Oil Price Shocks and U.S. Economic Activity

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Abstract

Our understanding of the sources of oil price fluctuations and their effects on the U.S. economy has undergone important transformations in the last decades. First, several studies have demonstrated the importance of identifying the causes of oil price fluctuations, whether they are driven by demand or supply shocks, instead of assuming that oil price changes are exogenous to the evolution of the world's economic activity. Second, new methodologies have allowed researchers to re-evaluate the functional form of the relationship between oil prices and U.S. GDP, its components and job flows. Third, significant advances have been made in understanding the relationship between oil price uncertainty, news, economic policy uncertainty and aggregate economic activity. Finally, investigations into the time-varying nature of oil price-macroeconomy relationship have provided important insights into the reasons why unexpected increases in oil prices appear to shock less now than in the 1970s. This paper reviews the studies that have contributed to these different aspects of the literature.

Key words: oil prices, economic activity, transmission channels, supply, demand, asymmetries.

JEL codes: C32, E32, Q41, Q43

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1 Introduction

The oil crisis of the 1970s spurred the interest of academics, policy makers and practitioners in studying the relationship between oil price fluctuations and economic activity. Our understanding of the source of these fluctuations, as well as their effects, has evolved considerably since then; recent advances in time series econometrics have enabled researchers to quantify the role of supply and demand driven oil price increases and to investigate the functional form of the oil price-macroeconomy relation, dynamic general equilibrium models that tackle the role of volatility and different structural shocks have been developed, and textual analysis of news-media has bolstered a line of research into the link between economic policy uncertainty and oil price fluctuations.

The aim of this paper is to present a selective review of the literature on the effects of oil price shocks on U.S. aggregate economic activity. Instead of providing an extensive survey, we review the seminal papers in the area and then focus on studies that have advanced our understanding of the effects of oil price shocks by applying new methodologies or using new datasets. Although there is a large and growing literature examining the effect of oil price shocks in an international setup, this paper focuses on U.S. data which have been the primary testing ground for new econometric methods. We start by reviewing the theoretical underpinning for the supply and demand transmission channels, paying particular attention to whether these channels imply an asymmetric response of economic activity to positive and negative oil price shocks.

Most of this paper is concerned with empirical studies that explore the relationship between oil price changes and the macroeconomy. Earlier investigations, following the oil crises of the 1970s, presumed that oil price fluctuations stemmed from disruptions in the Middle East and were exogenous to the U.S. economy. Hence, crude oil prices were taken as given when testing whether oil price movements had predictive content for future changes in real economic activity. Later studies that relied on vector autoregressions assumed that oil prices were predetermined with respect to the macroeconomic variables of interest.[1] These studies found some empirical support for a recessionary impact of positive oil price shocks.

As researchers extended the sample period to include the oil price collapse of the mid-1980s, the empirical evidence for a link between oil prices and the macro economy further weakened. A line of investigation into the functional form and structural stability of the relationship thus emerged. Initially, this literature revealed a seemingly asymmetric effect of oil price increases and decreases on future GDP growth. However, improvements in econometric methodology in the last ten years have called into question this conclusion. When reviewing the literature on the effects of oil price shocks on aggregate economic activity, labor reallocation, consumption and investment, we discuss the contributions made by studies that use these newer econometric techniques.

One of the big advances in our understanding of the sources of oil price shocks has been the recognition that, with an integrated global oil market, oil price fluctuations are not only driven by supply disruptions but also by changes in the demand for crude oil. Thus, recent empirical studies have aimed at identifying the source of oil price changes, as well as

[1] Motivation and evidence for this assumption may be found in Kilian and Vega (2011).

estimating the impact of supply and demand driven shocks. An increasing body of literature aimed at modeling the effect of these structural shocks suggests identifying the source of the shock is key for understanding the response of real oil prices and aggregate economic activity. This review summarizes these recent developments.

A rapidly growing line of investigation has addressed the interaction between uncertainty, oil prices and economic activity. This literature has provided new insights into the effect of heightened oil price uncertainty on economic activity and investment decisions, as well as on the impact of news on consumption.

The remainder of this paper is organized as follows. The next section discusses the theoretical foundations for the different transmission channels of oil price shocks. Section three reviews the literature that seeks to disentangle the role of supply and demand driven oil price shocks. The following section presents the empirical evidence regarding the effect of oil price shocks on aggregate economic activity. More specifically, we review the literature that investigates the impact of oil price shocks on output, consumption, and investment. Section 5 reviews the studies that investigate the effect of oil price shocks on stock returns. The sixth section reviews work that analyzes the impact of oil price shocks on job flows. Section 7 summarizes the contributions of studies that focus on the interaction between uncertainty, oil prices and economic activity. Section 8 discusses several papers that have investigated whether the effect of oil price shocks has changed over time and the last section concludes.

2 The transmission channels of oil price shocks: Theoretical underpinnings

Unexpected exogenous increases in the price of oil can be transmitted to real economic activity through a variety of channels. This section reviews theoretical transmission mechanism and discusses whether the mechanism at hand implies a symmetric response to positive and negative oil price shocks.

2.1 Supply side channels

Most macroeconomics textbooks posit that exogenous oil price shocks affect real output and inflation because they constitute a negative supply shock for the domestic economy of an oil importing country. More specifically, an unexpected increase in oil prices is assumed to decrease the economy's aggregate supply as it increases the cost of production (see Rotemberg and Woodford, 1996). In an economy where the aggregate production function is continuous and differentiable, the effect of an increase in energy prices is bounded by the share of energy expenditure in GDP. This direct supply channel implies a symmetric response of real economic activity to positive and negative oil price shocks.

Unexpected oil price increases may also operate through costly reallocation of labor and capital across sectors (see Hamilton, 1988; Davis and Haltiwanger, 2001). Following an unexpected increase in the real price of oil, resources may relocate from industries that use energy intensively in consumption (e.g., motor vehicles) or production (e.g., chemicals), to industries that rely less on energy. Yet, this reallocation process is costly due to the mismatch between the desired and actual distribution of capital and labor. Hence, costly sectoral reallocation would amplify the effect of an unexpected energy price change beyond the share of energy expenditure in GDP.

All in all, transmission channels that operate through the reallocation of labor (or capital) amplify the supply-side effect of oil price shocks beyond the share of crude oil in the value added. Moreover, they imply an asymmetric response of economic activity to unexpected oil price increases and decreases.

2.2 Demand side channels

Oil price shocks may also affect aggregate economic activity through demand side channels. First, an unexpected increase in oil prices is associated with higher energy and, especially, gasoline prices. The more expensive gasoline is, the more households have to spend on transportation and, thus, the smaller their discretionary income. Hence, unexpected increases in the price of crude oil lead to reductions in purchasing power and discretionary income, which result in curtailed consumption expenditure (see, e.g. Edelstein and Kilian, 2009; Baumeister and Kilian, 2017; Baumeister, Kilian and Zhou, 2018). The magnitude of this discretionary income effect will be larger the less elastic the demand for energy is, but its magnitude will be limited by the share of energy spending on aggregate personal consumption expenditure. Because the nominal energy share has always been smaller than 10% –according to the Bureau of Economic Analysis it was 4% in 2017–, this effect is likely to be small.

Unexpected oil price increases may also operate through costly reallocation of labor and capital across sectors (see Hamilton, 1988; Davis and Haltiwanger, 2001). Following an unexpected increase in the real price of oil, resources may relocate from industries that use energy intensively in consumption (e.g., motor vehicles) or production (e.g., chemicals), to industries that rely less on energy. Yet, this reallocation process is costly due to the mismatch between the desired and actual distribution of capital and labor. Hence, costly sectoral reallocation would amplify the effect of an unexpected energy price change beyond the share of energy expenditure in GDP, leading to an increase in involuntary unemployment. Hamilton's (1988) work proposed another channel whereby costly labor reallocation may amplify the impact of oil price fluctuations on economic activity and may lead to an increase in voluntary and involuntary unemployment. He argued that as oil prices increase and workers get laid off, these workers will tend to wait until conditions in the sector where they work improve rather than decide to relocate to other industries. Thus, the presence of frictions in the reallocation of resources implies that higher oil prices may amplify recessions and mitigate expansions.

However, the effect of an oil price shock might be amplified via the operating cost channel. Indeed, following an unanticipated increase in the real price of oil, consumers could reduce their spending on durable goods that are intensive in the use of energy (see, Hamilton 1988 and Kilian, 2014). Work by Edelstein and Kilian (2007, 2009) found that spending on automobiles is affected by this channel. However, they found no evidence for the operating cost channel on other consumption spending components that use energy.

Hamilton (2009b), Blanchard and Galí (2010), Edelstein and Kilian (2009) and Baumeister and Kilian (2017) posit that oil price shocks primarily affect the economy through variations in discretionary income that, in turn, lead to changes in consumer spending. Baumeister, Kilian and Zhou (2018) show that the discretionary income channel is identical to the terms of trade channel. This transmission channel implies a symmetric response of aggregate economic activity to oil price increases and decreases.

General equilibrium models such as those proposed by Rotemberg and Woodford (1996), Finn (2000) and Leduc and Sill (2004) provide other mechanisms whereby the contractionary effect of oil price increases might be amplified. In Rotemberg and Woodford (1996) the amplification is generated by the interaction of mark-up pricing and labor utilization, whereas in Finn (2000) and Leduc and Sill (2004) amplification is due to capital utilization and, in the latter, due to the presence of wage rigidities. Yet, none of the mechanisms proposed in these models trigger an asymmetric response of economic activity and the empirical support for these mechanisms is unclear.

The real options literature (Bernanke, 1983; Pindyck, 1991) posits that an increase in uncertainty regarding the present value of future cash flows will lead to a decline in the purchase of capital goods. These theories would thus suggest that if oil price increases are associated with heightened uncertainty about future profits, investment will decline. In addition, if heightened uncertainty about future oil prices causes households to incur higher precautionary saving, a reduction in households' spending on both durable and nondurable goods will ensue (Edelstein and Kilian, 2009). In brief, unexpected increases in oil prices that result in greater uncertainty about future oil prices may cause households and firms to postpone spending on durable goods and investment and thus may lead to a decline in aggregate output.

A related channel through which increased oil price uncertainty may have a negative effect on real GDP is related to the presence of nominal rigidities. Plante and Traum (2014) show that in a New Keynesian model where oil usage affects the utilization rate of capital, the interaction of precautionary saving motives and nominal rigidities results in a slowdown in real GDP when the economy is hit by an exogenous increase in real oil price volatility. Similarly, Başkaya, Hülagü and Küçük (2013) find that increases in oil price volatility that operate in conjunction with higher oil prices lead to economic contractions. In brief, recent theoretical studies that tackle the effect of heightened uncertainty in a general equilibrium framework uncover a transmission channel that could amplify the effect of oil price shocks, and may lead to asymmetries in the response to oil price increases and decreases.

3 Accounting for fluctuations in oil prices: supply, demand and speculation

Since the 1970s energy crisis, academics and policy makers have been interested in understanding what causes unexpected movements in oil prices and the consequences of these changes. Until the early 2000s it was common to study the effect oil price shocks on aggregate economic activity without differentiating the source of the shock. This practice was motivated by the belief that large changes in the price of crude oil had been historically driven by supply disruptions in the Middle East, which were exogenous to U.S. macroeconomic outcomes. Yet, in the last fifteen years or so, it became evident that this empirical strategy was incorrect.

Barsky and Kilian (2002) were the first to note that assuming exogeneity was problematic as crude oil prices could respond to demand shifts reflected in higher global real economic activity, thus violating the exogeneity assumption. Motivated by this idea, as well as by recognizing that oil price movements are a result of both supply and demand forces, Kilian (2009b) developed a structural vector autoregressive model (SVAR) of the global oil market that decomposed the dynamics of oil prices into the components associated with changes in supply and demand. To identify the shocks, Kilian (2009b) imposed a recursive structure in the SVAR –which implied a short-run vertical crude oil supply– and estimated the model using monthly data from January 1973 to October 2006. He showed that oil supply shocks accounted only for a small part of the variation in real oil prices whereas a large part of the fluctuations had been driven by demand shocks.

The framework developed by Kilian (2009b) was extended and modified in the following years. For instance, Kilian and Murphy (2012) investigated the sensitivity of Kilian's (2009b) findings to alternative identification schemes. More specifically, instead of imposing exclusion restrictions, they attained identification by using sign restrictions. The findings of Kilian and Murphy (2012) resembled those of Kilian (2009b) in that oil supply disruptions explained only a small fraction of the variation in the real price of crude oil.

Lippi and Nobili (2012) built on the work by Backus and Crucini (2000) to develop a theoretical model with two industrialized countries -the United States and the rest of the industrialized world (RoW)– and an oil exporting country. This theoretical framework allowed them to trace the effect of aggregate demand and supply shocks –originating in the US and the RoW- on the oil importing economies. They then mapped the fundamental shocks derived from the model to the observed responses of real oil prices and oil production in a sign-identified SVAR. Lippi and Nobili's (2012) estimates of the effect of an oil supply shock are similar to those of Kilian (2009b), albeit more negative and persistent. In addition, they showed that unexpected increases in rest-of-the-world demand –which are associated with increases in oil market-specific demand- lead to an increase in the real price of oil and a decline in U.S. industrial production, whereas demand shocks that originate in the U.S. had the opposite effect.

Kilian and Murphy (2014) later refined their own methodology (i.e., Kilian and Murphy 2012) to account for the role of speculation in driving oil price fluctuations. They included the change in global inventories in their sign-identified SVAR and modified the identification assumptions accordingly. Similar to the previous studies, Kilian and Murphy (2014) found that oil supply disruptions explain a small proportion of the movements in real oil prices relative to flow demand and speculative demand shocks.

Recent work by Baumeister and Hamilton (2018) proposes a framework where the researcher's beliefs on information about the contemporaneous coefficients are summarized through priors on particular parameters. Baumeister and Hamilton's (2018) findings stand in contrast to the earlier literature (e.g., Kilian 2009b, Kilian and Murphy 2012 and 2014) in that they estimate a larger contribution of oil supply shocks to historical movements in oil prices. This estimated larger role of oil supply shocks may be traced back to the assumptions inherent in their model.[2]

Herrera and Rangaraju (2018) investigated how different identification assumptions and modelling strategies influence estimates of the effects of oil supply shocks on real oil prices and U.S. real GDP. They re-evaluated the time-invariant SVAR models of Kilian (2009b), Kilian and Murphy (2012, 2014) and Baumeister and Hamilton (2018) using a common sample that spans the period between January 1973 and December 2016. First, they confirmed the importance of including crude oil inventories in the SVAR to correctly pin down the price elasticity of oil demand (see Kilian and Murphy, 2014). Second, they showed that models that impose a small short-run price elasticity of supply (Kilian and Murphy, 2014) result in a smaller response of the real oil price to oil supply disruptions than specifications that allow for a larger elasticity (Baumeister and Hamilton, 2018). They showed that, if the researcher is willing to consider a prior that conditions on values of the short-run price elasticity of oil supply that are supported by microeconomic estimates, the differences in the response of real oil prices to oil supply shocks across specifications diminish.

The work by Aastveit (2014) contributes to this literature by using a richer data set in a factor augmented vector autoregressive (FAVAR) model. He examined the impact of different types of oil shocks on a wide range of U.S. macroeconomic variables. He confirmed that oil demand and oil supply shocks have different effects on the responses of the real price of the oil, real economic activity, the labor market, and the stock market. Aastveit (2014) findings coincide with previous studies: oil demand shocks are far more important than oil supply shocks as much of the variation in oil prices and other macroeconomic variables arises from shifts in the aggregate demand or oil specific demand.

As we mentioned earlier, this paper focuses on U.S. economic activity. However, an increasing number of papers has looked into the contribution of demand and supply driven shocks to economic activity in an international setup (see Bodenstein, Guerrieri and Kilian, 2012). An example is the work by Lippi and Nobili (2012) discussed above.

In brief, our summary of the methods and findings concerning the role of supply and demand shocks in driving oil prices and economic activity reveals two key insights. First, the inclusion of changes in crude oil inventories in the SVAR model is key to identify the role of speculation as well as to correctly estimate the short-run price elasticity of oil demand. Second, while differences in the estimated response of the real oil price to supply and demand driven shocks are largely driven by the identification assumptions, the consensus that has emerged from this studies is that demand shock account for a large proportion of the fluctuation in oil prices.

4 Oil price shocks and U.S. economic activity

In this section, we review the empirical studies that analyze the effect of oil prices shocks on U.S. economic activity. To get a better view on the empirical relevance of the various transmission mechanisms, we also discuss papers that investigate the impact of oil prices on aggregate output, consumption, investment and stock returns.

[2]See Kilian and Zhou (2018) for a detailed discussion.

4.1 The impact on aggregate output

Following the 1970s stagflation, economists became interested in analyzing the effect of fluctuations in oil prices on economic activity. Indeed, over the years, a large number of empirical studies found a statistically significant relationship between higher oil prices and lower economic activity.[3] The earliest contributions to this literature considered linear regression models and tested whether oil price changes Granger caused aggregate economic activity (see e.g., Hamilton, 1983).

Since then, this body of literature has vastly expanded. Thus, instead of reviewing all the papers, we focus on two areas of research that have captured the interest of academics and policy makers: the functional form of the relationship between oil price changes and aggregate production and the interaction between monetary policy and oil price shocks.

After the 1986 oil price collapse, studies that explored the oil price-macroeconomy relationship using longer samples found evidence of instability in the relationship. This instability was then shown to be connected to an asymmetric response of U.S. economic activity to oil price increases and decreases. Mork (1989) showed that if a researcher regressed the real GNP growth on lags of oil price increases and decreases (controlling for other non-oil variables), the lags on the decreases were statistically insignificant whereas the lags on the increases were jointly significant and negative. Similarly, Hooker (1996) implemented rolling Granger causality and structural stability tests and found that the oil price-macroeconomic relation seemed to have become unstable. Motivated by these findings, Hamilton (1996, 2003) proposed an asymmetric functional form based on a nonlinear transformation of the real price of oil (the net oil price increase) that corrects for previous oil price declines. Nonlinear models that analyze the dynamic relationship between oil prices and the macroeconomy thus became the workhorse of the empirical literature for the next twenty years.[4]

By the early 2000s, researchers seemed to agree that unexpected increases in oil prices were correlated with economic contractions whereas oil price declines had no significant effect on the economy. Kilian and Vigfusson (2011a) questioned the methodology used by previous studies to examine the issue of asymmetry. They observed that these studies were based on censored VAR models and proved that the impulse response estimates reported in the earlier literature are inconsistent and exaggerate the recessionary effects of higher oil prices. Instead, they proposed a nonlinear model that nests both symmetric and asymmetric responses of aggregate economic activity to oil price increases and decreases. They found that real GDP growth responds symmetrically to positive and negative oil price shocks. In contrast with the earlier literature, Kilian and Vigfusson (2011a,b, 2017) showed that a linear model provided a good approximation for the oil price-real GDP relationship.[5]Evidence

[3] See, e.g., Rasche and Tatom (1977, 1981), Hamilton (1983) and Burbidge and Harrison (1984).

[4] See, e.g., Loungani (1986), Mork (1989), Lee, Ni and Ratti (1995), Davis, Loungani, and Mahidhara (1996), Lee and Ni (1996), Balke, Brown and Yucel (2002).

[5] Hamilton (2011) disagrees with Kilian and Vigfusson (2011a) and claims that the lack of evidence against the null of symmetry based on the slope-based test, which Kilian and Vigfusson (2011a) insist should not be used, is due to different datasets, different measures of oil prices, different price adjustment, the inclusion of contemporaneous regressors and the number of lags. Kilian and Vigfusson (2011b) refute these arguments. The substance of Kilian and Vigfusson's findings is also supported by more recent research including Kilian

of asymmetric responses to oil price shocks exists, if at all, only when large (2 standard deviations) shocks are considered and tends to be sensitive to the inclusion of the Great Recession period. Only in some disaggregate data is there credible evidence of asymmetric responses.[6]

Regarding the interaction between oil price shocks and monetary policy, some disagreement remained by the mid-2000s. In particular, while some economists have considered oil price shocks as the cause behind economic downturns, others have argued that the recessionary impacts associated with higher oil prices were mostly a result of the contractionary monetary policy implemented by the Fed to prevent any inflationary pressure on the economy (see Bohi, 1989). Bernanke, Gertler and Watson (1997) – hereafter BGW – provided some evidence supporting this view. Using a censored structural vector autoregression model[7], they conducted a counterfactual analysis where the systematic monetary policy response was shut down such as to keep the federal funds rate at its pre-oil shock level. Their counterfactual analysis implied that, had the federal funds rate remained unchanged following an unexpected increase in the real price of oil, then the recession could have been avoided. Hamilton and Herrera (2004) challenged this conclusion on two basis. First, they showed that the BGW's counterfactual was not feasible as it entailed a large and persistent increase in the price level; hence, the required monetary policy shocks would not have been modest. Second, Hamilton and Herrera (2004) found that BGW results were largely driven by the use of shorter lag structure, which was inconsistent with the more delayed response of economic activity found by previous studies.

Along similar lines, Herrera and Pesavento (2009) investigated whether the contribution of systematic monetary policy to the economic recession that ensued an oil price shock was different before and during the Great Moderation. They showed that the contribution of systematic monetary policy to the dynamic response of output and prices was considerably smaller during the Volcker-Greenspan era than before the Great Moderation. Moreover, if the response of systematic monetary policy had been shut-down for a year, the volatility of GDP growth would have declined 27% in the pre-1980 period but only 8% in the post-1980 period.

Kilian and Lewis (2011) – hereafter KL – also built on the work of Hamilton and Herrera (2004) by using additional data and methodological advances to show that the response of monetary policy to oil price shocks did not lead to important output fluctuations even in the pre-Volcker period. They observed that the censored VAR model estimated in BGW was subject to the pitfalls expounded in Kilian and Vigfusson (2011a) and thus estimated a linear SVAR. Despite the differences in data frequency, model specification and sample period, KL findings are similar to Herrera and Pesavento (2009). Their analysis suggests that the systematic response of monetary policy to oil price shocks was more concerned with stabilizing output before the mid-80s and was less responsive to oil price shocks since the

and Vigfusson (2013, 2017) and Ravazzolo and Rothman (2013).

[6] See Herrera, Lagalo and Wada (2011, 2015), Alsalman and Herrera (2015), Herrera and Karaki (2015), Kilian and Vigfusson (2011b) and Karaki (2017).

[7] It is important to note that Kilian and Vigfusson (2011a) proves that impulse responses estimated using VAR models with censored oil price variables are inconsistent and invalid

start of the Great Moderation.

While the literature includes a large number of papers that investigate the question of nonlinearity using data from OECD (see Herrera, Lagalo and Wada, 2015) and countries in the Gulf Cooperation Council (see, e.g., Ben Cheikh, Ben Naceur, Kanaan and Rault, 2018), there are only a few papers exploring the connection between monetary policy and oil price shocks using non-U.S. data. Notable exceptions are Choi et al. (2018). This is clearly an area where there is plenty of room for future research.

We conclude this section by noting that there are several theoretical papers that explore the interaction between oil price shocks and systematic monetary policy (see e.g., Leduc and Sill 2004, Kormilitsina 2011, Plante 2014). Because we restrict ourselves to reviewing empirical studies we will abstain from including an extensive review of those papers. However, let us remark that Leduc and Sill (2004) address the same question as the above summarized empirical studies. Namely, what is the contribution of the systematic monetary policy response to the recessionary effect of an oil-price shock? Their work, which uses a calibrated general equilibrium model, supports the findings of the empirical literature in the sense that none of the monetary policies commonly proposed are able to completely eliminate the recessionary impact of an oil price shock.

This literature, however, has largely ignored the fact that the real price of oil need not be exogenous with respect to the domestic economy. The only theoretical analysis of monetary policy responses when the price of oil is endogenously determined in global markets is Bodenstein, Guerrieri and Kilian (2012) who show that it is detrimental to domestic welfare for the central bank to respond do oil price shocks directly.

4.2 Do oil price shocks depress consumption?

In the literature that emerged after the 1970s oil price shocks, the answer given to this question is positive, especially because oil price increases depressed the demand for motor vehicles. In fact, given that personal consumption expenditures constitute the largest component of real GDP, it is probably not surprising that researchers still seek to understand how oil price changes affect consumption. For instance, Edelstein and Kilian (2009) studied the impact of changes in purchasing power driven by fluctuations in oil prices on personal consumption expenditure. They analyzed the effect on aggregate and disaggregate spending components to assess the importance of the uncertainty and the operating cost channels. They showed that the elasticity of personal consumption expenditure with respect to the overall price of energy was negative for both aggregate and disaggregate spending components. Their findings indicated that spending on durables had the largest elasticity. They reasoned that the large response in durables consumption stems from the reduction in spending on motor vehicles following the negative shock to purchasing power caused by higher oil prices. This result falls is in line with the long held view that the automobile sector suffered the most during periods of large oil price increases (see for e.g. Davis and Haltiwanger, 2001; Ramey and Vine, 2006).

Edelstein and Kilian (2009) –hereafter EK– posit that if oil prices affect consumption only through the discretionary income effect, then the response of consumption to an energy price shock should have an upper bound that is equal to the amount of the loss in purchasing power. Nevertheless, they found that the response of consumption is almost four times as large as the response of discretionary income, which they interpret as evidence that channels other than the discretionary income are at play. In particular, EK suggest that the fact that spending on motor vehicles is more responsive than spending on other durables indicates that the operating cost channel is relevant.

EK sought to disentangle the importance of different transmission channels for consumption. In contrast, Alsalman and Karaki (2018) –hereafter AK– investigated whether personal consumption expenditure responds asymmetrically to positive and negative structural shocks in the crude oil market. Moreover, they studied whether the effect of oil price changes on personal consumption expenditure depends on the source of the shock. They found that aggregate PCE responds asymmetrically to positive and negative oil-specific demand shocks. Their results indicate that oil supply shocks have a limited effect on aggregate PCE. However, a positive aggregate demand shock leads to a significant reduction in aggregate PCE with a delay of about a year. This delay is explained by the combination of two dynamic responses. First, a positive aggregate demand shock stimulates U.S. economic activity through increased exports. Second, over time, as global economic activity rises, the real price of oil increases and output growth declines. Their results suggest that oil-specific demand shocks significantly decrease aggregate PCE for almost all horizons.

Regarding the components of PCE, Alsalman and Karaki (2018) found important differences in the responses to supply and demand driven oil price shocks. First, they showed that an adverse oil supply shock increases consumption spending on services, but decreases consumption spending on goods with the reduction in durables being larger than in nondurables. Second, whereas they find a negative response of PCE to aggregate demand shocks, there appears to be significant heterogeneity in the response across PCE components. For instance, while most spending components exhibit a decline, other spending components –such as recreation services and nondurables– respond positively. Last but not least, oil-specific demand shocks trigger an unambiguously negative effect on most spending components. Indeed, a positive oil-specific demand shock largely reduces spending on motor vehicles and new autos and increases spending on foreign autos.

Most of the literature on the effect of oil price shocks on consumption has focused on U.S. data. To the best of our knowledge, there are only a few working papers that employ international data such as Iacoviello (2016) and Bokan, Dossche and Rossi (2018). This is clearly an important area for future research as studying the effect of oil price shocks on consumption for oil importing and oil exporting countries would improve our understanding on the transmission mechanism of oil price fluctuations.

In brief, recent investigations have confirmed the negative effect of oil price shocks on U.S. aggregate consumption. However, the magnitude of the effect appears to be modest (see Baumeister and Kilian, 2017; Baumeister, Kilian and Zhou, 2018). These studies have underlined the importance of the purchasing power and operating cost channels in accounting for the decline in aggregate consumption. Motor vehicles continue to play a key role in explaining the contraction in PCE. This is especially the case when the increase in oil prices is due to an unexpected increase in oil-specific demand.

4.3 The effect of oil price shocks on investment

As noted earlier, there are several theoretical models that would imply a negative effect of oil price shocks on investment. Moreover, some of these models would predict an asymmetric response to oil price increases and decreases. Empirical studies into the dynamic effects of oil price shocks on investment have lately focused on the question of asymmetry, as well as on the impact of oil price uncertainty.

For example, Edelstein and Kilian (2007) used a bivariate recursively identified VAR model, with oil prices ordered first, to estimate the effect of oil price shocks on investment and to investigate the presence of asymmetry. Their estimates provide some evidence of asymmetry in the response of investment to oil price increases and decreases. Yet, Edelstein and Kilian (2007) argue that this asymmetry is an artifact for two reasons. First, they show that asymmetry in aggregate investment is due to the inclusion of investment spending in the coal mining, and the oil and gas industries. In other words, investment in these industries falls when oil prices decline whereas lower oil prices foster investment in other industries. Second, Edelstein and Kilian (2007) provide evidence that the apparent asymmetry is also due to the exogenous shift in investment stemming from the 1986 Tax reform Act. In other words, if the researcher accounts for these two factors, then the effect of oil prices on investment is small.

Baumeister and Kilian (2017) studied the effect of lower oil prices on investment during the recent oil price decline. They found that lower oil prices led to a sharp decrease in investment in the oil sector. Furthermore, their findings revealed a limited increase in investment in other sectors. They show that nonresidential investment grew at a slower pace than real GDP between 2014Q2 and 2016Q1 because of to the 48% decrease in oil investment.

Lee, Kang and Ratti (2011) studied the effect of oil price shocks on investment, both by estimating the direct effect of oil price shocks on firm-level investment and in interaction with firm stock price volatility and with firm sales growth. They use a panel of firm-level data for manufacturing firms (SIC code 2000-3999) spanning the period between 1962 and 2006. They found that oil price shocks negatively affect investment. They also show that firms that experience a higher degree of uncertainty experience a sharper decline in investment spending following a reduction in the real price of oil. Finally, their results reveal that oil price shocks affect investment for at least two years after the shock.

In contrast, Kilian (2014) and Baumeister and Kilian (2017) find little support for the hypothesis that increased uncertainty regarding future oil prices has a significant effect on investment on industries not related to the oil sector. Nor do they find a significant effect at the aggregate level. These results suggest the lack of a consensus regarding the importance of the uncertainty channel at the aggregate level.

Given the predominant role of the public sector on the exploration and extraction of crude oil in most oil exporting countries, it is possibly not surprising that the micro-level literature has focused on the U.S. After all, investment and production by private firms is more prevalent in the U.S. and the number of oil fields with good quality data is larger. However, aggregate investment data is available at the country level from the National Income and Product Accounts (NIPA) and could thus be exploited by future research to investigate the effect of oil price shocks in other countries.[8]

Summarizing, there appears to be an agreement regarding the negative effect of oil price shocks on investment. Furthermore, the theoretical implication of the real options theory –whereby investment would decrease in the face of heightened uncertainty– is borne out in the data for oil drilling in Texas.

5 Oil Price Shocks and Stock Returns

Empirical studies on the effect of oil price shocks on stock returns have produced somewhat conflicting results over the years. On the one hand, the earlier work of Chen, Roll and Ross (1986) and Huang, Masulis and Stroll (1996) failed to find a significant relationship between prices of oil futures and stock returns. On the same vein, the more recent study of Wei (2003) found that the oil price shock of 1973-74 had no significant effect on U.S. stock returns. On the other hand, Kling (1985) and Jones and Kaul (1996) provided evidence of a negative relationship between oil price shocks and stock returns.

Kilian and Park (2009) provided an explanation for these contrasting results. Using the framework of Kilian (2009b) to model the global oil market and identify the source of the oil price shock, they demonstrate that the response of U.S. stock returns differs greatly depending on the underlying source of the shock. On the one hand, changes in precautionary demand, especially those linked to political disturbances in the Middle East, are shown to account for large decreases in U.S. stock returns. On the other hand, oil price hikes that stem from unanticipated increases in global economic activity have a positive effect on stock returns. Moreover, their study suggests that shocks to crude oil production have little impact on U.S. stock prices relative to oil price increases driven by changes in global economic activity or precautionary demand for crude oil. At the disaggregate level, they found that alternative structural shocks to the crude oil market have different effects on industry stock returns. For instance, an increase in the price of oil caused by a positive oil-specific demand shock generates a small increase in stock returns for the oil and gas industry whereas returns on shares of stocks for the auto industry will experience a persistent decline. Their results reveal, however, that stock returns appreciate within a year for both industries when the oil price increase is caused by a positive aggregate demand shock. Thus, Kilian and Park (2009)'s findings emphasize that investors need to understand the source behind the oil price adjustment in order to adequately adjust their portfolios and suggest that one explanation for the early conflicting results is a change in the composition of oil price shocks.

Alsalman and Herrera (2015) investigated an alternative explanation, the possible non-linear nature of the relationship between oil price shocks and stock returns. Their study tests the null of symmetry in the response of U.S. stock returns to positive and negative oil price innovations. They found evidence that a linear model does a good job at capturing the dynamic effect of oil price shocks for aggregate stock returns. Yet, the response of stock returns for a few more disaggregate portfolios (e.g., healthcare, textiles, aircraft) appears to

[8] It is important to note that using international data creates a new challenge because one has to model the real exchange rate (see Kilian and Zhou, 2018).

be asymmetric.

Baumeister and Kilian (2017) studied the effect of the sharp decline in oil prices after June 2014 on stock returns. Their findings reveal that lower oil prices during that period have appreciated stock returns for companies that produce consumer goods such as tobacco and food products. Moreover, stock returns for retail sales companies appreciated more than stocks for the average company. For instance, they found that Amazon's stock returns have increased by 38 percent. Obviously, the biggest losers are companies in the petroleum and natural gas sector, where average stock returns declined by 28 percent.

Ready (2017) proposes a different method for separating demand and supply driven changes in oil prices based on information on asset prices. He first develops a simple model of oil production at the firm level, which takes into account the fact that oil is a depletable resource, to motivate the classification of oil price shocks. He then estimates trivariate SVAR model in the change in oil price, an index for oil producing firms and innovations to the VIX, which allows him to extract oil demand and supply shocks. Identification is attained via short-run restrictions. The structural shocks are then projected into the market return, the aggregate CRSP stock index and a world-wide stock index from Global Financial Data. Unlike previous studies, Ready (2017) finds that both supply shocks and demand shocks have a significant effect on U.S. and world stock prices. Moreover, industries that produce consumer goods are more affected by supply driven shocks, whereas industries that are intensive in the use of oil as an input are more affected by demand driven shocks. Of course, unlike earlier studies, Ready's model is not designed to recover shocks to the global demand and supply of crude oil.

All in all, in the last decade or so, empirical investigations into the dynamic response of U.S. stock returns to oil price shocks have found evidence of a statistically significant relationship. First, unexpected increases in oil prices that stem from economic expansions or precautionary demand for crude oil appear to have a greater negative impact on stock returns than oil price increases that stem from curtailed oil production. However, recent investigations suggest the effect of supply driven shocks is stronger for stock returns of consumption goods whereas that of demand driven shocks is stronger for sectors that use oil intensively as an input. Second, whereas a linear model is a good approximation to the relationship between oil prices and aggregate U.S. stock returns, a nonlinear model appears to be needed for some disaggregate portfolios. Finally, it is worth noting that empirical investigations using data for other oil importing countries have found that oil price shocks have a negative or insignificant effect on stock returns (see e.g., Park and Ratti 2008, Cong et al. 2008, and Wang, Wu and Yang 2013). In contrast, for oil exporting countries such as Norway (Park and Ratti, 2008) the impact is positive.

6 The Effect of Oil Prices on Job Flows

As mentioned before, costly sectoral reallocation constitutes one of the transmission channels that amplify and generate asymmetries in the response of economic activity to oil price shocks. In this subsection, we review the literature that evaluates the empirical relevance of this transmission channel. In particular, we focus on the process of labor reallocation among firms.

Davis and Haltiwanger (2001) – hereafter DH – studied the effect of oil price shocks on aggregate and sectoral job creation and job destruction using a structural near-VAR model. Their empirical framework takes into account the possible asymmetry in the response of labor flows to oil price shocks by including the absolute change in their oil price index as a measure of oil prices in the near-VAR. Their findings indicate that oil price shocks have a stronger effect on job flows in manufacturing than monetary policy shocks. Moreover, their results show that job destruction is more responsive than job creation to oil price innovations. DH concluded that unexpected increases in the real price of oil have an asymmetric effect on the response of job creation and destruction in total manufacturing. These asymmetries can be directly related to the transmission mechanism through which oil prices operate. DH argued that if oil price shocks operate through aggregate channels, then an unexpected increase in the real price of oil will lead to a decrease in job creation and an increase in job destruction. However, they argued that if oil shocks primarily operate through the costly sectoral reallocation channel, then a positive oil price shock will lead to an increase in both job creation and job destruction implying a positive change in the gross job reallocation rate. Based on a visual examination of the impulse response functions, DH concluded that important asymmetries were evident in the responses of industry-level job creation and job destruction to a positive oil price shock. The magnitude of these asymmetries was larger for industries that have a higher degree of energy intensity, capital intensity, and product durability. For instance, DH found important asymmetries in the response of job creation and job destruction to a positive oil price shock in the transportation equipment industry. Their results imply that oil price shocks give way to important costly reallocation effects, which amplify the recessionary impact of oil price increases and diminish the expansionary impact of lower oil prices.

Kilian and Vigfusson (2011a,b; 2017) criticized studies that incorrectly incorporated censored variables as both regressands and regressors in censored oil price VAR models because they yield inconsistent estimates of the response to oil price shocks. In fact, they showed that these censored VARs produced biased estimates of the impulse response functions. Using the methodology proposed by KV (2011a), Herrera and Karaki (2015) – hereafter HK – reevaluated the empirical evidence on the effect of oil price shocks on job creation and job destruction. They first investigated whether job flows respond asymmetrically to positive and negative oil price innovations and found little evidence against the null of symmetry, especially after accounting for data mining. Then, they tested whether an unexpected increase in the real price of oil leads to a significant change in the job reallocation rate. A glance at their impulse response estimates suggests that oil price shocks have a significant effect on gross reallocation rates for several industries such as textiles, petroleum and coal, rubber and plastics and transportation equipment. However, they fail to reject the null of symmetry for job flows in most manufacturing sectors when data mining robust critical values are used. Finally, HK investigated whether the effect of oil price shocks on job flows had changed since the start of the Great Moderation. Their results indicate that oil prices have led to larger changes in the response of job reallocation since the mid-1980s, which can possibly be attributed to a change in the transmission mechanism through which oil prices operate.

Karaki (2018b) built on the work by Herrera and Karaki (2015) to investigate whether regional job flows respond asymmetrically to oil price increases and decreases. In line with Herrera and Karaki (2015), he found no evidence against the null of symmetry after using data mining robust critical values. His investigation contributed to the literature on regional U.S. business by showing that oil price shocks trigger limited job reallocation across U.S. states.

While DH and HK focused on the effect of oil prices on job flows in the manufacturing sector, Herrera, Karaki and Rangaraju (2017) – hereafter HKR – analyzed the effect of oil price shocks on job flows on various sectors of the U.S. economy (i.e., agriculture, construction, mining, utilities, manufacturing and services). They found the effect of oil price shocks on job creation and destruction for industries in the agriculture and utilities sectors to be limited. Nevertheless, they showed that an unexpected decline in oil prices reduces the pace of job creation for the oil and gas industry and decreases net employment in support activities for mining. Moreover, they found that an unexpected decline in the real price of oil leads to a decrease in the excess job reallocation rate, which indicates a reduction in the fluidity of labor markets within these industries. As for the services sector, the sector that has the largest share of employment in the U.S. private sector, HKR found that lower oil prices generate a significant reduction in the excess job reallocation rate for almost all industries. Their results indicate that following a decline in the real price of oil, jobs shift away from the oil and gas industry to industries in manufacturing, services and construction. As theory would suggest, the job creation rate tends to increase the most for industries that are energy intensive.

HKR make a novel contribution to the literature by evaluating whether the response of job creation and destruction is driven by changes in job flows from entering and closing firms or existing firms. Their results demonstrate that a year after the reduction in the real oil price, the increase in total private job creation is mainly explained by increases in job creation from expanding establishments in services and manufacturing. However, by the second year, the continued increase in job creation can be attributed to increases in job creation for both opening and expanding establishments in services, manufacturing and construction. As for the response of total private job destruction, HKR found that the increase in job destruction, a year after the shock, is accounted for by the pace of job destruction in closing establishments. Yet, at longer horizons, changes in job destruction for contracting establishments explain a larger part of the changes in total private job destruction.

In brief, recent empirical evidence suggest that changes in job flows play an important role in the transmission of oil price shocks to U.S. economic activity. In particular, unexpected oil price increases lead to significant declines in net employment growth for industries that use energy intensively but foster employment in the oil and gas industry. However, statistical evidence of an asymmetric response to oil price increases and decreases in aggregate job creation and job destruction is tenuous and is only found for a few energy-intensive sectors.

7 Oil Price Uncertainty, Information and Aggregate Economic Activity

Several theoretical models imply a negative effect of increased oil price volatility on real economic activity, consumption and investment. Hence, a strand of literature has aimed at empirically analyzing different aspects of uncertainty associated with oil price shocks. A related and complementary line of investigation has explored the impact of unexpected changes in oil prices on economic uncertainty as well as the effect of news regarding oil price changes. In this section we review the work related to these topics.

7.1 Oil Price Uncertainty

Lee, Ni and Ratti (1995) and Ferderer (1996) were possibly the first studies to explore the importance of oil price uncertainty in driving economic activity. Lee, Ni and Ratti (1995) investigated whether oil price shocks have a greater impact on the rate of growth of GNP in an environment where prices have been unstable than in a stable environment. To investigate this question they constructed a measure of oil price shocks –based on a Generalized Autoregressive Conditional Heteroskedasticity (GARCH), GARCH(1,1) model– that takes into account not only the magnitude but also the size of the forecast error. They found that positive shocks have a negative effect on economic activity, whereas the effect of negative shocks is statistically insignificant. Ferderer (1996), on the other hand, used a daily oil price index to compute a measure of monthly oil price volatility. He found that both the level and the volatility of oil prices helped forecast the rate of growth of industrial production. Furthermore, he found an asymmetric response of economic activity to oil price increases and decreases.

The work of Lee, Ni and Ratti (1995) and Ferderer (1996) contributed to the literature on the effects of oil price shocks on the macroeconomy in two important aspects. First, it highlighted the importance of accounting for the effect of the volatility of oil prices in forecasting economic activity. Second, it provided some empirical evidence in support of an asymmetric relationship between oil price changes and output growth. However, an important pitfall in these articles is the assumption that oil prices are exogenous with respect to the U.S. economy. In contrast, Elder and Serletis (2010) relaxed this assumption and allowed for lagged feedback from the U.S. economy to the price of oil.

Elder and Serletis (2010) estimated a bivariate GARCH-in-Mean VAR with oil prices and aggregate economic activity. Their estimates are indicative of a negative and significant effect of heightened oil price uncertainty on U.S. real GDP. They also find some evidence that the negative impact of oil price volatility is greater for durable goods and investment; this finding is consistent with the theories of investment under uncertainty and real options.

Jo's (2014) work deviated from previous studies by modeling oil price uncertainty as following a stochastic volatility process, instead of a GARCH process. This allows the first and second moments of the oil price to have their own innovation and, then, for the time-varying oil price uncertainty to enter in the mean equations of the VAR. In addition, her work differs from Elder and Serletis (2010) in that it tackles the effect of oil price uncertainty on global instead of U.S. economic activity. Jo (2014) found that an unexpected increase in oil price volatility that leaves unchanged the first moment of the oil price series would have a negative and persistent effect on industrial production. Jo (2014) findings are consistent with earlier theoretical literature such as Bernanke (1983). However, Jo(2014) findings are in contrast with earlier empirical and theoretical literature (see, e.g., Plante and Traum 2014) as they indicate that oil price uncertainty on itself –not in conjunction with an increase in the oil price level– has a detrimental effect on industrial production growth.

On a related topic, Kilian (2014) stresses that oil prices are an important part of the expected cash flow of oil companies and oil refineries, but they are not an important part of the cash flow for manufacturing companies. He suggests the reason why some studies find seemingly large negative effects of higher oil price uncertainty on investment by manufacturing companies is that oil price uncertainty may reflect macroeconomic uncertainty.[9]

Van Robays (2016) used a threshold VAR model that allows for nonlinearities in the response function, to assess whether macroeconomic uncertainty affects oil price volatility. The high/low uncertainty regimes are defined as periods in which world industrial production growth is higher/lower than a threshold value, which is estimated within the model. Conditional on being in a low or high uncertainty regime, Van Robays (2016) estimated the impact of oil supply and demand shocks on the real price of the oil. The estimation results indicated that higher macroeconomic uncertainty leads to higher oil price volatility. She found that oil demand and supply shocks have a large and significant effect on the real price of the oil in the high uncertainty regime.

Summing up, methodological advances in the modeling and estimation of uncertainty have deepened our understanding of the effect of oil price uncertainty on the U.S. economy in two important dimensions. First, new empirical evidence points to a negative effect of unexpected increases in oil price volatility on aggregate economic activity, even if the mean remains unchanged. Second, there appears to be a connection between uncertainty regarding global economic activity and the volatility of oil prices. Third, an unresolved problem is that standard measures of oil price uncertainty relate to short-horizons, whereas economic theory suggests that what matters is oil price uncertainty at much longer horizons (see Kilian, 2014). For example, when extrapolating monthly or quarterly GARCH estimates of the conditional variance to longer horizons, the conditional variance quickly converges to the unconditional variance. The latter is constant, so we would not expect a large recessionary effect.

7.2 Oil Price Shocks and Economic Uncertainty

A recent and fast growing strand of literature has investigated the effect of uncertainty shocks on aggregate economic activity. For instance, Baker, Bloom and Davis (2016) developed an index of economic policy uncertainty based on the frequency of newspaper articles that contain specific words related with economic policy uncertainty in the U.S. Following a similar strategy, Knotek and Zaman (2018) constructed an historical index of energy price news by computing the monthly frequency of articles in The New York Times that mentioned energy

[9] Oil and oil products are not an important part of cash flows of investment for most companies (see Kilian, 2014).

prices. However, they interpret their NYT index as a measure of the information available to the consumer and not the measure of policy uncertainty. Their paper started by estimating a multiple-regime threshold vector autoregressive model, which comprises energy inflation, energy inflation excluding food and energy prices, and real consumption growth. Estimation results using a Bayesian framework suggest that a model with two regimes (i.e., high and low energy inflation) is preferred over a non-switching model. Moreover, the results provide evidence of asymmetries and nonlinearities in the response of consumer spending to positive and negative energy price shocks. These asymmetries are more evident for large than for small energy price shocks. Knotek and Zaman (2018) proposed an information channel whereby oil price shocks could have an asymmetric effect on consumer spending. Namely, consumers are better informed about raises in oil price than regarding declines. The reason for this asymmetric flow of information is found in the asymmetric news coverage provided for oil price increases and decreases.

The reader might wonder why oil price shocks might matter for economic policy uncertainty. On one hand, Baker, Bloom and Davis (2016) suggests that heightened economic policy uncertainty can lead to lower investment, employment and production. On the other hand, the work by Knotek and Zaman (2018) suggests that consumers might be more attentive to news regarding energy prices when large oil price shocks hit the economy. If periods of higher oil prices come hand in hand with increased economic policy uncertainty, one could expect a future decline in economic activity.

Along this line of reasoning, Kang and Ratti (2013) investigated the effect of structural oil price shocks on economic policy uncertainty using a structural VAR model similar to Kilian (2009b). They find that shocks to oil production do not significantly affect economic policy uncertainty, whereas shocks to global real aggregate demand have a negative effect on economic policy uncertainty. Moreover, their results suggest that positive oil price shocks associated with increased precautionary demand for crude oil lead to a significant increase in U.S. economic policy uncertainty.

Kang et al. (2017) disaggregate oil production shocks by origin, US and non-US, and investigate their influence on US economic policy uncertainty. They argue that US economic policy uncertainty responds differently to these two types of shocks: an adverse US oil supply shock has a positive and statistically significant effect on economic policy uncertainty, whereas a non-US supply shock has no significant effect.

We conclude this section by remarking that this new strand of literature on the connection between news, economic policy uncertainty and oil price shocks opens interesting avenues of research. In fact, the renewed interest in understanding this link is not surprising given the large swings in economic policy uncertainty (Baker, Bloom and Davis, 2016) and the increased oil price volatility experienced around the Great Recession (Herrera, Hu and Pastor, 2018).

8 Have the effects of oil price shocks changed over time?

Since the oil price shocks of the 1970s bolstered a line of research into the macroeconomic effects of oil price changes, the crude oil market has experienced important transformations. Oil futures started trading officially in the New York Mercantile on March 30, 1983. This event roughly coincided with the decline in volatility experienced by the U.S. economy, commonly termed the Great Moderation. More recently, fracking has enabled oil producers to extract oil from tight formations and has considerably increased production in the U.S. (see e.g. Kilian 2016, 2017). Thus, a number of studies have explored the stability of the oil price-macroeconomy relationship since the mid-1980s.

Among the papers that explore changes in the response of the U.S. economy to oil price shocks after the Great Moderation, we highlight the work by Blanchard and Galí (2010) and Herrera and Pesavento (2009). The former started by noting that episodes of high oil prices in the late 1990s did not appear to have such a large impact on GDP growth and inflation as the oil prices shocks of the 1970s. To investigate the nature of this apparent change, they first estimated a SVAR where oil price shocks are identified by assuming that they are predetermined relative to the other macroeconomic variables and the model is estimated over two different sample periods, pre and post the Great Moderation. They found that the response of GDP growth, employment, prices and wages in the post-1984 period was muted relative to the pre-1984 period, confirming similar results for private consumption reported by Edelstein and Kilian (2009). Then, they used a new-Keynesian model with real wage rigidities where they analyzed three possible explanations: a decrease in real wage rigidity, an improved monetary policy response to oil price shocks, and a decrease in the share of oil in production and in consumption. Edelstein and Kilian (2009) and Kilian and Lewis (2009) provides compelling evidence against the two last explanations. In fact, work by Kilian (2008c, 2009a, 2009b) indicates that changes in the importance of the structural shocks underlying oil price fluctuations are the main drivers of the decline in the responsiveness of U.S. real economic activity.

As mentioned earlier, Herrera and Pesavento (2009) explored the contribution of better monetary policy in accounting for changes in the response of U.S. economic activity to oil price shocks since the Great Moderation. Their work suggests that better monetary policy during the Volcker-Greenspan era helped to dampen fluctuations in aggregate economic activity stemming for oil price shocks. As in Blanchard and Galí (2010), their study is based on splitting the sample at the time of the change and using time-invariant regressions.

The rapid increase in shale oil production and the recent swings experienced by the price of crude oil have rekindled the interest of policy makers and academics on the effect of oil price fluctuations. For instance, Baumeister and Kilian (2017) investigated the response of U.S. real GDP to the sharp drop experienced by oil prices after June 2014. They found that this decline resulted in increased real consumption and non-oil related business investment, which gave rise to a 1.3 percent expansion in GDP. Yet, this stimulus was largely offset by a decline of investment in the oil industry.

Herrera, Karaki and Rangaraju (2017) exploration into the effect of oil price changes on job reallocation during the period of the rapid shale expansion and the subsequent decline in oil prices is consistent with Baumeister and Kilian (2017). Indeed, their study revealed that the oil price decline had little impact on net employment; out of the 0.5 percentage points change in the net employment between 2004:I and 2014:IV, oil price changes contributed only 0.08 percentage points. Interestingly, regardless of the changes in the U.S. economy and the crude oil market, Baumeister and Kilian's (2017) and Herrera, Karaki and Rangaraju's (2017) investigations suggest that oil price decline still fail to stimulate aggregate economic activity.

Karaki (2018a) studied the contribution of structural oil price shocks on state-level unemployment during the shale boom period. He found that among oil supply shocks, aggregate demand shocks, oil-specific demand shocks, and the unobserved shock in unemployment, aggregate demand shocks contributed the most to explaining the changes in state unemployment rates for both oil producing and oil importing states.

Have the effects of oil price shocks changed over time? There appears to be ample evidence in the literature to suggest that this is the case. On the one hand, the effect of unexpected oil price increases on the U.S. economic activity seems to have diminished since the mid-1980s. The reason why oil price changes might not shock as much as earlier appears to be mainly related to a change in the composition of the shocks (supply versus demand driven). On the other hand, will the fracking revolution change the way in which oil price shock affect the U.S. economy? We expect that as more data become available, researchers will be able to tackle this question and study how the changes undergone by U.S. oil industry since the fracking revolution affect the response of the U.S. economy.

9 Conclusion and Policy Implications

This paper provided a survey of influential papers that investigated the effect of oil price shocks on U.S. economic activity. First, we discussed the different theoretical channels through which oil prices operate. In particular, we revisited the direct and indirect supply and demand channels that imply a symmetric/asymmetric response of economic activity to oil price increases and decreases.

We then reviewed the literature that seeks to disentangle the source behind oil price fluctuations and, thus, demonstrates that supply and demand driven shocks should be identified separately. We highlighted two insights derived from these studies. First, taking crude oil inventories into account is key for correctly identifying the effect of demand driven shocks. Second, demand driven shocks account for a larger percentage of fluctuations in oil prices than supply driven shocks.

Then, we summarized the results from recent empirical studies that investigated the effect of oil price shocks on U.S. real GDP, consumption, investment and stock returns. We examined how the literature evolved in the past 30 years and lead researchers to re-evaluate their beliefs regarding the consequences of oil price shocks. For instance, we noted that the development of improved econometric techniques led researchers to re-evaluate the notion that oil price increases and decreases have an asymmetric effect on aggregate economic activity, as well as more disaggregate macroeconomic variables such as the components of

GDP, stock returns and job flows. All in all, recent studies indicate that the relationship between oil price shocks and U.S. aggregate economic activity is well captured by a linear relationship, but some evidence of asymmetric responses is found at the more disaggregated level, at least for large shocks.

Moreover, our review expounded important developments in what was thought to be the contribution of the systematic response of monetary policy to higher oil prices. While there was a strong belief in the 1990s that monetary policy could exacerbate the recessionary impacts of oil price shocks, the recent literature shows little evidence for this claim.

Our comprehensive review of the literature highlighted that oil prices mainly affect the U.S. economic activity by disrupting consumption and investment. Several important lessons are derived from this rich literature. First, oil price shocks affect consumption mainly through the discretionary income channel and to a smaller extent through the operating cost channels. Second, the source behind the oil price shock matters for the dynamic response of consumption. While an oil price hike caused by curtailed oil production has little effect on consumption, demand shocks in the crude oil market have important effects on households' spending. Regarding investment, recent work has demonstrated that the recent oil price decline had a large adverse effect on investment in the oil sector. The role of oil price uncertainity and its impact on investment and aggregate economic activity remains an open question and has to be explored in future work.

We conclude our review by noting two new lines of research that appear to be growing quickly but are not reviewed in detail in this paper. On the one hand, there has been increasing interest in understanding the connection between economic policy uncertainty, oil price uncertainty and economic activity. The use of textual measures of uncertainty and the development of econometric techniques that allow researchers to separate the effect of shocks to the mean and the variance has encouraged the exploration of this connection. Moreover, the relevance of pursuing this line of research would seem to be increasing given the current political and economic climate. On the other hand, the fracking revolution has bolstered a line or research into the differences between the responses of conventional and unconventional oil production to changes in oil price shocks. Clearly, as additional microeconomic and time series data becomes available, researchers will be able to investigate the impact of the fracking revolution on the oil price-macroeconomy relationship.

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