September 19, 2020

Oil Shocks and Total Factor Productivity in Resource-Poor Economies: The Cases of France and Germany.

by

Jean-Paul Azam[1]

Toulouse School of Economics, University of Toulouse-Capitole.

Abstract: This paper shows that the two oil shocks that occurred in 1974-85 and 2003-15 inflicted sizable damage to total factor productivity (TFP) in France and Germany. These are resource-poor economies whose firms are importing most of their inputs of extractive commodities. The real prices they pay for them impact directly on their value added and hence on GDP in aggregate. We single out the price of crude oil as the most important and volatile of this set of highly correlated prices. This real price depends both on the world commodity market and on the exchange rates between the US dollar and the relevant European currencies, themselves determined by monetary policy in the US and in Europe. The significance of this mechanism is confirmed econometrically, and its quantitative implications are assessed. On average, these countries have lost more than 1% of potential TFP per year during these oil shocks, Germany being affected noticeably more severely than France. Historical analysis shows that episodes of US dollar appreciation have significant impacts on French and German TFP via this channel.

Key Words: Oil Shocks, Total Factor Productivity, France, Germany.

JEL Classification Numbers: N10, N14, N70, O47.

---

[1] This paper owes much to generations of students who attended my "North-South Economic Relations" lecture course and contributed many questions and debates about the issue covered here and many others. None of them is responsible for its shortcomings. Helpful comments by Michael Burda, Mohamed Saleh and John B. Taylor are gratefully acknowledged, without implicating. The author acknowledges funding from ANR under grant ANR-17-EUR-0010 (Investissement d'Avenir program).

1. Introduction

The oil shock that took place between 1973 and 1986 (exclusive) has left a deep footprint in the memories of the economics profession. The word “stagflation” was then created to name the combination of rising inflation and unemployment that was observed at the time. Bruno and Sachs (1985) provided a powerful analysis of this phenomenon, emphasizing the supply-side impact of the shock. However, the received wisdom that stagflation was caused by the oil shock has been challenged by Barsky and Killian (2001), who offer a monetary alternative. Despite some attempts by a series of authors to attract attention to the New Century Oil Shock (NECOS) that took place between 2002 and 2016 (exclusive), it did not have the same impact on the profession. Dvir and Rogoff (2009) have analyzed more than a century of oil price data, showing that NECOS was highly significant indeed by its size, although their sample does not follow it up to its end in 2015-16. Hamilton (2009) provides a thorough study of the causes and consequences of the first spike of NECOS, using data up to December 2008. Among other topics, he traces in detail the impact of the spike on the automobile industry. El-Gamal and Jaffe (2010) cannot either do full justice to NECOS, as their data stop in 2009, nearly halfway into the shock. Nevertheless, they bring out the key point that the prices of most extractive commodities tend to move quite closely together, at least for the big swings, so that the oil shocks involve in fact the nearly simultaneous boom and bust of a large number of extractive commodities prices. This confirms a point made by Bruno and Sachs (1985) 25 years before. Among others, Pirrong (2012) illustrates this point by looking at the price of copper, whose time profile is quite like that of crude oil, but his data set also stops in 2009. Similarly, Ross (2012) provides a much deeper analysis of the Old Century Oil Shock (OCOS) than of the more recent one. McNally (2017) offers a longer perspective, thanks to data that span up to 2015 for some series. The first objective of the present paper is to provide a useful description of OCOS and NECOS simultaneously, as it can be argued convincingly that the latter ended in the trough of January 2016, opening up a new period, and that its magnitude was may be larger than the former’s.

The second objective of the present paper is to determine whether the current neglect of NECOS by the macroeconomics profession is deserved or not. Blanchard and Galì (2009) and Blanchard and Riggi (2013) have somehow addressed this question for the case of the USA, concluding that such neglect is in fact deserved in that case. Both papers split their samples into two periods, trying to compare them to see what structural changes could explain the lack of impact of the NECOS that they find. Blanchard and Riggi (2013) emphasize improved wage flexibility between the two periods as a shock absorber. They also bring out that monetary policy became less responsive to short-run fluctuations, i.e., more Friedman-like. However, their two sub-samples are far from obviously comparable. While the first one ends just at the end of the worst part of OCOS, on the way down in 1983, their second one ends in 2007. As shown below, NECOS was still on and biting until 2015. In other words, their second subsample truncates the worst part of NECOS and raises some legitimate suspicion about the validity of their conclusions. Some of the differences that they bring out might as well come from the fact that the first sub-sample includes a nearly full-blown oil shock while the second one stops at the first tremors of the second one. Some support for this diagnosis is provided by Hamilton (2009), who performs a post-sample test of the Blanchard-Galì structural VAR model, using four additional quarters. It shows that the model does in fact predict that US real GDP growth would have been on average 0.7% higher over 2007Q4–2008Q3 in the absence of the oil price spike.

The time is ripe now to perform a more even-handed comparison of the macroeconomic impacts of the two big oil shocks as the required data are now available. However, we keep our ambition modest relative to Blanchard and Riggi (2013) who use a full-blown New-Keynesian structural VAR model applied to the US economy. Similarly, Lippi and Nobili (2012) use a structural VAR model, which distinguishes the impacts of the oil shocks on the US economy as a function of their nature, in the same spirit as Killian (2009). They distinguish demand shocks and supply shocks. We instead use a simple Neo-Classical aggregate production function approach, to gauge the impacts of OCOS and NECOS on aggregate total factor productivity, using data from ALFRED St Louis. We do not either try to trace the impacts of TFP changes on the respective labor markets and unemployment, inflation, etc., as Bruno and Sachs (1985) have done. The model used is akin to Solow (1974), except that we assume that the third input beside capital and labor is imported, representing extractive commodities. The value added produced by extracting and shipping them does not accrue to the importer's domestic GDP, but to the exporters' ones, as a first approximation. This point is a basic datum of national accounting: GDP is just the sum total of all the value added by the firms of the domestic economy, while part of the domestic (gross) output is used up to pay for these imported inputs and is not included in GDP. It follows immediately that aggregate total factor productivity (TFP), which is computed using GDP, given domestic capital and labor, depends on the real prices paid for these imported inputs. Bruno and Sachs

(1985) have an extensive discussion of this point. The next section sketches the formal derivation of this prediction from the modified Solow (1974) model mentioned above.

The rest of the paper aims at testing empirically the relevance of this simple theoretical prediction regarding the supply side of the macroeconomy. To gauge whether this subtle distinction is useful, we focus on the cases of mature industrialized economies of continental Europe, which have exhausted long ago their reserves of most extractive commodities. France and Germany are quite representative of this type of economies, and their experience through the two shocks is analyzed below. Strangely enough, most of the literature on oil shocks and the macroeconomy has focused on the US economy, which has now become the largest oil producer in the world, nicknamed "Saudi America" by *The Economist*. A case can be made that this issue is even more relevant for resource-poor economies like France and Germany. The data used in this study are in open access in ALFRED St Louis, the Archive Library of the Federal Reserve Bank's Economic Data of St Louis. We take the TFP series from there, spanning 1971-2017. The first observation is only used here as a lagged value. These are yearly data, which determine the frequency we use for the other series too. Because of the long-haul perspective of the study, nothing much is lost by working with such frequency of observation.

Most of these commodities' prices tend to move in a highly correlated fashion, and we focus on the most important and most volatile of these imported input prices, namely that of crude oil (El-Gamal and Jaffe, 2010). For the sake of homogeneity, we use the price of the West Texas Intermediate (WTI) crude oil over the whole period. It could be argued that the Brent crude, which is mainly pumped in the North Sea, has become over time the more relevant oil for European countries and that its price is always a few percentage points higher than WTI's. This reflects its lower refining and transportation costs for neighboring European countries that Brent exporters can pocket as buyers arbitrage between the two. However, its production only started in the late 1970s and its dominant position only got established over time for these economies, with a drawn-out overlap period that raises some intractable issues for splicing the two series. Moreover, these two prices are highly correlated over time when they exist, making the choice between the two series a bit frivolous for estimation purposes. We first bring out graphically the sheer magnitude of the two oil shocks for these economies and offer some measurement to compare their sizes. An important wrinkle to add is that for these European economies, the exchange rate to the dollar is playing a big part in determining the real price of oil paid by domestic firms. The crude price is determined in dollar terms in the world market while domestic firms buy and sell in domestic currency. As shown below, this may affect the precise dates at which the oil shocks hit France and Germany, as well as their amplitudes. We then move on to test econometrically these predictions using yearly data over the period 1972-2017 for these two countries.

Over our sample period, then, we find that the real price of oil does affect TFP significantly for these mature economies. Although the estimated response of TFP to changes in the real price of oil looks quite small, we must consider that these big oil shocks involve massive and sustained increases in the real price of oil. It follows that these shocks have inflicted some sizeable losses of potential TFP to these economies. However, we do find like Blanchard et al. that the magnitude of the impacts changed between the two big shocks, but this did not result from significant changes in the structure of the model. External determinants seem to have changed somehow the nature of the shocks, especially due to US monetary policy. It seems also that the creation of the Eurozone somehow increased the resilience of the French economy, at least for a while, without any similar change occurring in Germany. Although this is captured simply by using a dummy variable for 1999 on, while many other things happened over those years that could explain this contrasting finding, we offer some suggestions to explain it based on the key role played by Germany in the euro system and in anchoring member states' currencies ever since monetary cooperation started in Europe in the early 1970. It seems thus that this mildly "Hayekian" de-nationalization of money (James, 2012) had some significant stabilizing effects with a beneficial impact on the supply side in France.

2. GDP as Aggregate Domestic Value Added

Let us start from the basic Solow (1974) model, as does Hamilton (2009), where output Q is produced using capital K and labor L, as well as an additional input Z, capturing extractive commodities. Time t is also included as usual to capture the impact of exogenous technical progress. Lippi and Nobili (2012) use a CES version of the same model.

The production function is assumed well-behaved and reads:

$$Q = F(K, L, Z, t). \tag{1}$$

The new twist introduced here is that Z is entirely imported at a real price p in terms of output. This is admittedly an exaggeration, as even the most mature continental European economy still has some extractive resources left to exploit, but it is a convenient "stylized fact", which captures the main point of this exercise.

The representative firm is assumed a price taker on the world market and its value added, i.e., GDP, is then determined as:

$$Y(K, L, p, t) \equiv \max_{Z} Q - pZ. \tag{2}$$

The change in TFP is defined as the change in Y, holding K and L constant. It can be derived by taking the total differential of (2) for any given values of K and L:

$$dY = \underbrace{(\partial F/\partial Z - p)}_{=0 \text{ by FOC}} dZ - Z\,dp + \partial F/\partial t\,dt\,. \tag{3}$$

For convenience, it is useful to write this expression in terms of percentage variation rates as:

$$\frac{dY}{Y} = -\frac{pZ}{Y}\frac{dp}{p} + \frac{F(.)}{Y}\frac{\partial F(.)}{\partial t\,F(.)}\,dt\,. \tag{4}$$

Therefore, these simple calculations can be summarized by spelling out the basic testable proposition of this paper as:

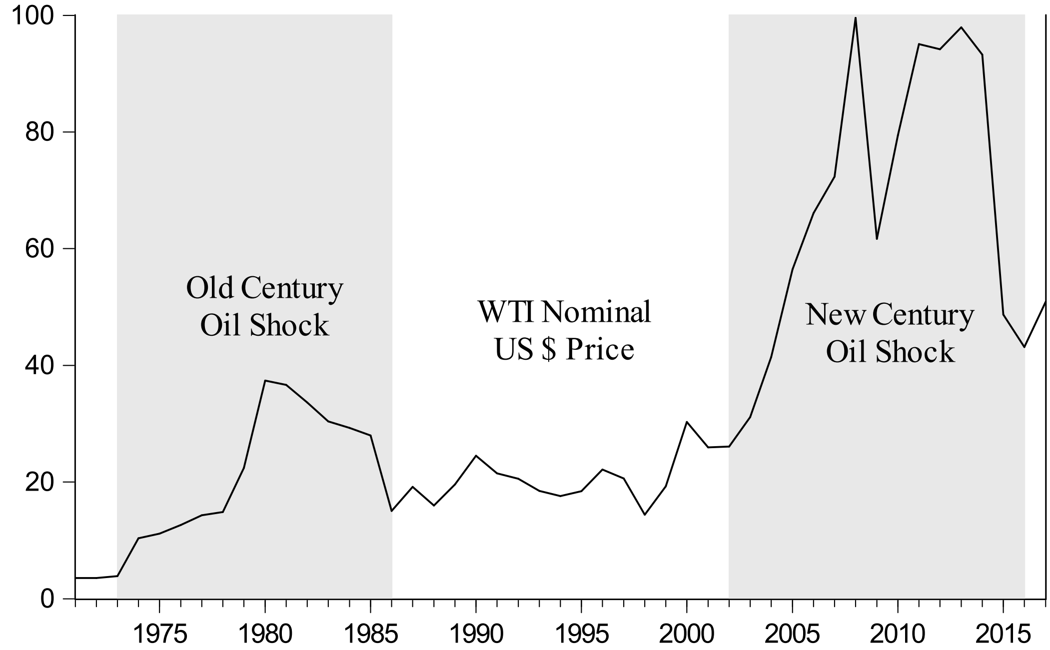
***Proposition* 1:** Aggregate total factor productivity is a decreasing function of the price of imported inputs and an increasing one of exogenous technical progress.

Notice that the coefficient of the change in price (*i*) cannot be called the "share of oil in GDP", as the oil bill paid by the representative firm is excluded from GDP, and (*ii*) it has no reason to remain constant over time, except when a Cobb-Douglas aggregate production function is assumed. Our econometric findings presented below are roughly supportive of the latter constant-elasticity specification.

3. The Two Massive Oil Shocks of the Last Half-Century

Our starting date corresponds to a major shift in the market regime for oil in the world. Before that, since 1933, the world oil market was under a control regime, as the Interstate Oil Compact (Libecap, 1989, Smith, 2012) and the "Seven Sisters", i.e., the largest oil companies, were in fact controlling oil output and prices very tightly (McNally, 2017, Ross, 2012). A major game change occurred over the two years 1971-72, as the Bretton Woods' gold-exchange standard was abandoned, on the one hand, independently followed by a loss of control on the part of the Interstate Oil Compact, on the other hand. The key point was that the Nixon administration had surreptitiously changed that regulating body's agenda. In the 1930s, the objective was to keep oil prices high enough so that the high-cost oil-producing states, like Illinois, Oklahoma, etc. could stay in business despite Texas' huge extraction cost advantage. To achieve this goal, the Texas Railroad Commission took a leading position, as Texas was *de facto* the swing player in the market. Libecap (1989) shows this convincingly using illuminating historical evidence. However, Nixon had been elected on a platform to keep inflation under control and he chose a strategy involving price controls, with the support of Arthur Burns, the FED's chairman he appointed in 1970. Hence, his administration exerted pressure on the Interstate Oil Compact, which is not a Federal agency, to open the gates to increase sales and lower prices (Smith, 2012). As excess reserves cannot be run down below zero, the limits of such a strategy are bound to be met soon. In the same movement, the Seven Sisters lost quite quickly their hold on oil production abroad, as a wave of national oil companies were created during the first half of the 1970s or so, culminating in the first years of OCOS (McNally, 2017, Ross, 2012). Although some of these national companies were pursuing a mainly political agenda, like the punitive price policy implemented by OPEC after the Yom Kippur war, this was partly offset by the discovery of large reserves in Alaska and the North Sea. Moreover, a proliferation of oil-producing countries took place, as many small exporters became profitable when the prices were high (Ross, 2012). The market thus became in fact more competitive over those years, under the stronger influence of global macroeconomic forces.

Figure 1 plots the nominal WTI crude oil price over our period of analysis. The two massive oil shocks can easily be seen, as well as their dates of occurrence that can be determined unambiguously. The natural definition to capture this visual evidence is to call an oil shock a major, i.e., large and lasting, boom-and-bust deviation from a hypothetical smooth path. We use a more precise definition in the empirical part below. Figure 1 brings out the contrast between these massive shocks and the smoother price fluctuations during the inter-shock period. One cannot fail to notice that this smoother period includes what Stiglitz (2003) called "The Roaring Nineties", "The World's Most Prosperous Decade". There is an issue about the years 1998-2002, which witnessed a mild spike in the WTI nominal price, peaking in 2000. From a US point of view, it does not seem to belong obviously to NECOS. However, we will see later that it was amplified significantly for France and Germany by a sizeable appreciation of the US dollar in terms of Euro.



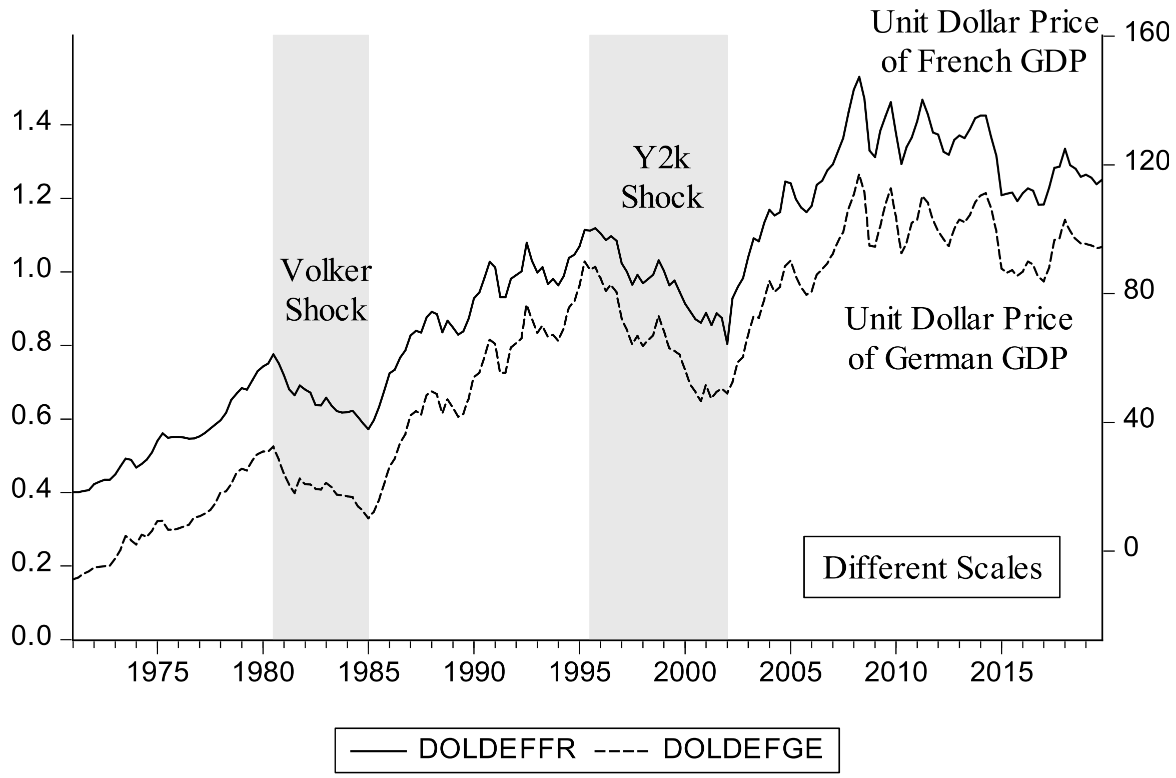
Data Source: ALFRED St Louis

Figure 1: Nominal WTI Oil Price and the Two Oil Shocks

The Unit Dollar Prices of French and German GDPs

A more substantive issue is involved in the choice of a deflator. Because our analysis focuses on imported inputs in the production process, the use of the CPI would be inappropriate. We use instead the GDP deflator, which may be interpreted as an index of the market prices of domestic products. Then, this deflator must be translated into US $ terms using the market exchange rate for comparison with the WTI price of oil. We have used quarterly data to construct the series of the Unit Dollar Price of GDP in France and Germany, which are plotted in figure 2. The economies under study here have switched from a system of national exchange rates to the euro system, which involves a de-nationalization of money via a supra-national European central bank, the ECB. This came about gradually over the whole sample period (James, 2012). The "snake" was created in 1972 in which the member states agreed to limit the fluctuations of their exchange rates within a narrow 2 1/4 % band. France quit and returned into the snake at times, thus showing some residual autonomy with a negative impact on her credibility. Then, in the wake of the 1991 Maastricht treaty, the ECU was created, imposing even more discipline. A more decisive jump was made in January 1999, when the euro started to be used exclusively for financial dealings and industrial transactions. Then the national currencies were fully replaced by the euro even for small day-to-day private transactions in 2002. Hence, there is not just a statistical problem raised by the change in the units of account of the relevant currencies, but a deep systemic shift is in fact involved. The former problem is straightforward, and we just translated the national currencies exchange rates prior to that date using the official conversion rate of January 1, 1999. The resulting deflator may be called the unit dollar price of domestic GDP. It can go up either because of inflation, as the GDP deflator goes up, or as a response to an appreciation of the domestic currency or the euro relative to the US $. This entails mechanically that the real price of oil can work as a channel of transmission of changes in the exchange rate, so that the dates of the actual oil shocks faced by France and Germany may differ from what we saw above. This turns out over our sample period to be an important source of shocks for France and Germany.

Two main such "Dollar Shocks" are relevant in this respect and can be seen clearly from Figure 2. The latter plots the unit dollar prices of GDP in France and Germany, respectively, using different scales related to the different GDP deflators. Eyeballing the data shows convincingly that the main changes in the national series are obviously caused by common causes, except for minor details. The obvious external cause of disturbances is the US dollar. We thus observe that two major deviations in these series, labeled here "Volker Shock" and "Y2k Shock", affected simultaneously the two series in a very similar fashion. Notice that we here define the shocks by only considering the appreciation phase of the US $, as it is not too clear from the plots when to end them otherwise. Paul Volker was made the chairman of the FED in 1979 by Jimmy Carter and he endeavored to suppress the two-digit inflation soaring at the time by imposing a rigid monetarist policy. This made the interest rate jump in the two-digit range, hitting even 20% for a short while, and attracted a massive capital inflow that entailed a steep nominal appreciation of the US $.



Data Source: ALFRED St Louis

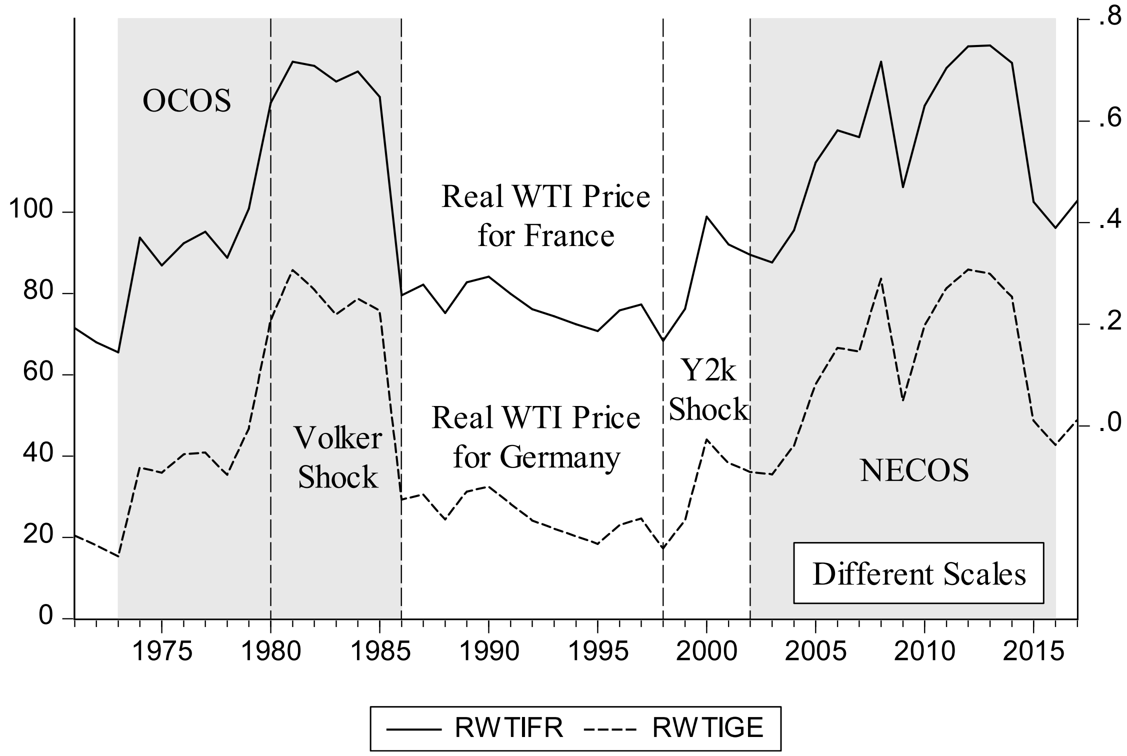
Figure 2: Unit Dollar Price of GDP in France and Germany

The second “pot-hole” we observe in the series occurred under Alan Greenspan’s chairmanship. Kohn (2012, Fig 1B, p.178)) presents an illuminating chart showing that Alan Greenspan was then obeying very closely the Taylor rule that induced a rise in the Federal Funds rate in two steps from 1995 to 2000 aimed at cooling down the US economy. After a peak above 6% in 2000, which justifies the “Y2k” label (rather than “Greenspan Shock”), Greenspan gave up the Taylor rule in the wake of 9/11 and started the “Great Deviation” by cutting the Federal Funds rate up to 3 percentage points below that recommended by the Taylor Rule (Taylor, 2012). He then caught up a bit a few months before the end of his term in 2006 in response to the increasing fiscal deficit entailed by the wars in Afghanistan and Iraq. As mentioned above, the resulting appreciation of the US dollar relative to the euro made a big change for French and German firms, transforming the mild WTI price spike of 1998-2002 into a real shock. This is developed below.

Lastly, notice that from 2008 on, the unit dollar prices of the two European countries GDPs went slowly downwards in a bumpy fashion, reflecting a slow and irregular depreciation of the euro relative to the US dollar, despite the quantitative easing strategy undertaken by Ben Bernanke since his landing at the FED in 2006. Taylor (2019) explains this evolution by comparing the strategies pursued by the FED, the ECB, and the Bank of Japan, using illuminating charts. Citing Allan Meltzer, he interprets the quantitative-easing or related strategies implemented by the three central banks as an example of “competitive devaluation”. In this race to the bottom, the ECB went further down than its competitors, as the euro depreciated against the two other currencies. Although it was less brutal than the Volker and Y2k shocks, this downward slide slowed down the bust phase of NECOS for the European firms. There is no doubt that the Eurozone was entering a turbulence episode that culminated with the Greek crisis, with some trouble also arising in other Eurozone member countries in the periphery.

The Oil Shocks in France and Germany

Figure 3 plots the real WTI crude oil prices for France and Germany, respectively, over the 1971-2017 period, using the unit dollar prices of French and German GDPs as deflators. The numbers on the vertical axis may be interpreted as the WTI price expressed as a fraction of the unit dollar price of French or German GDP, although the scales are different for each curve. The French units can be read on the right-hand side. This nearly half-century may simply be characterized as a relatively stable 12-year episode between 1986 and 1998 (inclusive), during which the real price fluctuates mildly, with a slight downward slope, bracketed by the two major oil shocks, lasting about 12 and 17 years, respectively. It is interesting to notice that the pure oil shocks and the dollar shocks channeled by the price of oil combine differently in the two cases. In OCOS, there is a large overlap, as the Volker shock is just amplifying the oil shock proper and slowing down the bust period for France and Germany. In contrast, the Y2k dollar shock occurs before the oil market goes wild. Hence, while the Volker dollar shock is just enhancing the oil price shock during OCOS, its successor is in fact taking a head-start before NECOS, just lengthening its duration by four years. It is therefore natural to define the extended NECOS (ENECOS) by including that part of the Y2k dollar shock whose impact on TFP was channeled by amplifying the 2000 nominal WTI price spike into a large deviation of the real price of oil paid by domestic firms, i.e., the 1998-2002 period, as seen above. The relevant ENECOS thus lasted from 1998 to 2016 (exclusive). Notice that the real price rise between 1998 and 2000 is slightly larger than the one between 1973 and 1974, justifying their equal treatment as genuine parts of the oil shocks.



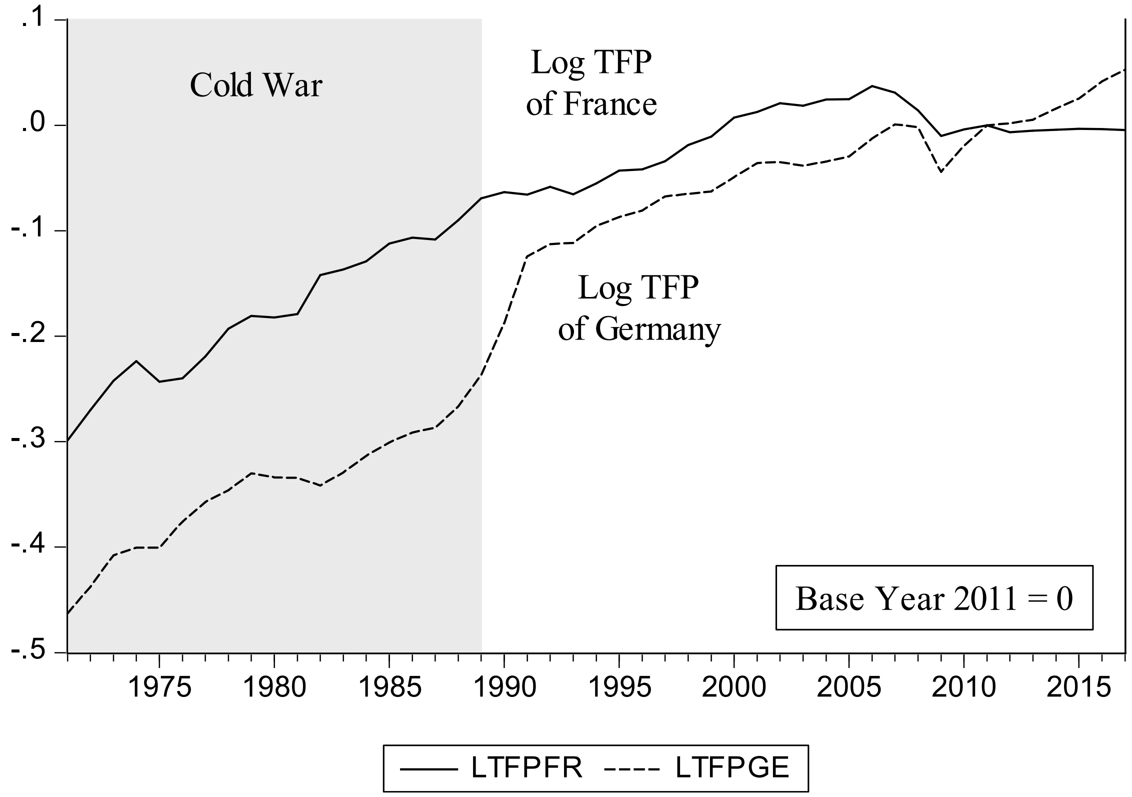
Data Source: ALFRED St Louis

Figure 3: The Two Major Oil Shocks in France and Germany Since 1971

Impacts on French and German TFP

At first sight, it seems unlikely that the very bumpy, or even rugged, time profile of the real price of oil in France and Germany could explain the very smooth evolutions of TFP in these two countries over the near half-century under study. This diagnosis seems vindicated by looking at figure 4, which plots the Log TFP series for France and Germany over the 1971-2017 period. Eyeballing the data suggests that:

(*i*) there is a long-run tendency for TFP growth to slow down over time, and this is captured in the econometric analysis performed below by a quadratic trend in addition to the linear one. Moreover, it seems that the slowdown is not perfectly smooth, as two mild breaks in the trend seem to occur first about 1989-90, in the wake of the fall of the Berlin wall and the end of the Cold War, and second, more abruptly, about 2006-7. The latter period marks the change in the Chairmanship of the FED, Ben Bernanke succeeding Alan Greenspan, soon to be followed by the financial crisis, as the Lehman brother's bankruptcy was declared in 2008. As mentioned above, a "competitive devaluation" episode followed, in the words of Meltzer and Taylor, during which the euro depreciated faster than the dollar (and the yen). Although this was most certainly not the aim pursued by the ECB, this depreciation of the euro mechanically kept the real price of oil higher than it would have been otherwise.



Data Source: ALFRED St Louis

Figure 4: Log TFP for France and Germany: 1971-2017

(*ii*) OCOS seems to be marked by two significant dents that cut TFP by a few percentage points in France, while Germany seems to be hit more severely by the Volker Shock, from which she seems to have a hard time recovering; the end of the Cold War seems to play a key part in this recovery, as both countries' TFPs seem to follow very similar paths afterwards from 1991 on until 2009. Burda and Severgnini (2018) offer an analysis of the very steep recovery of German TFP between 1989 and 1993 at the Bundesländer (or region-states for Berlin, Bremen, Hamburg, and their surrounding regions) level. They show that this brisk acceleration mainly took place in the newly re-unified eastern regions, where it petered out soon, leaving a steady TFP gap behind the West in its wake.

(*iii*) during NECOS, the French TFP does not seem to bounce back from the significant shortfall that took place after 2006, while the German one seems to recover very quickly.

On the face of it, then, it seems that we do not need to invoke the oil shocks to explain what happened to French and German TFPs over the 1971-2017 period. The two series mostly differed markedly during the Cold War, and the fall of the Berlin wall and the subsequent re-unification of Germany might be deemed to provide ample material to explain that. However, the more careful empirical analysis performed in the next section shows that the real price of oil cannot be dismissed as a key determinant of TFP in the long run, as predicted by (4).

4. Econometric Analysis and Damage Assessment

The descriptive analysis performed in the previous section puts out the challenge of gauging whether the world has changed so much that NECOS can safely be neglected in the 21st century macroeconomic context. To answer this question, we need both to evaluate the relevant sizes of the shocks as well as to estimate the resulting impact they have on TFP. We first perform some basic empirical analysis in the present section, focusing on testing the impact of the real price of oil on TFP, before assessing the damages inflicted on France and Germany in terms of lost potential TFP.

Testing the impact of real WTI oil price on TFP in France and Germany

Notice that TFP is given in ALFRED St Louis as of January 1st each year. Therefore, it is natural to lag all the relevant explanatory variables one period to capture their impact during the time when TFP changed to reach the given January 1st TFP number. We present the same equation estimated for France and Germany, respectively. The dependent variable is the log of TFP, and the real WTI price is similarly entered as a logarithm whose coefficient can thus be interpreted as an elasticity. The findings reported below suggest that it is estimated very precisely on our samples, as could be predicted assuming a Cobb-Douglas production function. As mentioned above, these economies have made a major shift in their macroeconomic policy framework between the two oil shocks. We investigate whether the creation of the euro made an important difference by including a euro dummy, taking the value 1 from 1999 onwards. We tested whether this impact was due to a change in the elasticity with respect to the price of oil, using an interaction term between the euro dummy and the real price of oil (see Table A.2). This was rejected. Another institutional major change was the fall of the Berlin wall and the end of the cold war. This is captured by a dummy variable that takes the value 1 up to 1989 and 0 afterwards. We also tried an interaction term between the Cold war dummy and the real price of oil, without any significant impact (see Table A.2). Finally, we include an auto-regressive mechanism for the error term to capture the drawn-out convergence dynamics of the random deviations from the deterministic part of the model and to estimate its speed of convergence.

Corroborated Predictions

Table 1 presents the findings for the two countries. All the included variables are highly significant at the 99% threshold except for the WTI price term which is so at the 95% one, and the context dummy variables (Coldwar and Euro) that impact only one country in turn. The oil price term's coefficient's *p*-values are 4.41% for France and 1.15% for Germany, representing strong confidence levels. The estimated elasticities are (*minus*) 1.08% for France and 1.77% for Germany, suggesting that the latter is in fact more sensitive to the real price of oil than the former. This might be due to the larger size of its manufacturing sector, which is arguably consuming more fossil fuel and other imported extractive commodities whose prices are strongly correlated with that of crude oil. Moreover, France relies a lot more on nuclear energy for electricity production than Germany, reducing relatively its dependence on fossil fuels, starting even before the mid-1970s (Hecht, 2009). President Giscard d'Estaing then stepped up the nuclear electricity generation program explicitly for reducing French dependence on imported oil during OCOS, a program that kept on growing for many years. The well-known motto was at that time: "In France, we have no oil, but we have ideas". Although these estimates might suggest a small response to the oil shocks at first sight, the key point is that these small numbers are multiplied by huge numbers, given the sizes of the shocks involved. Some calculations are presented below to assess the damage inflicted to the two countries in terms of potential TFP.

The trend term predicts an increase in TFP at the basic rate of 1.75% per year for France and 1.36% for Germany, while the negative sign of the quadratic trend suggests a slight tendency for this growth to slow down over time. We also find that joining the euro had a sizable positive impact on TFP in France, while it has no significant impact in Germany.

This suggests that the widely shared belief at the time that creating the euro was simply aimed at harnessing all the member countries' currencies to the German Mark and its credibility was realistic. Our estimate is at least not negative for Germany, suggesting that the cost to that country's credibility was negligible. Not surprisingly, we find that the Cold War was a real drain on Germany's TFP, while it had no significant impact in this respect in France. The coefficients of the auto-regressive residuals are strongly significant and just above one half in both countries so that the average lags are just above 1 year and so are the half-lives of the deviations in the two countries.

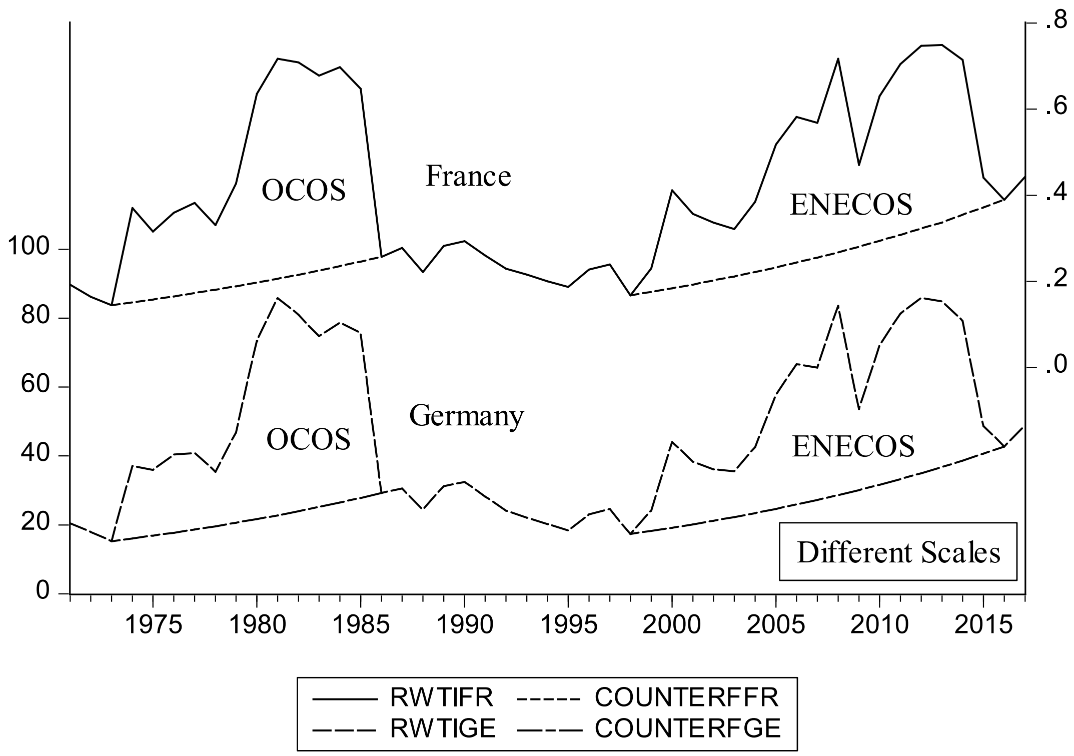
Table 1: The Determinants of TFP in France and Germany

Dependent variable: log TFP	**France**	**Germany**
Intercept	- 0.35484***	-0.3289***
	(-16.15666)	(-9.2162)
Log Real WTI Price (-1)	-0.01083**	-0.0177**
	(-2.08262)	(-2.6553)
Cold War (-1)	0.0086	-0.078***
	(0.9002)	(-4.8291)
Euro (-1)	0.0292***	0.0064
	(2.99817)	(0.5161)
Trend	0.01748***	0.0136***
	(14.8310)	(7.7279)
Trend squared	-0.0002***	-0.0000***
	(-10.6847)	(-3.3026)
Auto-Regressive Residuals	0.5117***	0.5098***
***AR* (1)**	(3.5037)	(3.9198)
Number of Observations	45	45
R^2	0.9894	0.994
***F*-test**	593.8277	1056.031
Durbin-Watson Statistics	1.5742	1.6734

Econometric Package Used: EViews7. *t*-statistics in parentheses.

Assessing the Damage

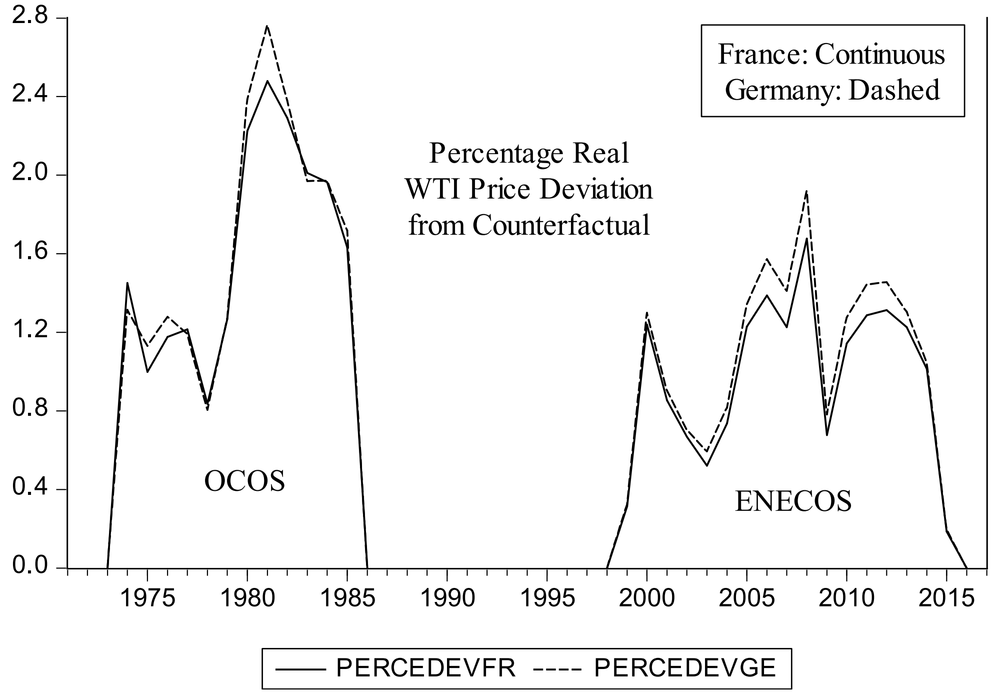
To assess the impact of the real WTI price shocks, including their extension in terms of dollar shocks, we must first define a counterfactual scenario that can be used as a benchmark. During the two shocks, we take as the counterfactual real price path for each country the one resulting from a constant growth rate between 1973 and 1986, for OCOS, and between 1998 and 2016, for ENECOS. This is the most natural assumption to make for describing what behavior the real WTI price would have displayed in a hypothetical "shock-less" environment. On the one hand, Hotelling (1931) established the simple arbitrage rule that equates the growth rate of the real price of an exhaustible resource to some long-run expected interest rate, in equilibrium, and on the other hand, Friedman (1968) has revived the Wicksellian concept of "natural rate of interest", understood as the interest rate that is consistent with macroeconomic stability (Wicksell, 1898). Hence, for the sake of determining a counterfactual path that the real price of WTI oil would have followed in the absence of the oil shocks, it is natural to assume that it would have grown at a constant rate, somehow related to some unspecified "natural rate of interest".



Data Source: Author's calculations based on ALFRED St Louis data.

Figure 5: Actual and Counterfactual Real WTI Prices for France and Germany

In France, these counterfactual growth rates would have been about 4.43% per annum during OCOS and 4.70% during ENECOS, while they would have been 5.01% and 5.02% per annum, respectively, for Germany. Figure 5 plots the actual and counterfactual real WTI oil prices for France and Germany during the 1971-2017 period to convince the reader that no tricks are hidden behind this choice of counterfactual paths. It is visually evident that using a linear path instead would not make much difference, but we could not invoke the Hotelling-Friedman-Wicksell pedigree that the chosen one has in that case.



Data Source: Author's calculations from ALFRED St Louis' data. The numbers are reproduced in appendix table A.1.

Figure 6: Percentage Real WTI Price Deviations from Counterfactual

Figure 6 plots the real WTI price deviations from counterfactual for the two countries during the oil shocks, measured as percentage deviations from the counterfactual path as $\left(p_{ti} - p_{ti}^{c}\right)/p_{ti}^{c}$, in obvious notation. They are very similar, just hitting most of the time a bit harder in Germany. This is probably due to a slightly faster growth of the GDP deflator in France, which is not as sanguine against inflation as Germany (James, 2012). In both countries, it seems that the real price shock was larger in height during OCOS, when it peaked in 1981 at about 248 % against about 178% in France and in 2008 at 276 % against 192 % in

Germany, on the one hand, while it lasted longer during ENECOS, 17 years against 12, on the other hand.

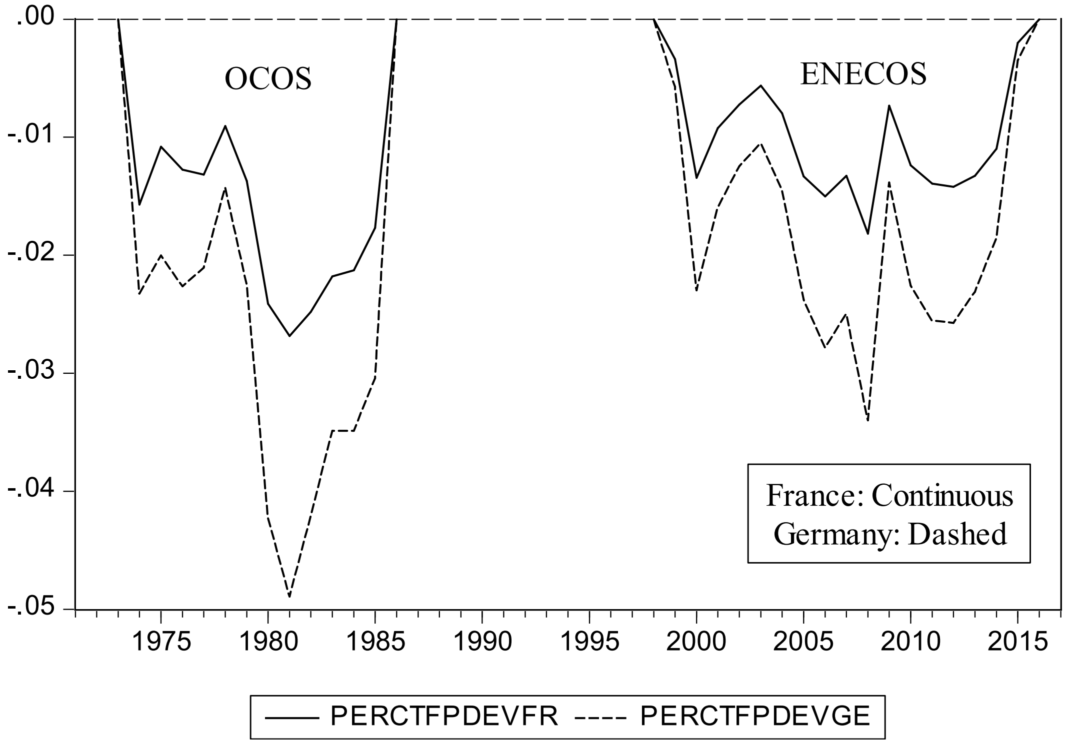


Figure 7: Percentage Losses in Potential TFP in France and Germany

To complete this assessment of the damage inflicted to the two economies, we ask the following question: by which percentage would TFP have been higher had the real WTI price followed the counterfactual path rather than the actual one? To answer it, we just need to produce a properly rescaled mirror image of figure 6 by multiplying each country's real WTI price deviations by the relevant elasticity estimated in table 1, as implied by (4). Figure 7 plots the findings, and the actual numbers are given in appendix table A.1. The plots show undoubtedly that Germany lost a lot more potential TFP than France to the oil shocks. At the worst points of the two shocks, in 1981 and 2008, respectively, Germany lost about twice as much potential TFP than France. In the former case, France lost 2.69 % in potential TFP, while Germany lost 4.89 %. In the latter case, France lost 1.82 % while Germany lost 3.40 %. As we know from the above, these striking differences are due both to the fact that the elasticity of her TFP with respect to the real price of oil is larger in absolute value (1.77 % *vs.* 1.08 %), and to the larger amplitude of the oil shocks that hit her, as seen at figure 6. These results can be summarized by adding up the yearly percentage losses over the 12 and 17 years, respectively. Although we find reasonably similar numbers for the total real WTI price deviations in the two countries, this translates into quite different losses in potential TFP because of the significantly different estimated elasticities. Table 2 presents the findings together with their average values per year in parentheses.

Table 2: Percentage Points of Potential TFP Lost to the Oil Shocks

	Germany	**France**	**Difference**
OCOS	35.72%	21.17%	14.55%
(12 years)	(2.98%)	(1.76%)	(1.22%)
ENECOS	32.55%	18.08%	14.47%
(17 years)	(1.91%)	(1.06%)	(0.85%)

Data Source: Author's calculations from tables A.1 and 1. Averages in parentheses.

Despite the *caveat* due to the use of a simplistic albeit natural counterfactual path for generating the price deviations and their cost in terms of lost potential TFP, it is clear that table 2 does not allow us to neglect the impact of the two big oil shocks of the past half-century. Given our econometric estimates and our quantification strategy, it turns out that Germany was even more severely hit than France. These findings support the claims that Germany's TFP would have been on yearly average 2.98% higher during the 12 years of OCOS and 1.91% so during the 17 years of ENECOS. These are very sizable and sustained losses. Although France seems to have been more shielded from these shocks by the pattern of its industrial specialization, including its higher reliance on nuclear energy for electricity production, the damage incurred during the two shocks cannot be dismissed as irrelevant either. During OCOS, we find that TFP would have been on average 1.76% higher for 12 years had the shock been avoided. Like in the case of Germany, we find that the average loss per year is smaller during the second shock, but its average value of 1.06% is still far from negligible. This is also true in aggregate terms for each country, respectively, but in a smaller proportion, falling from 35.72% to 32.55% in Germany and from 21.17% to 18.08% in France. These are large numbers that should play a more prominent part in policy debates, at least in Europe.

5. Conclusion

The econometric analysis performed in this paper and its quantitative implications called convincingly current macroeconomists to revisit their analyses of the recent "financial crisis" and its aftermath by paying more attention to the supply side impact of the New Century Oil Shock. This seems especially relevant for continental European countries that have almost exhausted their reserves of extractive commodities long ago. Not only do they need to import most of their inputs of extractive commodities, but they must pay for them mainly in US \$. This entails that the price their pay in real terms depends not only on the market for crude oil and its boom and bust cycles, but on European and US monetary policies as well. The rare episodes of sustained appreciation of the US \$ in terms of European currencies brought out above also took a toll on oil-using European firms that must be added to the pure oil-price shocks. Our estimates entail that France lost on average each year about 1.76% of potential total factor productivity, *ceteris paribus*, during the 12 years that the Old Century Oil Shock lasted while Germany lost even more of it during the same period, about 2.98%. During the Extended New Century Oil Shock, which lasted 17 years, the aggregate loss was spread out over a longer period and was on average a bit smaller in both countries, 1.91% for Germany and 1.06% for France. Nevertheless, our findings do not provide any excuse for the current neglect of this kind of supply-side shocks by the macroeconomics profession. Our historical analysis suggests that the monetary policies pursued by the ECB and the FED played a part in these events, as the occasional depreciation of the euro relative to the US dollar kept the price of oil paid by French and German firms higher than it could have been, thus keeping aggregate TFP, and thus GDP *ceteris paribus*, below its potential value. Moreover, the size of the losses incurred by these European import-using firms suggest a clear explanation for why forward-looking financial markets had a nosedive during the recent "financial crisis". Kate Kelly (2014) tells a suggestive anecdote in this sense by noticing that Lehman Brothers' top professionals were very quick to move to the NYMEX to trade in primary commodities after their previous employer's bankruptcy. But this is another story that shows the way to further research.

References

Barsky, Robert B., and Lutz Killian (2001); "Do we Really Know that Oil Caused the Great Stagflation? A Monetary Alternative", *NBER Macroeconomic Annual 2001,* 16, 137-198.

Blanchard, Olivier J., and Jordi Galì (2009): "The Macroeconomic Effects of Oil Price Shocks: Why are the 2000s So Different from the 1970s?", in Jordi Galì and Mark Gertler (Eds.): *International Dimensions of Monetary Policy*, 373-429, University of Chicago Press: Chicago.

Blanchard, Olivier J., and Marianna Riggi (2013): "Why Are the 2000s so Different from the 1970s?", *Journal of the European Economic Association*, 11 (5), 1032-1052.

Bruno, Michael, and Jeffrey Sachs (1985): *Economics of Worldwide Stagflation*, Harvard University Press: Cambridge, Mass. (2013 Reprint).

Burda, Michael C., and Battista Severgnini (2018): "Total Factor Productivity in German States since Reunification: Evidence and Explanations", *Journal of Comparative Economics*, 46(1), 192-211.

Dvir, Eyal, and Kenneth S. Rogoff (2009): *The Three Epochs of Oil*, NBER Working Paper No.14927, April 2009.

El-Gamal, Mahmoud A., and Amy Myers Jaffe (2010): *Oil, Dollars, Debt, and Crises*, Cambridge University Press: Cambridge and New York.

Friedman, Milton (1968): "The Role of Monetary Policy", *American Economic Review*, 58 (1), 1-17, March 1968.

Hamilton, James D. (2009): "Causes and Consequences of the Oil Shock of 2007-08", *Brooking Papers on Economic Activity*, 1 (Spring), 215-261.

Hecht, Gabrielle (2009): *The Radiance of France. Nuclear Power and National Identity after World War II*, MIT Press: Cambridge, Mass.

Hotelling, Harold (1931): "The Economics of Exhaustible Resources", *Journal of Political Economy*, 39 (2), 137-175.

James, Harold (2012): *Making the European Monetary Union*, Belknap Press of Harvard University Press: Cambridge Mass. and London.

Kelly, Kate (2014): *The Secret Club that Runs the World. Inside the Fraternity of Commodity Traders*, Portfolio Penguin: London, U.K.

Killian, Lutz (2009): "Not All Oil Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market", *American Economic Review*, 99 (3), 1053-1083.

Kohn, Donald L. (2012): "It's Not So Simple", in Evan F. Koenig, Robert Leeson and George A. Kahn (Eds.): *The Taylor Rule and the Transformation of Monetary Policy*, 173-182, Hoover Institution Press: Stanford, CA.

Libecap, Gary D. (1989): "The Political Economy of Crude Oil Cartelization in the United States, 1933-1972", *Journal of Economic History*, 49 (4), 833-855.

Lippi, Francesco, and Andrea Nobili (2012): "Oil and the Macroeconomy: A Quantitative Structural Analysis", *Journal of the European Economic Association*, 10 (5), 1059-1083.

McNally, Robert (2017): *Crude Volatility. The History and the Future of Boom-Bust Oil Prices*, Columbia University Press: New York.

Pirrong, Craig (2012): *Commodity Price Dynamics. A Structural Approach*, Cambridge University Press: Cambridge and New York.

Ross, Michael L. (2012): *The Oil Curse. How Petroleum Wealth Shapes the Development of Nations*, Princeton University Press: Princeton and Oxford.

Smith, Julia Claudia (2012): "East Texas Oilfield", Handbook of Texas Online, Texas State Historical Association, accessed 7/04/2012.

Solow, Robert M. (1974): "Intergenerational Equity and Exhaustible Resources", *Review of Economic Studies*, 41, 29-45.

Stiglitz, Joseph, E. (2003): *The Roaring Nineties. A New History of the World's Most Prosperous Decade*, W. W. Norton & Co., New York.

Taylor, John B. (2012): "The Great Deviation", in Evan F. Koenig, Robert Leeson and George A. Kahn (Eds.): *The Taylor Rule and the Transformation of Monetary Policy*, 163-172, Hoover Institution Press: Stanford, CA.

Taylor, John B. (2019): *Reform of the International Monetary System. Why and How?*, MIT Press: Cambridge, Mass.

Wicksell, Knut (1898): *Interest and Prices. A Study of the Causes Regulating the Value of Money*, Large Print Edition published 2014 by Skyler J. Collins.

Appendix

Table A.1: Real WTI Price Percentage Deviations from Counterfactual

Dates	France	Germany
OCOS	-	-
1974	145.12%	131.41%
1975	99.86%	113.45%
1976	117.69%	127.82%
1977	121.54%	119.03%
1978	83.54%	80.59%
1979	126.66%	127.01%
1980	222.54%	238.61%
1981	247.97%	276.48%
1982	229.12%	238.00%
1983	201.63%	197.12%
1984	196.45%	197.10%
1985	163.30%	171.86%
ENECOS	-	-
1999	31.39%	32.36%
2000	124.05%	129.87%
2001	85.32%	90.36%
2002	66.85%	70.38%
2003	52.03%	59.44%
2004	73.60%	81.59%
2005	122.95%	134.16%
2006	138.78%	157.27%
2007	122.58%	141.14%
2008	167.77%	192.03%
2009	67.64%	78.12%
2010	114.33%	127.61%
2011	128.69%	144.32%
2012	131.29%	145.48%
2013	122.61%	130.51%
2014	101.30%	104.80%
2015	185.30%	19.71%

Data Source: Author’s calculations (see Figure 6).

Table A.2: Test of Euro-Real Oil Price and Cold War-Real Oil Price Interaction Terms

Dep. variable: log TFP	France		Germany	
Intercept	- 0.3564***	- 0.3515***	-0.3344***	-0.3253***
	(-15.7086)	(-14.5779)	(-8.4481)	(-6.7009)
Log Real WTI Price (-1)	-0.01204**	-0.0078	-0.0162**	-0.0187*
	(-1.9029)	(-0.8730)	(-1.9811)	(-1.6912)
Cold War (-1)	0.0089	0.0029	-0.0783***	-0.0838
	(0.9121)	(0.1665)	(-4.7312)	(-1.5693)
Euro (-1)	0.0347**	0.0275***	0.0226	0.0068
	(1.8508)	(2.6283)	(0.4540)	(0.5217)
Interaction Euro*Log Real	0.0042	-	-0.0049	-
WTI Price (-1)	(0.3645)		(-.3360)	
Interaction Cold War*Log	-	-0.0046	-	-0.0017
Real WTI Price (-1)		(-0.4035)		(0.1162)
Trend	0.01752***	0.01759***	0.0135***	0.0135***
	(13.1293)	(12.8765)	(7.5216)	(7.4182)
Trend squared	-0.0002***	-0.0002***	-0.0000***	-0.0000***
	(-10.2218)	(-10.1019)	(-3.0659)	(-3.0957)
Auto-Regressive Residuals	0.5187***	0.5244***	0.5112***	0.5104***
***AR* (1)**	(3.5137)	(3.5506)	(2.8135)	(2.8026)
Number of Observations	45	45	45	45
R^2	0.9895	0.9895	0.9941	0.9940
***F*-test**	497.3814	497.7286	884.0577	881.6750
Durbin-Watson Statistics	1.5719	1.5787	1.6591	1.6658

Econometric Package Used: EViews7. *t*-statistics in parentheses.

Data Information: The annual raw series of Total Factor Productivity come from the Archive Library of the Federal Reserve Bank of St Louis Economic Data. The GDP Deflators and the Exchange Rates come from the same source as quarterly data. They have been combined to produce the Unit Dollar Prices of French and German GDPs in quarterly data form, and then averaged year-wise to produce annual data for estimation purposes. The nominal WTI Oil price series come from the same source as monthly data and have been averaged to produce annual data for estimation purposes. The computer package used is EViews 7 version 7. The routines used for estimation, testing and plotting are pre-programmed and no additional programming has been performed.