity between oil and the other two primary inputs is higher than one), the weight of this input in total costs will diminish (and this is equivalent to an increase in mark-ups in terms of GDP) and labour demand will decline. Conversely, if following the same shock the relative demand for oil declines less than proportionally (that is, if the substitution elasticity between oil and the other two primary inputs is lower than one), the mark-up in terms of value added will diminish, and labour demand for a given level of GDP and real wages will increase.[6]

2.3.2 LABOUR SUPPLY

Just as labour demand encapsulates firms' decisions, labour supply reflects the wage claims of workers. The wage claims of workers[7] will generally increase with higher inflation (in terms of gross production) and productivity. Conversely, rises in the unemployment rate will diminish the wage pressure, because this reduces the probability of finding a job and raises the probability of losing it. As a result, following Layard et al. (1991), wage claims of workers will be represented by the following equation:

$$\Delta w = \Delta\psi + \Delta p^{Q} + \left(\Delta y - \Delta l\right) - \lambda\,\Delta U \qquad [16]$$

where ψ is a variable reflecting other labour market institutions —such as, among others, unemployment benefits, and the coordination and centralisation of collective bargaining— that may also influence labour supply.

Substituting in this expression the definition of production prices [7], it is found that the real oil price has a positive effect on the wages demanded by workers:

$$\Delta w = \Delta\psi + \Delta p + \left(\Delta y - \Delta l\right) - \lambda\,\Delta U + s_O^{Q}\left(\Delta p^{O} - \Delta p\right) \qquad [17]$$

Although in this expression the transmission of oil prices to wages is equal to the weight of these products in the consumption basket, this is usually considered a ceiling and, if the trade unions have little wage bargaining power, the pass-through will be lower. In the Spanish case, given the widespread prevalence of indexation clauses in collective agreements, the transmission is almost full and, more importantly, asymmetric, because these clauses are only activated when inflation goes beyond the target and not when it falls short. Accordingly, even though an oil price fluctuation may only be temporary, an increase in the price of this raw material will induce a permanent rise in unemployment and therefore in the NAIRU.

2.3.3 LABOUR MARKET EQUILIBRIUM: THE NAIRU

As said above, the NAIRU is the unemployment rate compatible with stable inflation. Since, in order to prevent inflationary pressure, the labour market should be in equilibrium, the NAIRU will be the unemployment rate that solves the equation system consisting of the labour demand curve (expression [15]) and the labour supply curve (expression [17]). Hence, using both equations and disregarding the integration constant, the following expression for the NAIRU is obtained:

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6. This approximation is perhaps an excessive simplification of the problem, since theoretically, when factor cost shares in gross production are allowed to change, the marginal cost determining the selling price is not simply the unit labour cost. In fact, in this case, marginal cost should also include the real price of oil. In any event, this new element will have an incremental effect explained in the main text. See, for example, Estrada and López-Salido (2005).

7. A significant factor not considered here is that the wages and prices relevant to workers are not the same as those relevant to producers. In fact, the relevant worker wage excludes Social Security contributions and income tax (these are included in the labour cost of firms), and the relevant price for workers includes indirect taxes and imported goods prices. To simplify the analysis, only imported oil prices will be considered.

$$NAIRU = \frac{1}{\lambda}\left\{\psi + Ln(\mu) - s_O^Q\left(o - q\right)\right\} \qquad [18]$$

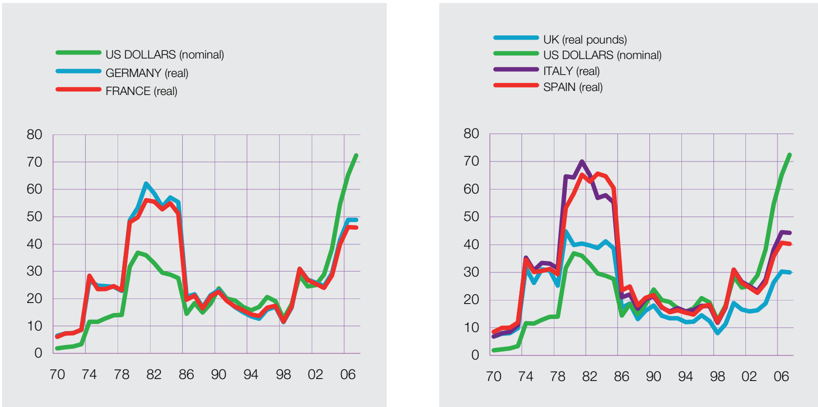
This means that the level of the NAIRU will depend on labour market institutions and will increase as the production mark-up increases, that is, as the market departs from perfect competition. Also appearing in the expression is the weight of oil costs in gross production; since this ratio will depend negatively on the real price of oil, increasing oil prices will drive the NAIRU upwards, and even more so as the economy becomes more oil intensive.

Therefore, it can be said that the level of the NAIRU will increase with increasing real oil price. On the other hand, a high NAIRU reduces the potential employment of the economy and, thus, potential output, and, moreover, the labour market participation of the working-age population is lower in countries with higher unemployment rates. As noted above, this is a consequence of the unemployment rate being an (inverse) indicator of job finding probability. Obviously, for a given working-age population, potential employment will be lower when there is a lower long-term participation rate. Hence oil price shocks have an additional channel through which to affect potential output.

3 Empirical evidence on the importance of these channels

The presence and importance of the theoretical effects of oil prices on the potential output of the economy described above can be easily illustrated. Chart 1 shows Brent oil prices from 1970, both in US dollars and in real terms (that is, taken on board each country's exchange rate and general level of prices), for some European countries. As can be seen, although from 2002 the oil price in US dollars has been higher than the levels reached in the first half of the 1980s, in real terms the 2007 level was still lower than the early 1980s peak and, although it was temporarily exceeded in mid-2008, oil prices fell dramatically in the second half of that year.[8]

OIL PRICE IN US DOLLARS AND REAL TERMS CHART 1



SOURCES: Reuters, The Economist, AMECO and Banco de España.

Chart 2 shows some preliminary evidence on the importance of the first and second channels discussed in the previous section. The top panel portrays the relationship between TFP growth rate in GDP terms (Y-axis) and the real oil price growth rate (X-axis); in the bottom panel, the GDP growth rate has been replaced by the investment rate.[9,10] As can be seen, the correlation between TFP growth and real oil price growth is negative and statistically significant (t-ratio = -10.3). This result suggests that the elasticity of substitution between oil and primary inputs is higher than one. However, the estimated coefficient implies that the effect is not very high; in fact, since the average growth rate of real oil prices in this period is 4%, the average reduction in TFP growth would be just 0.04%. In the investment case,

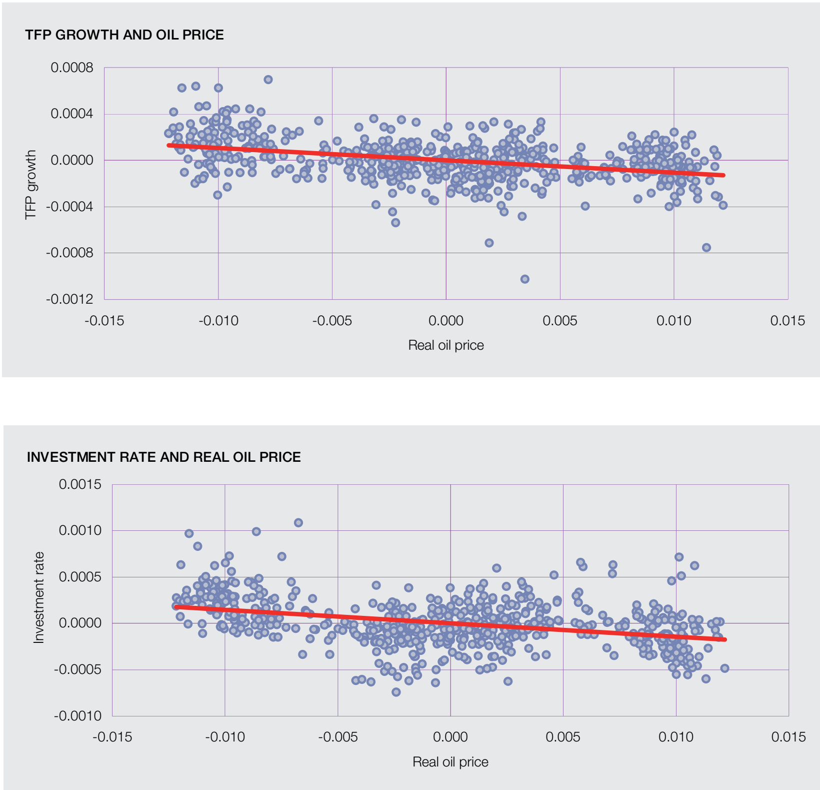
8. In any event, it should be noted that the oil price in real terms is not the ideal variable for analysis. The problem is that oil derivatives are subject to a high tax burden which influences the price paid by final consumers and, therefore, determines their spending decisions. The lack of complete information on these taxes for all countries prevents us from including them in these simple exercises, but in the countries which provide that information there is a general upward trend in the tax burden from the sixties. This means that, for a given oil price shock in the international markets, the fluctuation in the oil derivatives selling price will be smaller now than in the past.

9. Both the TFP used here and the NAIRU (analysed below) were obtained from the AMECO database constructed by the European Commission. It includes 11 euro area countries (the absences are Luxembourg and Slovenia, due to data limitations), the UK, Sweden and Denmark for the period 1965-2007.

10. All the variables are presented in deviations from time averages for each country. Therefore, the estimated slopes can be understood as the between-estimator for a panel. In any case, other determinants of the variables on the vertical axis are not taken into account. This means that the simple correlations estimated here could be biased if the omitted variables are related to real oil prices.

a negative and statistically significant correlation is estimated (t-ratio = -9.8), as suggested by the theoretical model. Further, the effect in this case is more important, since it entails an average reduction in the investment rate of 0.05 percentage points from 1965, i.e. nearly 2 percentage points in 2008.

PRODUCTIVITY, INVESTMENT AND OIL PRICE CHART 2



SOURCES: Reuters, The Economist, AMECO and Banco de España.

Chart 3 shows the simple correlation between the NAIRU and the real oil price. As can be seen it is positive and statistically significant (t-ratio = 9.2), suggesting it dominates the negative effect of oil prices on the unemployment rate. The two lower panels provide more information on this effect, by isolating the demand side of the market (mark-ups of prices over marginal costs) from the supply side (the mark-up of wages over the marginal rate of substitution). Thus, the middle panel plots the inverse of the real unit labour cost, which can be considered a good approximation to the behaviour of firms' mark-ups. The correlation obtained is not significant (t-ratio = 0.3).[11] By contrast, there is a positive and significant correlation (t-ratio = 10.1) between wage claims of workers (after productivity and unemployment effects are taken into account) and the real oil price (bottom panel of Chart 3). Therefore, it seems that the wage pressure induced by an increase in oil prices is relieved by the hiring of fewer workers by firms, thus raising the unemployment rate.

11. Notice these results are not consistent with those obtained for TFP growth since, in line with the analytical derivations in the previous section, they suggest that the elasticity of substitution between oil and primary input is unity.

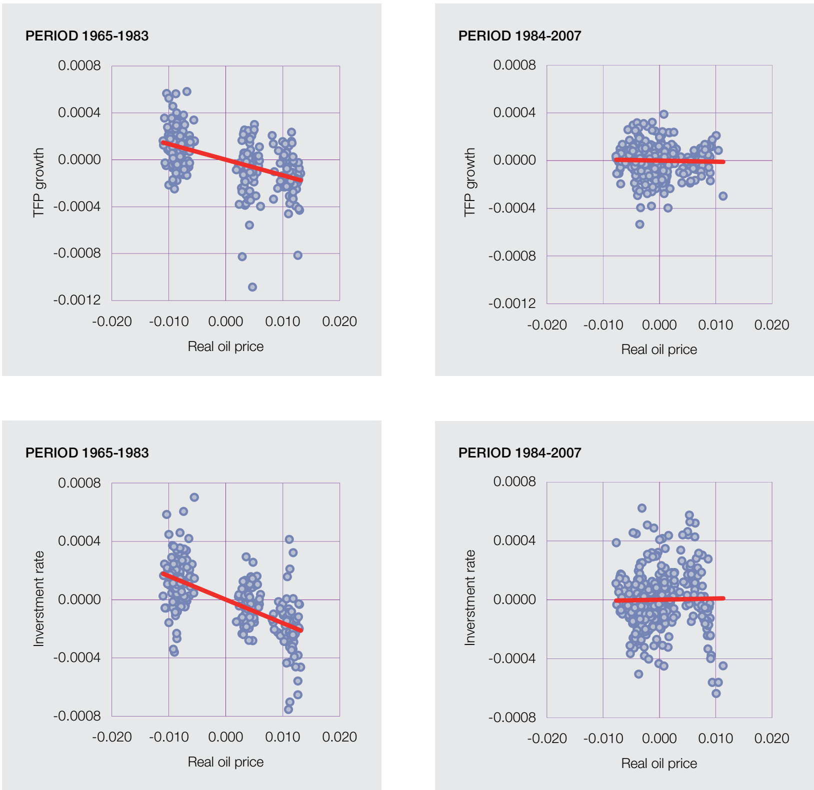
NAIRU, LABOUR DEMAND AND SUPPLY AND OIL PRICE CHART 3

SOURCES: Reuters, The Economist, AMECO and Banco de España.

In the last few years some papers have alerted of a structural change in the size of the effects of oil prices on the importing countries of this raw material in recent decades. In particular, Blanchard and Gali (2007) show that the negative and positive impact on activity and inflation, respectively, of an oil price increase has substantially diminished from the mid-1980s. Although these authors do not consider the (measured) productivity channel and the optimal capital stock, when the sample used in this paper is divided in the same year (1984) as that considered in the above-cited paper, the correlations estimated previously change significantly.

Thus, as can be seen in the left-hand panels of Chart 4, before 1984 the correlation between TFP growth rate and real oil price growth rate was negative and significant at standard levels of significance (t-ratio = -9.6) and the same was true of the investment rate (t-ratio = -13.6). However, alter that year, the regression coefficient in both cases diminishes dramatically, losing statistical significance (t-ratio = -0.6 y 0.3, respectively). These results suggest that from the mid-1980s oil prices have barely affected labour productivity growth, neither producing a decline in TFP growth nor inducing a substitution of labour by capital.

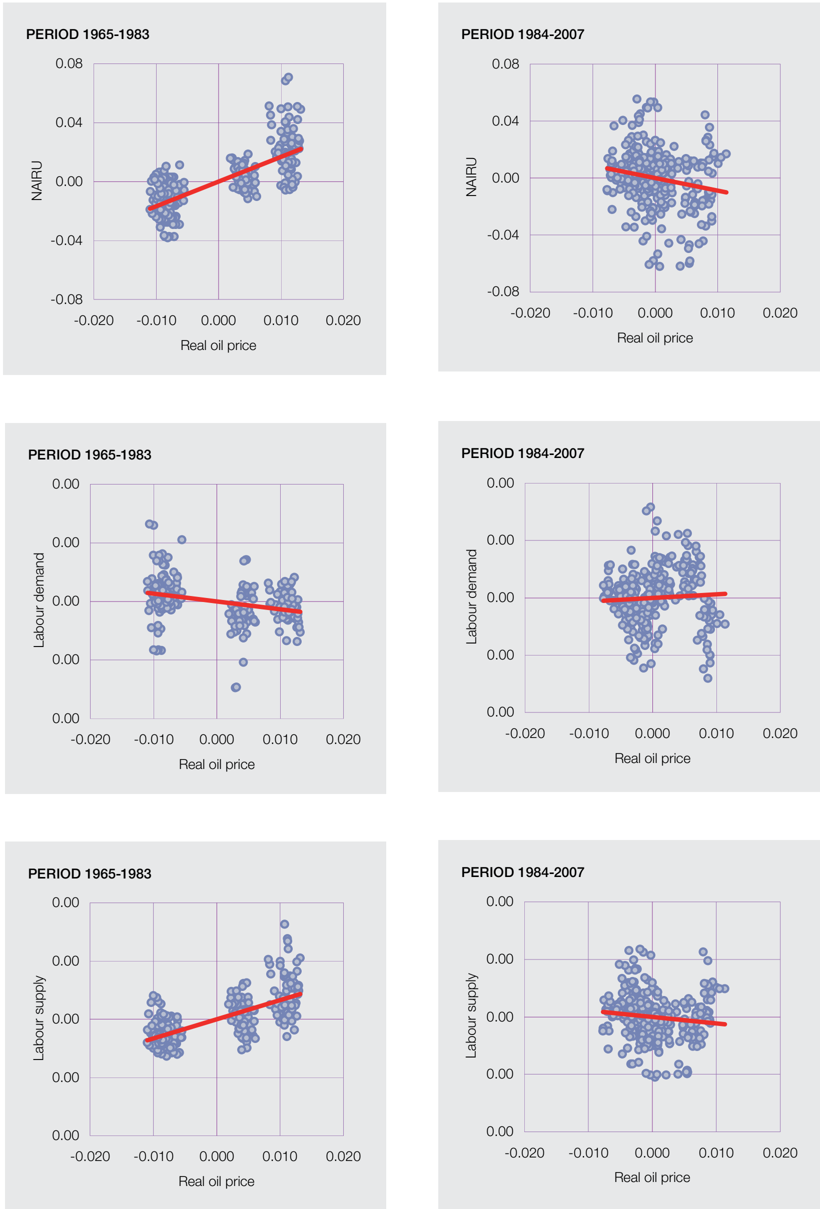
PRODUCTIVITY, INVESTMENT AND OIL PRICE IN DIFFERENT SAMPLES CHART 4



SOURCES: Reuters, The Economist, AMECO and Banco de España.

In the case of the NAIRU, the results are even clearer, as can be seen in the upper panel of Chart 5. A positive correlation in the first period (t-ratio = 18.1) gives way to a negative one, albeit non-significant (t-ratio = -0.6), in the second. The lower panel of that chart provides more evidence on the factors behind the lack of response of the NAIRU to real oil prices in the second part of the sample. In the first place, mark-ups have gone from acting as a compensative factor of this kind of disturbance (the correlation was negative and the t-ratio = -5.5) to being an element that stresses the initial oil price shock (positive correlation and t-ratio = 1.8). Contrastingly, whereas in the first part of the sample workers did not accept the real income loss implicit in an increase in oil prices for an importing country (positive correlation and t-ratio = 15.3), they seem to have changed that behaviour from 1984 (negative correlation and t-ratio = -1.3). It should be noted that the effect of oil prices on wage claims relied on the significance of oil derivatives consumption in the total household consumption basket, and this have declined in most of the countries considered.

NAIRU, LABOUR DEMAND AND SUPPLY AND OIL PRICE IN DIFFERENT SAMPLES — CHART 5



SOURCES: Reuters, The Economist, AMECO and Banco de España.

Although this empirical analysis has severe limitations, it is consistent with the evidence that the impact of oil price shocks has decreased in the developed economies and with the role that seems to have been played in this process by the reduction in labour market real rigidities associated with the recent labour market reforms in most European countries [Blanchard and Gali (2007)]. It is also noteworthy that this raw material has lost importance in the productive process in most of the countries considered. In any event, other factors that may help to explain this are a change in the substitution elasticity between oil and other productive inputs, and the role played by taxes on the oil derivatives demanded by final consumers.

4 Conclusions

Oil prices reached very high levels in the first half of 2008, declining very significantly in the second half of the year. The analysis of the effects of these fluctuations on the economy is usually limited to emphasising its negative impact on demand and its positive bearing on inflation. Not always taken into account, however, is the possible effect on the potential output of the economy. This latter effect stems from the impact of oil prices on (measured) productivity, capital stock and the structural unemployment rate (NAIRU) of the economy, and, according to certain preliminary evidence, can be significant. In the case of the NAIRU, this effect may be amplified when there is little competition in product markets and an increase in oil prices is followed by increased mark-ups, or when high wage indexation generates a pass-through of oil price shocks to wages. In this respect, reforms that increase competition in product markets and improve wage-setting mechanisms help to reduce the negative effects of oil price increases on the long-run growth of the economy. At least the asymmetric working of these mechanisms should be avoided.

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