

OIL PRICES AND THE ECONOMY*

*Paulo Soares Esteves***

*Pedro Duarte Neves****

1. INTRODUCTION

The importance of oil prices to explain economic fluctuations emerged when the remarkable price stability that characterized the Golden Age period was interrupted in the early 70s. The recent conflicts on Iraq and the strong increase of oil prices in 2004 contributed to perk up the debate concerning the importance of oil prices to industrialized economies, as scenarios of a new oil shock have been frequently put forward.

This paper resumes the main channels through which oil prices affect the economy. Recent empirical findings are confronted with simple indicators and some models simulations, as a way to derive useful rules of thumb for the effects of oil prices both in real activity and inflation. Concerning the direct and short-run effects on inflation an elasticity of around 0.01 seems to hold over the last 30 years across the countries considered (G7 and Portugal). Concerning GDP, elasticities of around -0.02 for the main developed countries (underlying a higher value for the euro area countries) and -0.04 for Portugal emerge as possible rules of thumb when oil prices are at a level around 25 USD.

The paper is organized as follows. Section 2 presents the evolution of oil prices against inflation and GDP growth in the OECD area since the early 70s. A simple graphic analysis shows that periods with more pronounced increases in oil prices

were connected with higher inflations and lower GDP growth rates.

Section 3 presents the main channels underlying the transmission of oil prices to the economy. Despite the great unanimity concerning the signal of the effects on inflation and GDP, the transmission channels underlying those effects are complex and evolve over time. Nevertheless, an oil price shock would inevitably produce lower effects today than in the past given the reduction of the oil expenditure share on GDP— reflecting the decline of the relative price of oil as well as the reduction in the consumption of oil per unit of output — and the lessons drawn for monetary authorities from the past oil price shocks. Reflecting a more intensive use of oil and a strong sensitiveness to the external environment, that characterizes a small and open economy, the effects on the Portuguese economy are more pronounced than in the main developed countries.

Section 4 presents estimates for the overall impact of an oil price increase on GDP and prices, both for the main developed countries and Portugal. Despite the considerable uncertainty surrounding those estimates, they may constitute useful rules of thumb.

Finally, section 6 resumes the main conclusions.

2. OIL PRICES AND THE ECONOMY SINCE THE EARLY 70S

The remarkable stability of oil prices during the Golden Age period was interrupted in the 70s. Reflecting the premeditated action of OPEC (Organization of Petroleum Exporting Countries), by con-

* The views expressed in this article are those of the authors and not necessarily those of the Banco de Portugal.

** Economic Research Department.

*** ANACOM, *Autoridade Nacional de Comunicações* previously at the Economic Research Department.

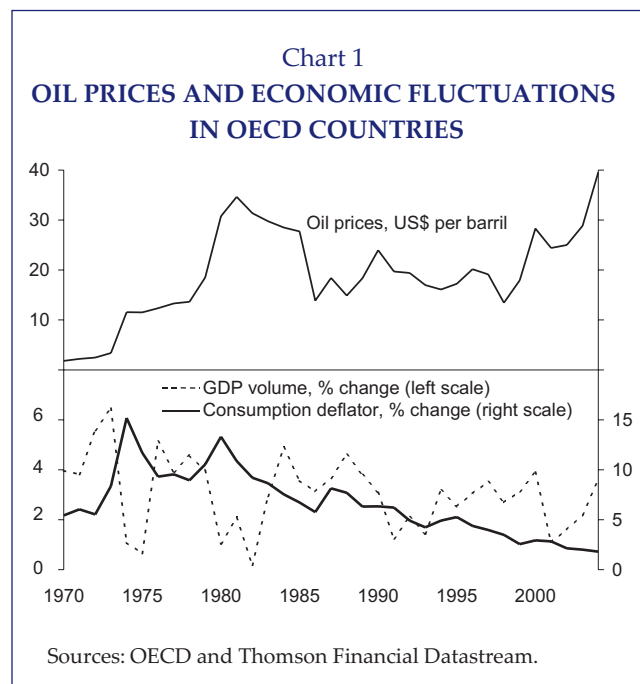
straining the quantity supplied to the market, oil prices reached 11.5 USD per barrel in 1974, more than tripling from the previous year and almost 5 times above the 1972 figure. Some years later, in 1980-81, oil prices increased again sharply, reaching values around 30 USD per barrel, doubling from the levels achieved in the previous year.

During these two oil shocks, the inflation rate in OECD countries reached maximum figures of about 15 per cent in 1974 and 13 per cent in 1980, while the GDP decelerated intensely to rates of growth close to zero in 1975 and 1982, after average values around 4-5 per cent observed in the years before the two oil shocks (see Chart 1)⁽¹⁾.

In the first half of the 80s, the OPEC became unable to enforce the production quotas set for its members and new producers entered the market. Given the increasing oil supply and the serious disagreements within OPEC, prices started to decline, collapsing in 1986 and starting to fluctuate within a narrower band. During this period, inflation in OECD countries recorded a noticeable downward trend from two digit figures to figures close to 2 per cent, while the GDP growth became more stable – the standard deviation of the GDP growth rate decreased to almost half of the figure registered in the period 1970-1985.

Over the last years, however, oil price volatility remained a central feature of the world economy. Oil prices decreased to around 10 USD per barrel in late 1998 and early 1999. After seriously misjudging the oil market in that period, OPEC has successfully pushed prices upward, and prices increased vigorously, reaching figures close to 30 USD per barrel in 2000⁽²⁾. Most recently, oil prices registered a pronounced increase, namely reflecting the developments related with the war in Iraq, reaching a new historical maximum above the 50 USD during the second half of 2004.

Despite the less pronounced fluctuations than in the past, oil prices continue to influence decisively inflation, being also frequently pointed out as a key factor explaining the real fluctuations of the OECD economies. For instance, Muelbauer and Nunziata (2001) successfully predicted the US



economy recession in 2001 using a multivariate analysis in which oil prices play a prominent role. Thus, the recent increase of the oil price to levels above 40 USD bring back the fears of a new slow-down in the world economy.

3. PASS-THROUGH CHANNELS FROM OIL PRICE CHANGES

The most usual channels to explain the effects of oil prices on the economy are the strong link between oil prices and the terms of trade (see Backus and Crucini (2000)) and the role of oil as an intermediate production factor (see Bruno and Sachs (1985)). Both channels explain why an oil price increase tend to raise inflation and to decrease GDP.

The relation between oil prices and inflation is easily achieved, namely considering the strong link between energy consumer prices and oil prices, while a negative correlation of oil prices with GDP was reported, among others, by Hamilton (1983), Mork *et al.* (1994), Rotemberg and Woodford (1996), Raymond and Rich (1997), Bernanke *et al.* (1997), Hamilton (2003), Jiménez-Rodríguez and Sanchez (2004) and Jones *et al.* (2004). Moreover, the same negative correlation seems to emerge when microeconomic data is used (see, for instance, Keane and Prasad (1996), Davis and Haltiwanger (2001), Lee and Ni (2002)).

(1) The brent crude prices are the ones considered (retropolated for the period before 1983 using the prices of the Arabian light crude).

(2) For the role of OPEC in this period see Kohl (2000).

However, some controversy remains in respect to the transmission channels underlying those effects. Firstly, these effects tend to evolve over time, reflecting the declining vulnerability of the industrialized economies to oil prices (see Hooker (1996)). Secondly, those effects could be complex and difficult to estimate, as they depend on the reaction of policy authorities and on the expectations concerning the persistence of the shock. More recently, Hamilton (2003) supported this last point, confirming that oil prices increases are much more important than oil prices decreases, and that increases after a period of stable prices tend to produce larger effects than the ones that correct previous declines on prices, explaining a non-linear relationship between oil prices and economy.

As the aim of this section is to present in a very simple manner the channels surrounding the effects of oil prices fluctuations on economy (see also Stuber (2001)), those channels are presented separately in terms of inflation and GDP.

3.1. Effects on inflation⁽³⁾

The channels through which oil prices affect consumer prices could be distinguished between first round effects — further decomposed in direct and indirect effects — and second round effects (see also Bank of England (2000)).

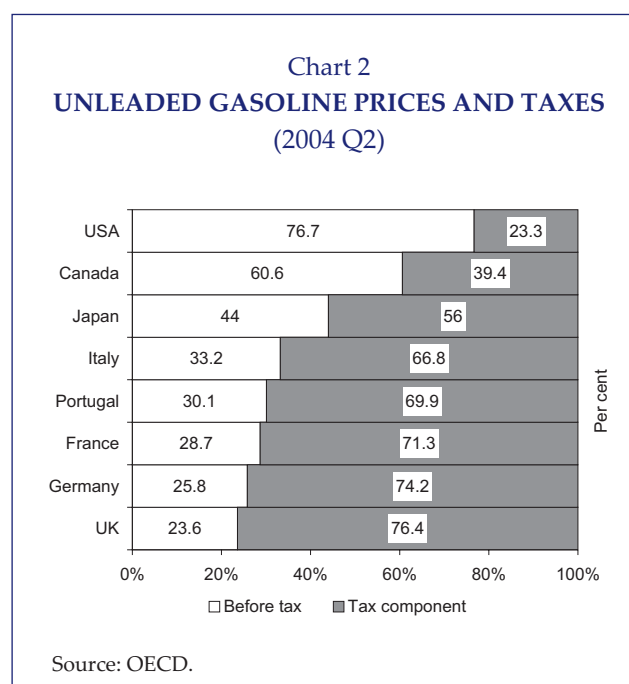
3.1.1. First round effects

First round effects reflect the fact that fuel — as well as goods and services with a direct content of oil (transports, for instance) — is included in the consumer price index. First round effects on prices can be direct and indirect, as it is useful to distinguish the impact on the energy components of the index, the so called direct effects, and the impact on the components of the index that have a high content of energy, the so called indirect effects.

Direct effects

Considering the direct effects, the larger the share of energy — fuels, electricity and gas — in

(3) This sub-section follows very closely Esteves and Neves (2004).



consumption expenditure the larger the direct impact on the CPI of a given energy price change.

The importance and the structure of tax rates also affects the size of these first round direct effects. If the tax rate has an *ad valorem* structure (i.e. the tax corresponds to a fixed proportion of the final price) an increase in the cost of energy will be totally transmitted to the consumer. However, if the tax corresponds to a specific tax (i.e. x cents by unit of energy) an increase in the cost of energy will be only partially transmitted to the consumer, at least before any adjustment of the tax. Usually, tax systems are more complex than these very simple illustrations, reflecting the existence of both *ad valorem* and specific components. Chart 2 shows the sizeable discrepancies of the tax component in unleaded gasoline prices across several countries, which are reflected on the final consumer prices given that prices before taxes should be very similar across the different economies⁽⁴⁾. The tax component is considerably higher in the European countries, including Portugal, than in the non-European G7 countries.

Table 1 shows for the G7 countries the very strong correlation between annual rates of change of oil prices in national currency and the consumer

(4) The overall picture would be the same considering the diesel prices. More detailed information is easily obtained in the OECD International Energy Agency (IEA) quarterly publication (Energy prices & Taxes).

Table 1

OIL PRICES AND CONSUMER ENERGY PRICES
(Annual rates of growth, 1971-2003)

| | Consumer energy prices | | |
|---------------------------------|--|------------|-------|
| | Correlations coefficients | Elasticity | |
| Oil prices in national currency | USA | 0.741 | 0.143 |
| | Japan | 0.763 | 0.128 |
| | Germany | 0.662 | 0.097 |
| | France | 0.811 | 0.139 |
| | Italy | 0.797 | 0.156 |
| | UK | 0.568 | 0.101 |
| | Canada | 0.416 | 0.066 |
| | G7 (weighted average) | 0.721 | 0.130 |
| | G7 (weighted average) ^(a) | 0.698 | 0.139 |
| | Portugal | 0.322 | 0.095 |
| | Portugal ^(a) | 0.174 | 0.061 |
| | Portugal ^(b) | 0.248 | 0.121 |

Sources: OECD, Thomson Financial Datastream and Banco de Portugal.

Notes:

(a) Considering data from 1986 to 2003.

(b) Considering data from 1986 to 1998.

energy components of the national CPIs. A simple linear estimation between these two variables points to an elasticity around 0.1, i.e. that the energy component of the CPI tends to react by 1 to 10 to the change in oil prices.

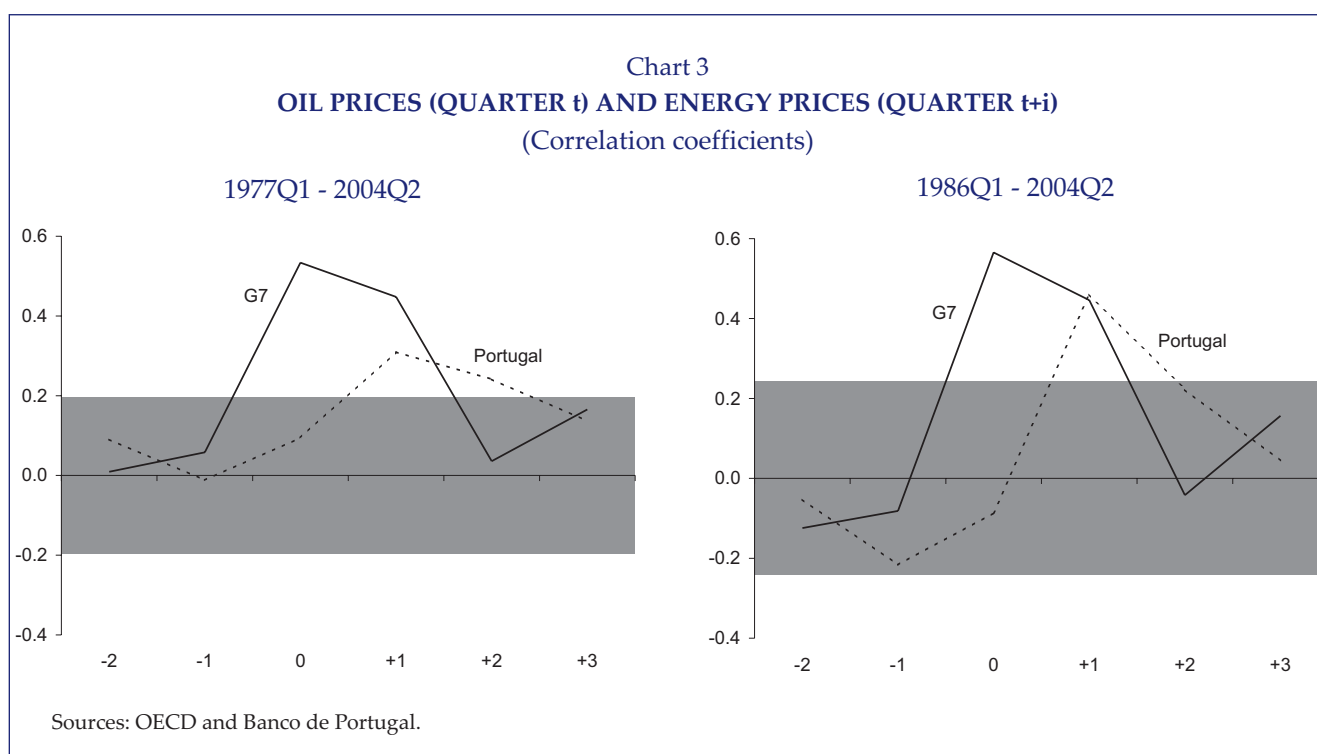
An important result is the stability of this rule of thumb. In fact, the same rule holds when data from 1986 to 2003 is used and thus there is no evidence that a smaller vulnerability of inflation to oil prices could be attributed to a decline of the magnitude of the so called first round direct effects. Moreover, the results do not suggest very significant differences across countries, namely connected with the above mentioned differences on taxes on energy products.

Finally, the results for Portugal have a lower statistical significance (suggesting other important factors explaining energy prices) but the estimates are not very different from the G7 average. The exception occurs in the period 1986-2002, where energy prices registered a lower sensitivity to oil prices changes. This result is likely to have been determined by the policy followed in the later 90s (abandoned in 2002) that isolated the consumer fuel prices from the fluctuations of oil prices in international markets, by allowing the change of tax-

ation on fuel products. In fact, when the latest years of sample are excluded, the estimated elasticity between oil and consumer energy prices became closer to the ones obtained for the G7 average.

Combining this sensitivity to the present weight of energy in final household's consumption – which tends to be close to 10 per cent – one concludes that inflation reacts by approximately 1 to 100 to the change in oil prices. That is, if the price of oil increases by 100 per cent, the direct effect on inflation is roughly one percentage point. This rule of thumb gives a rough approximation of the magnitude of the direct first round effects of an oil price change in inflation. And this rule seems to have been broadly stable reflecting the stability of oil component expenditure share on total consumption. Despite the decline of the relative price of oil and of the oil consumption per unit of output, the stability of this share could be explained by an increase of the tax component on energy consumer prices⁽⁵⁾.

An important feature is the high speed of transmission to prices underlying these direct effects. This point is illustrated in Chart 3 that presents the quarterly correlation coefficients between oil



prices changes in national currency changes and the lagged and led changes of the consumer energy prices (the shadow area corresponds to the correlation coefficients not statistically different from zero at a 95 percent confidence level).

As expected the correlation structure points to a causality from oil prices to energy prices — the correlations using lagged energy prices are not statistically different from zero.

Considering data for the G7 countries, the evolution of oil prices just tends to affect the chain rate of the energy consumer prices in the current and one step ahead quarters — this means that these direct effects tend to occur during three months after the oil price change, and there is no evidence of a different transmission profile since the second half of the 80s, reinforcing the stability of the above mentioned rule of thumb. The results for Portugal suggest that the transmission was slightly slower — however, the data for the latest years point to some evidence of an increasing speed of transmission.

(5) Despite the same effects on energy prices, it should be stressed out that the results for the economy are of course different, because part of the energy price increase is transferred to a domestic sector, e.g. the public sector, instead to the oil exporter country.

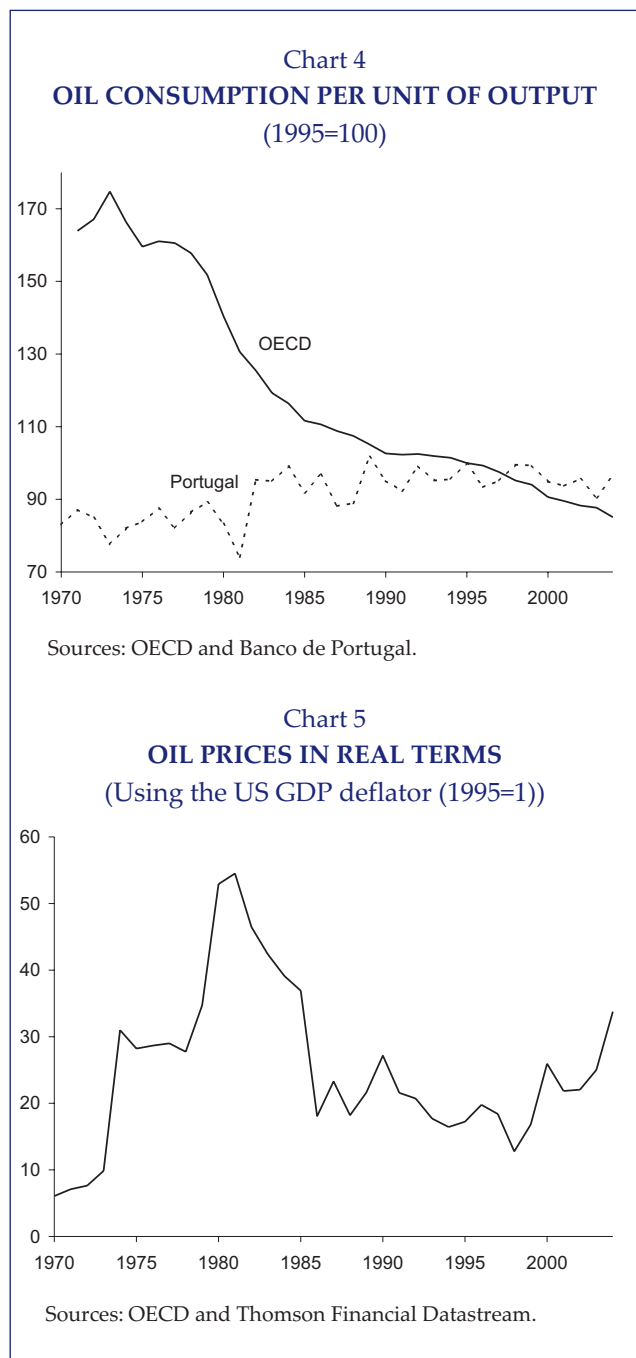
Indirect effects

As mentioned above, changes in oil prices will also produce first round indirect effects as prices of goods and services with some content of energy will react to an increase in the cost of energy. The most obvious cases are transports (air and surface) — components highly energy-intensive — but a large proportion of the price index is also likely to be affected.

Contrarily to the above mentioned direct effects it is not straightforward to derive any quantification of these indirect effects. However, as the magnitude of these effects on price depends on the importance of energy as an input, there are two reasons why they should be smaller in current days than in the 70s⁽⁶⁾.

Firstly, there was a strong decline in the use of oil per unit of GDP in the OECD countries (Chart 4). It is common to accept that this decline in oil intensity reflected the adjustment of the world economy to a new era of higher and more unpredictable oil prices, through the use of alternative sources of energy and more energy-efficient tech-

(6) Of course, as in consumer energy prices, those effects could have been balanced by the increase of energy taxes. However, it should be stressed that the increase of taxes on the energy used at the production sector should have been lower than the ones observed at the consumer level.



nologies. It should be mentioned that this trend was not observed in Portugal, reflecting probably a different stage of its developing process during the period, characterized namely by a decline of the weight of the agricultural sector.

Secondly, there was a decline of the oil prices in real terms (Chart 5), diminishing its role as a production input. Considering the US GDP deflator⁽⁷⁾, the relative price of oil stood throughout the 90s at

(7) Real price of oil estimated for the US economy in order to allow a direct comparison between the GDP deflator and the international oil price denominated in USD.

levels that correspond to less than half the maximum levels observed in the early 80s.

Finally, the increase of competition, in particular in those markets more exposed to oil prices, may have reduced the ability to transpose to final prices the increase of energy costs.

3.1.2. Second round effects

In addition, price developments are also affected by the so called second round effects, that are related with macroeconomic reaction to a change of oil price. Besides the above mentioned first round indirect effects, these second round effects constitute an additional factor why changes in consumer energy prices tend to produce contemporaneous but also lagged effects on the remaining components of CPI. This point is illustrated in Table 2 that presents the correlation coefficients between the annual change of oil prices in national currency and the lagged and led changes of consumer prices excluding food and energy (usually referred as underlying inflation).

As expected, the correlation coefficients are not so significant as in the case of the energy prices (Table 1), as other factors than oil prices are more important to explain non-energy prices. Nevertheless, the results suggests that energy prices tend to explain changes on the other prices — the highest coefficients are to the one year ahead underlying inflation⁽⁸⁾.

Typically, the second round effects are associated with a circular wage-price causality. If employees do manage to increase their nominal wages in line with the rise in consumer prices — rather than accepting lower real wages — additional inflation pressures emerge, through a wage-price spiral. Therefore, the magnitude of those second round effects clearly depend on the labour market flexibility and on the credibility of monetary policy, which is key to the formation of inflation expectations. The experience of the two oil price shocks is able to describe the important role of monetary policy.

In the oil price shock of 1973-1974 there is a strong evidence that substantial second round effects on inflation took place in many industrial

(8) This is reason why inflation measures that exclude the evolution of energy prices do not constitute a reliable measure of core inflation (see Marques *et al.* (2002)).

Table 2

ENERGY PRICES VS UNDERLYING INFLATION
(Annual rates of growth, 1977-2003)

| | | Correlation coefficients | | | | |
|--|----------------------------|---|-------|-------|--------|--------|
| | | Overall consumer prices excluding food and energy | | | | |
| | | t-1 | t | t+1 | t+2 | t+3 |
| Oil prices in national currency (t) | USA..... | 0.143 | 0.336 | 0.403 | 0.209 | -0.021 |
| | Japan..... | -0.070 | 0.063 | 0.163 | 0.116 | -0.064 |
| | Germany | -0.048 | 0.170 | 0.236 | 0.176 | -0.059 |
| | France..... | 0.203 | 0.257 | 0.261 | 0.277 | 0.234 |
| | Italy..... | 0.196 | 0.334 | 0.336 | 0.264 | 0.182 |
| | UK..... | 0.129 | 0.317 | 0.231 | -0.001 | -0.117 |
| | Canada | 0.126 | 0.150 | 0.370 | 0.390 | 0.151 |
| | G7 (weighted average)..... | 0.092 | 0.254 | 0.313 | 0.191 | 0.003 |
| | Portugal | 0.165 | 0.322 | 0.380 | 0.363 | 0.375 |

Source: OECD.

economies. This outcome reflects the combined effects of latent inflationary pressures, already present in the beginning of the 70s, the large magnitude of the oil price shock, the relatively low flexibility of labour markets and, last but not the least, the accommodative stance of monetary policies in the more advanced economies. It is commonly accepted by economists that a tighter monetary policy was required, as suggested by the fact that *ex post* real interest rates became negative in 1974 and remained so until 1978, in a large number of countries. The lack of anti-inflationary credibility contributed to unsustainable levels of real wages and thus to marked increases in the unemployment rate.

The experience with the second oil price shock was different. In spite of the fact that inflation remained high in the period 1981-82 — at two digit figures — it fell significantly in the subsequent years. A decisive factor for that evolution was the decline in real wages, in clear contrast with what had happened in the first oil price shock. In addition, the response of monetary policy — characterized by increases in the nominal interest rates — assured that *ex post* real interest rates were positive. Monetary policy was relatively successful in the second oil price shock, as measured by the moderate evolution of inflation expectations and the subsequent reduction of inflation⁽⁹⁾.

These lessons drawn for monetary policy authorities from the previous shocks and a more flexible labour market — through more decentralized wage settlements and the increasing competition from countries with much lower wages, following the world economy globalization — should allow for lower second round effects on inflation than the ones observed in the past.

3.2. Terms of trade effects

Oil price increases represent a negative terms of trade shock for oil net importers countries. Assuming that oil demand is inelastic to its price, the effect of an oil price shock is totally transmitted to GDP by the increase of the domestic resources that are necessary to reallocate in order to assure the same imported oil volume. Thus a very simple indicator to account for this income effect is given by the weight of import oil to GDP⁽¹⁰⁾.

Using this indicator, the results presented in Table 3 show a generalized decrease of the GDP sensitivity to oil prices during the last 30 years, reflecting the use of less energy-intensive technology.

(9) On this issue, European Central Bank (2000) provides a very useful discussion for the euro area.

(10) The use of this rule could also be justified by the use of a production function where besides labour and capital oil is considered as an intermediate factor (see Esteves (2004)).

Table 3

TERMS OF TRADE ELASTICITIES

| | Energy net exports (% of GDP) | | | Considering spillover effects | | |
|------------------------|-------------------------------|-----------|-----------|-------------------------------|-----------|-----------|
| | 1977-2002 | 1986-2002 | 2001-2002 | 1977-2002 | 1986-2002 | 2001-2002 |
| USA | -0.012 | -0.008 | -0.010 | -0.016 | -0.010 | -0.012 |
| Japan..... | -0.022 | -0.012 | -0.014 | -0.027 | -0.014 | -0.017 |
| Germany | -0.019 | -0.011 | -0.013 | -0.038 | -0.022 | -0.026 |
| France..... | -0.017 | -0.009 | -0.011 | -0.038 | -0.020 | -0.024 |
| Italy..... | -0.031 | -0.016 | -0.019 | -0.052 | -0.028 | -0.033 |
| UK..... | -0.004 | -0.001 | 0.001 | -0.020 | -0.010 | -0.010 |
| Weighted average | -0.016 | -0.009 | -0.011 | -0.025 | -0.014 | -0.017 |
| Portugal..... | -0.037 | -0.024 | -0.029 | -0.060 | -0.036 | -0.043 |

Sources: Using data from OECD, Banco de Portugal and Hooper *et al.* (2000).

gies and the reduction of the relative price of oil. Table 3 also highlights the higher sensitiveness of the Portuguese GDP to oil prices fluctuations. The share of net oil imports to GDP in Portugal is almost 0.04 considering the whole period, declining to around 0.025 in the 1986-2002 period and increasing to almost 0.03 in the period 2001-2002. The weighted average of the six countries considered⁽¹¹⁾ moved from -0.02 in all period to a value close to -0.01 at the end of the sample.

However, these initial effects are enlarged by the spillover effects related with external trade links across economies. Using the trade-income elasticities presented in Hooper *et al.* (2000) to compute these spillover effects, estimates for the overall effect on GDP are presented in the right side of Table 3⁽¹²⁾.

Considering the average figures for 2001-2002, this analyses point to an average GDP-oil price

elasticity close to -0.02, but with important differences across countries — from values between -0.01 and -0.015 for UK, US and Japan to values between -0.02 and -0.03 for most euro area countries. The highest elasticity is achieved to Portugal (around -0.04), given the more intensive use of oil but also by higher spillover effects reflecting the openness level of the Portuguese economy.

This rule should be carefully used, and the results presented above should be conditioned on the observed oil prices — around 25 USD in the period 2001-2002. Reflecting the lack of an unitary substitution between oil and the other production factors (see Backus and Crucini (2000) and Esteves (2004)), the oil expenditure share in GDP depends on its relative price. This feature implies a non-linear effect of an oil price change, towards a higher elasticity when the imports share (i.e. oil price) is higher. In other words, for instance, a 100 per cent increase of oil prices will produce higher results when the reference scenario considers as baseline an oil price of 40 USD per barrel than one of 10 USD. The use of a constant elasticity — reflecting a sample average — could be misleading given the traditional volatility of oil prices.

It is also worth mentioning that those elasticities do not account for the effects related with the monetary policy reaction to an oil price increase.

(11) The Canada was not consider because its energy net imports are very influenced by the non-oil component.

(12) The overall effect on GDP of each country (vector E_T) is computed according to:

$$E_T = [I - \text{diag}\left[\frac{x}{y}\varepsilon_{x,y}\right]\left[\frac{x_i}{x}\right]\text{diag}\left[\varepsilon_{m,y}\right]]^{-1} E_0$$

where $\left[\frac{x}{y}\varepsilon_{x,y}\right]$ is the diagonal matrix composed by the weighs of exports in GDP per country $\frac{x}{y}$ multiplied by the respective exports elasticity to external income $\varepsilon_{x,y}$, $\left[\frac{x_i}{x}\right]$ is a matrix where each line represents the trade partners shares on the exports of each country, $\text{diag}\left[\varepsilon_{m,y}\right]$ is the diagonal matrix with the imports elasticities to domestic income in each country and E_0 is the vector of the initial effects given by the weigh of energy net exports on GDP.

Table 4

EFFECTS OF A 100 PER CENT INCREASE OF OIL PRICES

| | | Year 1 | Year 2 | Year 3 |
|---|----------------------|--------|--------|--------|
| European Commission (2004) ^(a) | | | | |
| Euro area | Consumer prices..... | 0.9 | 1.1 | 1.2 |
| | GDP | -1.2 | -1.5 | -1.6 |
| International Energy Agency (2004) ^(b) | | | | |
| Euro area | Consumer prices..... | 0.7 | 1.5 | - |
| | GDP | -0.7 | -1.4 | - |
| US | Consumer prices..... | 0.7 | 1.5 | - |
| | GDP | -0.4 | -0.8 | - |

Notes:

(a) Original shock is 25 per cent since the beginning of 2004 (oil price around 30 USD in 2003).

(b) Original shock from 25 to 35 USD per barrel.

4. CURRENT ESTIMATES FOR THE OIL PRICES EFFECTS

The focus of this section is on the quantitative assessment of the effects of oil prices on inflation and GDP both for G7 countries and Portugal. Those results should be considered as illustrative, because the usual caveats when dealing with these kind of models produce a lot of uncertainty on the results: (i) the macroeconomic models constitute a very simplified representation of the real world and thus do not capture precisely the functioning of the economy; (ii) econometric simulations tend to reproduce the average behaviour of the economy, and, in general, do not deal easily with the above mentioned structural changes related with oil intensity or the weight of energy taxes in consumer prices; (iii) the simulation results depend crucially on the assumptions on the form of economic agents' expectations and the reaction of monetary and fiscal policies.

Besides these usual problems when simulating models, an important issue is that the usual macroeconomic models do not seem to be able to produce reliable results concerning the effects of oil prices on GDP. For instance, the simulations of the OECD Interlink model and of the IMF Multimod (reported in Dalsgaard *et al.* (2001) and Hunt *et al.* (2001), respectively) point to very low effects of oil prices on GDP. In spite of being commonly used to produce scenarios for the world economy, the problem is that these kind of models do not account for the mechanisms through which

oil prices affect permanently GDP, namely its role as an intermediate production function (on this issue see Jones *et al.* (2004) and Esteves (2004)).

This section presents the results of two recent studies published by the European Commission (EC) (to the euro area) and the International Energy Agency (IEA) (both to the euro area and the US), and the simulations for Portugal carried out with the Annual Macroeconometric Model (AMM) used at Banco de Portugal as the benchmark model to produce forecast or simulation exercises.

4.1. Recent OECD and EC simulations

Table 4 presents the rescaled results of the studies of the EC and the IEA. The shock corresponds to a permanent increase of oil price by 100 per cent, taking as initial price 30 USD and 25 USD, respectively.

Concerning the effects on inflation, the results are very similar for the euro area and the US economy. In the first year, the effects are slightly below the "1 to 100" rule above mentioned to measure the first round direct effects (between 0.7 and 0.9 per cent to the euro area and 0.7 to the US). The major differences are related with the lagged effects on inflation across the EC and the IEA simulations. While in the EC study the transmission to prices seems to be very quick — with inflation being just 0.2 and 0.1 percentage points above the baseline in the second and third years, respectively — in the International Energy Agency, the peak on inflation occurs in the second year of simula-

tion (0.8 percentage points), leading to a more pronounced effect in consumer price level (1.5 per cent in the IEA and 1.1 in the EC).

Concerning the effects on GDP, the accumulated effect two years ahead is -0.8 per cent for the US economy, while both the EC and the International European Agency results converge to values close to 1.5 per cent for the euro area. These results confirm a lower sensitiveness of US GDP to an oil price change, but they are lower than the ones suggested by the terms of trade rule (-1.2 and -2.5 per cent to the US and the euro area, respectively).

Interestingly, the results produced by more specialized literature are closer to the ones suggested by the terms of trade rule. As referred in Jones *et al.* (2004), an accumulated GDP-oil price elasticity during two years between -0.05 and -0.06 seem to be in line with the recent empirical findings for the US economy — namely Mork *et al.* (1994) and Hamilton (2003). The results reported in Jiménez-Rodríguez and Sanchez (2004) point also to an elasticity of -0.05 for the US and are in a range from -0.03 to -0.05 for the euro area countries (these lower effects may be related with the embodied depreciation of the euro). However, a part of these estimated effects on GDP are related with the answer of monetary policy to oil price changes rather than the oil price shocks themselves — for instance, Bernanke *et al.* (1997) reduces the accumulated response of the US GDP during 42 months from -0.055 to around an half, to -0.023, when the federal funds rate is kept unchanged at 4 per cent. Thus, controlling for the temporary effects related with monetary policy reaction, these figures are nearer to the terms of trade rule than to the OECD and EC studies.

4.2. Results for Portugal

Results for Portugal can be achieved with the model usually used at Banco de Portugal as a forecasting and simulating tool. This model, contrarily to the most usual macroeconomic models, considers a production function where oil is an intermediate factor, therefore increasing its ability to capture an oil price increase as a negative supply shock. Chart 6 reports the results both in GDP and in consumer prices of an increase of oil prices of 100 per cent, against a baseline in which oil price is

kept constant at 25 USD, and spillover effects are considered using the procedure presented above.

The inflation is quickly affected in the first year (around 1.2 percentage points), and then the effects start to disappear. Five years after the shock inflation is very close to the baseline. As to the GDP, its growth is mainly affected during the first four years. After that period the effects start to die out, converging to a long-run effect on GDP level close to 4 per cent (in line with the “terms of trade rule”).

5. CONCLUSIONS

This paper tries to resume the effects of oil prices on the economy, both on GDP and inflation, presenting in a simple way the main channels underlying those effects and, when possible, providing some rules of thumb for the size of the effects.

Concerning the effects on inflation, the main conclusions are the following.

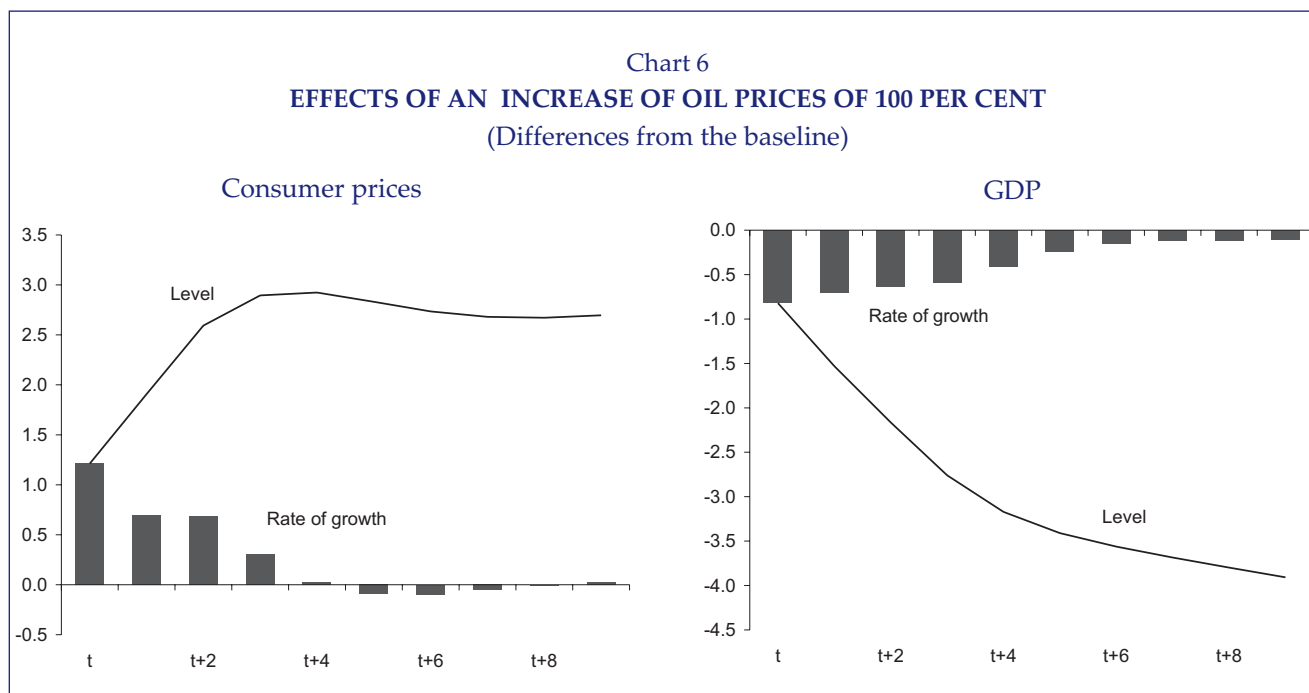
(i) The effects of oil prices in inflation may be decomposed into:

(ia) First round direct effects on energy consumption components. The results suggest that consumer energy prices tend to react approximately 1 to 10 to an oil price change, which represents a reaction of 1 to 100 in overall inflation rate. This rule of thumb seems to be stable both over the last 30 years and across countries.

(ib) First round indirect effects are associated with the fact that oil is an important production input in other sectors of activity. It is not easy to derive any rule of thumb for these indirect effects. However, the decline of oil prices and the reduction of oil consumption per unit of output is likely to have reduced the size of these types of effects.

(ic) Second round effects are mainly influenced by the credibility of monetary policy and the flexibility of labour market. On this issue, given the lessons from the previous oil-shock episodes, presently, monetary policy seems to be more oriented towards the moderation of inflation expectations, allowing to reduce the magnitude of these second round effects.

(ii) The effect on prices of an oil price increase of 100 per cent is around 1-1.5 per cent in the second year, both for the euro area and the US, while



for Portugal, the effect is larger, amounting to around 2 per cent in the second year.

Considering the effects on GDP, some conclusions seem to emerge, using indicators that try to measure the importance of oil as a production factor and as a source of a terms of trade shock, as well the available model simulations and the recent empirical findings of specialized literature.

(i) There is a strong evidence that the negative reaction of GDP to oil price increases declined over the nineties, reflecting both the decline of the relative price of oil and the reduction of oil consumption per unit of output.

(ii) It is dangerous to extrapolate a constant GDP-oil price elasticity in order to produce simulations concerning the effects of a new oil price shock. Reflecting the small substitution between oil and other resources (in particular over the short and medium terms) the impact of the shock depends positively on the price of oil. Thus the GDP-oil relationship is nonlinear, towards more sizeable effects when oil price is higher. In other words, the effects on GDP when oil price increases from 10 to 20 USD are smaller than then ones that would occur if oil price doubles from its current level above 40 USD.

(iii) Considering a price of around 25 USD and using the net imports share on GDP, a negative elasticity of around -2 per cent may emerge as a

prudent rule of thumb for the main developed countries, encompassing however important differences across countries, towards lower effects in the UK, US and Japan (in the range -1 to -2 per cent) and more pronounced ones in the main euro area countries (in the range -2.5 to 3 per cent). Those values are within the ones produced by standard macroeconomic projection models and the ones produced by more recent empirical findings of specialized literature.

(iv) The Portuguese GDP exhibits a higher sensitivity to oil price shocks, reflecting simultaneously a more intensive use of oil and a high openness of the economy. The indicators and the simulation results from the AMM model used at Banco de Portugal suggest as rule of thumb a negative elasticity of around -0.04 (i.e. an increase of the oil price from 25 to 50 USD could lead to an accumulated loss of GDP of around 4 per cent).

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