Oil Demand, Supply, and Medium-Term Price Prospects: A Wavelets-Based Analysis

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Abstract

The global "great recession" was precipitated in part by record high prices of oil and other commodities. Previous severe recessions have typically resulted in significantly lower energy prices, which in turn spurred growth and fueled a healthy recovery. In part due to expansionary monetary policies worldwide, oil prices have remained relatively high, making it difficult for the global economy to stage a strong recovery. The result is a short-to-medium term forecast of weak to modest growth, which – combined with continuously falling energy-intensity of GDP – means that oil demand will remain stagnant or at best grow modestly. Under these circumstances, surging supply from U.S. shale and similar technologically-driven unconventional oil sources is likely to create excess supply and put strong downward pressure on oil prices. Voluntary reduction in oil production to prevent falling prices is highly unlikely, because swing producer Saudi Arabia and other GCC countries need revenues at the level of current volumes and prices in order to meet core budgetary requirements and prevent regime-change risk in the aftermath of "Arab Spring" revolts. Our wavelet analysis of all countries that have ever produced more than one million barrels of oil per day shows that regime change by itself would not result in significant reduction in oil production – although it may result in lower investment and therefore prevention of further increase in production capacity. However, war that destroys physical installations for the production and/or transport of oil can significantly disrupt oil supplies. In sum, if the outright war scenario is excluded, we expect prices to fall precipitously in the medium term (3-5 years). However, the continued threat of currently-contained civil wars into larger confrontations can maintain the current prices, especially if unprecedented monetary easing continues.

1 Introduction

The last few decades have been characterized by a repeating pattern of banking, currency, and energy-price crises with drastic consequences. High energy prices tend to curb demand because of ensuing recessions, as well as substitution to alternative fuels and improved demand efficiency. Simultaneously, high prices stimulate new investments in energy assets, thus increasing supply at the same time that demand growth is hampered. This boom-bust pattern is best exemplified by the 1980s episode following the 1979 energy crisis.

The oil price euphoria of 2007–8 looks likely to be followed by a long-term adjustment similar to the 1980s. Oil demand in key markets is facing a structural slowdown through energy efficiency gains and substitution effects, including those promoted by government policy. At the same time, rising supplies of oil and gas from unconventional reserves enabled by innovation and technological breakthroughs look poised to usher in a new period of falling oil prices, other things held constant. In this paper, we discuss the possibility that the 1979-1988 boom and bust oil price cycle is about to repeat itself, in contrast to the most common oil price forecasts that predict a continued rising trajectory through the 2020s, based mainly on Asian economic growth. We also investigate possible geopolitical catalysts that could alter a downward facing outlook moving forward.

We discuss the long-term secular global business cycle and its impact on global oil demand and prices, including the effect of financial mania in other asset prices as well as demand responses due to ensuing recessions and demand efficiency adjustments, in Section 2. We then investigate in Section 3 the impact of rising oil prices shock on global oil supply, which is tantamount to moving from one Hubbert curve to a higher one, usually due to technical innovations spurred by the high prices. We test for significant alteration of Hubbert curve trajectories in various countries' oil production using a wavelet analysis that allows us to focus on significant changes at moderate frequencies (corresponding to the medium term 3–5 year period), abstracting from high frequency moves that are caused by transient weather, political, or financial drivers.

Hubbert curves are named after Marion King Hubbert's 1956 curve fitting approach that correctly predicted medium term peak in U.S. oil production by 1970. Ensuing hysteria about indefinitely rising oil prices resurfaced in the mid-2000s, then dubbed "peak oil," predicting that Middle East oil production would also peak in the near future. Of course, both demand and supply responded to high-price pressures in the early 1980s, with demand declining due to recession and improved efficiency, and supply increasing in North Sea and other areas. The same pattern appears to be repeating in the medium term, as discussed below.

The combinations of decelerating demand and accelerating supply clearly would result in precipitously declining prices, other things held equal. In Section 4, we consider the potential for oil production response to declining prices and/or reduced returns on investment of petrodollar proceeds in the form of cuts in production by Organization of Petroleum Exporting Countries (OPEC) and other major producers.

Using a Discrete Wavelet Transform (DWT) analysis, we measure the effects of price and investment return variables on oil production at various frequencies, showing that, traditionally, swing producer Saudi Arabia and similar exporters were the only countries that exhibited strong tendency to cut production strategically to prevent major price collapse. We argue that the current geopolitical environment, especially in the aftermath of "Arab Spring" revolts, would not allow for such production cuts. This leaves involuntary production cuts, or the credible risk thereof, as the only factors that may prevent oil prices from falling in the medium term.

Using our wavelet analysis for all major oil producers over the past half century, we find that regime change by itself has not resulted in significant lasting reduction of oil production, although it may hamper investment and prevent transition to higher Hubbert curves than other countries that enjoy sustained political and institutional stability. War, on the other hand, especially war in which production and/or transportation infrastructure is destroyed, can result in significant disruption of oil production capacity in the medium term and beyond, driving prices to new heights, at least in the short to medium term.

Thus, we conclude that the most likely scenario – absent war – is for oil prices to decline significantly. In case of significant war, for example, escalation of current Middle-East sectarian conflicts in Syria and Bahrain into overt war between Saudi Arabia and Iran, oil prices might skyrocket above all historical levels. Current prices are only sustainable under the scenario of continued inflationary policies by central bankers and the unrealized but ever-present threat of such war.

2 The Business Cycle and Oil Demand

Contrary to the complacent views of the early 2000s that a "great moderation" had been established and that the secular business cycle had been tamed by careful coordination of countercyclical fiscal and monetary policies, the business cycle roared back to prominence after the housing and stock market crashes during the years 2006–2009. Figure 1 shows the relationship between the secular business cycle, measured in terms of world gross domestic product (GDP) growth, on the one hand, and energy use growth on the other. A clear synchronization of accelerations and decelerations of GDP growth and energy use growth is clear in this graph.

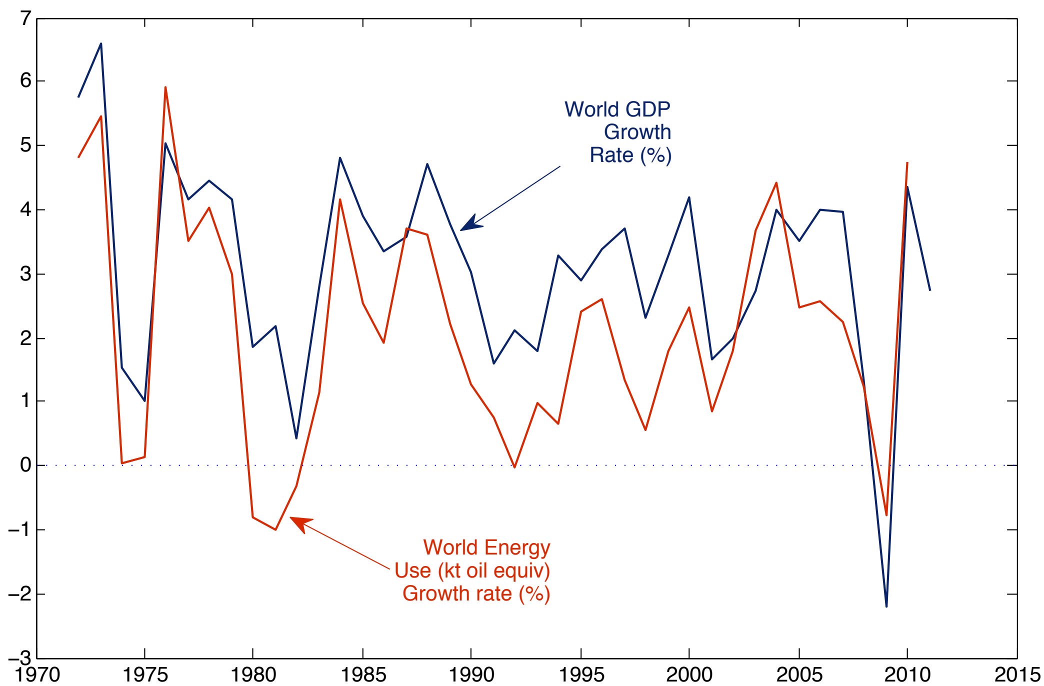


Figure 1: GDP and Energy-Use Growth-Rate Cycles. Source: World Bank WDI.

Our ultimate concern in this paper is the medium term forecast of oil prices under different scenarios. This section is concerned with the current phase of the global business cycle and its effect on medium term forecasts of energy demand. Toward that end, Figure 2 summarizes the relationship between real oil prices and economic recessions and recoveries. In this graph, oil prices have been normalized by gold prices in order to fit nicely in the same range, thus the price is shown in terms of 1/50th ounces of gold per barrel of oil, which is mean reverting to a level of about 3.3/50th ounces of gold per barrel of oil, where it was in 1971 before President Nixon decided to close the gold window (until then, the Dollar was fixed at $35 per ounce of gold, and central banks were allowed to redeem their Dollars in gold).

Figure 2 thus shows the relationship between two mean reverting processes: oil prices denominated in gold (with a mean of roughly 3.3/50th ounces of gold per barrel of oil) and global GDP growth, which reverts to a mean of roughly 3.1%. A pattern that has been studied extensively in the literature becomes obvious graphically: Whenever the gold-denominated price of oil gets too high (for example, in 1973, 1979, 2001, and 2005-2008), GDP growth declines severely, falling into negative territory circa 2008–9. Conversely, and endogenously, once a severe recession leads to significantly lower real (gold-denominated) oil prices, the global economy undergoes a vigorous recovery (for example, in 1977, 1984, 1988, and 2000).

The graph also shows that while oil prices have fallen below their average following the "Great Recession" of 2006–9, oil prices have failed to fall below their mean level for significant degrees and/or any extended period of time. This is in part due to

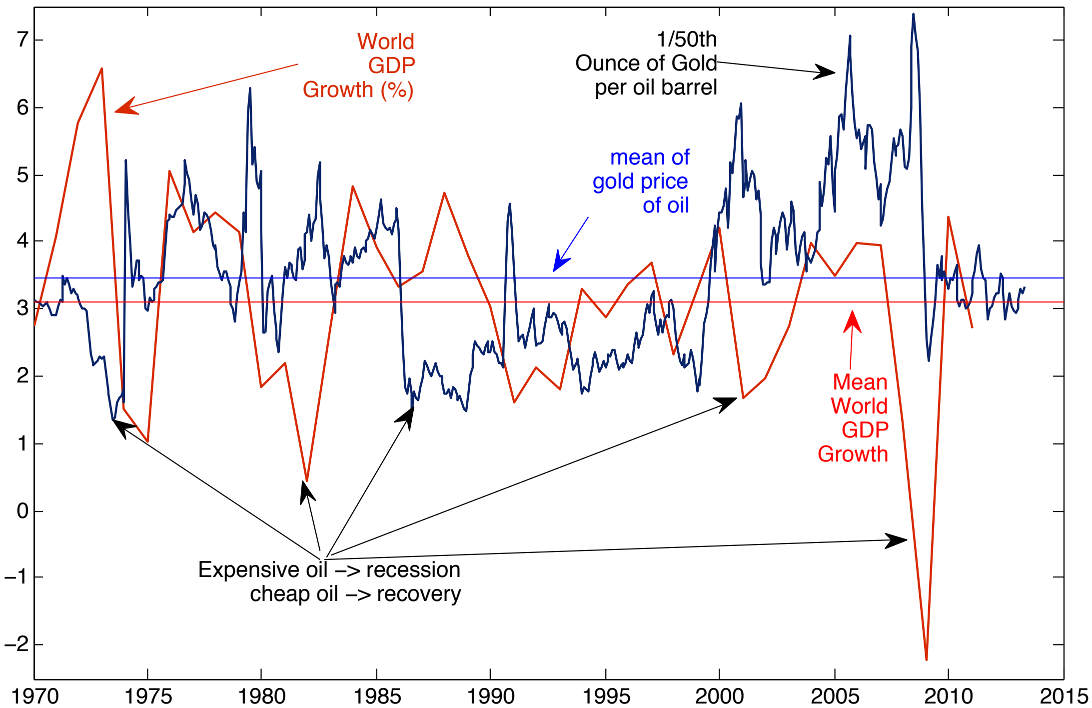


Figure 2: The Relationship between Oil Prices and Recessions/Recoveries. Sources: World Bank WDI and IMF IFS.

the unprecedented and coordinated expansionary monetary policies of central banks around the world, using variants of the Federal Reserve Bank's "quantitative easing," the purchase of long term assets to boost their values and reduce long term interest rates, in the hope of spurring economic recovery. However, instead of fueling real economic recovery, these unconventional expansionary policies have kept commodity prices, especially oil for our purposes, too high for a strong recovery to commence.

Consequently, economic growth is expected to remain sluggish at best, with fast growing countries like China witnessing significantly slower growth rates and many

European countries experiencing contractions or stagnation. Thus, the International Monetary Fund in its April 2013 issue of World Economic Outlook has forecast modest real GDP growth rates of 3.2%, 3.3%, 4.0%, and 4.4%, respectively, for 2012, 2013, 2014, and 2015. The forecast higher growth rates in 2014 and 2015 may prove to be too optimistic, and at any rate are not sufficiently high to compensate for the long period of economic contraction and/or slow growth worldwide. Thus, we expect the global business cycle to continue its lackluster performance over the 3–5 year medium term, which, according to Figure 1, would translate into slow if any growth in energy use.

The effect of continued lackluster global economic growth on energy demand is further compounded by the secular trend for energy-intensity of output to decline. Figure 3 shows this phenomenon, which may be attributed in part to growing shares of low-energy-intensity service sectors in global GDP and in another part to higher energy efficiency in all sectors: The number of kilograms of oil equivalent needed to produce constant year 2005 $1,000 of GDP has declined from nearly 237 in 1990 to 181 in 2010, a 31% decline in energy intensity of real output over two decades.

In this context, the industrialized world has been a leader in oil-demand destruction, in part through mandated efficiency standards. The new U.S. target for vehicle efficiency to reach 54.5 miles per gallons by 2025 is reminiscent of 1975 legislation that mandated then doubling automobile efficiency to 27.5 miles per gallon by 1985. The 1970s-80s program rendered the U.S. 32 % more oil efficient. Japan was even more aggressive, improving oil efficiency by 51% over the same time period. De-

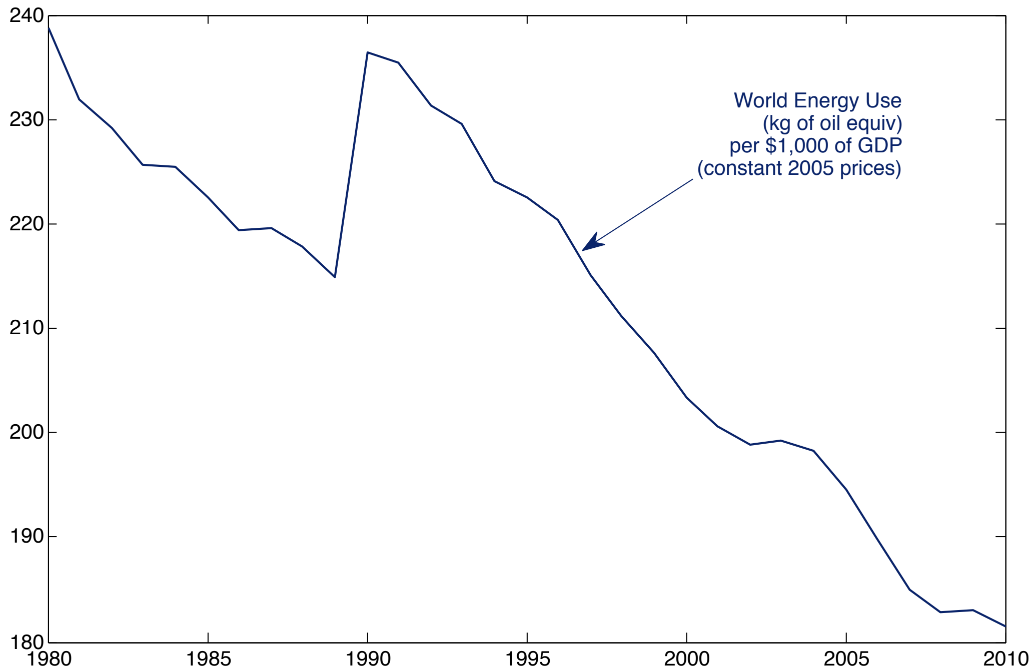


Figure 3: Falling Energy Intensity of Output. Source: World Bank WDI.

veloping countries soon thereafter adopted or imported the same technologies and contributed to demand destruction, especially as their service sectors grew disproportionately, thus contributing to the global pattern of declining GDP energy intensity.

Combining the recurring two factors of slow GDP growth and declining energy intensity of GDP, we can forecast demand destruction to continue – as already seen to be in progress in various regions in Figure 4. Unfortunately, BP Statistical Review data, used in Figure 4, are only available up to 2011. However, data from PIW up to April 2013 show demand destruction in Asia Pacific between 2011 and April 2013, as Chinese and Indian growth have declined in recent quarters.

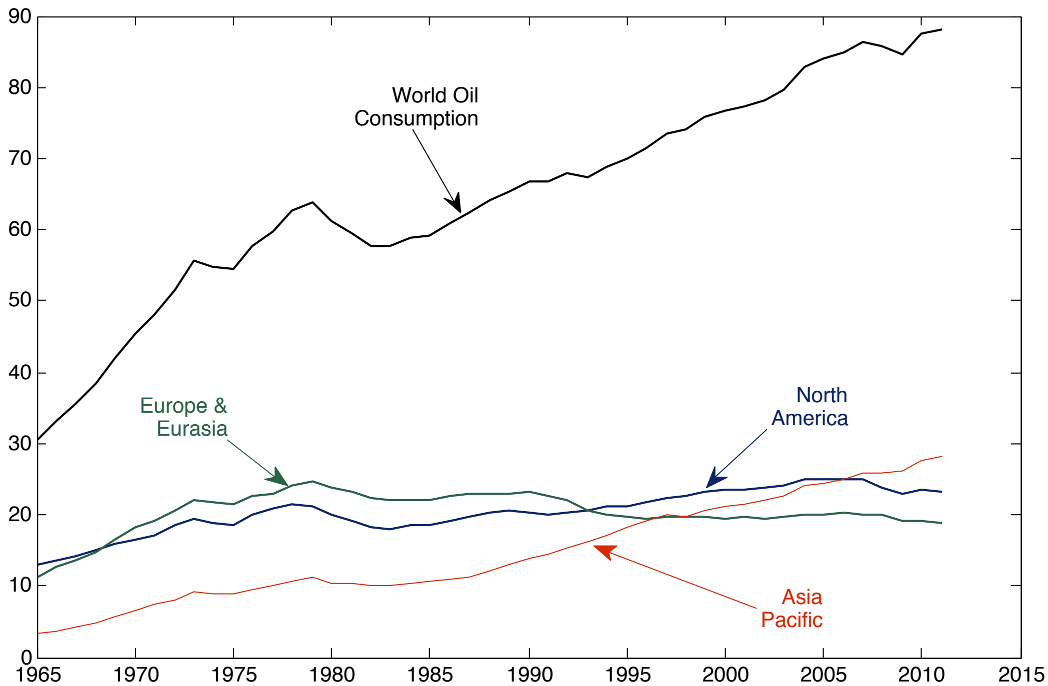


Figure 4: Oil Consumption (millions of barrels per day) by Region. Source: BP

Therefore, if supply were to grow significantly, we expect oil prices to fall, other things equal. Before proceeding to study supply trends in Sections 3 and 4, we consider here the effect of financial speculation on accentuating price movements, both upward and downward. Toward that end, we revisit the relationship between oil and gold prices, implicit in our choice to plot gold-denominated oil prices in Figure 2. Figure 5 shows nominal Dollar-denominated oil and gold prices. We can see that they have at times been synchronized and at others not. In order better to study the relationship at various frequencies, we utilize a wavelet-based approach, which allows us to look for different patterns of co-movement at various frequencies in various time periods (something that traditional Fourier-style frequency domain analysis would not make possible; some technical details on our software implementations are included in the Appendix, and the wavelet analysis of time series is studied extensively in [12]).

Figure 5: Oil and Gold Prices. Source: IMF IFS.

Figure 6 shows the wavelet coherence between oil and gold prices, using monthly data form the International Monetary Fund's International Financial Statistics. Areas of significant co-movement, possibly with a phase shift – i.e. where one variable leads the other – are surrounded by thin white boundaries and have arrows plotted to show the phase shift direction. Arrows pointing to the right indicate in-phase (i.e.

synchronized) co-movements of the two series. Arrows point to the left indicate anti-phase (i.e. synchronized but moving in opposite directions) co-movememts. Arrows pointing up indicate oil price cyclical movement leading movements in gold, and arrows pointing down indicate gold price movements leading oil prices.

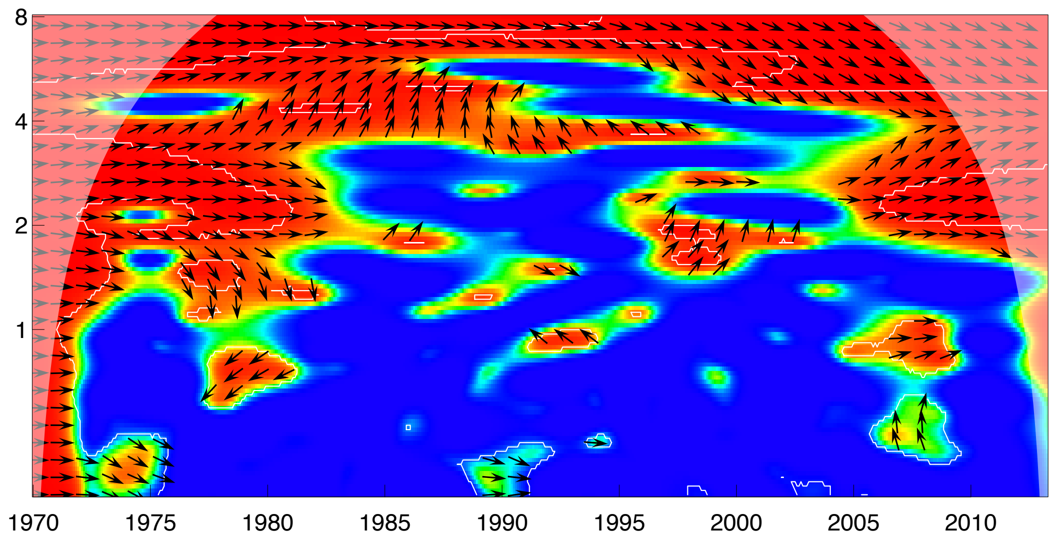


Figure 6: Wavelet Coherence for Gold and Oil Prices (period in years on vertical axis). Data Source: IMF IFS.

We can see that for long periods exceeding 5 years, oil and gold price series are synchronized in phase, with a very slight lead taken by gold prices starting around 1998. We see very short term co-movements with periods of less than six months in four episodes: (i) before 1972, when both oil and gold prices were fixed, (ii) around 1973, when the two series were reasonably synchronized with gold leading the way (which can be seen in Figure 5, where gold prices start rising after 1971, and oil only catches up after the Arab Israeli war of 1973), (iii) around the 1990 first Iraq war, where the two series were synchronized, and (iv) around 2008, when oil prices led gold prices.

Further short-term comovements, albeit at slightly lower frequency with period of six months to one year, occurred (i) around the Iranian revolution in 1979, with anti-phase movements that were gold-price-led, (ii) shortly after the Iraq war, again in anti-phase but oil led fashion, and (iii) around 2006–8 with full synchronization as all commodity prices spiked before the crash. Co-movement at lower frequency yet, around 2-year periods, occurred (i) throughout the 1970s in full phase synchronization, until the pattern broke down in the early 1980s, (ii) resurfacing briefly around 1985 in oil-price-led fashion, (iii) reappearing briefly around the first Iraq war in 1990, and then (iv) resurfacing in oil-led fashion as oil prices rebounded in 1998.

Of primary interest for us in this paper are the medium-term (3 to 5 years) patterns, which showed interesting reversion to oil-price led comovment during the oil-demand destruction period of the 1980s shown in Figure 4. In particular, we aim to investigate the possibility of replay of demand destruction due to weak economic recovery, combining with surges in oil production (from the North Sea and other areas in the 1980s, from shale oil now), to result in significantly lower oil prices.

Another paper in this study (by Ken Medlock) discusses the differences between the two periods, especially after Fed Chairman Paul Volker raised interest rates very strongly in the early 1980s to fight inflation, whereas current Fed Chairman Ben Bernanke has led other central bankers in lowering interest rates to near zero. However, our focus in this paper abstracts from financial considerations, which may strongly affect speculative behavior, for example, through margin buying when interest rates are abnormally low, but mostly at higher frequencies. However, such speculative behavior may amplify fundamentals-driven price trends in the short term. By focusing on medium-term effects on real oil prices, we can limit our attention to real-economy fundamental demand and supply considerations. We have already discussed demand considerations in this section, and we now turn to supply considerations in the following two sections.

3 Oil Supply Response to High Price

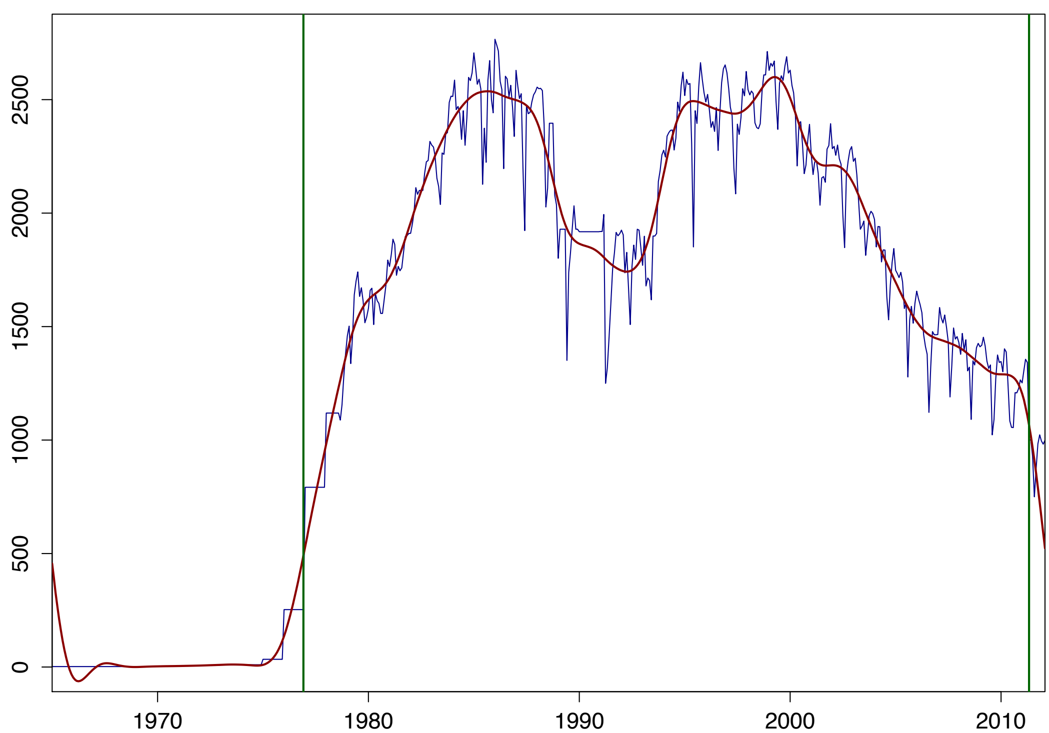


Figure 7: U.K. Oil Production in Thousands of Barrels per Day.

High oil prices provide energy companies both with the funds to invest and the incentive to explore more expensive oil production technologies. A classic example is shown in Figure 7, where high oil prices after the oil "shock" of 1973 contributed to technological progress that boosted output significantly circa 1978, especially from North Sea production, which had been modest from its inception in the mid-1960s, but was heralded in the late 1970s as one of the greatest oil-sector investments, with new technologies allowing companies to drill deeper with platforms that can withstand stronger winds and waves than ever before.

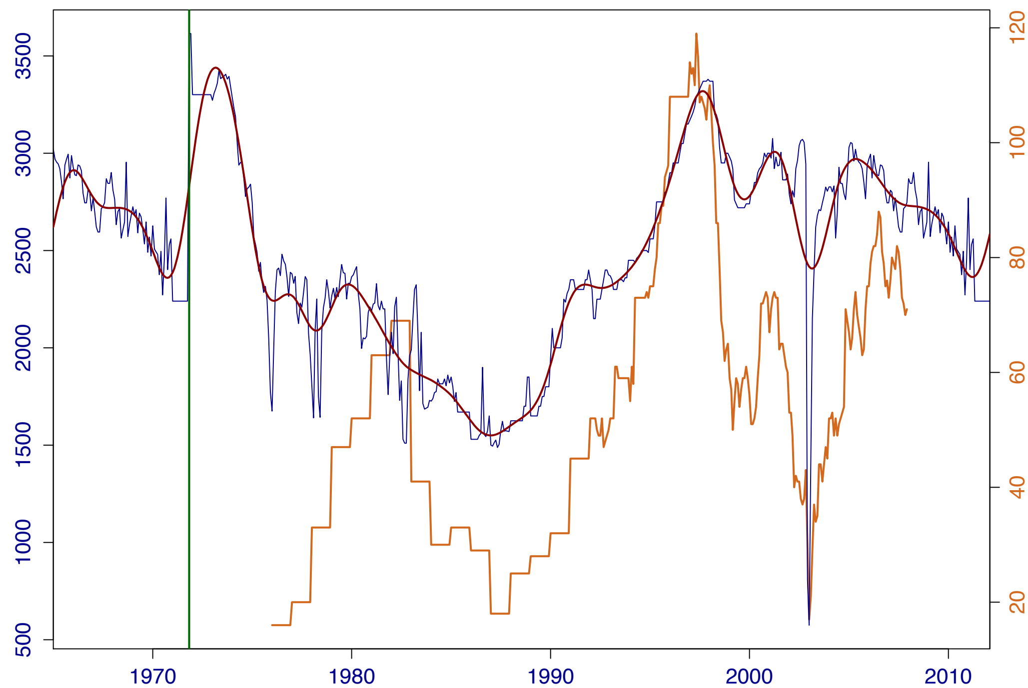


Figure 8: Venezuela Oil Production in Thousands of Barrels per Day.

The medium-term jump in U.K. oil production shown in Figure 7 is detected by abstracting from short-term events that may result in more transient changes in production. To illustrate the methodology employed in this paper, which is discussed in some greater detail in the Appendix, we may consider the case of Venezuelan production, shown in Figure 8. The jump in Venezuelan oil production circa 1973 is detected as a significant medium-term altering event, while the severe, but temporary, disruption due to the 2003 strike is not seen as significant at that frequency.

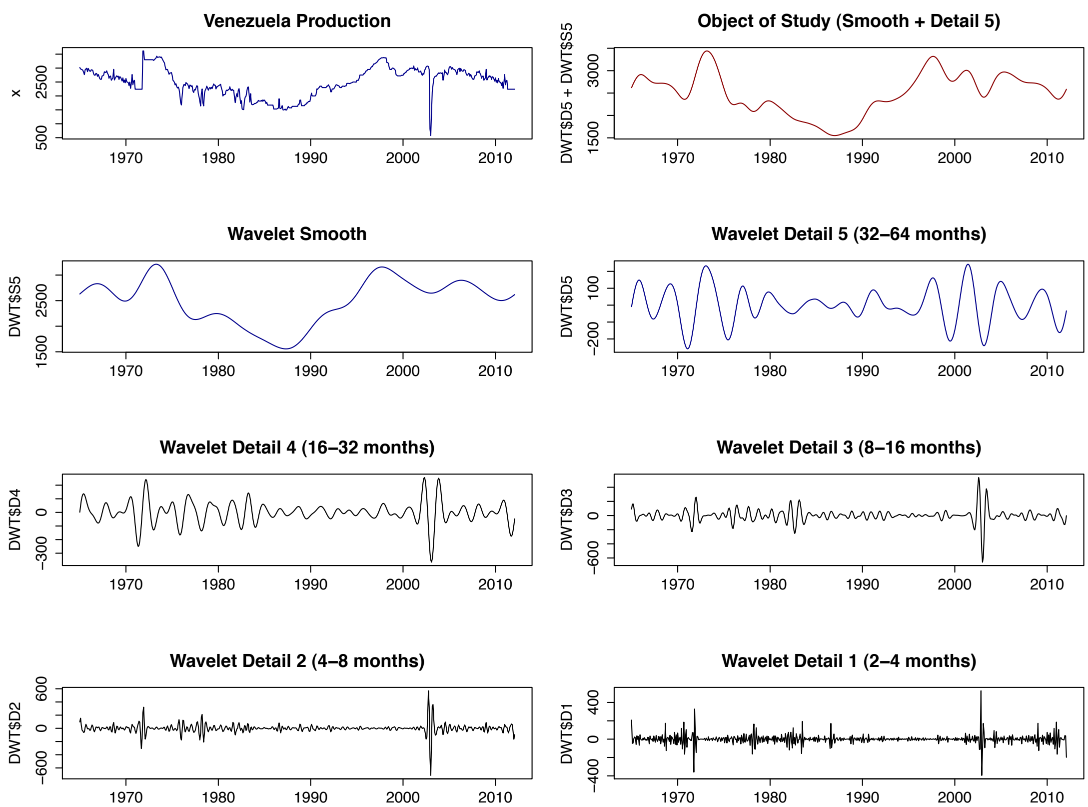


Figure 9: Discrete Wavelet Transform Decomposition of Venezuelan Oil Production.

Figure 9 shows the Discrete Wavelet Transform of Venezuela's production time series. The bottom six plots in Figure 9 show, respectively, the wavelet smooth component of the series, detail 5 (at period 32 to 64 months), and higher frequency details 4 through 1 corresponding to periods of 16–32 months, 8–16 months, 4–8 months, and 2–4 months. The object of our analysis for medium term disruptions in productions (positive responses to high prices in this section, and negative responses to wars in the next section) is the wavelet smooth plus the detail 5 component. In other words, all events with effects vanishing in less than 32 months are excluded. Comparing the top two plots in Figure 9, we can see that the production surge in 1973 was still evident in the smooth+detail 5 curve, but the short-lived production disruption due to the 2003 strike was absorbed in higher-frequency details 1–4, and therefore is not identified as a significant event for medium-term production.

Inspecting the wavelet analyses for the 19 countries that have produced one million barrels per day or more at some time between 1965 and 2012 (including the former Soviet Union, constructed by the sum of production of its post breakup republics for late sample data), we have detected strong upward breaks following high-price periods in a number of countries. This includes the case of the U.K. shown in Figure 7 and again in greater detail in Figure 28, as well as Angola circa 2005 (Figure 12), repeatedly in Brazil in 1998, 2005, and 2009 (Figure 13), in China in 2009 (Figure 15), in Mexico in 1981 (Figure 22), and Venezuela in 1973 (Figure 30).

These all constitute production boosts caused by extended episodes and projections of high oil prices, in most cases involving technological advances in offshore drilling and the like. The most significant development that may emerge in the medium term (at the writing of this paper, this would mean 2016–2020) is the shale oil revolution, in part made possible by decade-long high prices after the Iraq invasion of 2003, and projections of high prices due to continued robust demand growth in China and India and dwindling growth of reserves of conventional oil (the so-called "peak oil" hypothesis). As we can see in Figure 29, U.S. oil production has to-date followed more or less a typical Hubbert curve trajectory, with possible upward break detected as early as 2011 but too close to the end of the sample to be statistically meaningful. However, by all predictions, shale oil is expected not only to satisfy U.S. oil demand, but possibly to make it possible for the U.S. again to become a major oil exporter, recapturing pricing power, roughly forty years after losing it to the current swing producer Saudi Arabia.

The so-called "shale revolution" has unleashed an enormous amount of oil and gas activity in the United States. Shale gas production in the United States has increased from virtually nothing in 2000 to more than 10 billion cubic feet per day (bcfd) in 2010. Gross natural gas output in the U.S. hit 2.5 tcf this past summer, a record high. Shale gas production could more than quadruple by 2040, accounting for well over 50 percent of total U.S. natural gas production over the next two decades. Tight oil, that is unconventional oil from shale structures, is developing at an extraordinarily rapid rate in the US as well, reaching more than 1.5 million b/d and end 2012, or 1.6% of global production.[1]

[1] See Kenneth B. Medlock III, Amy Myers Jaffe, and Peter R. Hartley, "Shale Gas and U.S. National

U.S. analysts are now projecting that US oil production could rise significantly over the next decade as increased drilling in shale formations and deep water Gulf of Mexico translates into higher domestic output. Estimates range from an increase of 3 million to 10 million barrels per day (b/d) of oil and natural gas liquids production from shale formations by 2020, with some analysts projecting that the United States could become an exporter of natural gas liquids over time. Citibank estimates that US deep water production could hit 3.8 million b/d by 2020, up from 1.3 million b/d in 2011.[2]

4 Voluntary and Involuntary Supply Responses to Falling Prices

If we combine the results of Section 2 (decelerating or declining oil demand) and Section 3 (technological response boosting oil production, especially with shale oil coming online in the U.S. and possibly elsewhere), we would expect oil prices to fall precipitously. However, we know that in past episodes, for example, during the 1980s, other producers, led by swing producer Saudi Arabia, reduced their production quotas in response to demand destruction and increased production from non-OPEC countries. This is not at all surprising since the classical economic analysis of Hotelling [6] has shown that an oil producer's output will decline if prices are lower and/or the return on investment of oil proceeds declines.

Security" (working paper, James A. Baker III Institute for Public Policy, Rice University, Houston, TX, July 2011).

[2]Energy Information Administration Annual Energy Outlook, 2011, http://www.eia.gov/analysis/studies/worldshalegas/

In the event, Middle East producers did try in 1982 to reduce output in order to accommodate the increased production from non-OPEC producers by 4 million barrels per day. In March 1982, OPEC members met in an attempt to defend posted prices through production cutbacks, reducing the production ceiling from 31 million to 18 million barrels per day, with Saudi Arabia playing the role of swing producer to keep prices between $32 and $38 per barrel. By 1985, continued cheating on quotas by other OPEC members prompted Saudi Arabia to change strategies, again increasing its production to 6 million barrels per day, thus allowing oil to fall below $10 per barrel in late 1985.

In this paper, we consider five economic variables that may influence an oil producer's economic decision on production levels: (i) WTI price (which generally correlates with other oil prices) measuring the immediate monetary conversion upon sale, (ii) gold prices (measuring anticipated inflation, and its inverse, the value of the Dollar in which most oil sales are denominated and proceeds are invested), (iii) S&P500 index levels (measuring return on investment in stocks, and anticipated growth of the real economy), (iv) yield on 10 year U.S. Treasury Notes (measuring the riskless benchmark rate for moderately long-term investment), and (v) U.S. manufacturing purchasing managers' index (a widely followed measure of current economic activity). Figures 31–35 show, respectively, the behavior of these five economic series over the sample period 1965–2012. These figures also show significant jumps up or down in the medium-term trajectories of the series using the same DWT methodology utilized for analyzing production trajectories in Section 3 and the Appendix.

A great advantage of the DWT is the orthogonality of its detail components. The resulting decomposition of oil production and the economic variables that may influence it into orthogonal components at different frequencies thus allows us to regress separately each level of detail of production on the corresponding frequency detail of the economic variables of interest, assessing responsiveness of production to economic variables at various "speeds." The canonical case, shown in Tables 31–32, is Saudi Arabia, where in the very short term (2–4 months) oil production responded significantly (and in the same direction) only to gold prices. However, strong responses to WTI prices, S&P500 levels, and gold prices are all strongly positive and significant within the relatively short term of 4–8 months, and strong positive response to 10-year Treasury Notes only occurs at the relatively longer term of 16-32 months. This is consistent with Saudi Arabia's role as swing producer, for example, boosting its output during the first Iraq war of 1990 to bring prices down, and doing more than its share during the 1980s in cutting its production to combat falling prices because of demand destruction. Indeed, Figure 26 shows the strong reduction in output circa 1982, which was detected as a significant reduction with medium-term (32–64 months) consequences. Similar and synchronized reductions are observed in OPEC members Kuwait (Figure 20) and also UAE (Figure 27, albeit to a lesser extent that does not pass our testing methodology).

Output reductions in the early 1980s in Iran (Figure 18) and Iraq (Figure 19) were confounded by the 1980–8 Iran-Iraq war, wherein oil facilities were directly targeted from the very beginning. There are two main reasons to attribute the output disruptions in Iran and Iraq to their war rather than economic considerations. First, these disruptions preceded the output surges in North Sea and Mexico, the start of price reductions, and the responses of Saudi Arabia, Kuwait, and others. Second, inspection of Tables 15–18 shows very different patterns of oil responses at different frequencies from the canonical example of Saudi Arabia shown in Table 31–32: Iran's price response is much weaker at the 4-8 month detail and vanishes elsewhere, and Iraq's price response, although positive and strong in the 4-8 month detail, was perversely negative and significant in the 8-16 months. These confirm that the precipitous decline in oil production in these two countries was caused by their war.

Libya's output reduction in the early 1980s also cannot be attributed to the concerted effort by OPEC to prevent prices from falling too far too fast. In 1981, the Qaddhafi regime escalated its conflict with the United States by firing on US military aircraft in the Gulf of Sidra. Shortly thereafter, the U.S. forced American oil companies, including Exxon and Mobil, to withdraw from the country and imposed an embargo against Libyan oil in 1982. The regressions in Tables 21–22 show a sluggish, albeit correct-direction, price effect, at the 16–32 month detail level, but they also show opposite-sign reactions, for example, to the price of gold at the 4-8 month level, confirming that much of the variance in Libyan oil production was governed by non-economic considerations – as American demand for Libyan oil declined from half a million barrels per day to nothing, and as international oil companies abandoned the country. Although this was not a case of outright war between the U.S. and Libya, the effect on Libya's production was indeed similar to the effect of war.

This brings us to the final consideration for the medium term: At the time of writing this paper, could we witness a significant reduction in oil production by Saudi Arabia and other major OPEC producers, either voluntarily as prices begin to suffer downward pressure from shale oil production in the U.S., or involuntarily due to geopolitical factors? The most recent OPEC meeting in May 2013 suggests coordination to reduce production voluntarily is not likely, as West-African producers' pleas for a response to the shale-oil threat was rejected by Saudi Arabia and other major producers.[3]

It is widely known that Saudi Arabia responded to the "Arab Spring" revolt by offering a very generous redistribution of its petrodollar receipts in various forms.[4] Thus, it appears likely that the Kingdom needs both the current price and sales levels in order to meet both its core budgetary needs and the social-support spending to prevent Arab-Spring-country like discontent among its public. Therefore, voluntary reduction in production and sales would not be expected under such pressures, which means that oil prices would continue to fall under the pressures from surging supply and stagnating demand, other things constant.

The final question, therefore, is whether potential regime change in major producers (within or outside the current arrangements) could result in significant output disruption. To investigate this question, we look at other countries where regime changes have taken places, and find evidence that regime change by itself has not

[3]See Fauco, B., S. Kent and H. Hafidh. "U.S. Oil Boom Divides OPEC Cartel Struggles to Respond to Rise of Shale Drilling," *Wall Street Jounral*, May 28, 2013, page A1.

[4]See Kerr, S. "Saudi Arabia sets lavish spending figure," *Financial Times*, December 27, 2011.

resulted in significant medium term (32–64 month) disruptions in output.

Figure 30 shows that although investment (as measured by the number of rigs in operation in the country, shown in chocolate color) declined and output declined smoothly along the current Hubbert curve, Venezuela did not experience a significant lasting disruption of output upon the first election of Chavez in 1998. In the cases of Iran and Iraq, there is conflation of regime change in 1979 and the commencement of the Iraq-Iran war in 1980. However, because similar disruptions are observed in Iraq and Kuwait at the time of the 1990 Kuwait invasion and first Iraq war, and due to the considerations discussed in Section 3, we conclude that it was not the regime change in 1979 per se that resulted in production disruption, but the actual outbreak of war. In the case of Kuwait, production recovered quickly by 1993, but it remained low much longer in the case of Iraq, which was impacted much more significantly by the war. Thus, we conclude that regime change may hamper investment and prevent an oil producer from staying on the highest possible Hubbert curve, or get onto a higher one through technical progress and investment, but outright and significant medium-term involuntary output disruption may only occur in case of outright war that destroys production and/or transportation infrastructure.

5 Concluding Remarks

Comparing oil price patterns in the 1980s and the past few years may not immediately inspire our prediction of declining oil prices in the medium-term, in the absence of military activities or imminent threat thereof in major production areas such as the

Middle East. Inspecting Figure 10, which superimposes the real price trajectories of the periods 1974–97 and 1998–2013, using the consumer price index (CPI) as deflator, we seem to have a divergence between oil price paths in the 1980s and the past few years. However, the relatively high oil prices compared to the CPI is deceptive. Following the multiple rounds of "quantitative easing," wherein the Federal Reserve Bank and other central banks have engaged in massive purchases of long-term assets, driving interest rates down, all asset prices have risen precipitously. Figures 2 and 5, which, respectively, show the gold-denominated price of oil and the direct comparison of nominal oil and gold prices, tell a more compelling story of asset-price inflation, and suggests that CPI is the wrong deflator to use.

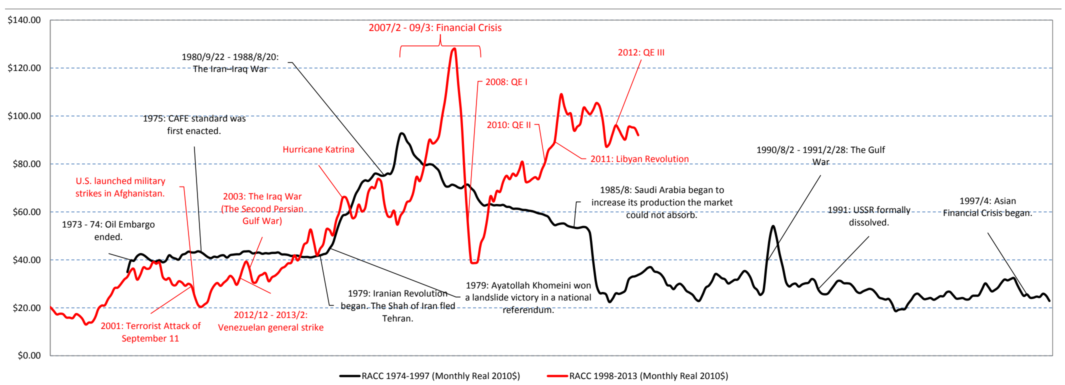


Figure 10: Real Price of Oil in 2010 $ (Deflated by CPI).

As shown in Figure 2, the gold-denominated price of oil has in fact remained near or slightly below its long-term average since falling from its height preceding the crash in 2008. We have argued that oil prices have thus not fallen sufficiently low to fuel a strong recovery in real terms (or quasi-nominal terms, using the misleading CPI to measure inflation, as shown in Figure 10). This paper suggests that this is because we have not yet witnessed the full effect of demand destruction and output growth fueled by the high prices of the past decade. As slow economic growth continues to contribute to demand destruction and as new oil supply, especially from shale, reaches the market, we expect oil prices to fall significantly over the next three to five years, barring the outbreak or imminent threat of war. The two scenarios at the two ends of the spectrum are outright war and prices spiking above their highest level in 2008 or prices falling to half their current levels. The only scenario under which prices continue at their current levels is continued asset-price inflation through quantitative easing combined with an imminent threat of war breaking out to justify financial prices well above the levels supportable by economic fundamentals in the medium term. The threat of Middle East sectarian wars spreading out of Syria and Bahrain to spark an overt war between Iran and Saudi Arabia may be the geopolitical catalyst supporting current prices, with the threat of significantly higher prices if an actual war ensues. Resolution of the conflict should trigger a quick decline in prices, especially if it coincides with tapering of the expansionary "quantitative easing" policies of central banks.

Appendix

In this Appendix, we show country-by-country analysis of oil production and its responses to economic factors. The analysis is conducted for all (twenty) countries that produced at least one million barrels per day at any point within our daily sample, which spans the period from 1/1/1965 to 2/1/2012. The twenty countries studied here are: Algeria, Angola, Brazil, Canada, China, Former Soviet Union, Indonesia, Iran, Iraq, Kuwait, Libya, Mexico, Nigeria, Norway, Qatar, Saudi Arabia, UAE, UK, USA, and Venezuela.

Instead of imposing any parametric restrictions on Hubbert curves that the different countries' productions may have been following, we use a nonparametric wavelet analysis, which imposes minimal smoothness conditions on the fitted production trajectories. Performing a discrete wavelet transform (DWT) analysis on each country's production trajectory [12], we test for breaks at the 3-5 year period (formally, 32 to 64 month) wavelet detail, using the testing methodology of [15] on the detail level 5, corresponding to that period, and testing at the 5% significance level. For each country's production series, we plot the actual production level time series, as well as a smoothed curve (the DWT smooth plus level 5 detail corresponding to that 32-64 month period); denoting any time period where a jump (either up or down) in level-5 detail was detected by a vertical green line. Superimposed on the same figures, also, is the number of rigs in operation in each country (wherever and whenever that data was available to us), shown in chocolate color.

Under each of these graphs, we also plot the continuous wavelet spectrum for the country's oil production time series, showing variation at different frequencies and different periods, as well as the wavelet power spectrum, showing overall which frequencies contributed the most to total variation of the time series. The pair of figures for each country thus illustrate Hubbert curve-like trajectories [see 1, 2, 5, 7, 9, 10, 11], as well as potential jumps onto higher Hubbert curves, for example due to technical progress or disruption because of war. All analyses in this paper were conducted using R, utilizing the packages 'zoo,' 'waveslim,' 'WaveCD,' and 'WaveletCo.' All DWTs were conducted using the maximum-overlap discrete wavelet transform with La(8) Daubechies wavelet and five to eight levels of detail.

We then turn our attention to integration of Hotelling-like considerations, which suggest that countries would increase or reduce their oil production depending on the price that they can fetch and the return that they can earn on their oil proceeds [see 6, 13, 14]. Regressing production levels on economic variables such as prices, etc., would produce spurious results because of well known unit-root problems. Running the regressions on first differences, possibly integrating error correction and other econometric techniques, is tantamount to a very simple wavelet analysis [see 12]. Because the discrete wavelet transform breaks the production series into orthogonal sub-series, we can conduct similar DWT on the right hand side economic variables that we use to explain economic responses of production to the following variables: (1) WTI price as a measure of the price per barrel produced, (2) S&P 500 index level as a measure of return on investment in stocks as well as expected economic growth, (3) gold prices as a measure of return on investment in other commodities as well as overall inflationary expectations, (4) ten year U.S. Treasury Note yields as a measure of risk-free return, and (5) US purchasing managers index (PMI) as a measure of economic activity and potential forecast of future demand growth. For each country, we report the results of regressions of oil production DWT detail levels 1 through 5 on the corresponding DWT details for these five variables, thus measuring responsiveness of supply to economic incentives at different frequencies.

At the end of the appendix, we also include graphs for the five economic variables listed above using the same methodology for the country-specific output. In other words, the top graph for each variable includes the time series as well as a smoothed curve with the smooth and level-5 detail, and breaks at the 32-64 month period level are designated by vertical green lines. The bottom part of each graph also includes the continuous wavelet spectrum of each economic variable.

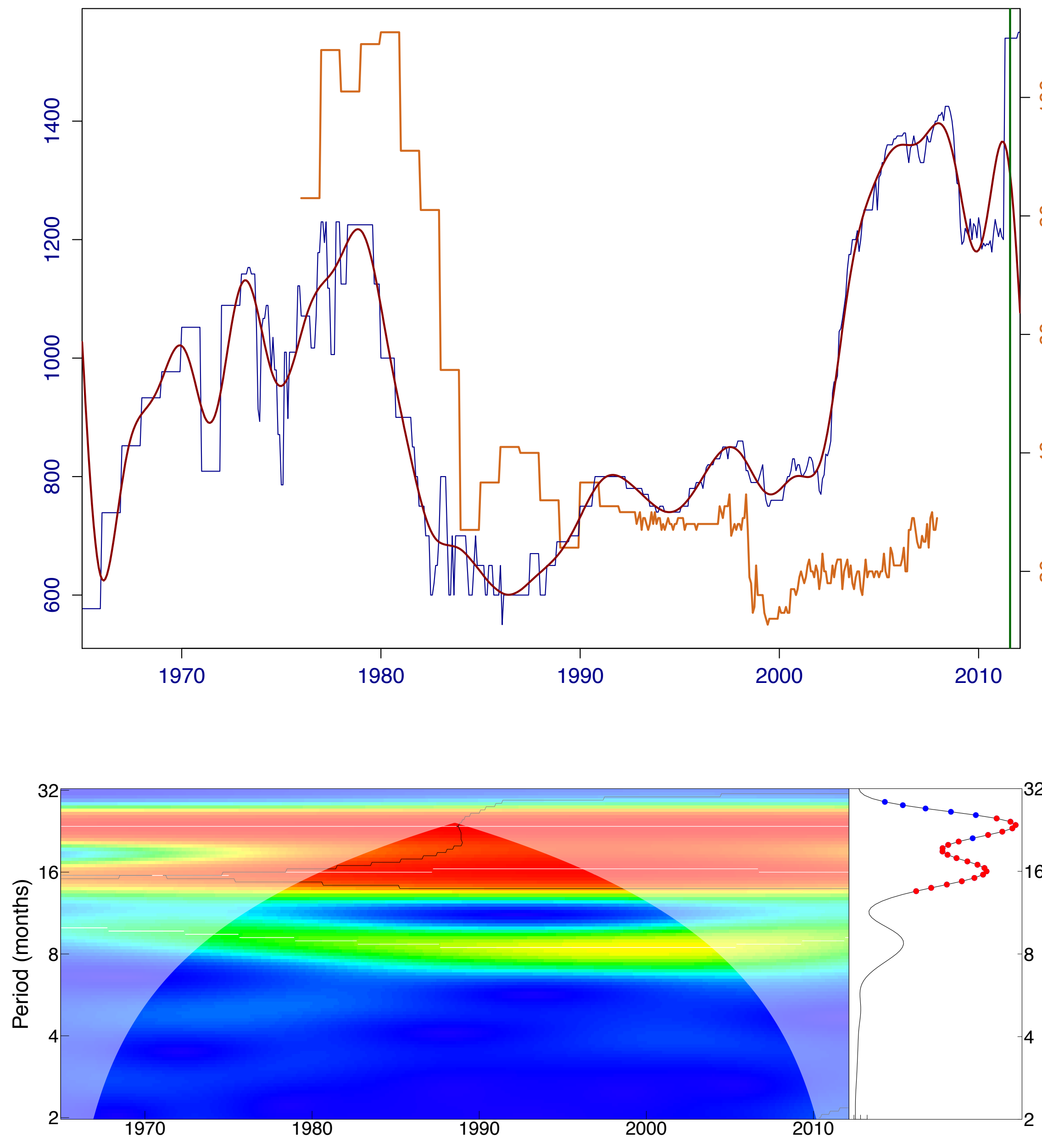


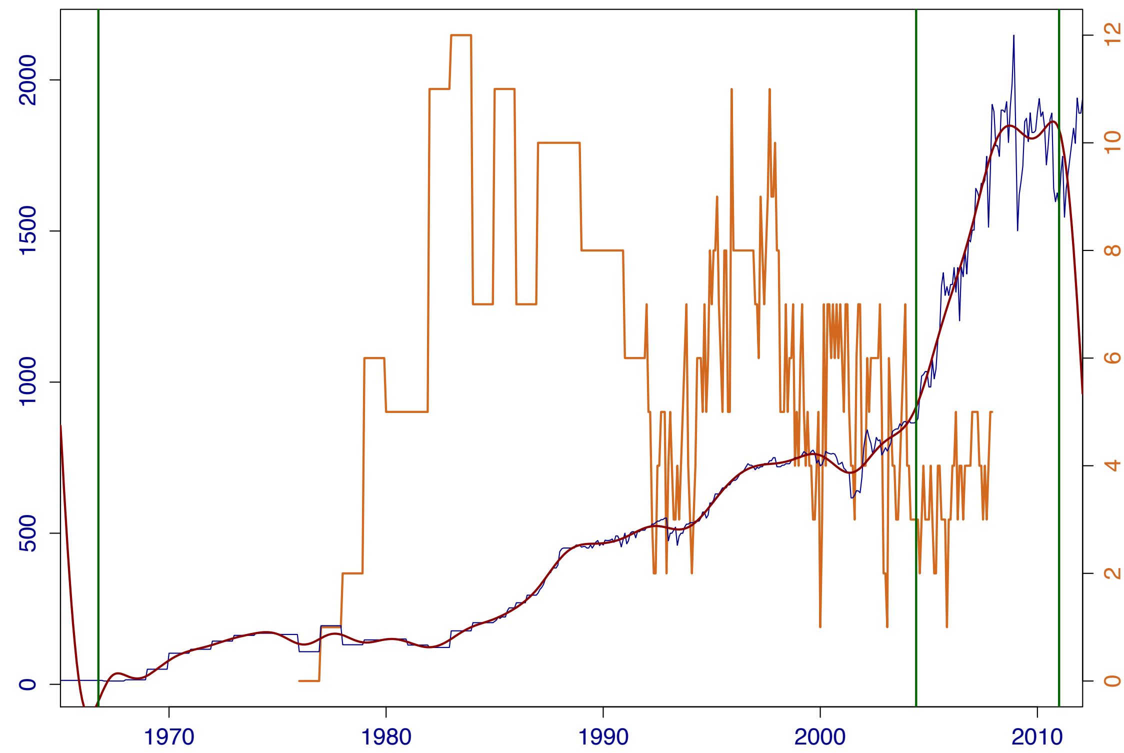
Figure 11: Algeria Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Algeria Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		1.28^{*}	
		(0.74)	
DSP500$D1$		0.20^{***}	
		(0.06)	
DGold$D1$		0.29^{***}	
		(0.05)	
DUS10yr$D1$		1.04	
		(7.18)	
DPMI$D1$		-2.95^{***}	
		(0.78)	
DWTI$D2$			2.29^{***}
			(0.61)
DSP500$D2$			0.32^{***}
			(0.05)
DGold$D2$			0.18^{***}
			(0.05)
DUS10yr$D2$			10.80^{**}
			(5.28)
DPMI$D2$			-1.80^{**}
			(0.82)
R^2	0.96	0.51	0.51
Adj. R^2	0.96	0.51	0.51
Num. obs.	566	566	566

Table 1: Algeria Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	0.27		
	(0.40)		
DSP500$D3$	0.14^{**}		
	(0.06)		
DGold$D3$	0.33^{***}		
	(0.04)		
DUS10yr$D3$	-25.96^{***}		
	(5.19)		
DPMI$D3$	0.76		
	(0.74)		
DWTI$D4$		0.16	
		(0.32)	
DSP500$D4$		0.16^{***}	
		(0.05)	
DGold$D4$		0.55^{***}	
		(0.04)	
DUS10yr$D4$		-1.85	
		(4.33)	
DPMI$D4$		0.49	
		(0.46)	
DWTI$D5$			4.82^{***}
			(0.51)
DSP500$D5$			0.02
			(0.04)
DGold$D5$			0.17^{***}
			(0.04)
DUS10yr$D5$			-11.14^{***}
			(2.87)
DPMI$D5$			4.47^{***}
			(0.40)
R^2	0.45	0.73	0.74
Adj. R^2	0.44	0.73	0.73
Num. obs.	566	566	566

Table 2: Algeria Production Regressions – part 2



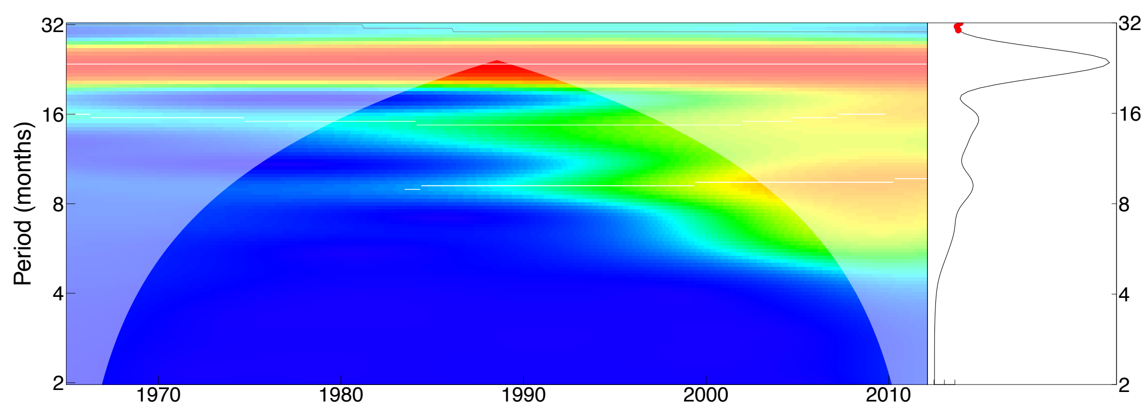


Figure 12: Angola Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Angola Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		0.04	
		(0.85)	
DSP500$D1$		0.31^{***}	
		(0.07)	
DGold$D1$		0.81^{***}	
		(0.06)	
DUS10yr$D1$		-12.60	
		(8.26)	
DPMI$D1$		-3.12^{***}	
		(0.89)	
DWTI$D2$			4.23^{***}
			(0.87)
DSP500$D2$			0.46^{***}
			(0.08)
DGold$D2$			0.38^{***}
			(0.07)
DUS10yr$D2$			-6.18
			(7.54)
DPMI$D2$			-1.38
			(1.17)
R^2	0.97	0.77	0.62
Adj. R^2	0.97	0.77	0.61
Num. obs.	566	566	566

Table 3: Angola Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	-0.51		
	(0.38)		
DSP500$D3$	0.57^{***}		
	(0.05)		
DGold$D3$	0.72^{***}		
	(0.04)		
DUS10yr$D3$	-12.96^{***}		
	(4.83)		
DPMI$D3$	-0.72		
	(0.69)		
DWTI$D4$		-0.68^{**}	
		(0.29)	
DSP500$D4$		0.45^{***}	
		(0.05)	
DGold$D4$		0.75^{***}	
		(0.04)	
DUS10yr$D4$		3.63	
		(3.94)	
DPMI$D4$		-0.32	
		(0.41)	
DWTI$D5$			0.85^{**}
			(0.40)
DSP500$D5$			0.07^{**}
			(0.03)
DGold$D5$			0.69^{***}
			(0.03)
DUS10yr$D5$			-1.20
			(2.24)
DPMI$D5$			-1.24^{***}
			(0.31)
R^2	0.83	0.88	0.91
Adj. R^2	0.82	0.88	0.91
Num. obs.	566	566	566

Table 4: Angola Production Regressions – part 2

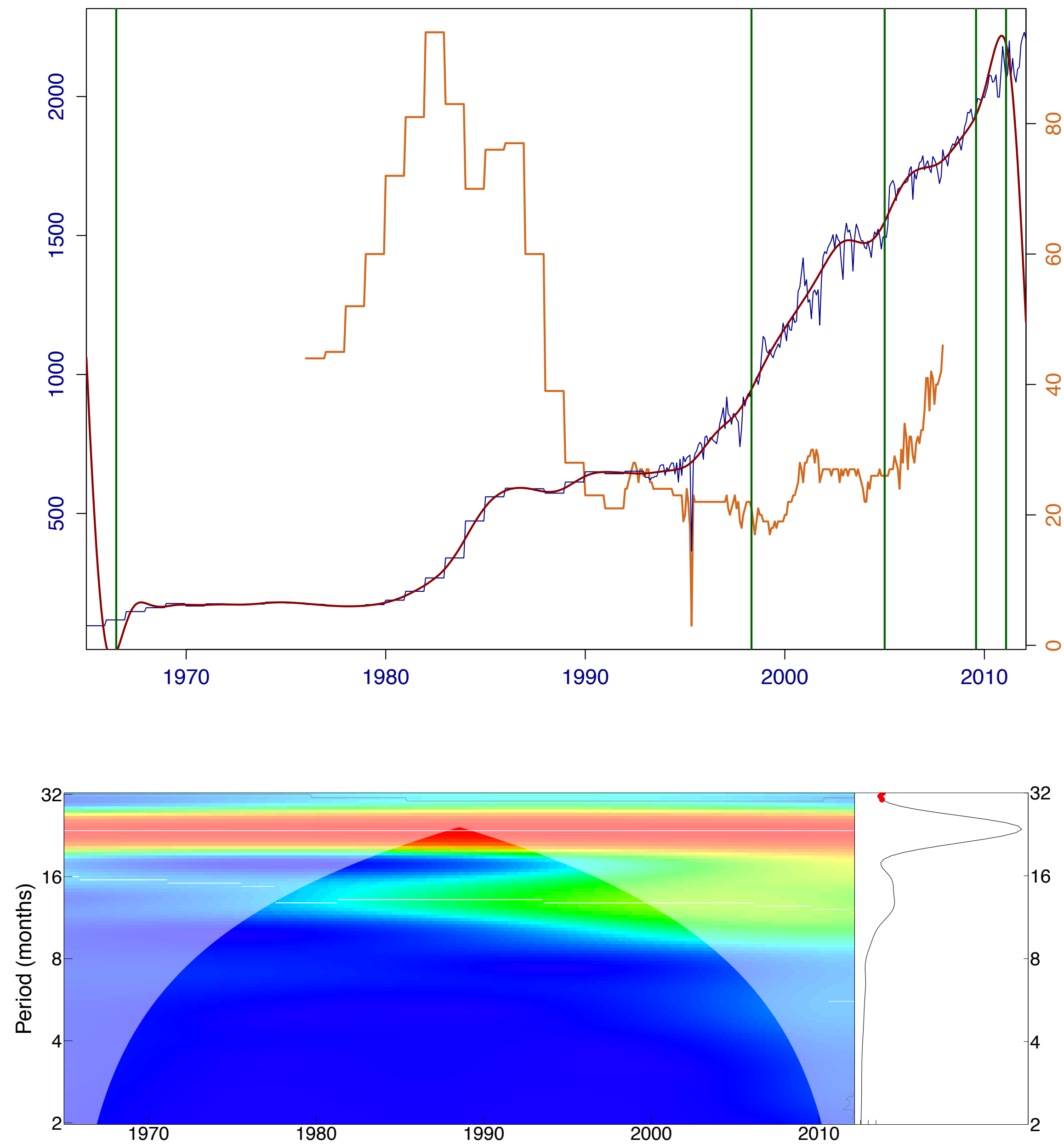


Figure 13: Brazil Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Brazil Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		2.43^{***}	
		(0.83)	
DSP500$D1$		0.46^{***}	
		(0.07)	
DGold$D1$		0.65^{***}	
		(0.06)	
DUS10yr$D1$		-7.91	
		(8.04)	
DPMI$D1$		0.23	
		(0.87)	
DWTI$D2$			3.86^{***}
			(0.63)
DSP500$D2$			0.57^{***}
			(0.06)
DGold$D2$			0.54^{***}
			(0.05)
DUS10yr$D2$			13.48^{**}
			(5.45)
DPMI$D2$			-2.39^{***}
			(0.85)
R^2	0.97	0.79	0.81
Adj. R^2	0.97	0.79	0.81
Num. obs.	566	566	566

Table 5: Brazil Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	0.47		
	(0.34)		
DSP500$D3$	0.58***		
	(0.05)		
DGold$D3$	0.77***		
	(0.03)		
DUS10yr$D3$	−5.34		
	(4.38)		
DPMI$D3$	−2.23***		
	(0.62)		
DWTI$D4$		−3.17***	
		(0.25)	
DSP500$D4$		0.32***	
		(0.04)	
DGold$D4$		1.04***	
		(0.03)	
DUS10yr$D4$		12.94***	
		(3.40)	
DPMI$D4$		−1.38***	
		(0.36)	
DWTI$D5$			−4.62***
			(0.62)
DSP500$D5$			0.31***
			(0.04)
DGold$D5$			1.07***
			(0.04)
DUS10yr$D5$			6.72*
			(3.50)
DPMI$D5$			−3.67***
			(0.49)
R^2	0.88	0.92	0.87
Adj. R^2	0.87	0.92	0.87
Num. obs.	566	566	566

Table 6: Brazil Production Regressions – part 2

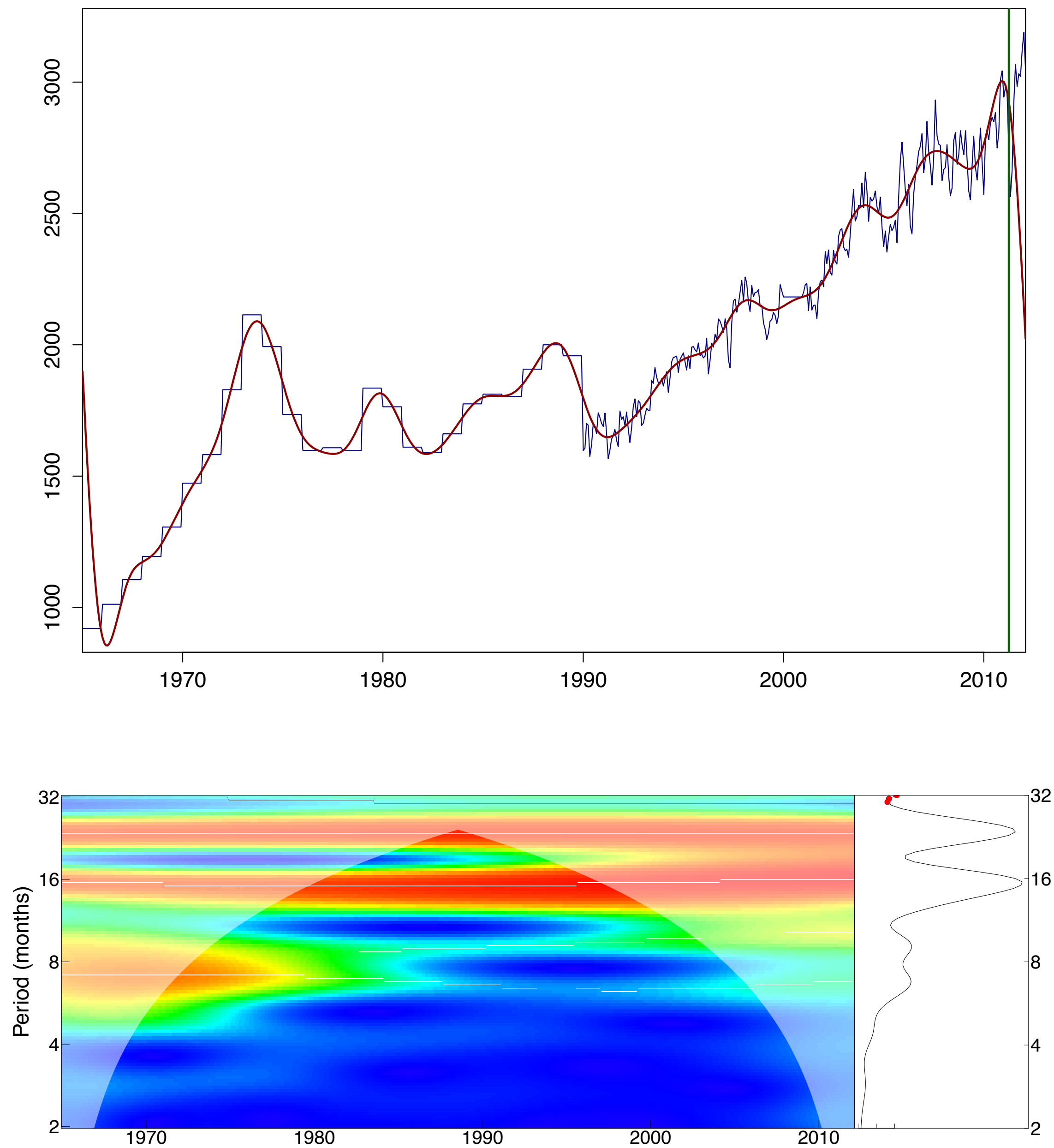


Figure 14: Canada Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Canada Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		1.65	
		(1.23)	
DSP500$D1$		0.20**	
		(0.10)	
DGold$D1$		0.78***	
		(0.08)	
DUS10yr$D1$		−17.68	
		(11.97)	
DPMI$D1$		−3.13**	
		(1.29)	
DWTI$D2$			−1.89*
			(0.99)
DSP500$D2$			0.54***
			(0.09)
DGold$D2$			0.98***
			(0.08)
DUS10yr$D2$			−17.46**
			(8.57)
DPMI$D2$			−0.35
			(1.33)
R^2	0.98	0.61	0.67
Adj. R^2	0.98	0.60	0.67
Num. obs.	566	566	566

Table 7: Canada Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	-0.86		
	(0.62)		
DSP500$D3$	0.66^{***}		
	(0.09)		
DGold$D3$	0.88^{***}		
	(0.06)		
DUS10yr$D3$	-46.46^{***}		
	(7.99)		
DPMI$D3$	0.91		
	(1.14)		
DWTI$D4$		-4.34^{***}	
		(0.37)	
DSP500$D4$		0.44^{***}	
		(0.06)	
DGold$D4$		1.02^{***}	
		(0.05)	
DUS10yr$D4$		17.12^{***}	
		(5.06)	
DPMI$D4$		-1.69^{***}	
		(0.53)	
DWTI$D5$			-4.34^{***}
			(0.72)
DSP500$D5$			0.37^{***}
			(0.05)
DGold$D5$			1.11^{***}
			(0.05)
DUS10yr$D5$			14.30^{***}
			(4.10)
DPMI$D5$			1.96^{***}
			(0.58)
R^2	0.73	0.84	0.86
Adj. R^2	0.73	0.83	0.86
Num. obs.	566	566	566

Table 8: Canada Production Regressions – part 2

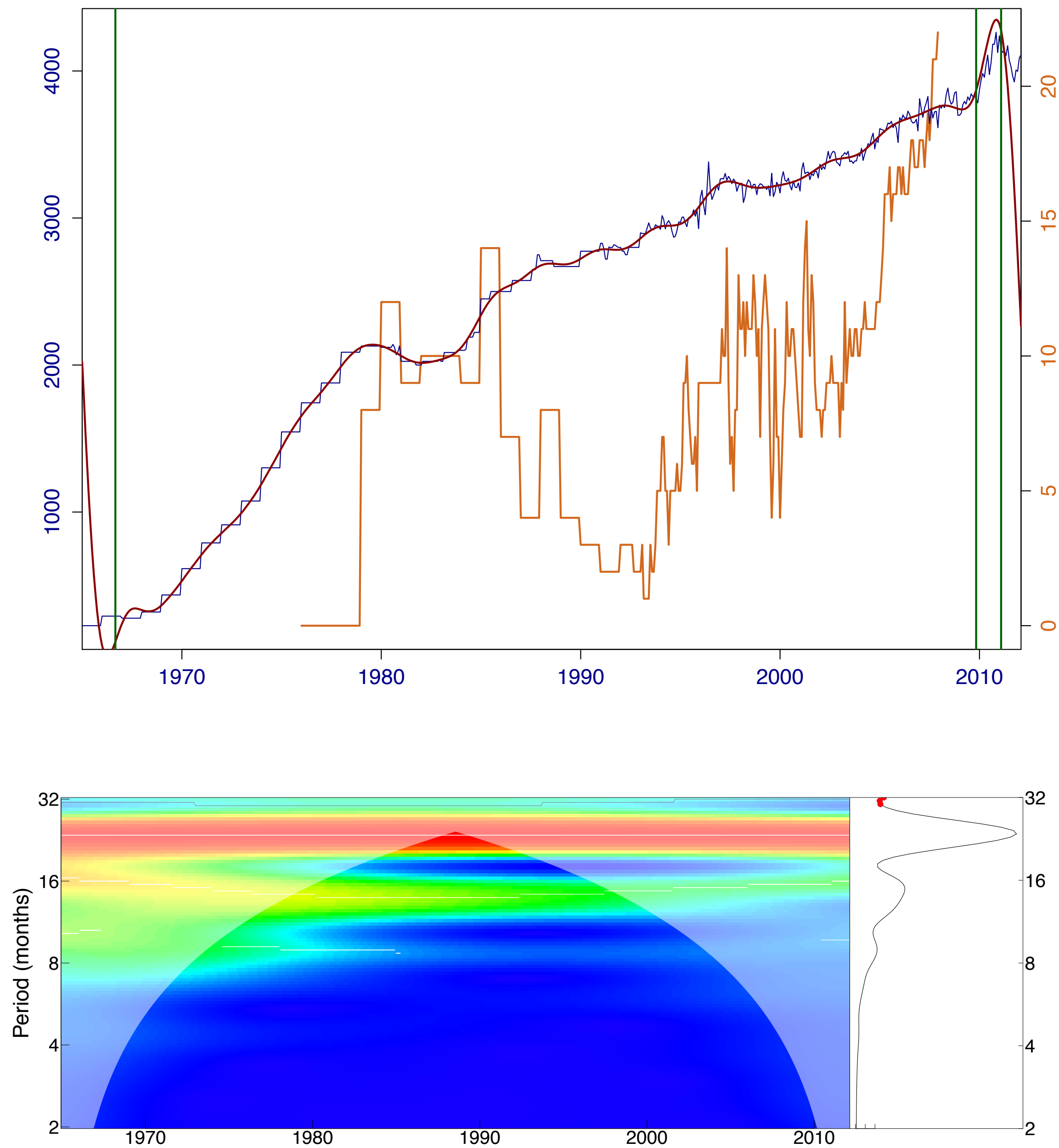


Figure 15: China Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	China Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		3.10^{**}	
		(1.24)	
DSP500$D1$		0.68^{***}	
		(0.10)	
DGold$D1$		1.41^{***}	
		(0.09)	
DUS10yr$D1$		2.60	
		(12.08)	
DPMI$D1$		-1.60	
		(1.31)	
DWTI$D2$			5.97^{***}
			(1.02)
DSP500$D2$			0.91^{***}
			(0.09)
DGold$D2$			1.14^{***}
			(0.08)
DUS10yr$D2$			4.26
			(8.76)
DPMI$D2$			-3.34^{**}
			(1.36)
R^2	0.97	0.85	0.85
Adj. R^2	0.97	0.85	0.85
Num. obs.	566	566	566

Table 9: China Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	2.71^{***}		
	(0.53)		
DSP500$D3$	0.73^{***}		
	(0.08)		
DGold$D3$	1.45^{***}		
	(0.05)		
DUS10yr$D3$	-9.88		
	(6.80)		
DPMI$D3$	-2.51^{***}		
	(0.97)		
DWTI$D4$		-4.24^{***}	
		(0.43)	
DSP500$D4$		0.24^{***}	
		(0.07)	
DGold$D4$		1.97^{***}	
		(0.05)	
DUS10yr$D4$		14.60^{**}	
		(5.87)	
DPMI$D4$		-0.98	
		(0.62)	
DWTI$D5$			-4.70^{***}
			(1.13)
DSP500$D5$			0.81^{***}
			(0.08)
DGold$D5$			1.62^{***}
			(0.08)
DUS10yr$D5$			7.55
			(6.39)
DPMI$D5$			-7.26^{***}
			(0.90)
R^2	0.90	0.92	0.88
Adj. R^2	0.90	0.92	0.88
Num. obs.	566	566	566

Table 10: China Production Regressions – part 2

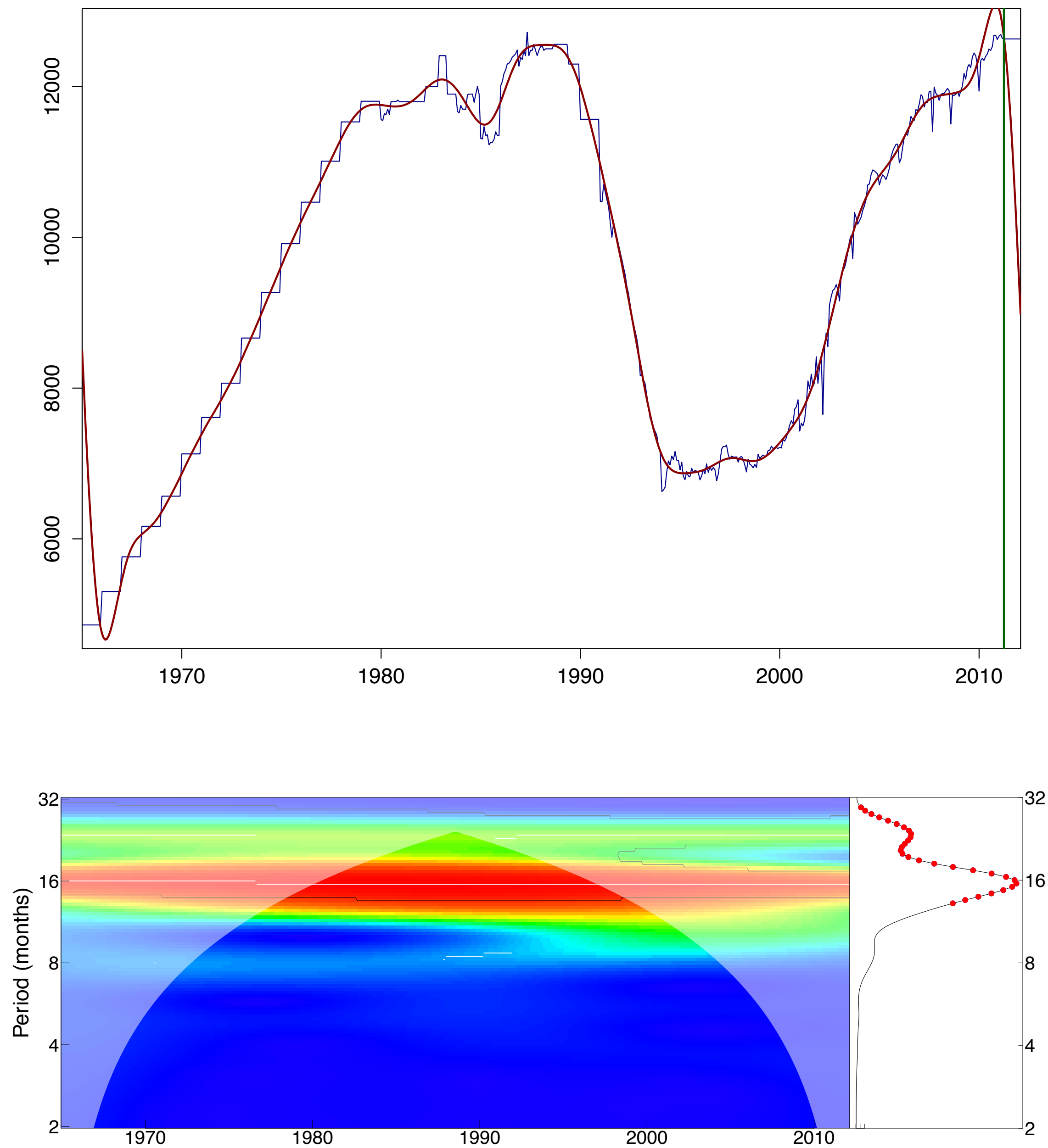


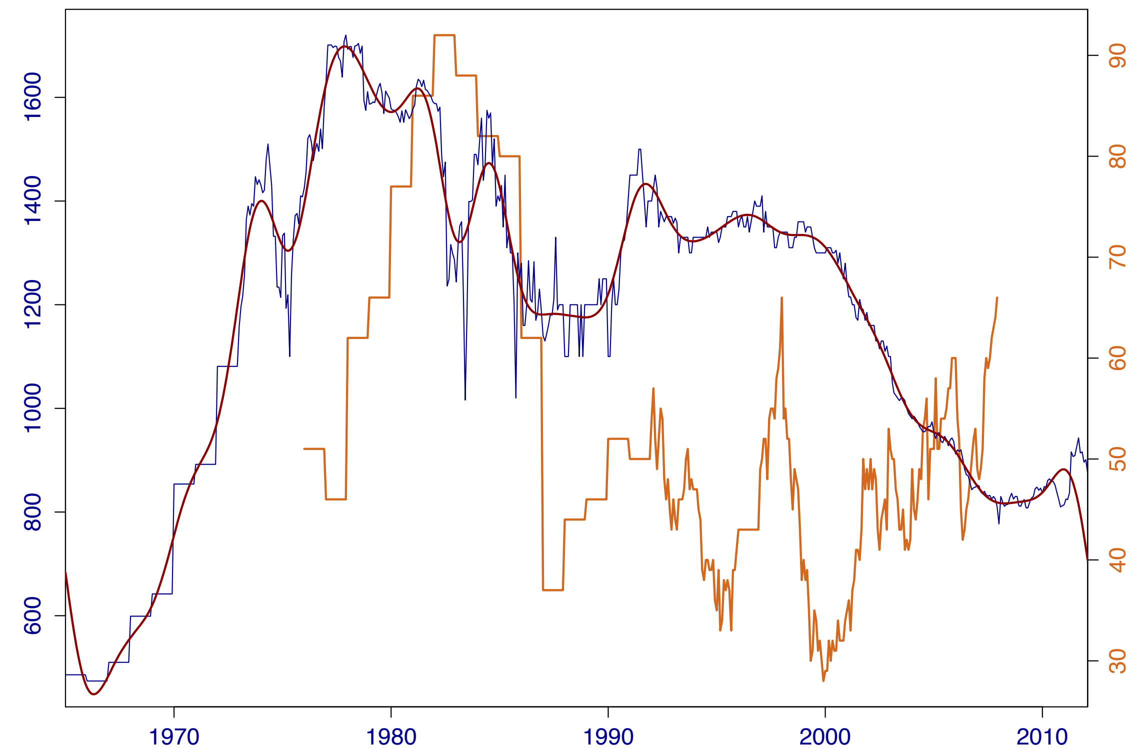
Figure 16: (Former) Soviet Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	F.Soviet Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		6.95^{**}	
		(3.47)	
DSP500$D1$		1.36^{***}	
		(0.27)	
DGold$D1$		2.73^{***}	
		(0.24)	
DUS10yr$D1$		-18.56	
		(33.66)	
DPMI$D1$		-6.99^{*}	
		(3.64)	
DWTI$D2$			15.36^{***}
			(2.47)
DSP500$D2$			1.86^{***}
			(0.22)
DGold$D2$			2.00^{***}
			(0.19)
DUS10yr$D2$			70.35^{***}
			(21.26)
DPMI$D2$			-12.25^{***}
			(3.31)
R^2	0.98	0.75	0.79
Adj. R^2	0.98	0.75	0.79
Num. obs.	566	566	566

Table 11: F.Soviet Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	7.53^{***}		
	(1.60)		
DSP500$D3$	0.80^{***}		
	(0.23)		
DGold$D3$	3.14^{***}		
	(0.15)		
DUS10yr$D3$	-136.44^{***}		
	(20.46)		
DPMI$D3$	1.92		
	(2.92)		
DWTI$D4$		-13.28^{***}	
		(1.15)	
DSP500$D4$		0.76^{***}	
		(0.19)	
DGold$D4$		4.35^{***}	
		(0.14)	
DUS10yr$D4$		42.89^{***}	
		(15.63)	
DPMI$D4$		-2.80^{*}	
		(1.64)	
DWTI$D5$			-20.02^{***}
			(2.36)
DSP500$D5$			2.25^{***}
			(0.17)
DGold$D5$			3.41^{***}
			(0.17)
DUS10yr$D5$			-68.81^{***}
			(13.37)
DPMI$D5$			-9.82^{***}
			(1.88)
R^2	0.81	0.89	0.88
Adj. R^2	0.80	0.89	0.88
Num. obs.	566	566	566

Table 12: F.Soviet Production Regressions – part 2



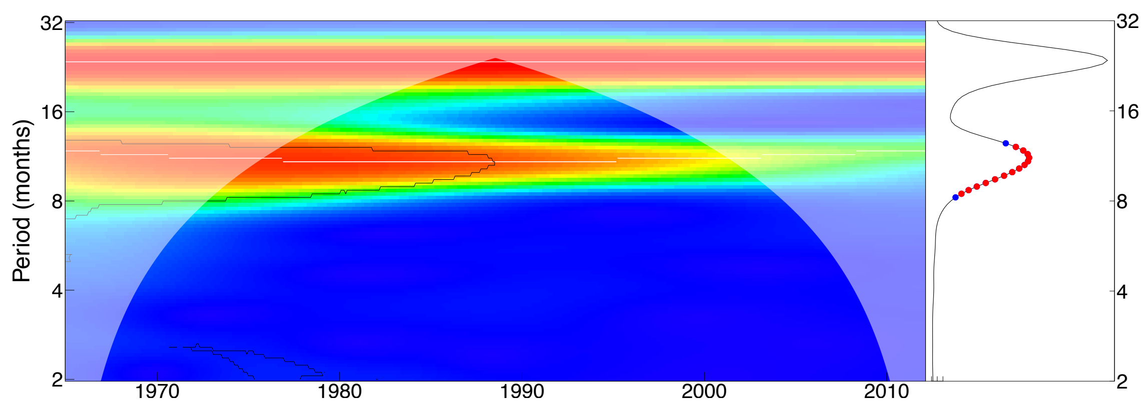


Figure 17: Indonesia Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Indonesia Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		-0.44	
		(0.84)	
DSP500$D1$		0.09	
		(0.07)	
DGold$D1$		0.19^{***}	
		(0.06)	
DUS10yr$D1$		3.79	
		(8.16)	
DPMI$D1$		2.22^{**}	
		(0.88)	
DWTI$D2$			1.23^{*}
			(0.65)
DSP500$D2$			0.09
			(0.06)
DGold$D2$			0.06
			(0.05)
DUS10yr$D2$			-5.67
			(5.58)
DPMI$D2$			0.54
			(0.87)
R^2	0.96	0.12	0.12
Adj. R^2	0.96	0.12	0.11
Num. obs.	566	566	566

Table 13: Indonesia Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	-0.69^{**}		
	(0.34)		
DSP500$D3$	0.16^{***}		
	(0.05)		
DGold$D3$	0.14^{***}		
	(0.03)		
DUS10yr$D3$	-11.05^{**}		
	(4.32)		
DPMI$D3$	0.82		
	(0.62)		
DWTI$D4$		-0.74^{**}	
		(0.31)	
DSP500$D4$		0.15^{***}	
		(0.05)	
DGold$D4$		0.20^{***}	
		(0.04)	
DUS10yr$D4$		38.44^{***}	
		(4.25)	
DPMI$D4$		-0.80^{*}	
		(0.45)	
DWTI$D5$			2.01^{***}
			(0.59)
DSP500$D5$			-0.19^{***}
			(0.04)
DGold$D5$			0.28^{***}
			(0.04)
DUS10yr$D5$			51.22^{***}
			(3.31)
DPMI$D5$			3.80^{***}
			(0.47)
R^2	0.21	0.32	0.47
Adj. R^2	0.20	0.32	0.47
Num. obs.	566	566	566

Table 14: Indonesia Production Regressions – part 2

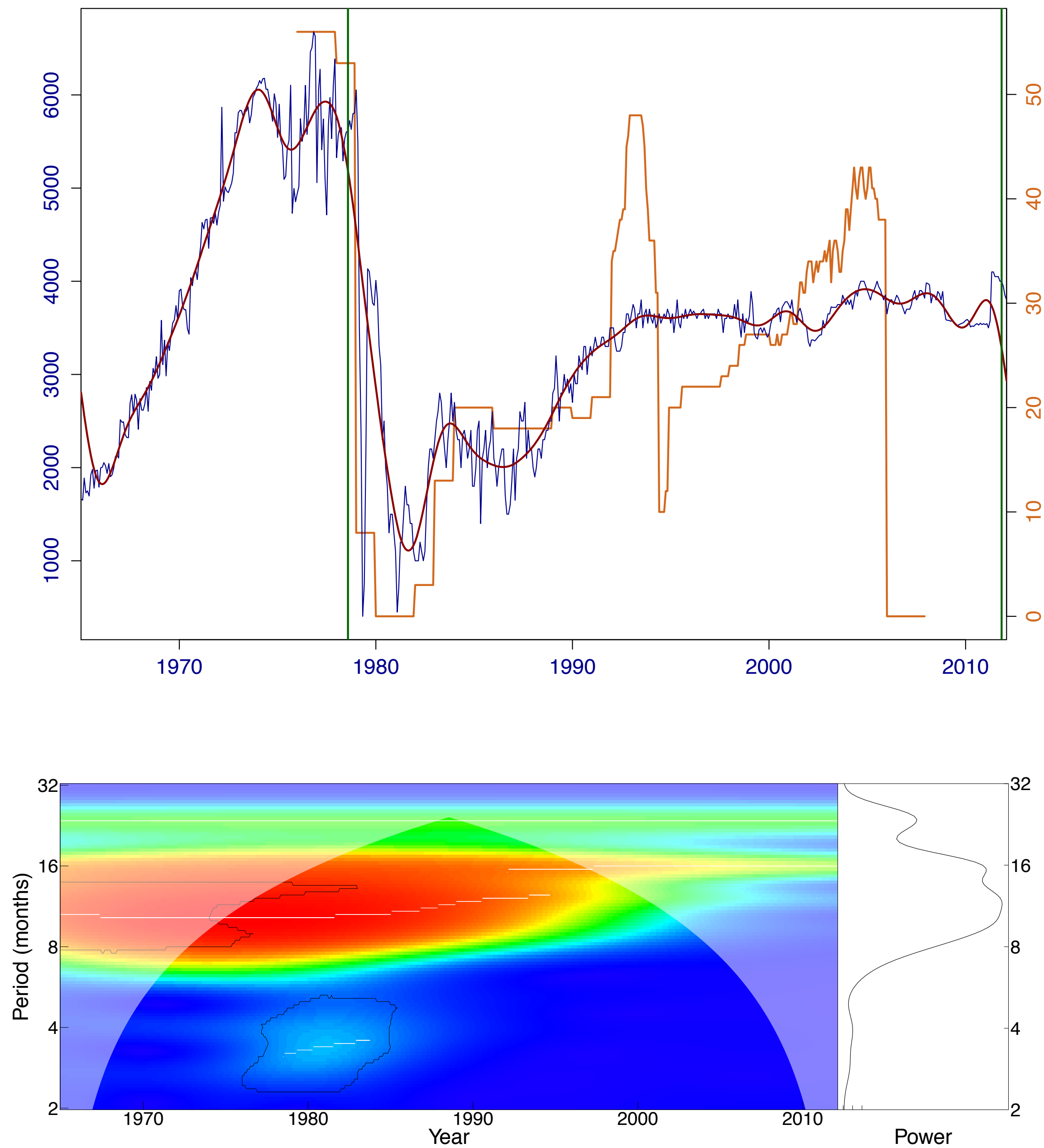


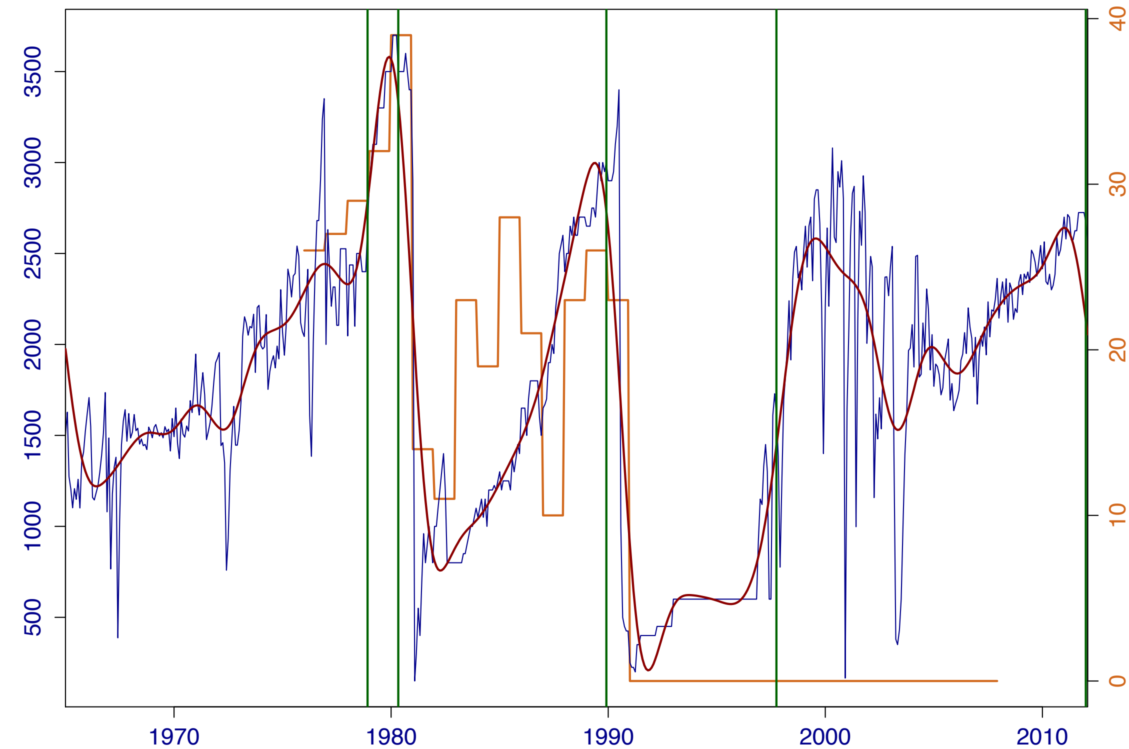
Figure 18: Iran Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Iran Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		-0.50	
		(5.38)	
DSP500$D1$		0.27	
		(0.43)	
DGold$D1$		0.87^{**}	
		(0.37)	
DUS10yr$D1$		-126.47^{**}	
		(52.27)	
DPMI$D1$		3.58	
		(5.65)	
DWTI$D2$			8.81^{*}
			(4.78)
DSP500$D2$			-0.20
			(0.43)
DGold$D2$			0.86^{**}
			(0.38)
DUS10yr$D2$			-31.81
			(41.21)
DPMI$D2$			3.77
			(6.42)
R^2	0.90	0.10	0.08
Adj. R^2	0.90	0.09	0.07
Num. obs.	566	566	566

Table 15: Iran Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	-0.43		
	(3.28)		
DSP500$D3$	-0.47		
	(0.48)		
DGold$D3$	1.78^{***}		
	(0.31)		
DUS10yr$D3$	21.36		
	(42.03)		
DPMI$D3$	17.93^{***}		
	(5.99)		
DWTI$D4$		3.28	
		(2.01)	
DSP500$D4$		-0.45	
		(0.34)	
DGold$D4$		1.68^{***}	
		(0.25)	
DUS10yr$D4$		114.76^{***}	
		(27.36)	
DPMI$D4$		-14.67^{***}	
		(2.88)	
DWTI$D5$			7.65^{***}
			(2.31)
DSP500$D5$			0.63^{***}
			(0.16)
DGold$D5$			-0.01
			(0.16)
DUS10yr$D5$			-158.01^{***}
			(13.08)
DPMI$D5$			13.51^{***}
			(1.84)
R^2	0.10	0.30	0.50
Adj. R^2	0.10	0.30	0.50
Num. obs.	566	566	566

Table 16: Iran Production Regressions – part 2



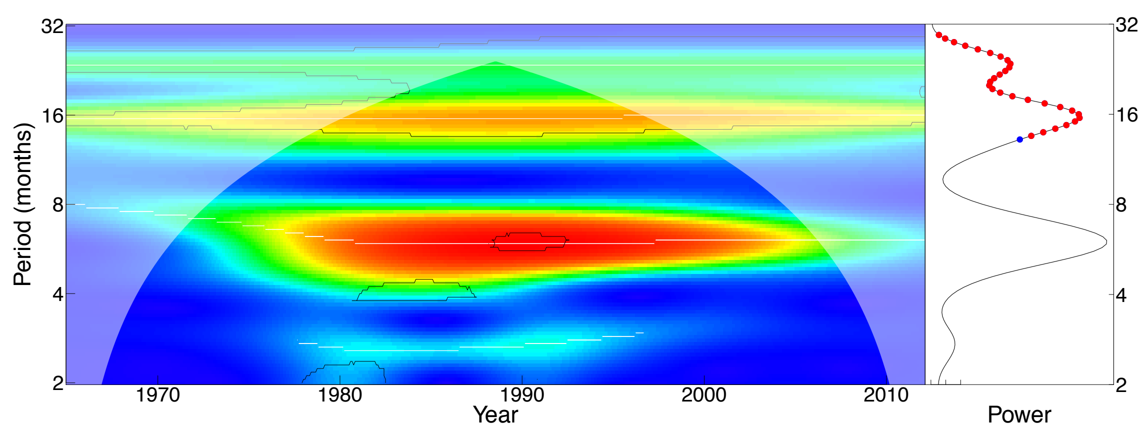


Figure 19: Iraq Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Iraq Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		1.07	
		(6.27)	
DSP500$D1$		1.24**	
		(0.50)	
DGold$D1$		−0.30	
		(0.43)	
DUS10yr$D1$		−0.33	
		(60.81)	
DPMI$D1$		−4.61	
		(6.58)	
DWTI$D2$			16.76***
			(4.93)
DSP500$D2$			−2.60***
			(0.44)
DGold$D2$			1.18***
			(0.39)
DUS10yr$D2$			−98.85**
			(42.54)
DPMI$D2$			14.52**
			(6.62)
R^2	0.83	0.03	0.08
Adj. R^2	0.83	0.02	0.07
Num. obs.	566	566	566

Table 17: Iraq Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	-11.00^{***}		
	(2.83)		
DSP500$D3$	1.03^{**}		
	(0.41)		
DGold$D3$	0.92^{***}		
	(0.27)		
DUS10yr$D3$	-15.27		
	(36.32)		
DPMI$D3$	30.89^{***}		
	(5.18)		
DWTI$D4$		-5.33^{**}	
		(2.15)	
DSP500$D4$		-0.58	
		(0.36)	
DGold$D4$		1.82^{***}	
		(0.26)	
DUS10yr$D4$		64.00^{**}	
		(29.20)	
DPMI$D4$		-2.55	
		(3.07)	
DWTI$D5$			-0.55
			(3.72)
DSP500$D5$			-0.58^{**}
			(0.26)
DGold$D5$			1.36^{***}
			(0.26)
DUS10yr$D5$			-88.15^{***}
			(21.06)
DPMI$D5$			1.66
			(2.96)
R^2	0.13	0.16	0.17
Adj. R^2	0.12	0.16	0.16
Num. obs.	566	566	566

Table 18: Iraq Production Regressions – part 2

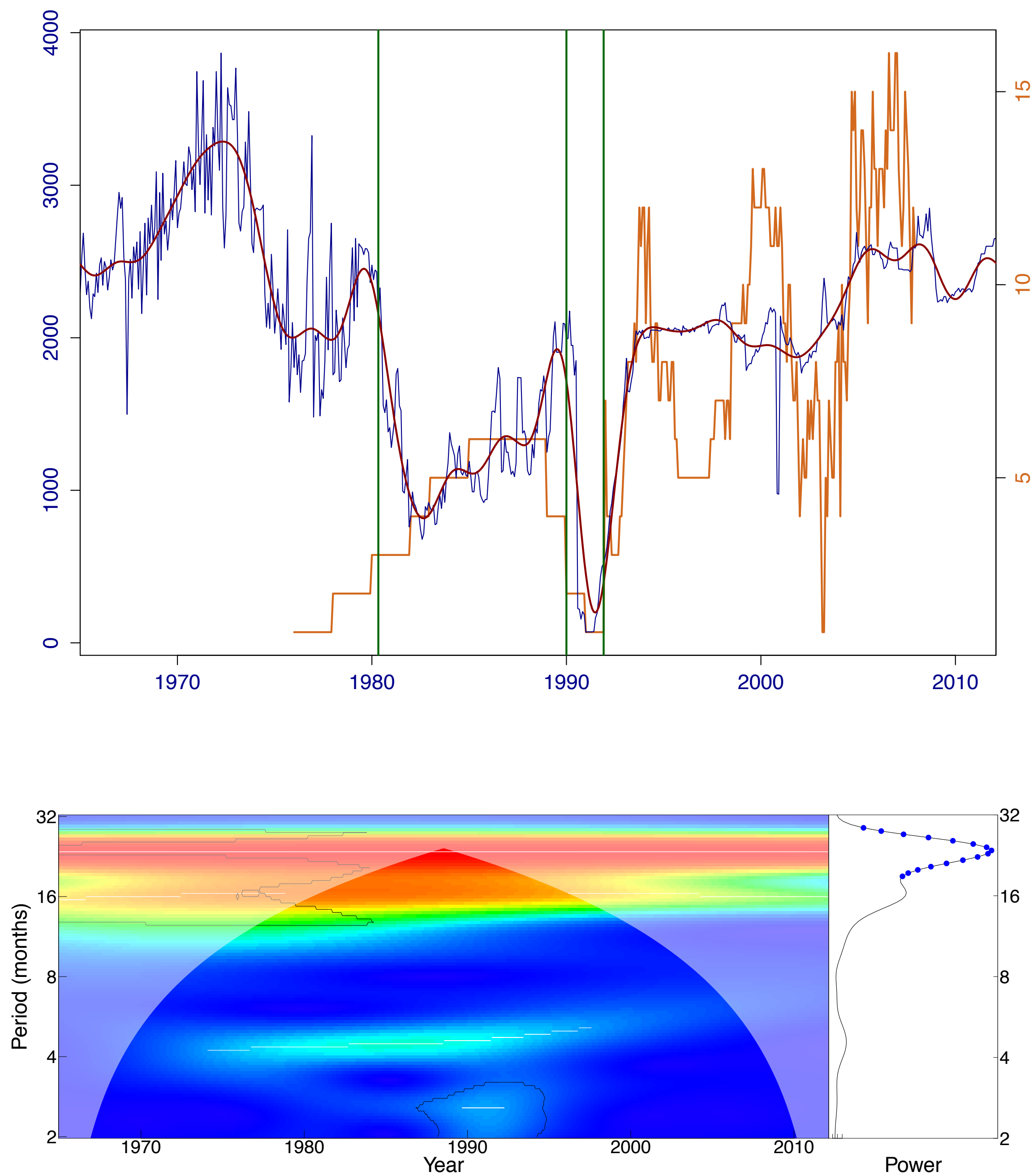


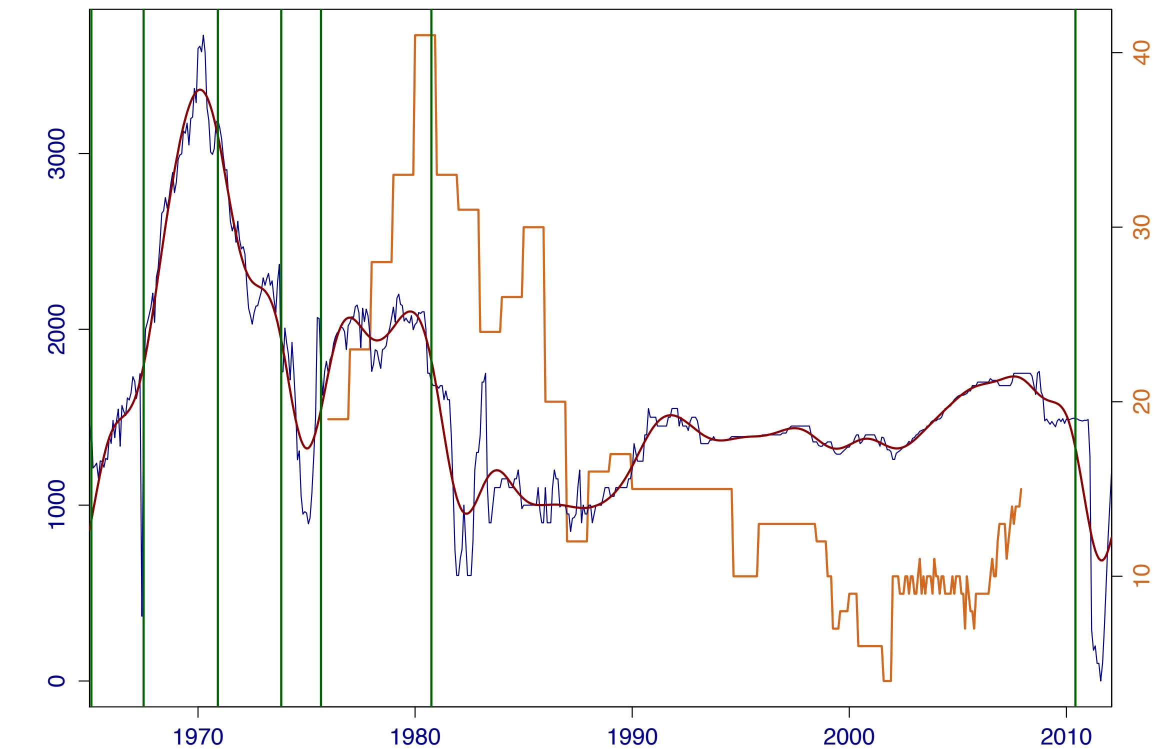
Figure 20: Kuwait Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Kuwait Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		-0.08	
		(5.57)	
DSP500$D1$		0.04	
		(0.44)	
DGold$D1$		0.18	
		(0.38)	
DUS10yr$D1$		-50.61	
		(54.09)	
DPMI$D1$		-7.14	
		(5.85)	
DWTI$D2$			-5.74^{*}
			(3.07)
DSP500$D2$			0.59^{**}
			(0.27)
DGold$D2$			-0.11
			(0.24)
DUS10yr$D2$			-84.71^{***}
			(26.45)
DPMI$D2$			6.91^{*}
			(4.12)
R^2	0.92	0.01	0.03
Adj. R^2	0.92	0.00	0.02
Num. obs.	566	566	566

Table 19: Kuwait Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	-6.16^{***}		
	(1.82)		
DSP500$D3$	1.53^{***}		
	(0.27)		
DGold$D3$	-0.91^{***}		
	(0.17)		
DUS10yr$D3$	-57.46^{**}		
	(23.39)		
DPMI$D3$	2.15		
	(3.33)		
DWTI$D4$		3.01^{**}	
		(1.23)	
DSP500$D4$		0.23	
		(0.21)	
DGold$D4$		-0.10	
		(0.15)	
DUS10yr$D4$		-16.15	
		(16.72)	
DPMI$D4$		-1.27	
		(1.76)	
DWTI$D5$			12.79^{***}
			(2.77)
DSP500$D5$			-0.23
			(0.20)
DGold$D5$			-0.52^{***}
			(0.20)
DUS10yr$D5$			-105.66^{***}
			(15.64)
DPMI$D5$			7.62^{***}
			(2.20)
R^2	0.07	0.04	0.11
Adj. R^2	0.06	0.03	0.10
Num. obs.	566	566	566

Table 20: Kuwait Production Regressions – part 2



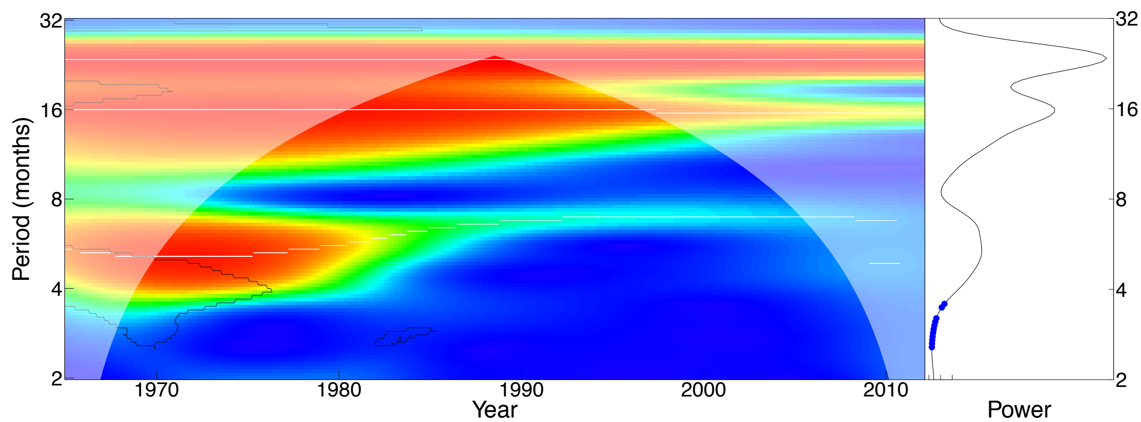


Figure 21: Libya Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Libya Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		-1.09	
		(2.52)	
DSP500$D1$		0.04	
		(0.20)	
DGold$D1$		0.07	
		(0.17)	
DUS10yr$D1$		24.17	
		(24.45)	
DPMI$D1$		-4.39^{*}	
		(2.64)	
DWTI$D2$			-1.15
			(1.86)
DSP500$D2$			0.30^{*}
			(0.17)
DGold$D2$			-0.31^{**}
			(0.15)
DUS10yr$D2$			10.29
			(16.00)
DPMI$D2$			-6.86^{***}
			(2.49)
R^2	0.90	0.01	0.03
Adj. R^2	0.90	0.00	0.02
Num. obs.	566	566	566

Table 21: Libya Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	-0.89		
	(1.29)		
DSP500$D3$	0.58^{***}		
	(0.19)		
DGold$D3$	-0.20		
	(0.12)		
DUS10yr$D3$	-74.35^{***}		
	(16.56)		
DPMI$D3$	12.69^{***}		
	(2.36)		
DWTI$D4$		4.30^{***}	
		(0.96)	
DSP500$D4$		-1.07^{***}	
		(0.16)	
DGold$D4$		-0.46^{***}	
		(0.12)	
DUS10yr$D4$		-136.43^{***}	
		(13.04)	
DPMI$D4$		19.12^{***}	
		(1.37)	
DWTI$D5$			2.63^{*}
			(1.54)
DSP500$D5$			-0.82^{***}
			(0.11)
DGold$D5$			0.04
			(0.11)
DUS10yr$D5$			10.90
			(8.72)
DPMI$D5$			19.58^{***}
			(1.23)
R^2	0.09	0.47	0.42
Adj. R^2	0.08	0.47	0.41
Num. obs.	566	566	566

Table 22: Libya Production Regressions – part 2

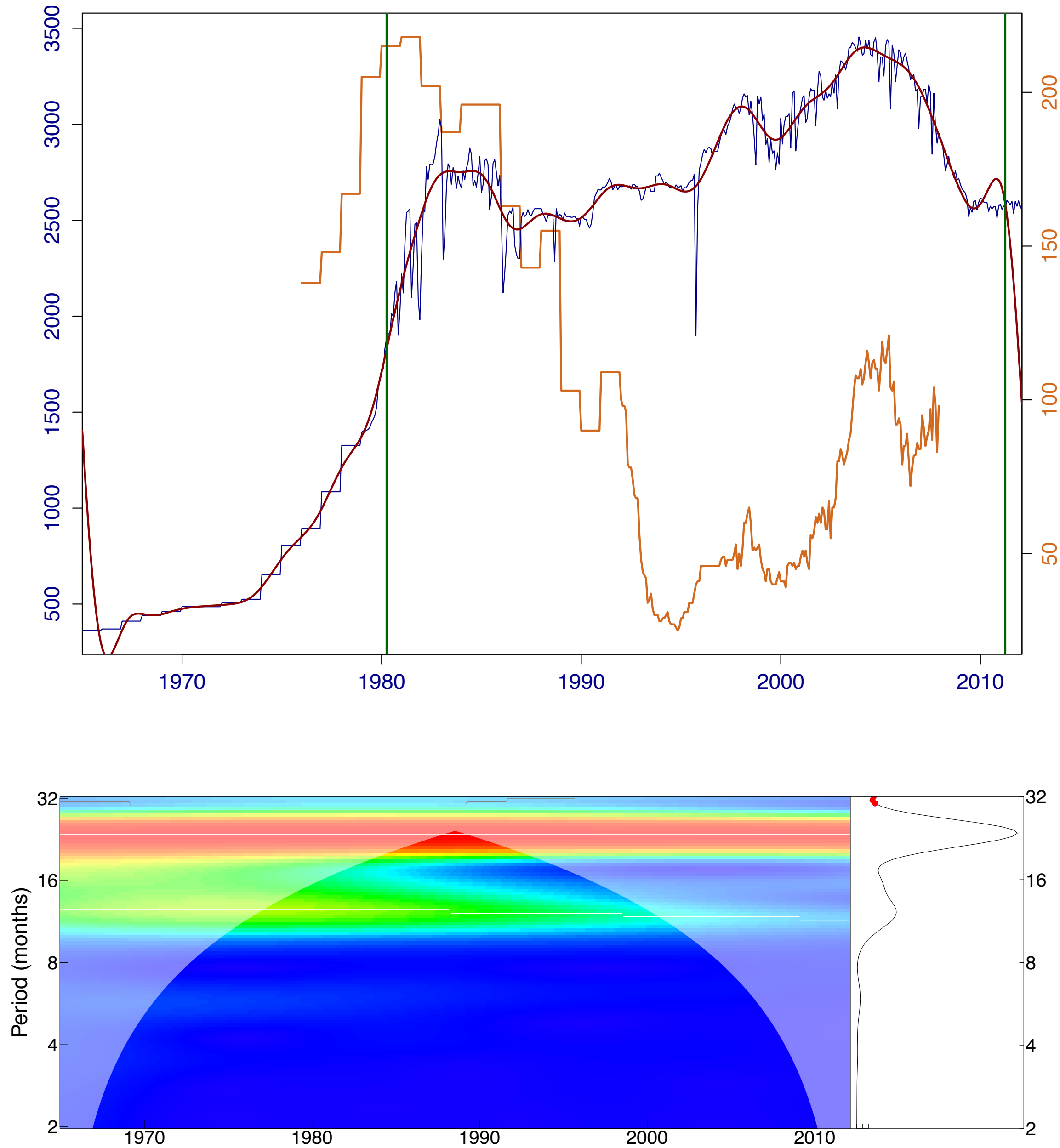


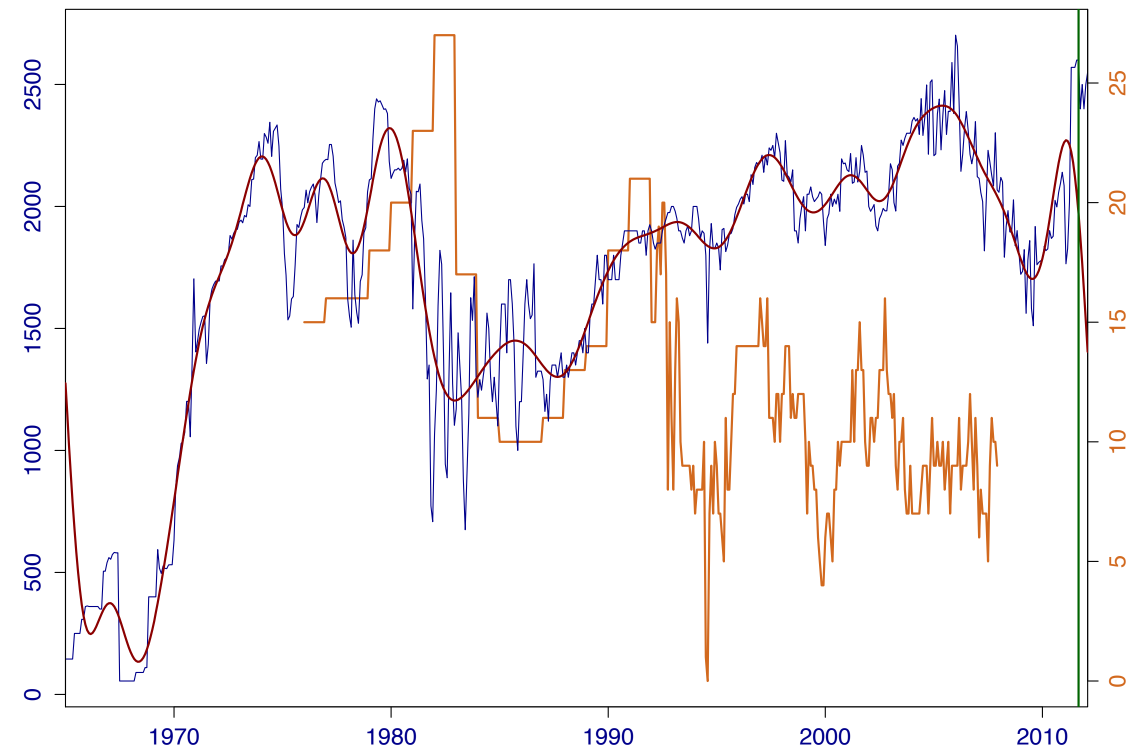
Figure 22: Mexico Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Mexico Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		3.82^{*}	
		(2.00)	
DSP500$D1$		0.65^{***}	
		(0.16)	
DGold$D1$		0.53^{***}	
		(0.14)	
DUS10yr$D1$		-3.94	
		(19.40)	
DPMI$D1$		-3.52^{*}	
		(2.10)	
DWTI$D2$			4.81^{***}
			(1.49)
DSP500$D2$			0.71^{***}
			(0.13)
DGold$D2$			0.45^{***}
			(0.12)
DUS10yr$D2$			37.19^{***}
			(12.86)
DPMI$D2$			-3.82^{*}
			(2.00)
R^2	0.95	0.44	0.47
Adj. R^2	0.95	0.44	0.46
Num. obs.	566	566	566

Table 23: Mexico Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	0.70		
	(0.69)		
DSP500$D3$	0.60***		
	(0.10)		
DGold$D3$	0.78***		
	(0.06)		
DUS10yr$D3$	29.89***		
	(8.81)		
DPMI$D3$	−7.71***		
	(1.26)		
DWTI$D4$		−2.65***	
		(0.40)	
DSP500$D4$		0.24***	
		(0.07)	
DGold$D4$		1.18***	
		(0.05)	
DUS10yr$D4$		17.91***	
		(5.41)	
DPMI$D4$		−2.43***	
		(0.57)	
DWTI$D5$			−3.86***
			(0.81)
DSP500$D5$			0.42***
			(0.06)
DGold$D5$			1.07***
			(0.06)
DUS10yr$D5$			24.38***
			(4.60)
DPMI$D5$			−2.86***
			(0.65)
R^2	0.65	0.85	0.83
Adj. R^2	0.65	0.84	0.83
Num. obs.	566	566	566

Table 24: Mexico Production Regressions – part 2



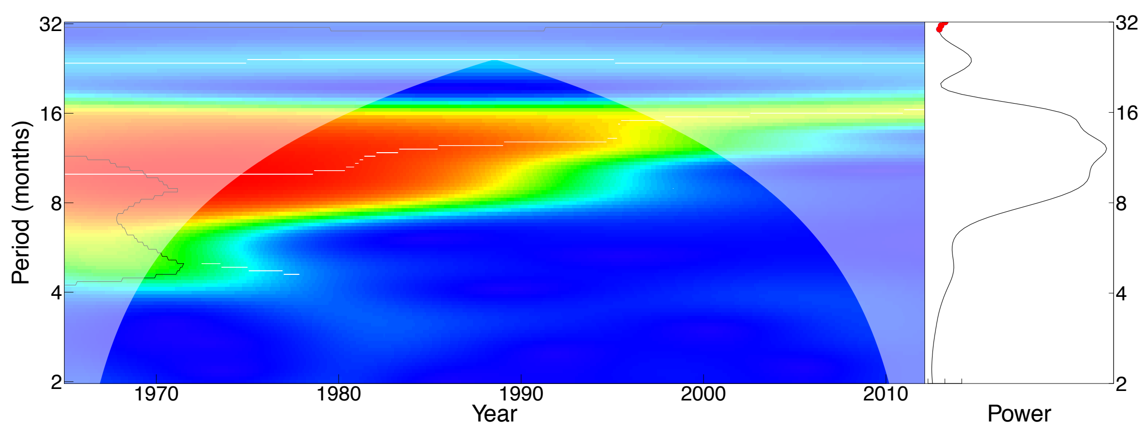


Figure 23: Nigeria Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Nigeria Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		3.05	
		(2.34)	
DSP500$D1$		0.23	
		(0.19)	
DGold$D1$		1.03^{***}	
		(0.16)	
DUS10yr$D1$		-5.98	
		(22.67)	
DPMI$D1$		4.59^{*}	
		(2.45)	
DWTI$D2$			5.66^{***}
			(2.15)
DSP500$D2$			0.50^{***}
			(0.19)
DGold$D2$			0.65^{***}
			(0.17)
DUS10yr$D2$			-20.62
			(18.53)
DPMI$D2$			-1.05
			(2.88)
R^2	0.93	0.42	0.34
Adj. R^2	0.93	0.41	0.34
Num. obs.	566	566	566

Table 25: Nigeria Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	-3.91^{***}		
	(1.31)		
DSP500$D3$	1.05^{***}		
	(0.19)		
DGold$D3$	0.55^{***}		
	(0.12)		
DUS10yr$D3$	-78.99^{***}		
	(16.76)		
DPMI$D3$	-0.35		
	(2.39)		
DWTI$D4$		-0.94	
		(0.89)	
DSP500$D4$		0.67^{***}	
		(0.15)	
DGold$D4$		0.90^{***}	
		(0.11)	
DUS10yr$D4$		-74.26^{***}	
		(12.09)	
DPMI$D4$		1.71	
		(1.27)	
DWTI$D5$			7.26^{***}
			(1.33)
DSP500$D5$			-0.03
			(0.09)
DGold$D5$			0.82^{***}
			(0.09)
DUS10yr$D5$			5.80
			(7.52)
DPMI$D5$			-3.25^{***}
			(1.06)
R^2	0.34	0.60	0.69
Adj. R^2	0.34	0.60	0.68
Num. obs.	566	566	566

Table 26: Nigeria Production Regressions – part 2

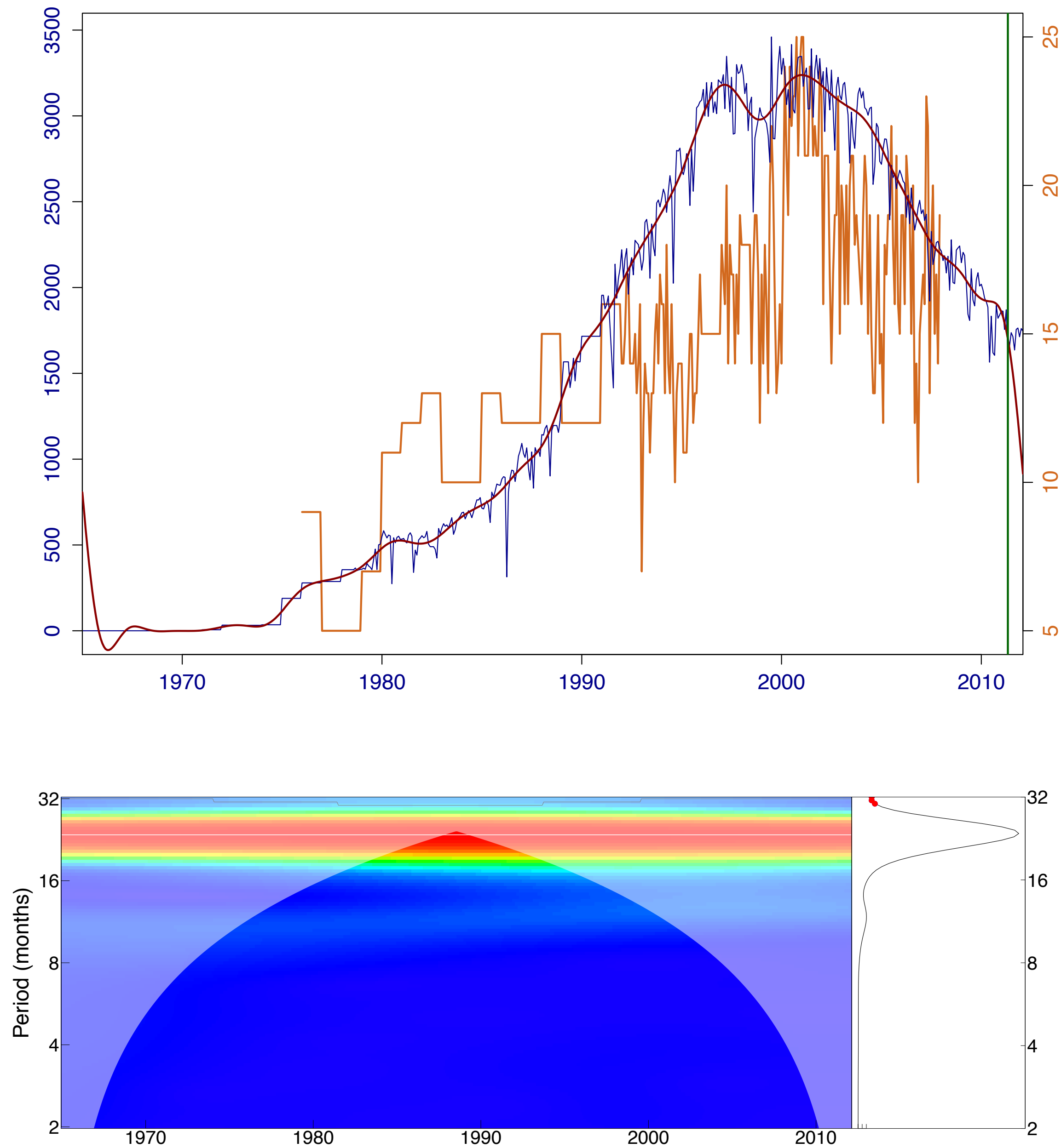


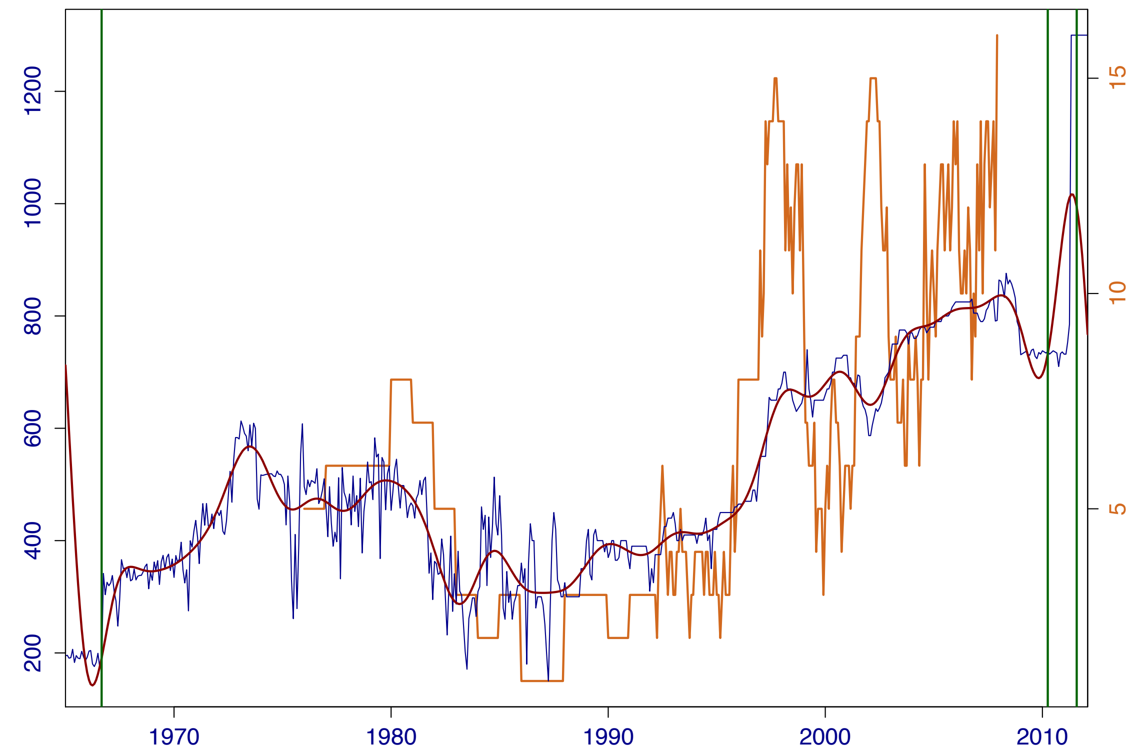
Figure 24: Norway Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Norway Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		3.49	
		(3.15)	
DSP500$D1$		-0.06	
		(0.25)	
DGold$D1$		0.81^{***}	
		(0.22)	
DUS10yr$D1$		5.89	
		(30.59)	
DPMI$D1$		0.68	
		(3.31)	
DWTI$D2$			5.36^{***}
			(1.55)
DSP500$D2$			0.40^{***}
			(0.14)
DGold$D2$			0.36^{***}
			(0.12)
DUS10yr$D2$			39.52^{***}
			(13.35)
DPMI$D2$			-6.56^{***}
			(2.08)
R^2	0.92	0.16	0.34
Adj. R^2	0.92	0.15	0.33
Num. obs.	566	566	566

Table 27: Norway Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	-5.53^{***}		
	(0.87)		
DSP500$D3$	0.74^{***}		
	(0.13)		
DGold$D3$	0.81^{***}		
	(0.08)		
DUS10yr$D3$	-23.56^{**}		
	(11.15)		
DPMI$D3$	-0.47		
	(1.59)		
DWTI$D4$		-2.79^{***}	
		(0.32)	
DSP500$D4$		0.23^{***}	
		(0.05)	
DGold$D4$		0.94^{***}	
		(0.04)	
DUS10yr$D4$		31.24^{***}	
		(4.35)	
DPMI$D4$		-0.27	
		(0.46)	
DWTI$D5$			2.59^{***}
			(0.69)
DSP500$D5$			0.17^{***}
			(0.05)
DGold$D5$			0.48^{***}
			(0.05)
DUS10yr$D5$			-3.13
			(3.90)
DPMI$D5$			-1.41^{**}
			(0.55)
R^2	0.48	0.84	0.76
Adj. R^2	0.47	0.83	0.76
Num. obs.	566	566	566

Table 28: Norway Production Regressions – part 2



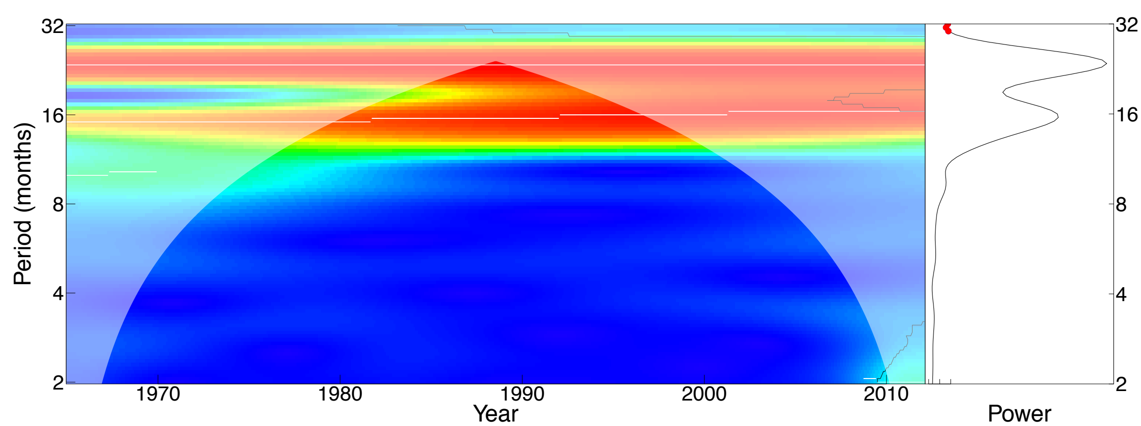


Figure 25: Qatar Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Qatar Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		-0.37	
		(1.02)	
DSP500$D1$		0.31^{***}	
		(0.08)	
DGold$D1$		0.39^{***}	
		(0.07)	
DUS10yr$D1$		5.44	
		(9.93)	
DPMI$D1$		-1.01	
		(1.07)	
DWTI$D2$			3.45^{***}
			(0.71)
DSP500$D2$			0.41^{***}
			(0.06)
DGold$D2$			0.09^{*}
			(0.06)
DUS10yr$D2$			5.71
			(6.12)
DPMI$D2$			-2.74^{***}
			(0.95)
R^2	0.96	0.41	0.50
Adj. R^2	0.96	0.40	0.50
Num. obs.	566	566	566

Table 29: Qatar Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	0.75**		
	(0.37)		
DSP500$D3$	0.07		
	(0.05)		
DGold$D3$	0.45***		
	(0.03)		
DUS10yr$D3$	−4.89		
	(4.77)		
DPMI$D3$	−1.68**		
	(0.68)		
DWTI$D4$		−0.48	
		(0.31)	
DSP500$D4$		0.22***	
		(0.05)	
DGold$D4$		0.66***	
		(0.04)	
DUS10yr$D4$		3.35	
		(4.24)	
DPMI$D4$		−2.27***	
		(0.45)	
DWTI$D5$			4.55***
			(0.50)
DSP500$D5$			−0.05
			(0.04)
DGold$D5$			0.36***
			(0.04)
DUS10yr$D5$			0.59
			(2.82)
DPMI$D5$			0.86**
			(0.40)
R^2	0.56	0.79	0.79
Adj. R^2	0.55	0.79	0.79
Num. obs.	566	566	566

Table 30: Qatar Production Regressions – part 2

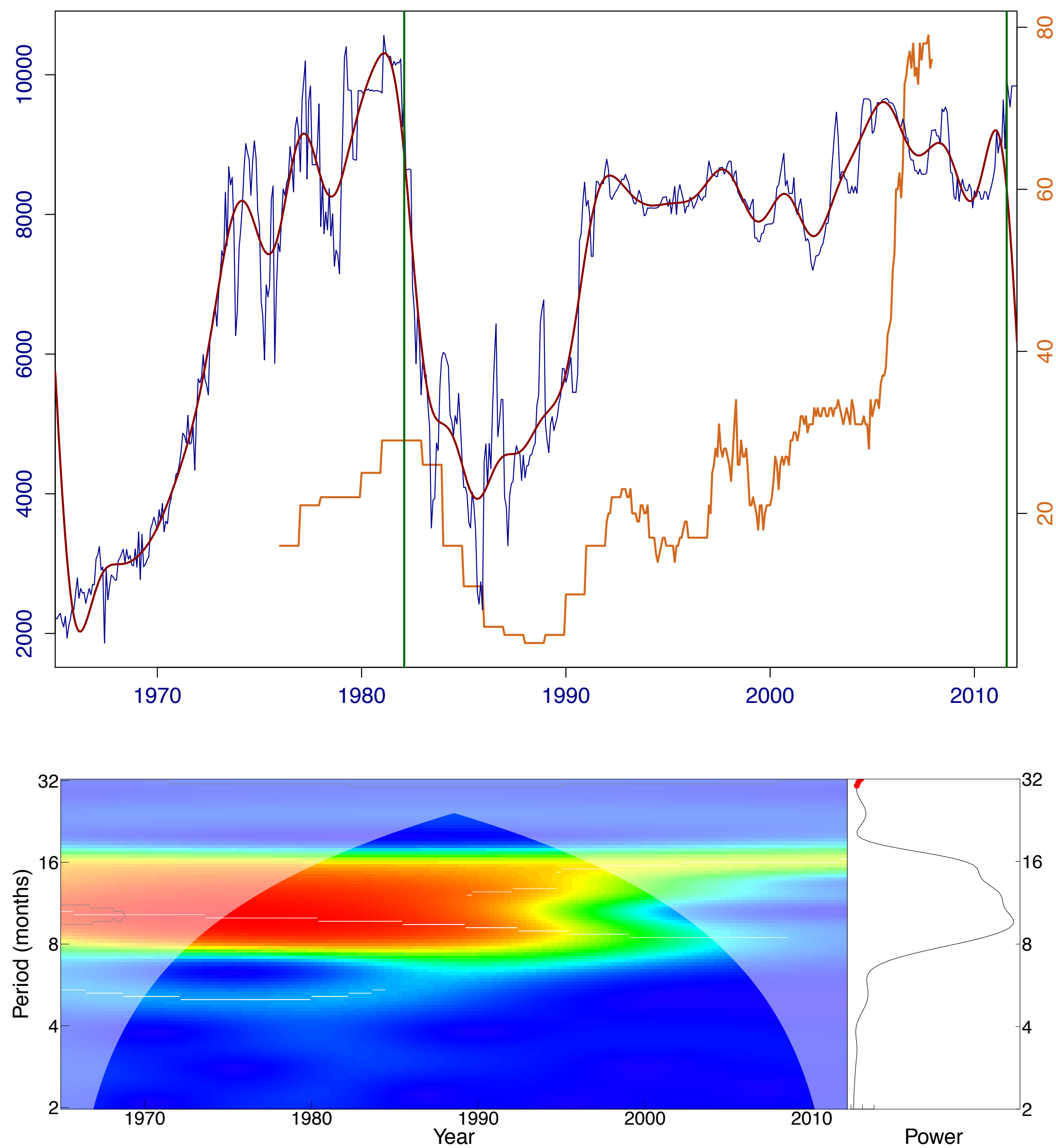


Figure 26: Saudi Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Saudi Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTID1		1.60	
		(8.42)	
DSP500D1		0.84	
		(0.67)	
DGold$D$1		3.36^{***}	
		(0.58)	
DUS10yr$D$1		−1.23	
		(81.72)	
DPMID1		−5.31	
		(8.84)	
DWTID2			16.86^{***}
			(5.97)
DSP500D2			1.42^{***}
			(0.53)
DGold$D$2			2.11^{***}
			(0.47)
DUS10yr$D$2			−23.13
			(51.47)
DPMID2			-17.83^{**}
			(8.01)
R^2	0.94	0.33	0.39
Adj. R^2	0.94	0.32	0.38
Num. obs.	566	566	566

Table 31: Saudi Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	11.72***		
	(4.20)		
DSP500$D3$	0.53		
	(0.61)		
DGold$D3$	3.22***		
	(0.39)		
DUS10yr$D3$	−46.47		
	(53.79)		
DPMI$D3$	−5.40		
	(7.66)		
DWTI$D4$		5.13	
		(3.72)	
DSP500$D4$		0.99	
		(0.63)	
DGold$D4$		3.23***	
		(0.45)	
DUS10yr$D4$		149.40***	
		(50.59)	
DPMI$D4$		−31.46***	
		(5.32)	
DWTI$D5$			40.52***
			(5.18)
DSP500$D5$			−1.06***
			(0.37)
DGold$D5$			2.42***
			(0.37)
DUS10yr$D5$			202.59***
			(29.30)
DPMI$D5$			14.11***
			(4.12)
R^2	0.38	0.45	0.62
Adj. R^2	0.37	0.44	0.61
Num. obs.	566	566	566

Table 32: Saudi Production Regressions – part 2

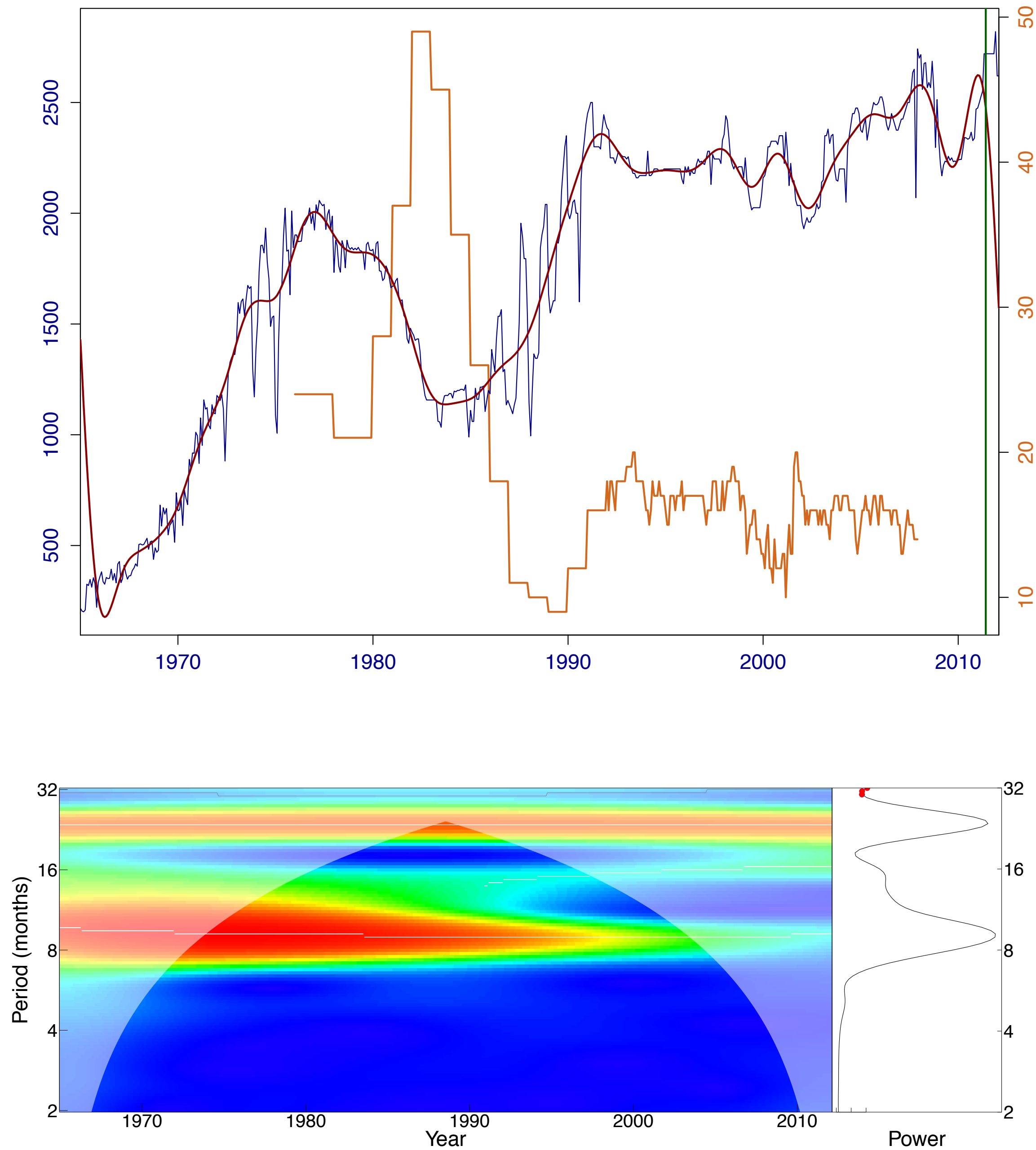


Figure 27: UAE Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	UAE Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		-3.84^{*}	
		(2.06)	
DSP500$D1$		0.94^{***}	
		(0.16)	
DGold$D1$		0.80^{***}	
		(0.14)	
DUS10yr$D1$		-2.50	
		(19.99)	
DPMI$D1$		-3.15	
		(2.16)	
DWTI$D2$			3.95^{***}
			(1.49)
DSP500$D2$			0.72^{***}
			(0.13)
DGold$D2$			0.54^{***}
			(0.12)
DUS10yr$D2$			28.40^{**}
			(12.87)
DPMI$D2$			-4.91^{**}
			(2.00)
R^2	0.95	0.45	0.49
Adj. R^2	0.95	0.45	0.48
Num. obs.	566	566	566

Table 33: UAE Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	-1.10		
	(1.27)		
DSP500$D3$	0.64^{***}		
	(0.19)		
DGold$D3$	1.09^{***}		
	(0.12)		
DUS10yr$D3$	36.37^{**}		
	(16.33)		
DPMI$D3$	-0.92		
	(2.33)		
DWTI$D4$		0.55	
		(0.67)	
DSP500$D4$		0.21^{*}	
		(0.11)	
DGold$D4$		1.20^{***}	
		(0.08)	
DUS10yr$D4$		6.45	
		(9.14)	
DPMI$D4$		0.51	
		(0.96)	
DWTI$D5$			9.91^{***}
			(0.75)
DSP500$D5$			0.31^{***}
			(0.05)
DGold$D5$			0.46^{***}
			(0.05)
DUS10yr$D5$			-3.43
			(4.23)
DPMI$D5$			0.12
			(0.59)
R^2	0.41	0.72	0.89
Adj. R^2	0.40	0.72	0.89
Num. obs.	566	566	566

Table 34: UAE Production Regressions – part 2

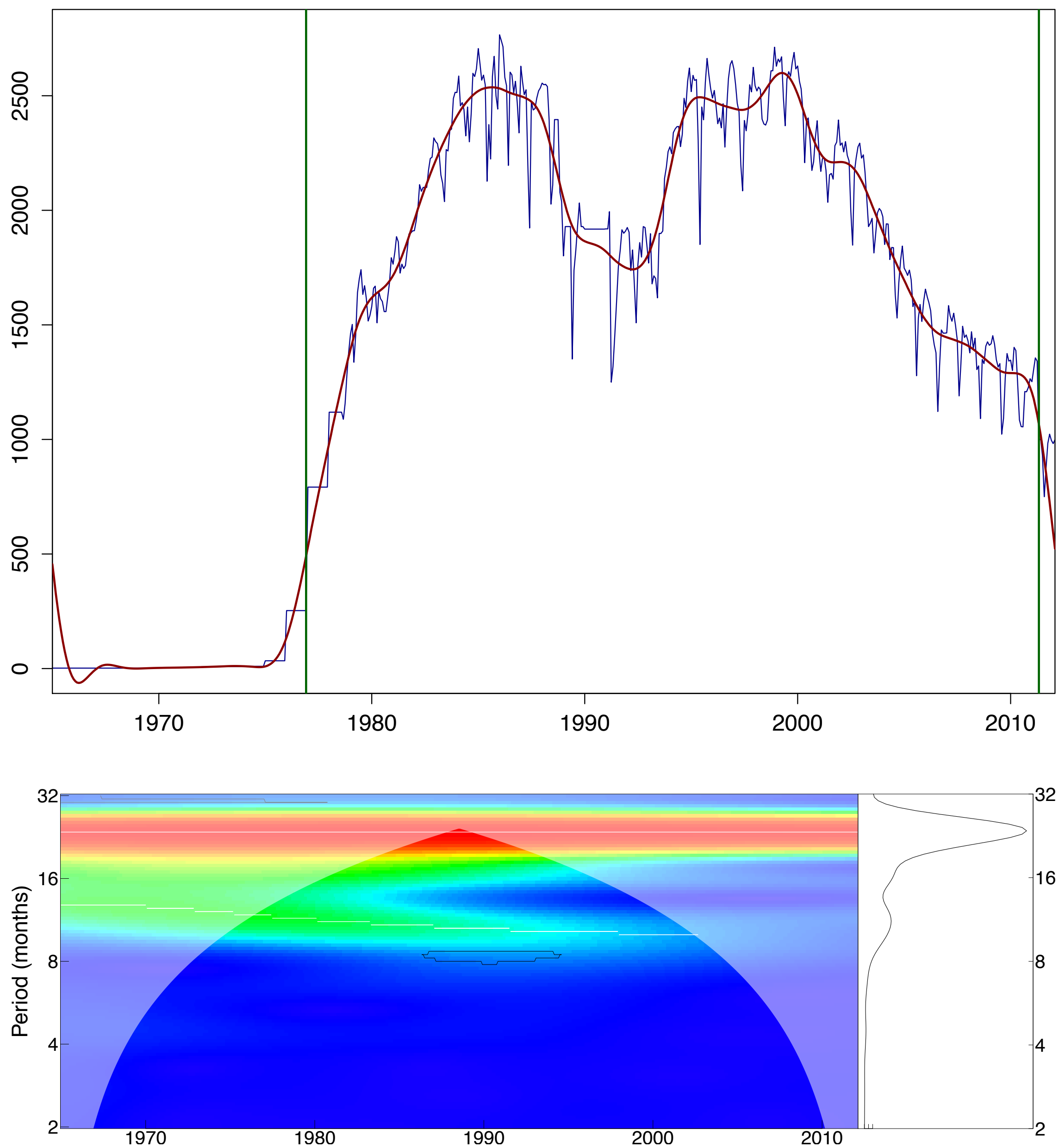


Figure 28: UK Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	UK Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		2.13	
		(2.34)	
DSP500$D1$		0.28	
		(0.19)	
DGold$D1$		0.28^{*}	
		(0.16)	
DUS10yr$D1$		18.12	
		(22.67)	
DPMI$D1$		2.20	
		(2.45)	
DWTI$D2$			-2.43
			(1.72)
DSP500$D2$			0.60^{***}
			(0.15)
DGold$D2$			0.27^{**}
			(0.14)
DUS10yr$D2$			46.26^{***}
			(14.87)
DPMI$D2$			-4.00^{*}
			(2.32)
R^2	0.89	0.11	0.13
Adj. R^2	0.89	0.11	0.12
Num. obs.	566	566	566

Table 35: UK Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	-2.19^{*}		
	(1.24)		
DSP500$D3$	0.38^{**}		
	(0.18)		
DGold$D3$	0.38^{***}		
	(0.12)		
DUS10yr$D3$	-101.43^{***}		
	(15.87)		
DPMI$D3$	4.76^{**}		
	(2.26)		
DWTI$D4$		-3.92^{***}	
		(0.53)	
DSP500$D4$		-0.05	
		(0.09)	
DGold$D4$		0.65^{***}	
		(0.06)	
DUS10yr$D4$		31.51^{***}	
		(7.16)	
DPMI$D4$		3.17^{***}	
		(0.75)	
DWTI$D5$			-5.41^{***}
			(0.83)
DSP500$D5$			0.17^{***}
			(0.06)
DGold$D5$			0.66^{***}
			(0.06)
DUS10yr$D5$			1.88
			(4.70)
DPMI$D5$			0.68
			(0.66)
R^2	0.20	0.31	0.46
Adj. R^2	0.19	0.30	0.46
Num. obs.	566	566	566

Table 36: UK Production Regressions – part 2

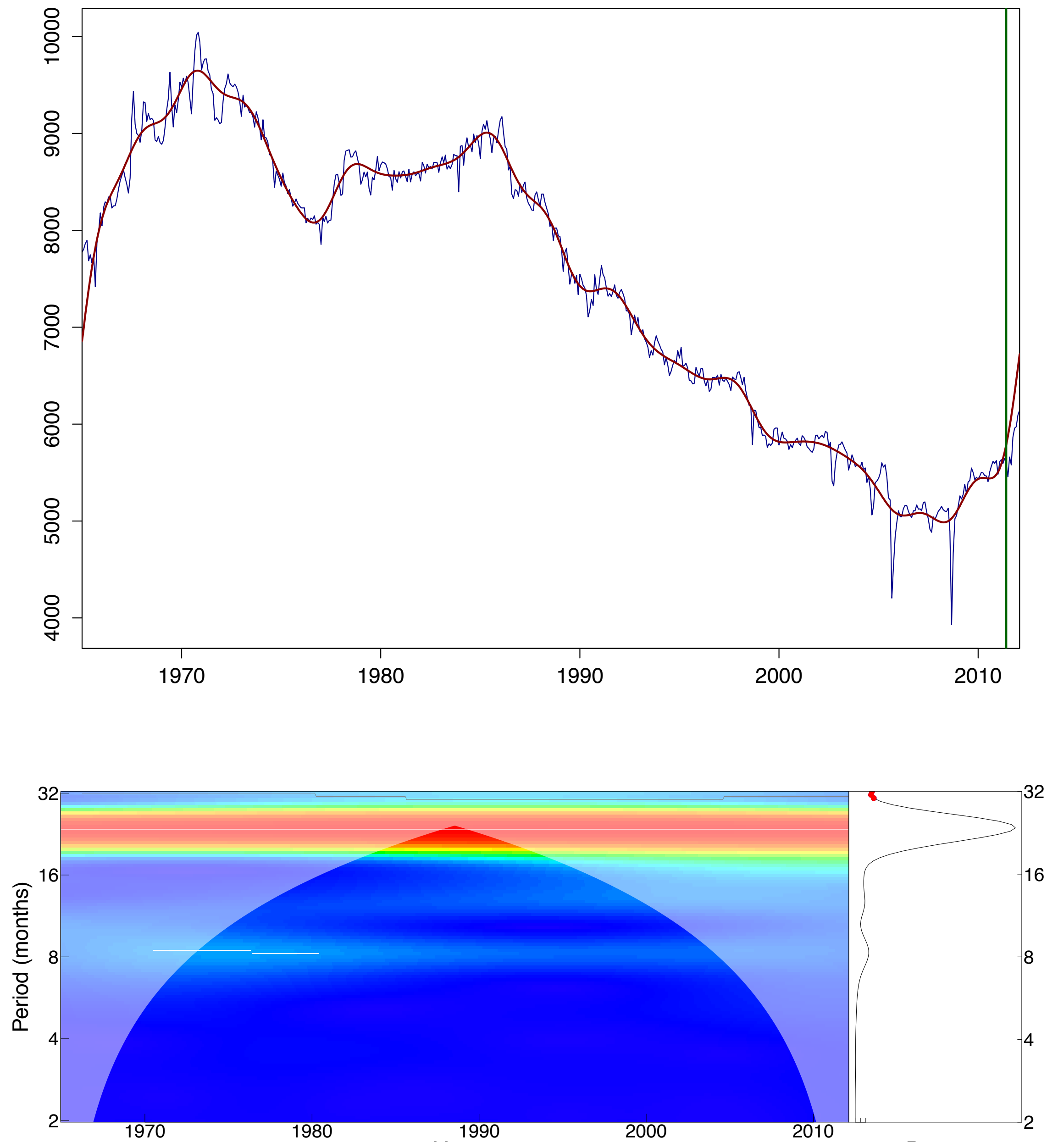


Figure 29: USA Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	USA Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		-6.61^{**}	
		(2.66)	
DSP500$D1$		-0.66^{***}	
		(0.21)	
DGold$D1$		0.00	
		(0.18)	
DUS10yr$D1$		40.93	
		(25.83)	
DPMI$D1$		-9.64^{***}	
		(2.79)	
DWTI$D2$			-1.97
			(2.13)
DSP500$D2$			-0.27
			(0.19)
DGold$D2$			-0.54^{***}
			(0.17)
DUS10yr$D2$			39.15^{**}
			(18.40)
DPMI$D2$			-6.23^{**}
			(2.86)
R^2	0.99	0.21	0.18
Adj. R^2	0.99	0.20	0.17
Num. obs.	566	566	566

Table 37: USA Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	-4.76^{***}		
	(1.36)		
DSP500$D3$	-0.05		
	(0.20)		
DGold$D3$	-0.59^{***}		
	(0.13)		
DUS10yr$D3$	10.19		
	(17.40)		
DPMI$D3$	-0.34		
	(2.48)		
DWTI$D4$		-0.03	
		(0.87)	
DSP500$D4$		-0.24	
		(0.15)	
DGold$D4$		-0.55^{***}	
		(0.11)	
DUS10yr$D4$		26.62^{**}	
		(11.82)	
DPMI$D4$		2.86^{**}	
		(1.24)	
DWTI$D5$			-5.02^{***}
			(1.08)
DSP500$D5$			0.04
			(0.08)
DGold$D5$			-0.54^{***}
			(0.08)
DUS10yr$D5$			47.15^{***}
			(6.13)
DPMI$D5$			-1.54^{*}
			(0.86)
R^2	0.21	0.32	0.62
Adj. R^2	0.20	0.32	0.62
Num. obs.	566	566	566

Table 38: USA Production Regressions – part 2

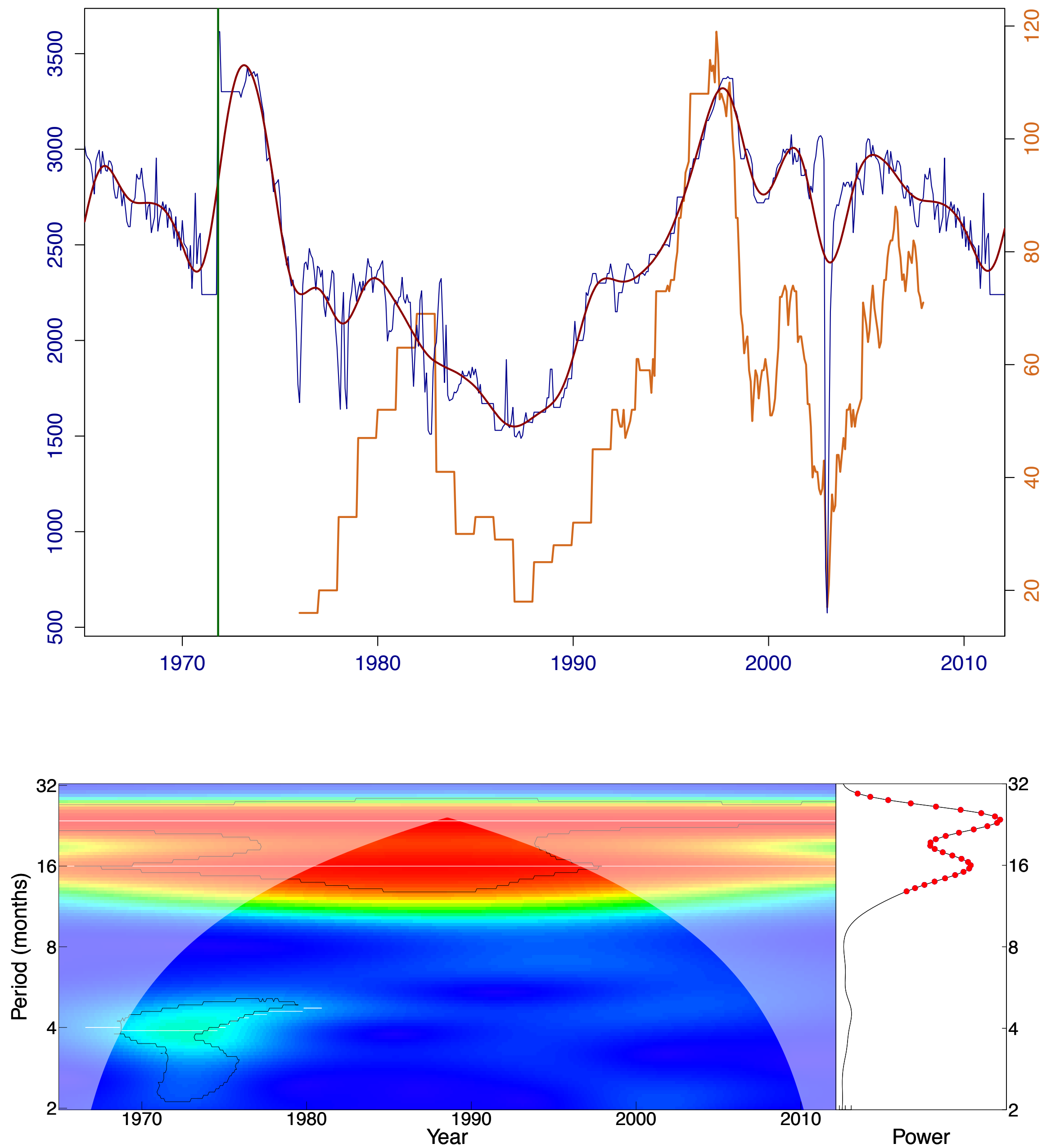


Figure 30: Venezuela Production (1,000 BBL; dark blue), level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), number of rigs (chocolate), and continuous wavelet spectrum (second plot)

	Venezuela Production	Prod Detail 1 (2–4 months)	Prod Detail 2 (4–8 months)
DWTI$D1$		2.26	
		(2.82)	
DSP500$D1$		0.04	
		(0.22)	
DGold$D1$		-0.57^{***}	
		(0.19)	
DUS10yr$D1$		5.09	
		(27.33)	
DPMI$D1$		1.47	
		(2.96)	
DWTI$D2$			-4.23
			(2.64)
DSP500$D2$			-0.16
			(0.24)
DGold$D2$			-0.14
			(0.21)
DUS10yr$D2$			18.30
			(22.80)
DPMI$D2$			-15.17^{***}
			(3.55)
R^2	0.97	0.05	0.07
Adj. R^2	0.97	0.04	0.07
Num. obs.	566	566	566

Table 39: Venezuela Production Regressions – part 1

	Prod Detail 3 (8–16 months)	Prod Detail 4 (16–32 months)	Prod Detail 5 (32–64 months)
DWTI$D3$	0.84		
	(1.72)		
DSP500$D3$	-0.41^{*}		
	(0.25)		
DGold$D3$	-0.26		
	(0.16)		
DUS10yr$D3$	-39.69^{*}		
	(22.00)		
DPMI$D3$	2.88		
	(3.13)		
DWTI$D4$		-1.36	
		(0.99)	
DSP500$D4$		1.29^{***}	
		(0.17)	
DGold$D4$		-1.09^{***}	
		(0.12)	
DUS10yr$D4$		11.67	
		(13.46)	
DPMI$D4$		-1.75	
		(1.41)	
DWTI$D5$			12.09^{***}
			(1.63)
DSP500$D5$			-0.59^{***}
			(0.11)
DGold$D5$			-0.68^{***}
			(0.11)
DUS10yr$D5$			-19.78^{**}
			(9.19)
DPMI$D5$			15.10^{***}
			(1.29)
R^2	0.04	0.17	0.29
Adj. R^2	0.04	0.17	0.28
Num. obs.	566	566	566

Table 40: Venezuela Production Regressions – part 2

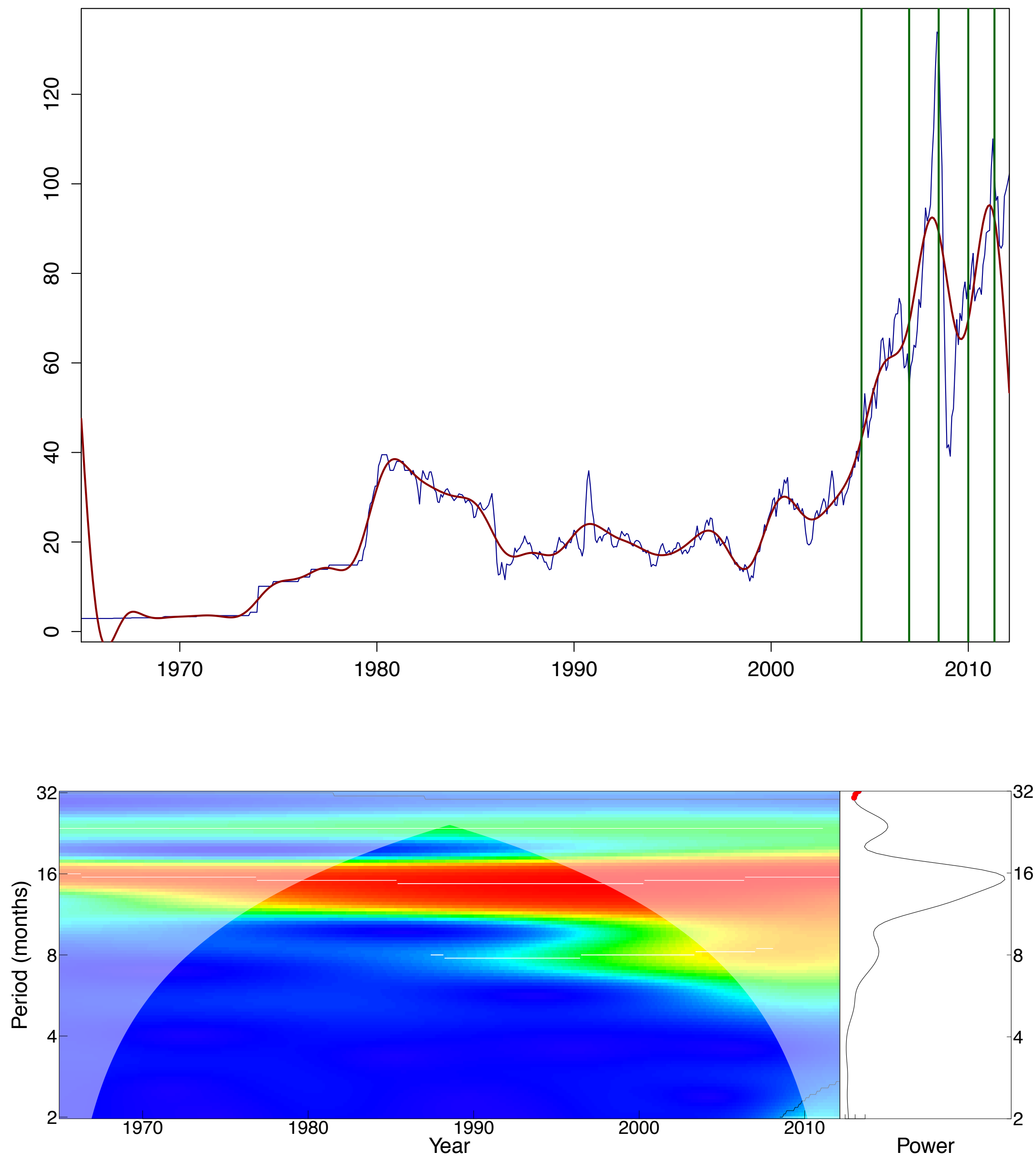


Figure 31: Monthly WTI price, level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), and continuous wavelet spectrum (second plot)

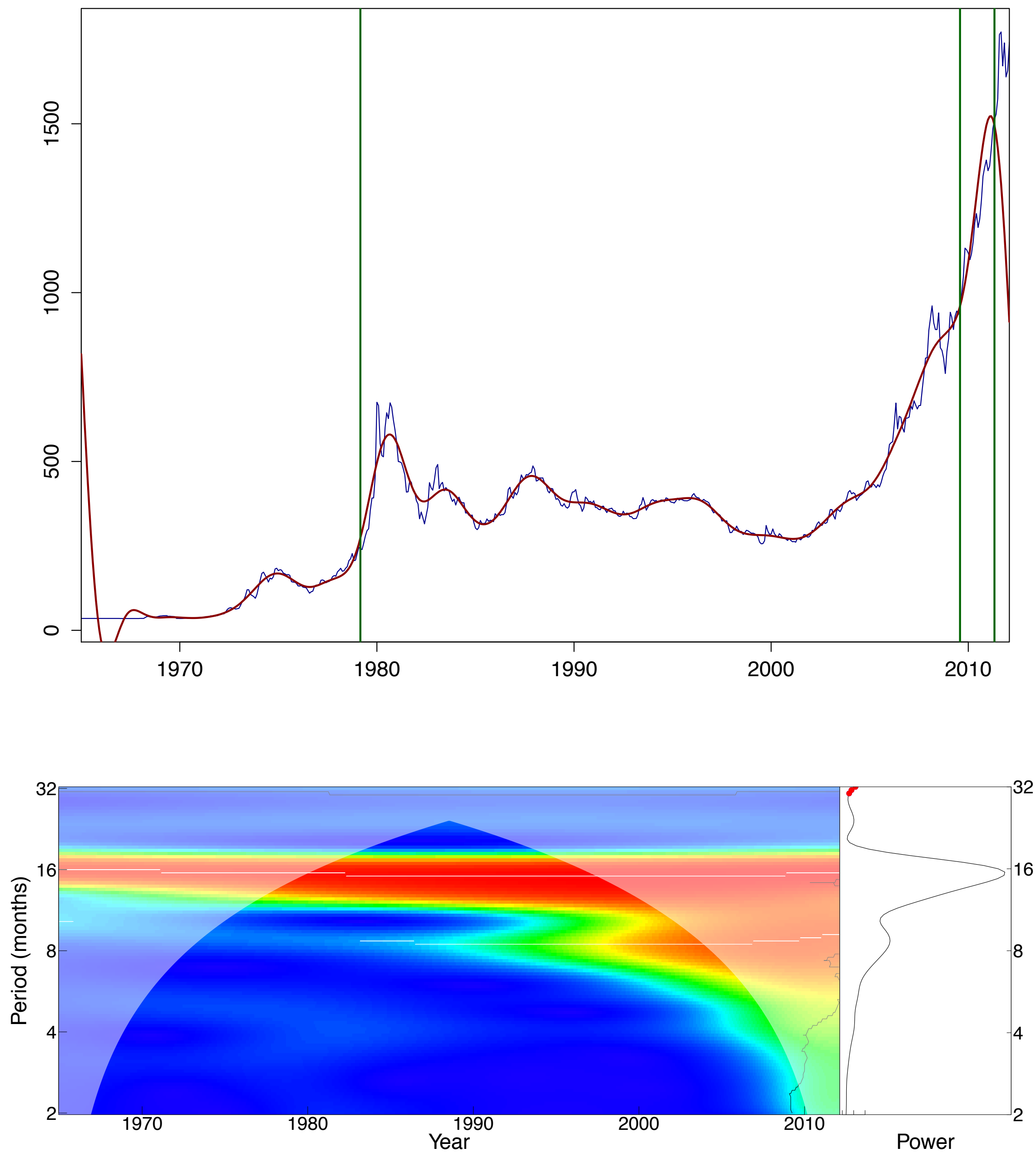


Figure 32: Monthly Gold price, level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), and continuous wavelet spectrum (second plot)

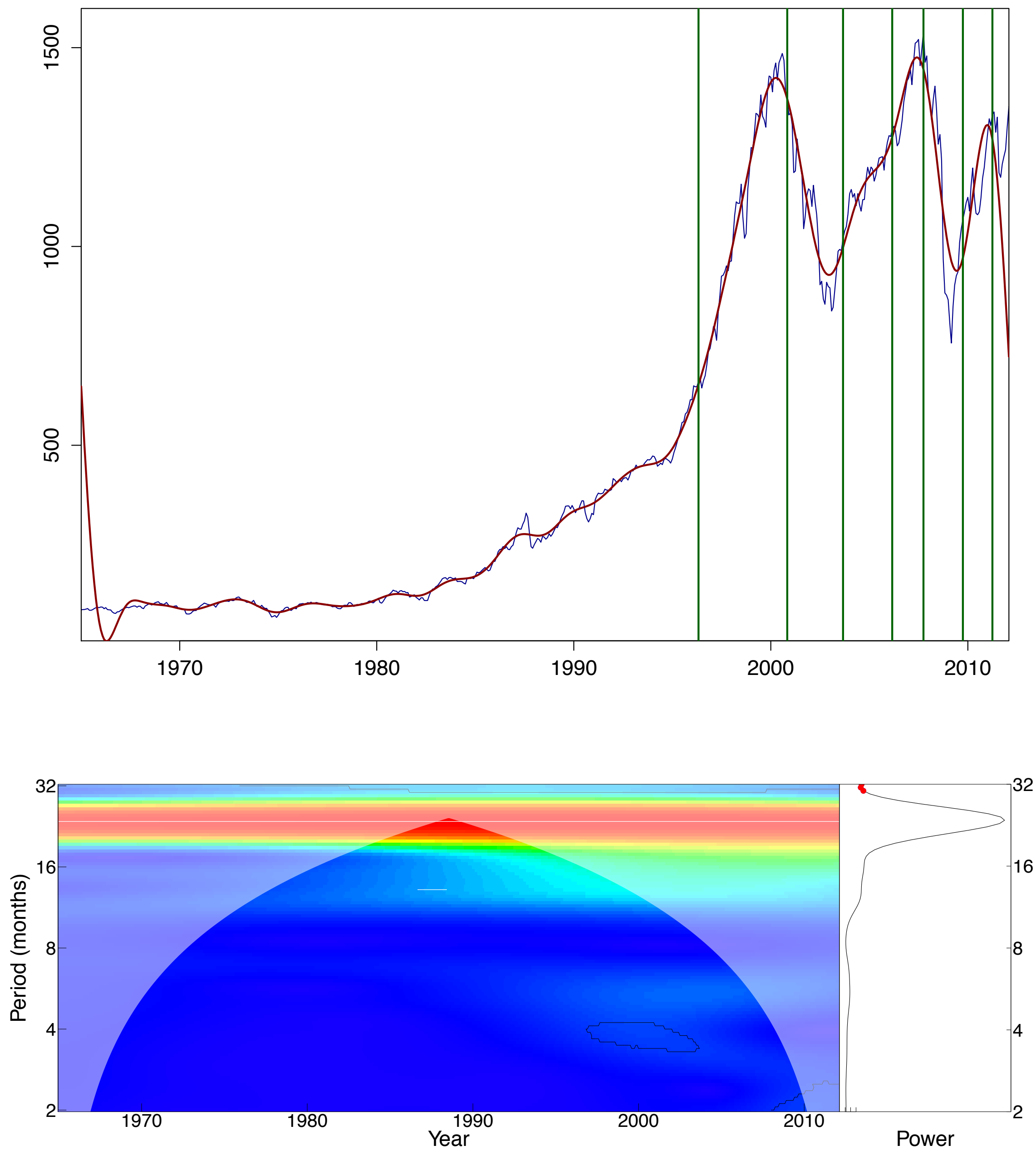


Figure 33: Monthly S&P500 Index Levels, level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), and continuous wavelet spectrum (second plot)

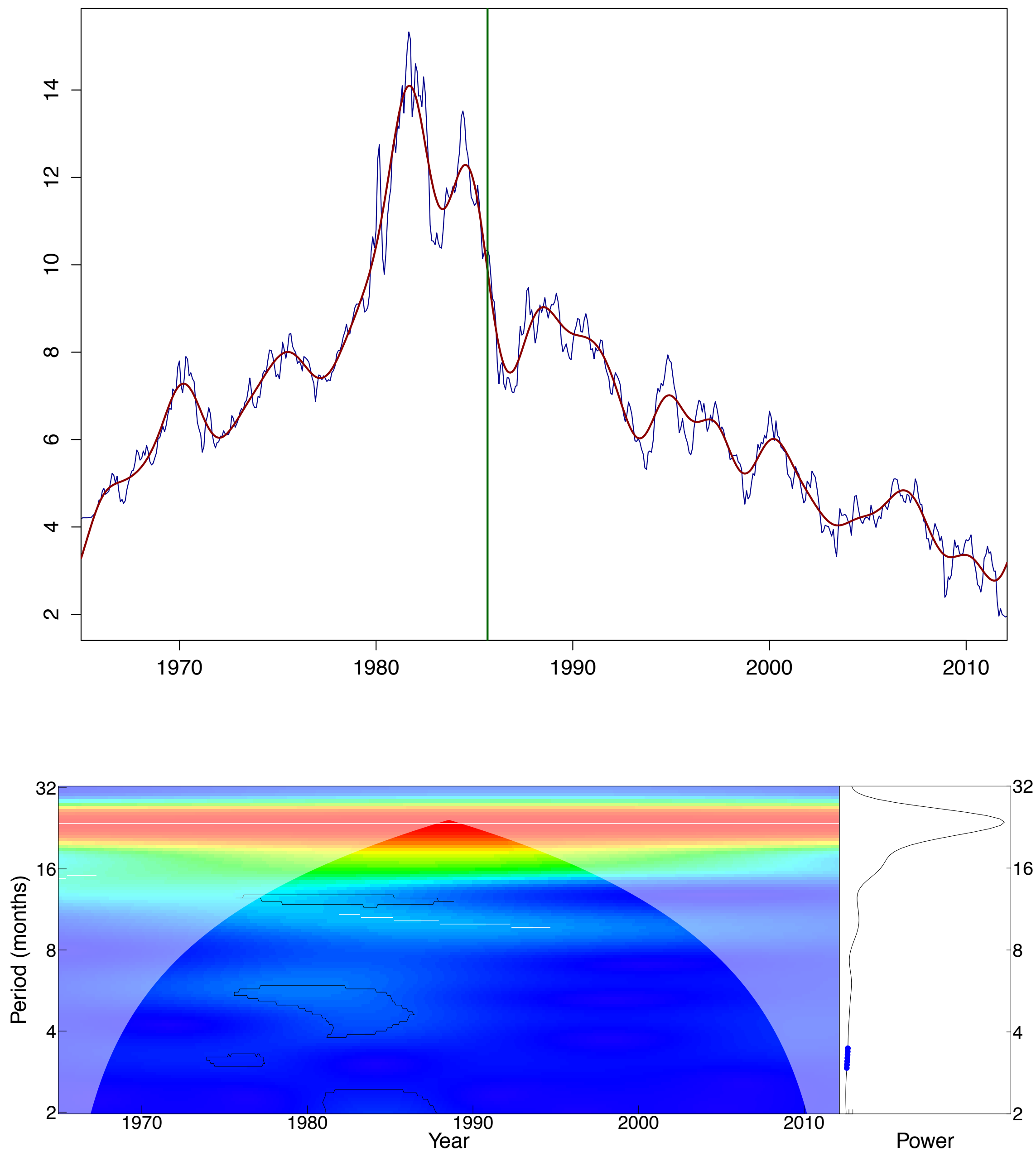


Figure 34: Monthly 10-Year US Treasury Yields, level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), and continuous wavelet spectrum (second plot)

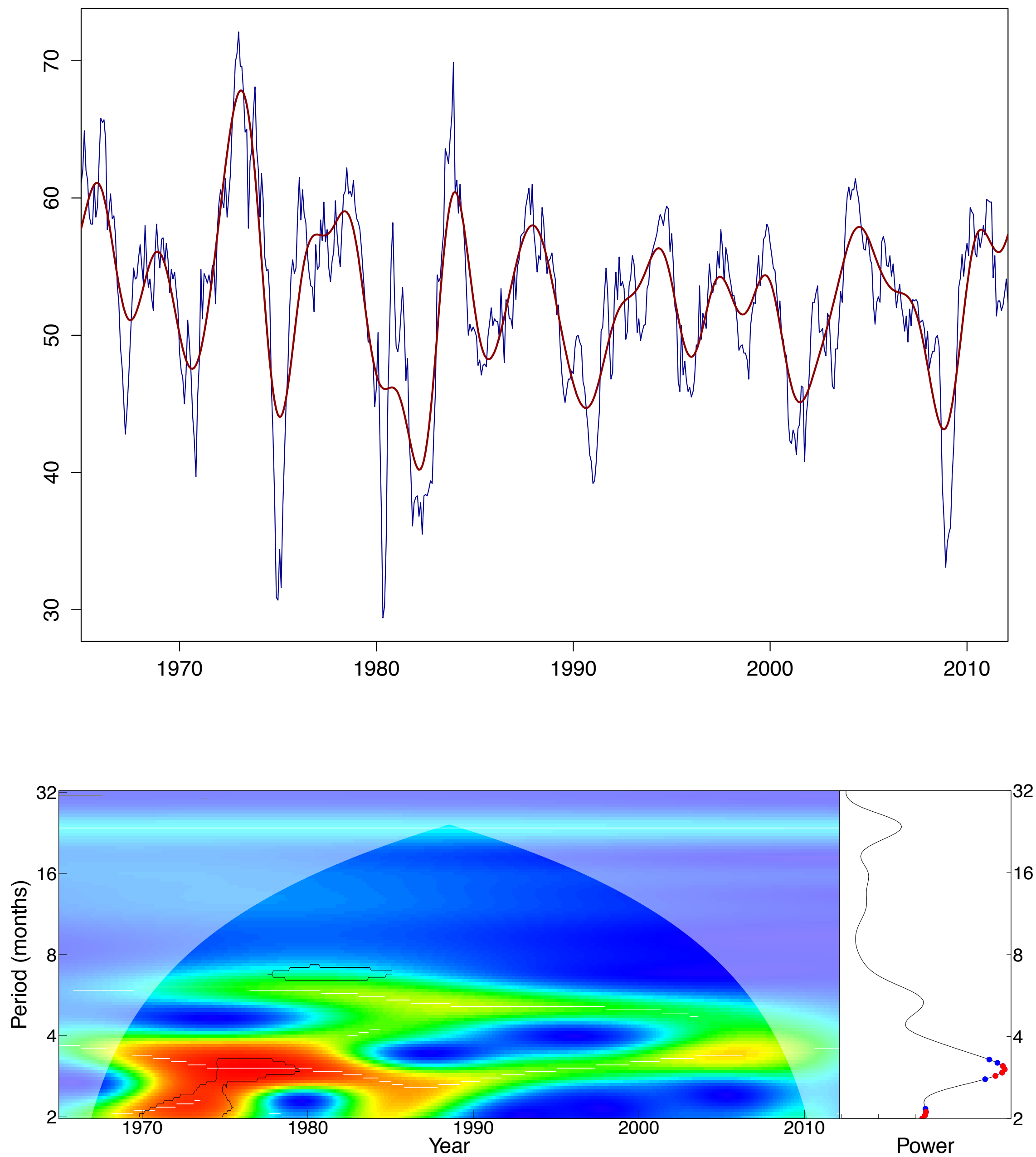


Figure 35: Monthly US Manufacturing PMI, level-5 wavelet detail + smooth (32-64 month wave; dark red), Identified Breaks in smoothed curve (dark green), and continuous wavelet spectrum (second plot)

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