

Cambridge Working Papers in Economics

Cambridge Working Papers in Economics: 1851

OIL PRICE VOLATILITY, FINANCIAL INSTITUTIONS AND ECONOMIC GROWTH

Uchechukwu Jarrett

Kamiar Mohaddes

Hamid Mohtadi

12 September 2018

Theory attributes finance with the ability to both promote growth and reduce output volatility. But evidence is mixed in both regards, partly due to endogeneity effects. For example, financial institutions themselves might be a source of volatility, as the events of 2008 suggest. We address this endogeneity issue by using oil price volatility as a source of exogenous volatility, to study the effect of finance. To do this, we use two empirical methodologies. First, we develop a quasi-natural experiment by studying the dramatic decline of oil prices in 2014 and beyond, using a synthetic control methodology. Our hypothesis is that the ability of oil-rich countries to mitigate the effects of this decline rested on the quality of their financial institutions. We focus on 11 oil-rich countries between 1980 and 2014 that had “poor” measures of financial development (treatment group) out of 20 such countries and synthetically create counterfactuals from the remaining (control) group with “superior” financial development. We subject both to the oil price shock of 2014. We find evidence that better financial institutions do indeed reduce output volatility and mitigate its negative effect on growth in the year that showed a sustained decline of the oil price. To address any remaining potential endogeneity between oil prices and finance, we further examine our findings by using a Panel CS-ARDL approach with 30 oil producing countries in our sample (and data over the period 1980-2016), illustrating that the effect of oil price volatility on growth is mitigated with better financial institutions. Our results make a strong case for the support of the positive role of financial development in growth and development.

Oil Price Volatility, Financial Institutions and Economic Growth*

Uchechukwu Jarrett^a, Kamiar Mohaddes^{bc} and Hamid Mohtadi^{cd}

^a Department of Economics, University of Nebraska, USA

^b Faculty of Economics and Girton College, University of Cambridge, UK
and Centre for Applied Macroeconomic Analysis, ANU, Australia

^c Economic Research Forum (ERF), Cairo, Egypt

^d Department of Economics, University of Wisconsin, USA
and Department of Applied Economics, University of Minnesota, USA

September 12, 2018

Abstract

Theory attributes finance with the ability to both promote growth and reduce output volatility. But evidence is mixed in both regards, partly due to endogeneity effects. For example, financial institutions themselves might be a source of volatility, as the events of 2008 suggest. We address this endogeneity issue by using oil price volatility as a source of *exogenous* volatility, to study the effect of finance. To do this, we use two empirical methodologies. First, we develop a quasi-natural experiment by studying the dramatic decline of oil prices in 2014 and beyond, using a synthetic control methodology. Our hypothesis is that the ability of oil-rich countries to mitigate the effects of this decline rested on the quality of their financial institutions. We focus on 11 oil-rich countries between 1980 and 2014 that had “poor” measures of financial development (treatment group) out of 20 such countries and synthetically create counterfactuals from the remaining (control) group with “superior” financial development. We subject both to the oil price shock of 2014. We find evidence that better financial institutions do indeed reduce output volatility and mitigate its negative effect on growth in the year that showed a sustained decline of the oil price. To address any remaining potential endogeneity between oil prices and finance, we further examine our findings by using a Panel CS-ARDL approach with 30 oil producing countries in our sample (and data over the period 1980-2016), illustrating that the effect of oil price volatility on growth is mitigated with better financial institutions. Our results make a strong case for the support of the positive role of financial development in growth and development.

JEL Classifications: C23, G20, F43, O13, O40, Q32.

Keywords: Oil price volatility, financial institutions, economic growth and development, and the resource curse.

* We are grateful to Magda Kandil and Jeffrey B. Nugent as well as participants at the 23rd Annual Conference of the Economic Research Forum and the Midwest International Economic Development conference for constructive comments and suggestions. Corresponding author: Kamiar Mohaddes (km418@cam.ac.uk).

1. INTRODUCTION

Theoretically, institutions of finance are supposed to promote economic growth via better capital allocation, the monitoring and influencing of firms' governance, the pooling of savings, and the promotion of specialization (Levine 1997, 2004). Theoretical considerations also extend to the contribution of finance to volatility reduction via its ability to allow agents to diversify risk. For example, Acemoglu and Zilibotti (1997) argue that better diversification enables a gradual allocation of funds to their most productive use, with more productive specialization reducing the variability of growth.

But the evidence on whether finance is growth promoting or volatility reducing are mixed. For example, while Levine (1997, 2004) shows that finance is growth promoting, Cecchetti and Kharroubi (2012) illustrate the advantages of finance in promoting growth exist only up to a certain point beyond which, they become a drag. Evidence on volatility reducing aspects of finance are equally mixed. For example, Braun and Larrain (2005) and Raddatz (2006) find that financial development reduces output volatility, while Easterly et al. (2000) find a U-shaped relationship between volatility and financial sector depth. Denizer et al. (2002) generally supports a negative correlation between financial depth and growth, consumption, and investment volatility, but Acemoglu, et al. (2003) and Beck et al. (2006) find that such a relation is not robust. A more recent paper by Dabla-Norris and Srivisal (2013) finds results regarding the volatility effects of finance that echo those found by Cecchetti and Kharroubi (2012) on the growth effects of finance: i.e., financial depth plays a significant role in dampening the volatility of output, consumption, and investment growth, but only up to a certain point. At very high levels, such as those observed in many advanced economies, financial depth amplifies consumption and investment volatility.

Most of the studies above are subject to some endogeneity issues that make establishing causality difficult. Consider the financial collapse of 2008 as an example. It is suggested that finance was actually the source of the crises and its associated volatility. However, if finance also helped to ameliorate further subsequent volatility effects that might have occurred, for example by allowing for greater risk diversification, then causal relation will not be easy to establish. But if we can find an exogenous source of volatility that is independent of finance, then we *can* examine causality. We find a nearly exogenous source of volatility in oil prices as they heavily impacted oil producing countries.¹ We then ask what the

¹ Note that the exogeneity assumption might not hold in practice where production decisions by some of the major oil producers, in particular Saudi Arabia, might have a significant contemporaneous impact on international oil prices. Mohaddes and Pesaran (2016), using a compact quarterly model of the global economy, formally test whether oil prices can be treated as weakly exogenous in the country-specific oil supply equations, and find that they cannot reject this hypothesis for all of the major oil producers, including Saudi Arabia and the United States. As for the potential impact of oil on finance, Zhang (2017) use a VAR approach and find that there may possibly be

effect of oil price volatility was on both the growth and the volatility of output among oil producers and whether financial institutions moderated the nature of the impact. The focus on oil producing countries rather than oil importing countries is because oil revenues often constitute a much larger source of revenues in oil producing countries than they constitute a component of expenditures in the oil importing countries. Moreover, the oil price collapse that occurred starting from the third quarter of 2014 and that plays a key role in the first part of our paper, is a “negative” volatility whose impact could not have been beneficial to oil producers.²

Because we use oil prices as our exogenous source of variation and study their effect on oil producing economies, our paper is also related to the oil curse literature, or more broadly, to the natural resource curse literature. Thus, we briefly review the relevant aspects of this literature. First, we note that the prevailing view of the natural resource curse, i.e., the alleged adverse effect of natural resource wealth on income or growth, has been challenged by those that show such an effect depends on the quality of the underlying institutions (Lane and Tornell, 1996; Mehlum et al., 2006; Robinson et al., 2006; Boschini et al., 2007) as well as those who shed doubt on the existence of the curse itself (Alexeev and Conrad, 2009; Azerki et al., 2017; Cavalcanti et al. 2011; Esfahani et al. (2014); Smith, 2015).³

Second, we note that in light of these challenges, a new strand of research has emerged that focuses on the *volatility* of resource wealth, instead. For example, Leong and Mohaddes (2011) and El-Anshasy et al. (2015) have shown that resource rent volatility negatively affects economic growth.⁴ But here again, the intermediating role of institutions arises. Using the Fraser chain-linked index of institutional quality, Leong and Mohaddes (2011) find that the negative effect of resource volatility on growth is moderated with higher quality institutions. By virtue of its focus on financial institutions, this paper is therefore also related to this last group of studies and is a further refinement of such studies. But

“some causality” from Brent prices to stock market (about a 23%). This would render our index of finance endogenous. For this reason, we further augment our SCM approach by using the panel CS-ARDL methodology in Section 3 to address any endogeneity issues; and show that our results are robust.

² See, for instance, Mohaddes and Raissi (2018) who make this point clear for macro aggregates (such as equity prices, GDP, and inflation) and not only for oil producing, but also of countries with high dependence on major oil producers (such as non-oil producing Middle East and North Africa countries).

³ For example, Alexeev and Conrad (2009) show that natural resources appear (falsely) to reduce growth rates because they boost base incomes and thus controlling for this effect, uncovers an underlying positive role of natural resources in economic growth. Azerki et al. (2017) use a highly exogenous instrument from the giant oil field discoveries dataset, to show that in the long-run oil boosts income. Similar conclusions are reached by Smith (2015). Cavalcanti et al. (2011), using the real value of oil production, rent or reserves as a proxy for resource endowment, illustrate that oil abundance has a positive effect on both income levels and economic growth. While they accept that oil rich countries could benefit more from their natural wealth by adopting growth and welfare enhancing policies and institutions, they challenge the common view that oil abundance affects economic growth negatively.

⁴ See also Mohaddes and Pesaran (2014).

because finance plays a particularly direct role in relation to volatility related issues, our focus on financial institutions is a more natural extension of the above studies.

We carry out our analysis in two ways depending on what we mean by oil price volatility. In the first approach, we view volatility as the dramatic drop that oil prices experienced starting from the third quarter of 2014. This allows us to consider this particular event as a quazi-natural experiment. Dividing oil producing countries into those with good financial institutions (control) and those with poor financial institutions (treatment) we study the effect of differences in financial depth across oil rich countries on their ability to deal with this dramatic oil price decline by synthetically constructing our counterfactuals for each treated country using the synthetic control technique originally pioneered by Abadie and Gardeazabal (2003). The advantage of this approach over the prevailing difference-in-difference methodology or its propensity score matching refinement is that the synthetic control approach overcomes the challenge of the selection of an appropriate control group. Such a group may or may not exist even in the absence of sampling errors, due to inherent uncertainties in the choice of a suitable control country (Abadie et al., 2010). The synthetic control method constructs a counterfactual that better aligns with the treated country along a variety of factors, reducing the pretreatment differences between the control and treated country.

In the second approach, our measure of oil price volatility is not event-based, but rather, based on the annual standard deviation of monthly oil prices over the period 1980 to 2016. For this we rely on data for 30 major oil producers and a regression approach using the cross-sectionally augmented autoregressive distributive lag (CS-ARDL) methodology (Cavalcanti et al., 2015, Chudik and Pesaran, 2015, and Chudik et al. 2016), which is estimated using the pooled mean group (PMG) estimation process (Pesaran et. al., 1999).

In what follows, Section 2 presents the methodology, estimation procedure, data, and results for the counterfactual synthetic control methodology, Section 3 does the same for the CS-ARDL methodology, and Section 4 provides concluding remarks and policy implications.

2. THE SYNTHETIC CONTROL METHOD

The synthetic control method is a counterfactual approach pioneered by Abadie and Gardeazabal (2003) hence forth known as AG. This is a variation of the difference-in-difference approach, but instead of a control group, determined by pre-intervention propensity matching, a *synthetic control* is constructed using a weighted average of potential controls to obtain the “best fit” that would closely match the treated unit’s pretreatment variables. AG use this methodology to study how terrorist activities in the Basque

region of Spain post 1960, reduced GDP per capita as compared to a synthetic control composed of other similar regions that were unaffected by the terrorism. An important modification of this methodology is a paper by Singhal and Nilakantan (2016) who study the effect, on economic performance, of counterinsurgency policies in India by comparing the performance of one specific region, Andhra Pradesh, which developed a specialty task force to combat the Naxalite insurgency, with a synthetic control of other similar states which did not have such a specialty task force. In Singhal and Nilakantan (2016), *all* states in India were impacted by the Naxalite insurgency but only Andhra Pradesh developed the task force. This is in contrast to the approach by AG in which treatment (terrorism) affected one region but not all.

Our method is more in line with Singhal and Nilakantan (2016) in that fluctuations in the world oil price affect *all* oil producing countries (analogous to terrorism in India), but the differences in the resulting volatility and growth across countries arises due to their *differing* level of financial development. To estimate possible mitigating impact of financial depth in this framework, the treated (control) countries are oil producers with “low” (“high”) levels of financial development.⁵ From this we construct a synthetic counterfactual (or control) for each treated country, where both the treated country and its counterfactual are similar in relevant aspects and especially in their dependence on oil (measured by oil to GDP ratios) but differ in their financial depth. A comparison of the predicted “outcome” in the synthetic control with the observed outcome in the treated country will tell us whether or not financial depth mitigates the effects of oil price volatility. The primary outcome variables are chosen to be output and growth as well as output and growth volatility, as these are the traditional performance metrics, and are the variables also involved in testing the natural resource curse hypothesis. We expect output and growth volatility to be lower and growth and output to be higher in the synthetic controls when compared to their treated counterparts. To test this econometrically, the differences in these measures are regressed on a dummy variable that represents pre- and post-oil decline with significant results of its coefficients telling a more encompassing story that helps us generalize findings across all treated countries.⁶

2.1 Methodology: Constructing the Synthetic Control Country

Consider a given set of control and treatment groups. Let $W = (w_1, w_2, \dots, w_j)$ be a $(J \times 1)$ vector of non-negative weights, where w_j is the weight applied to control country j in the resulting synthetic control corresponding to a given treatment country (if $w_j = 0$, there is no influence of country j on the synthetic

⁵ The split between “low” and “high” financial development is described in Section 2.2.

⁶ See later for expectations and implications of the signs and significance of these coefficients

control). Naturally, different vectors of \mathbf{W} will generate different synthetic controls. The optimal \mathbf{W} is obtained by minimizing the expression,

$$(\mathbf{X}_1 - \mathbf{X}_0\mathbf{W})'\mathbf{V}(\mathbf{X}_1 - \mathbf{X}_0\mathbf{W})$$

subject to $w_j \geq 0$ for all j and $w_1 + w_2 + \dots + w_j = 1$, where \mathbf{X}_1 is a $(K \times 1)$ vector of pretreatment GDP predictors for the treated country; \mathbf{X}_0 is a $(K \times J)$ matrix of the same K pretreatment GDP predictors for the J possible control countries, \mathbf{V} is a diagonal matrix of non-negative components reflecting the importance of different GDP predictors. AG suggests that the optimal choice of \mathbf{V} is one where the resulting synthetic control best matches the pretreatment GDP level of the treated country.⁷

The optimal weight vector \mathbf{W}^* is applied to the GDP of the control countries to obtain the resulting synthetic control. i.e. if we define \mathbf{Y}_1 as a $(T \times 1)$ vector of output levels for the treated country and \mathbf{Y}_0 as a $(T \times J)$ matrix of output levels for the control countries, the synthetic control for the treated country will be the $(T \times 1)$ vector \mathbf{Y}_1^* , such that

$$\mathbf{Y}_1^* = \mathbf{Y}_0\mathbf{W}^*.$$

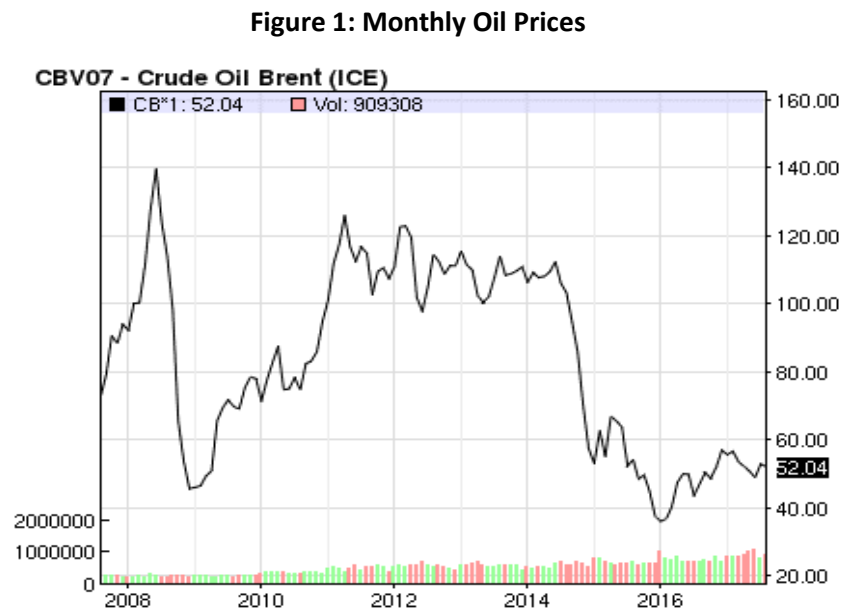
Given that the weights are derived from the pretreatment period, the differences between the treated country \mathbf{Y}_1 , and its synthetic control \mathbf{Y}_1^* , should be most prominent in the post treatment period as a result of change in the nature of the relationship between output and its predictors due to the treatment (i.e. if the treatment proves relevant). Thus, the difference between \mathbf{Y}_1 and \mathbf{Y}_1^* are attributed to the treatment. The degree of fit of the pretreatment variable of interest (in our case GDP) is what AG refers to as the root mean square prediction error (RMSPE). This is simply the sum of squares of the difference between the resulting synthetic control measures of GDP and the treated country's GDP in the pretreatment period. The output predictors used include the oil-to-GDP ratio, population, capital stock, initial level of output, imports, exports, trade-to-GDP ratios, capital restrictions (measured by the Chinn-Ito, 2006 index) and sovereign wealth funds, specifically, the value of the sovereign wealth fund each country possessed at the beginning of the oil price decline.⁸

⁷ To find the optimal vector \mathbf{W}^* , \mathbf{V} is initially assumed to be an identity matrix and an initial \mathbf{W}' is calculated. This \mathbf{W}' yields the best match to the treated country's GDP measure without taking into account the degree of importance of each of the predictors. Using this initial \mathbf{W}' , the optimal \mathbf{V} matrix is then calculated identifying the degree of importance placed on each predictor. Finally, \mathbf{V} is used to calculate the final optimal weight \mathbf{W}^* . \mathbf{W}^* takes the importance of the GDP predictors into account and provides a good fit to the treated country's pre-treatment GDP.

⁸ The ability of countries to draw on their sovereign wealth funds in order to dampen the negative effects of commodity price volatility is well documented in Mohaddes and Raissi (2017).

2.2 Estimation Procedure

As a step towards the goal of this paper we exploit the recent decline in oil prices in the third quarter of 2014 as a source of exogenous variation. As can be seen from Figure 1, the 2014 decline in the last nine years is second only to the fallout from the 2008 financial crisis (and not by much). Unlike the 2008 decline in which finance was the trigger for the crisis and subsequent reaction of the financial institutions that led to the mitigation of the crisis (Jarrett and Mohtadi, 2017), the 2014 decline has been attributed to a technology shock (shale oil extraction in the United States) and in this case, plausibly exogenous to financial depth in this regard.⁹ The technological advancements over the last decade have not only reduced the costs associated with the production of unconventional oil, but also made extraction of tight oil resemble a manufacturing process in which one can adjust production in response to price changes with relative ease. Therefore, one of the implications of the shale oil revolution is that U.S. production can play a significant role in balancing global demand and supply, and this in turn implies that the current low oil price environment could be persistent (see Mohaddes and Raissi, 2018). Moreover, a recent study has also found that output elasticity of unconventional new wells to price changes is 3-4 times conventional wells. This combination produces a floor for the oil prices that may be hard to escape (see, for instance, Bjørnland et al., 2016 and Mohaddes and Pesaran, 2017).



⁹ A clear example of this reaction by the financial institutions during the great recession is the increase in bank reserves as well as the reduction in lending activities. No such reaction was observed during the 2014 decline in oil prices making it exogenous to financial depth.

To determine the potential mitigating effect of financial depth on countries that suffer a significant deterioration of performance due to the drop in the price of oil, two factors need to be considered: first, to pay particular attention to oil rich/dependent countries as this would be the group most impacted by the shock; and the second, to sort the oil rich group into ones with “superior” financial depth and ones without. To accomplish these two goals, we first select countries in the 80th percentile in annual oil value to GDP ratio.¹⁰ Both the control and treatment group are then selected from this pool. Next, we choose a performance variable. Since all countries are equally exposed to the variations in the oil price, we must find a variable that transmits oil price volatility into country level effects to capture cross-country variations while also reflecting oil price volatility. The most commonly impacted variable is naturally the output level, making GDP an appropriate performance variable to use. Finally, we divide the selected countries into two groups; those above-median levels of financial development (Group A), and those below-median (Group B).¹¹ This cutoff was chosen with the number of countries in mind. If the cutoff is too high or too low, we would either no longer have enough countries in the control group with which to form appropriate synthetic controls or enough of the treated countries with which to make more general statements. Group A countries constitute the *potential* set for constructing the synthetic controls for each country in group B (the treated group).¹²

With these considerations, we have 26 countries with average oil to GDP ratio from 8.9% to 59%, and financial measure split between 16 treated countries in group B and 10 potential control countries in group A. From the selection of treated countries, we drop Egypt, Yemen and Venezuela because their political and social instability in post-treatment period, would certainly generate higher levels of output volatility that cannot be disentangled from volatility from oil price and as such, inclusion of these countries

¹⁰ Oil to GDP ratio is from Oil and Gas data (Ross, 2013), available at <http://thedata.harvard.edu/dvn/dv/mlross>

¹¹ The median used for this separation is the median of the average of all financial subset measures in the Fraser chain linked index that measures institutional quality, see section 2.3. The list of countries in each group is provided in the Appendix.

¹² To further emphasize the effect of financial depth, different cutoffs of financial depth were employed. Countries were split into two groups; one group above the 70th percentile level of financial development (Group A), and the second, having below the 40th percentile level of financial development (Group B) resulting in a sample of 15 countries with 9 treated countries in group B and 6 potential control countries in group A. There was some evidence in support of financial depth alleviating the negative effects of oil price volatility, but the results were mixed. The issue with this approach is the limitation in the number of potential control countries such that adequate synthetic controls may not be possible to construct. This limitation is also the reason why the fits obtained in the main analysis are not as accurate as some others in the literature, where what they study allows them to have more countries in their control “bucket”. The results for this analysis are not reported in this version of the paper but are available from the authors upon request.

will contaminate our results if left in our sample. We also drop Saudi Arabia given its singular ability to adjust extraction policies to influence changes in oil price which would potentially introduce treatment bias (see footnote 1).

In order to highlight the effect of financial depth, measures of financial depth themselves must be omitted from the set of output predictor variables that are used in the synthetic control construction since by design synthetic controls have higher levels of financial development than the treated country.

It is important to note that apart from our proposed indirect effect of financial depth on output through oil price volatility mitigation, there is also the well documented direct effect of financial development on output (see, for instance, Levine, 1997). This implies that we do not expect the pretreatment output levels to be a close match and should differ with varying degrees, depending on how much dispersion there is between financial development measures of the synthetic control and the treated country. Rather, than an obstacle to our analysis, we take advantage of this unique property by developing placebo tests in the following way: we make the erroneous assumption that countries in the control group with high financial development measures (Group A) have poor finances. We then create synthetic controls for each country in group A (one at a time) using the remaining control countries. First, we expect the output levels of both the synthetic control and the “treated” country in the placebo tests to better align due to resulting similar financial measures, i.e. we expect the synthetic controls of our placebo tests to have lower average RMSPE when compared with the average RMSPE of the treated countries. This will add an extra layer to our analysis and to the literature on the finance-growth nexus by showing the degree of importance of financial depth in determining levels of output when these placebo tests are carried out. Secondly, we would expect to see similar fluctuations in output in the pre and post treatment period for both the synthetic control and “treated” country in the placebo tests again as a result of similar financial depth measures. This will serve as verification that results picked up by the main test are valid.

We also rule out Chad from the main analysis due to a comparable lack of pretreatment fit of its synthetic control. While we allow some leeway for the pretreatment fit due to the absence of the financial depth measure in creating the synthetic control, the RMSPE for Chad is 3.5 standard deviations away from the mean of all countries in the treated group which average a RMSPE of 0.29. AG suggests that countries for whom adequate synthetic controls cannot be obtained (very high RMSPE) are outside the convex hull of the potential control countries. To intuit, this would otherwise amount to creating a synthetic control for the United States from countries in Sub-Saharan Africa. We therefore have 12 countries left in the treatment group. From this group, Nigeria is removed from the initial analysis as the country rebased its

GDP in 2013 just prior the treatment period under study, thus altering its measure of dependence on oil in the pre and post treatment periods. However, we draw on this particular example to make a separate point in Section 2.6 that ties well with our results while simultaneously providing valuable information about the natural resource curse literature.

2.3 Data

We use quarterly data (between 2006Q1 and 2016Q4), as this allows for more observations especially needed for the post-2014 period given that we only have three annual observations post 2014. Quarterly data is also very useful as it allows us to calculate annual volatility. For a majority of the countries with poor financial measures, quarterly observations on key variables are not reported and as a result, these variables need to be estimated. For the period chosen, quarterly data on imports and exports are the only data points available for the countries in our analysis. We therefore use these variables to generate quarterly output levels. To do so, we first obtain annual measures of import to GDP ratio, and then use the quarterly imports data to generate quarterly output measures for each country. Our assumption is that quarterly ratios remain roughly constant over the quarters within that year. We use this as our primary estimate of quarterly GDP given the relationship between imports and GDP and the well-established literature on marginal propensity to import resulting from changes in GDP (see, for instance, Chang, 1946, Shinohara, 1957 and Golub, 1983).

To further validate this as a viable measure, we obtain actual seasonally adjusted quarterly GDP data from 44 countries as well as their corresponding measures of quarterly imports and annual import to GDP ratios. We calculate GDP estimates based on the proposed system above and compare the estimates to the actual quarterly GDP measures. There is an overall correlation coefficient of 0.92, suggesting a significant relationship between the actual and our estimated output data. We also faced similar data restrictions with respect to the predictor variables. To overcome these limitations, we made similar assumptions that the variables remained constant across all quarters for each year, which is not unreasonable as we do not expect significant changes in capital stock and capital restrictions between each quarter of a particular year.

As a measure of financial depth, we turn to the financial components of the Fraser chain linked index of cross-country institutional quality. As a result, our measure of domestic financial depth is the average of the following sub-components of the Fraser chain index defined as follows:

- i. ownership of banks (oob) which measures the percentage of bank deposits held in privately owned banks where countries with a higher percentage of these deposits receive a higher “oob” rating;
- ii. private sector credit (psc) which measures government borrowing relative to private borrowing with higher government borrowing ratios receiving a lower rating. The assumption here is that greater government borrowing implies more central planning; and
- iii. interest rate controls (irc) uses data on credit market controls. Countries where interest rates are determined by the markets, countries with stable monetary policy and reasonable real deposit and lending rate spreads receive higher ratings (Gwartney et. al. 2015).

In general, these measures capture the degree of private financial freedom, assigning higher ratings to countries with greater financial freedom (giving them the ability to facilitate growth in their financial infrastructure) and lower ratings to countries with greater government or central control which financial market participants and researchers alike have suggested hampers financial growth. This measure differs from the more traditional indices of financial depth that measure observable outcomes (e.g, actual measures of private sector deposits and private sector lending) but instead capture a measure of the structural framework of the financial sector; its behavior and practices that tend to be stable over time. Therefore, we can make the claim that these countries do not necessarily become decentralized due to oil discoveries keeping our financial measures relatively stable in the pre and post treatment period. This implies that these measures are not subject to the potential reverse causality as a result of the findings of Beck and Poelhekke (2017) that suggest that oil price shocks can in turn influence the financial depth level. Since these financial indices are not affected, no such reverse causality exists.

2.4 Results and Interpretation

Table 1 shows the optimal weights assigned to each potential control country. To highlight the effectiveness of the matching process (with the preference slanted towards matching output levels), Table 2 shows the averages of the predictor variables for all treated countries and their corresponding counterfactual synthetic controls. The differences between the synthetic control and the treated group appear small, suggesting that the counterfactual and the treated countries are indeed similar at least with respect to these specific measures.¹³ However, given that oil volatility is an ongoing phenomenon, the oil

¹³ Since we place less emphasis on the fit of the level of the synthetic control and more on the volatility and growth differential, the corresponding graphs for the synthetic and treated countries are not as informative and as such are not reported here but are available upon request from the authors.

price decline of post-2014 period is not unique but one in the history of oil price volatility in the post-World War two period. As such, our approach does not contain a classic pre-treatment period in which control and treatment countries exhibit identical behavior. Rather, our control and treatment group differ by their financial depth and as such, the analysis we undertake below highlights the consequence of this difference for output by examining the relationship between the treated and control before and after the significant drop in oil prices.

[Insert Tables 1 and 2 here]

To provide a clearer picture and a conclusion that compares the performance of countries with high financial depth to those with low financial depth, the following regressions are run

$$ratio_output_{i,t} = \alpha_1 + \beta_1 dummy_{i,t} + \varepsilon_{1i,t} \quad (1)$$

$$ratio_growth_{i,t} = \alpha_2 + \beta_2 dummy_{i,t} + \varepsilon_{2i,t} \quad (2)$$

$$diff_output_{i,t} = \alpha_3 + \beta_3 dummy_{i,t} + \varepsilon_{3i,t} \quad (3)$$

$$diff_growth_{i,t} = \alpha_4 + \beta_4 dummy_{i,t} + \varepsilon_{4i,t} \quad (4)$$

Where *ratio_output* (*ratio_growth*) is the ratio of annual output (growth) volatility (treated volatility/control volatility) calculated from the resulting quarterly observations, *diff_output* (*diff_growth*) is the difference in annualized output (growth) between treated and control countries.¹⁴ The dummy variable is zero before 2014 and 1 after 2014. We expect β_1 and β_2 to be positive suggesting that the treated countries showed significantly more volatility than the control post 2014 with respect to output and growth. We also expect β_3 and β_4 to be negative suggesting that the treated countries had significantly lower output and growth post 2014 than their synthetic control.¹⁵

Table 3 captures the results from equations (1) to (4) above. Columns 1 to 4 show positive and significant coefficients as expected suggesting that the synthetic controls had less volatility due to their financial depth compared to their treated counterparts and this manifested as higher volatility in both growth and output post 2014. When we exclude the two countries (Cameroon and Indonesia) with oil-to-

¹⁴ The annual output (growth) volatility data is generated by computing the standard deviation of quarterly output (growth) in a given year. The growth rate of GDP is calculated as the first difference of natural logs of output. Note that the difference measure discussed here is always treated observations – synthetic control observations.

¹⁵ The smaller the difference in output or growth (less positive or more negative), the worse off the treated country is compared to the synthetic control

GDP ratios less than 10%, we observe that the coefficients are larger, giving credence to the idea that the ability of the financial sector to mitigate the negative effects depends on the degree of dependence.¹⁶

While a majority of the differences in output and growth are negative as was expected, none of them are significant. A possible explanation is that by 2016, the uptick in oil prices may have offset some of the negative effects observed in the 2014/2015 period. This effect should be especially pronounced with respect to the growth rate measures since a lower base value of GDP would exaggerate any increase in subsequent growth. To address this issue, the same regressions are estimated excluding 2016 and the results are summarized in Table 4. Concentrating on 2014 and 2015 only, we see negative and significant differences in output and growth in the post treatment period supporting the point above regarding the 2016 uptick in oil prices. Also, note that the results for growth are even stronger as expected per discussion above.

[Insert Tables 3 and 4 here]

2.5 Placebo Tests

Following the tradition in counterfactual methodologies, we perform placebo tests as a measure of robustness. To do this, we assume that the control countries with superior financial development measures actually have subpar financial measures and re-run the same analysis, one control country at a time. Each time a control country is being “treated”, it is removed from the control set.¹⁷

As hypothesized, the RMSPE in the placebo test is 0.133, slightly less than half of the RMSPE in the treatment group (0.299). This resulting better fit highlights the importance of the contribution of financial depth to output. The second and main point of the placebo tests is to determine if the effect found in the treated tests still persists when treated and synthetic controls have similar financial depth measures. According to our hypothesis, we expect that there should be no discernable difference in any of our variables before and after the reduction in oil price. In terms of our model, we expect much smaller and potentially insignificant coefficients β_1 , β_2 , β_3 and β_4 when compared to the same estimates in Tables 3 and 4 above.

¹⁶ This point will be formalized with the case study of Nigeria, see section 2.6.

¹⁷ This is in contrast to the methodology suggested by AG. AG uses the idea that if there is no real difference, the treated countries should also be introduced in the “bucket” of control countries used in forming synthetic controls for the placebo tests. Our approach takes things a step further and tries to show that this need not be done to show that the effect among financially deep countries is negligible. This suggests an even stronger repudiation of arguments against our findings compared to the standard approach by AG.

[Insert Tables 5 and 6 here]

To this end Table 5 replicates Table 3, from which we can see that the coefficients are far smaller and less significant than in Table 3, supporting the case for our main hypothesis that it is indeed the differences in financial depth that account for the differences in Table 3 between the pre and post 2014 periods. Columns 5 to 8 in Table 5 report the results for those countries that have much better fits¹⁸, being in line with the results from columns 1 to 4. To replicate the effect of differences in output and growth that take the uptick in oil price in 2016, Table 6 replicates the findings in Table 4 for the placebo tests as well. We see that one again, unlike Table 4, all coefficients are far smaller and statistically insignificant, suggesting that the effect of better financial depth is what is driving the results.

2.6 Nigeria the Oddity: Dependence Matters

In this section, which speaks more to the natural resource curse literature, we use the unique circumstances surrounding Nigeria's GDP as an experiment within an experiment to investigate the impact of oil dependence on the ability of the financial sector to mitigate the negative effects of oil price volatility. The premise is simple, Nigeria re-based its GDP measure in 2013 which saw its output grow by about 89% in one year. This revision took the non-oil sectors (mainly telecoms, manufacturing and the prolific entertainment industries) more prominently into account implying a lower dependence on oil in the post-2014 period compared to its pre-treatment period.¹⁹ We stipulate that, if the degree of dependence does not matter, we would expect to see similar results in Nigeria as we have encountered in the treated countries above, where post-2014 trend indicated higher comparative volatility (i.e. compared to their corresponding synthetic control). However, if dependence matters, we would see that Nigeria (the treatment country) is more volatile in the pre-2014 period than its financially advanced counterfactual and is less so when the degree of dependence on oil is reduced post 2014 after it's GDP has been rebased (despite the negative price shock and the synthetic control having greater financial depth, both of which should have implied even higher volatility for Nigeria post 2014).

[Insert Table 7 here]

¹⁸ These regressions exclude countries for which the nested option on Stata for synth estimation could not be used, resulting in much less precise fits.

¹⁹ See *Nigeria's GDP Step Change* in The Economist (April 12, 2014). <https://www.economist.com/news/finance-and-economics/21600734-revised-figures-show-nigeria-africas-largest-economy-step-change>

Table 7 highlights pre and post-2014 volatility measures as well as output and growth levels for Nigeria. From Table 7, we see that both output and growth volatility for Nigeria in the pre-2014 period was much higher when oil revenues made up a higher percentage of their GDP. In the post 2014 era however, we see that there is no difference in output volatility and an even smaller growth volatility when compared to its synthetic counterfactual. We find no discernable difference in average growth rates as all differences are insignificant but with respect to output, we see no difference in average output in the pre-2014 period²⁰, while the post 2014 period shows that Nigeria had higher average output levels when compared with the synthetic control, reflecting the reduced role of oil revenues in GDP. This strongly suggests that the ability of a country's financial sector to mitigate the negative effects of oil price volatility is positively correlated with the degree of dependence on oil, and as such, higher degrees of dependence on oil should be accompanied by higher financial depth.

3. The PANEL CS-ARDL MODEL

The results in Section 2 point to a significant effect of financial depth in mitigating oil price volatility, ultimately leading to higher levels of output and growth. To address concerns about the endogeneity between oil prices and finance (e.g. Zhang, 2017), we re-examine our earlier findings by extending the scope of our analysis to include more countries over a longer period of time as well as employing a different methodology – the cross-sectionally augmented autoregressive distributed lag (CS-ARDL) model.²¹ We are thus able to focus on four significant drops in oil prices between 1980 and 2016, namely 1986, 1998, 2009 and 2015. These four years indicate an unusually large drop in oil prices as will be explained shortly.

3.1 Methodology and Estimation Procedure

In an analysis such as this where institutional variables are involved, a high degree of persistence in the *level* of these measures is to be expected, rendering analyses that depend on taking a first difference or demeaning less than appropriate. An alternative would be to take five-year averages as is commonly done, but doing so eliminates some variation in other variables of interest such as the growth rate of oil prices

²⁰ This is to be expected given the way in which the counterfactual was created.

²¹ While this method is capable of addressing potential endogeneity issues, the drawback of this approach is the loss of sub annual data points for which to calculate annual output and growth volatility. As a result, this approach focuses on the eventual effects of financial mitigation on growth, given historic oil price volatility.

and its volatility. The CS-ARDL approach allows us to study the long-run effects of these persistent institutional variables in conjunction with the evolution of the more erratic behavior of oil prices using annual data. Moreover, in a series of papers, Pesaran and Smith (1995), Pesaran (1997), and Pesaran and Shin (1999) show that the traditional ARDL approach can not only be used for long-run analysis, but that it is also valid regardless of whether the regressors are exogenous or endogenous, and whether the underlying variables are $I(0)$ or $I(1)$. These features of the panel ARDL approach are appealing as reverse causality could be important in our empirical application. Furthermore, by employing a panel CS-ARDL model, we take into account cross-sectional dependencies in errors due to possible global factors (including the stance of global financial cycle) and/or spillover effects from one country to another which tend to magnify at times of financial crises.²² We therefore estimate the following equation:

$$\Delta y_{it} = \alpha_i + \sum_{l=1}^p \theta_{il} \Delta y_{i,t-l} + \sum_{l=0}^p \beta_{il} x_{i,t-l} + \sum_{l=0}^p \varphi_{il} w_{i,t-l} + \sum_{l=0}^p \delta_l \bar{y}_{t-l} + \sum_{l=0}^p \gamma_{il} z_{i,t-l} + \varepsilon_{it}, \quad (5)$$

where, y_{it} is the natural logarithm of real GDP per capita, Δy_{it} is the growth rate of real GDP per capita, and \bar{y}_t is the cross-sectional averages of y_{it} at time t , x_{it} is the growth rate of real oil prices (Δpoil_{it}), and w_{it} represents oil price volatility, driven by large price drops. To create this variable we interact realized real oil price growth volatility for year t , $\sigma_{\text{poil},t}$, constructed as the standard deviation of the year-on-year growth rates of the natural logarithm of real oil prices, $\text{poil}_{i\tau}$ during months $\tau = 1, \dots, 12$ in year t , with a dummy variable that takes the value of 1 during years of significant oil price drops and 0 otherwise. Therefore, in contrast to most studies in the growth literature which employ time-invariant measures of volatility, we are able to construct a time-varying measure of oil price volatility. Finally, z_{it} is a vector representing the interaction of the above measure (w_{it}) with the financial variables of interest, i.e. the financial components of the Fraser chain linked index of institutional quality explained in detail in Section 2.3. A comparison of models, one with estimates of w_{it} but without z_{it} and another with z_{it} but without w_{it} should provide evidence of the effect of the financial depth.²³ Comparing the coefficients of w_{it} and z_{it} , we expect the coefficients of z_{it} to be smaller so as to illustrate the effect of financial depth in mitigating the effects of negative oil price growth volatility

3.2 Data

We begin with an annual dataset comprised of 194 countries between 1980 and 2016. Note that we must allow for enough lags, p , such the residuals of the error-correction model are serially uncorrelated

²² See Chudik and Pesaran (2015) for details on cross-sectional adjustment.

²³ Since the only difference between these two specifications is the introduction of finance in the second interaction term z_{it} .

but not too many lags so that it imposes excessive parameter requirements on the data, i.e. allowing for enough degrees of freedom. Mohaddes and Raissi (2017) suggest capping the lags at 3 and this is the approach that we take. However, to allow for enough lags, sufficient time series observations for each country is needed, we therefore require each country to have at least 25 consecutive observations on y_{it} , x_t , w_{it} and z_{it} .²⁴

Because of missing observations for some of the countries in case of the institutional variables,²⁵ our sample is reduced to 62 countries. Moreover, since we are interested in countries that produce oil, we calculate the average of oil-value-to-GDP ratio for all countries in our dataset over a 30-year period and select only countries above the 50th percentile (which is a cutoff that includes countries that have at least an oil value to GDP of 0.09%). What remains is a sample of 30 oil producers with T greater than 25. Table 15 in the Appendix provides a list of the 30 countries, as well as their average financial measures and the ratio of oil value to GDP.

3.3 Results

Estimating equation (5) we present the long-run estimates of the CS-ARDL regressions in Tables 8-11. More specifically in Table 8 we examine the role of the domestic financial institutions as a whole; Table 9 examines the role of each subcomponent of financial institutions with Table 10 isolating the effect of financial institutions from overall institutions in general and finally in Table 11 we examine the effectiveness of the financial sector controlling, respectively, for differing degrees of openness. For each table, the first three columns are base regressions with which subsequent columns can be compared to show the effect of a variable in question.

[Insert Table 8 here]

In Table 8, the first three columns indicate that GDP growth is impacted positively and significantly by oil price growth and negatively and significantly by the oil price growth volatility in all three lag specifications. This provides support to that the fact that the oil curse, in the sense of oil abundance, is *not* the source of depressed growth in and of itself but that the volatility of its price *is*, being in line with

²⁴ Chudik et al. (2017) and Mohaddes and Raissi (2017) suggest the minimum T to be around 25 for each i .

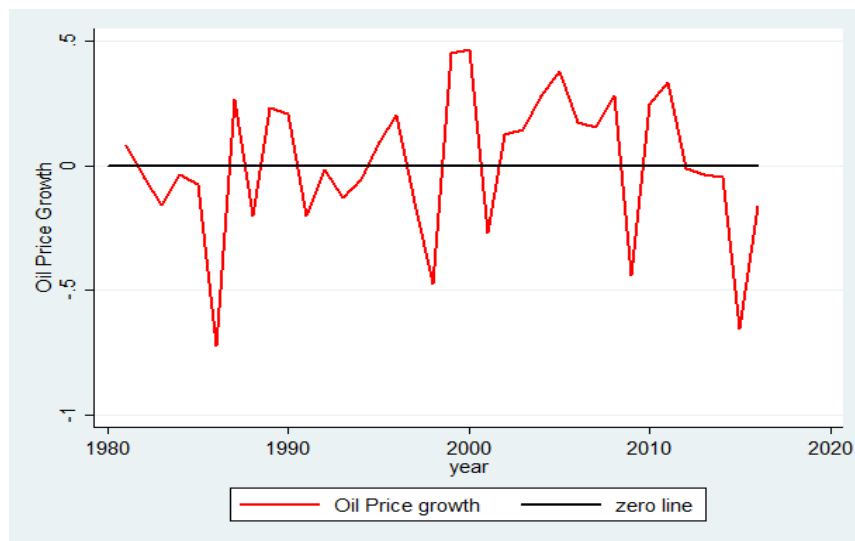
²⁵ While we have annual data on domestic financial institutions from 2000 onward, the data between 1970 and 2000 is reported at five year intervals only. However, since institutional variables change only very gradually over time, we obtain annual series for these variables from 1970-2014 by linearly interpolating each institutional variable on a country-by- country basis.

the most recent literature. The question is what is the effect of financial institutions in dampening this volatility curse.

3.3.1 The Role of Financial Institutions

Commodity prices are never entirely predictable and oil prices are no exception. However, moderate price fluctuations can be “expected” as the outcome of forecasting models within reasonable confidence bands and internalized by agents’ behavior as for example in firms’ and investors’ hedging strategies. Large shocks that deviate greatly from historical means, however, are often unexpected and this is where we would expect stronger financial institutions to better mitigate the resulting effects. The analogy to bank’s expected and unexpected loan default rates illustrates this point: expected loan defaults, those within certain standard deviation of the mean of the probability distribution of default, are considered idiosyncratic risks and allowed for in the loan reserves. However, unexpected defaults, i.e., those exceeding a pre-determined standard deviation from the mean, are considered part of systemic risk and only addressed by banks’ capital requirements. Under severe downturns as in 2008, banks with low capital were unable to survive the massive effect of default. Now consider Figure 2 below that shows oil price growth between 1980 and 2016. If we define unexpected shocks as those “out of the norm” when oil price shocks are greater than one standard deviation from the mean, we arrive at the “unexpected oil shocks” in 1986, 1998, 2009 and 2015.²⁶

Figure 2: Oil Price Growth, 1980 – 2016



²⁶ There are also periods that show positive oil price shocks, but we will only focus on the negative unexpected shocks as this is where we believe mitigation of financial institutions is most evident.

The fact that this approach includes the most recent large oil price drop provide us with a robustness check on the validity of SCM method which also focused on the same period. But since we are now also able to include other periods of large price drop here, our approach in this section goes beyond a robustness check and actually generalizes the hypothesis of the mitigating role of finance to any period where such a shock is experienced. Columns 4 to 9 of table 8 presents the results of this analysis.

As the first step, columns 4 to 6 introduce the measure of “negative oil shocks” which we have denoted as w_{it} in equation (5). This measure is constructed by the interaction of oil price growth volatility with a dummy variable which takes the value of 1, when oil price growth is negative *beyond* one standard deviation of the mean, and 0 otherwise, signifying unexpected negative oil price shocks. We see first and foremost that the magnitude of the coefficient of negative oil shocks is about *two and half times larger* than that of oil price growth volatility in columns 1 through 3. This suggests that a majority of the negative effects of volatility come from these large (and therefore likely unexpected) shocks, and that the “positive shocks” may have cushioned the overall effect of volatility, given the smaller coefficients in columns 1 to 3.

Our key results are shown in columns 7-9. Here, we examine the mitigating property of financial institutions in the face of large drops in oil prices. To do this, we interact the financial institutions index with our measure of negative oil shocks. Comparing columns 4-6 to columns 7-9, the strong mitigating role of financial depth in cushioning the effect of the negative oil shock is self-evident: the coefficients of “Finance” when interacted with “Negative Oil Shocks” in columns 7-9, although still negative, are far less than then negative effects of the corresponding coefficients of oil shock but without finance, about one tenth of the latter (i.e., -5.009 vs -0.309; -8.625 vs -0.893; -11.04 vs -0.868). This points to the benefits of strong financial institutions. Notice also that in columns 7-9 the coefficient of “Finance” itself is highly significant and positive. This reinforces the fact that the negative coefficient of the interaction term, comes entirely from the adverse effect of negative oil shock, not financial institutions. The mitigating effect of financial institutions in the presence of unexpected negative shocks echoes our finding of Section 2, where we used the SCM method. In the end however, finance can only cushion the blow, but not reverse it.

3.3.2 Decomposing the Financial Variables

Of interest is the financial mechanism by which risk is diversified and thus the volatility effect is mitigated. All three measures of finance as described in Section 2 are close proxies for the ability of the market to reflect risk premium and thus to allocate capital efficiently. With the measure of private sector credit, the

larger is the size of private sector credit relative to government borrowing, the less is the chance that credit is rationed via non-market and political methods and the greater the ability of the market to reflect risk premium. With the ownership of banks measure, less government bank ownership also suggests lower chances of credit rationing. The final measure of finance is a direct measure of the degree of interest rate control, the presence of which decreases the ability of the market to reflect risk premium eliminating the potential for efficient capital allocation. The ability for financial institutions to efficiently allocate capital is appealing as it has the potential to improve the productivity of capital and thus the rate of growth, describing in a bit more detail the way in which financial institutions can mitigate the effect of oil price growth volatility. Table 9 provides the results of each individual variable. Columns 1-3 provide the benchmark regressions. These are just duplicates of columns 4-6 of table 8. The rest of the columns repeat the pattern of columns 7-9 of table 8 in which finance interacted with deep negative oil shocks, repeating that pattern three times for each of the three subcomponents of financial depth.

[Insert Table 9 here]

The results in Table 9 indicate that, without exception, all sub-components of finance are capable of mitigating the impact of negative oil shocks, echoing the results found in Table 8. The strongest mitigation effect (measured by the degree of reduction in the size of the negative coefficient) belongs to the ownership of banks measure, followed by the interest rate control and private sector credit.

3.3.3 Openness and the Ability of Financial Institutions to Mitigate Volatility

As highlighted earlier, Chinn and Ito (2006) point to a connection between financial openness and financial institutions. Economic openness is a double-edged sword. On the one hand, it promotes growth, via specialization, economies of scale made in exports and reverse engineering via imports (see Bayoumi, Coe and Helpman, 1999; Datta and Mohtadi, 2006) and on the other, it acts as a pathway through which transmission of crises and volatility can spread, of which the former has been shown for the 2008 global financial crisis (Jarrett and Mohtadi, 2017). It is this latter effect that is of concern as it influences the ability of the financial sector to mitigate volatility by potentially adding extra sources of volatility. Studies of financial openness span the spectrum of outcomes; from those in which financial openness is identified as the culprit in the spread of crises (Ozkan and Unsal, 2012) to those that hail financial openness as a contributor to growth (Ranciere et. al. 2006; Schmukler, 2004). Studies of trade openness have not been exempt from this diversity of findings either, with findings ranging from those in which trade openness

reduces the impact of financial crises and contributes positively to growth (Cavallo and Frankel, 2008), to those in which it is a detriment, increasing the duration and the severity of crises (Classens et. al. 2010; Classens et. al. 2012). Given the wide-ranging opinions and evidence on the effects of economic openness, it is uncertain what role economic openness would play in the ability of financial institutions to mitigate the effect of oil price volatility. Furthermore, the volatility smoothing effects of trade, in particular, are less clear. An oil producer could potentially adjust its degree of trade openness by adjusting its production to export more (or less as the situation demands) in order to maintain a more stable revenue growth in the presence of oil price fluctuations (as seen more recently in Saudi Arabia). This raises the possibility that changes in the degree of openness is an important factor in identifying the efficacy of the financial sector in mitigating oil price volatility. While this issue has been addressed in the synthetic control methodology (which includes trade to GDP ratios as well as capital restriction measures), it has not been addressed, as yet, in the panel CS-ARDL approach. To properly identify the effects of the financial institutions, we introduce the following openness measures one at a time:

- i. Trade openness measure: the standard total exports plus imports as a fraction of GDP
- ii. The de-facto measure of financial openness/integration defined by Lane-Milesi-Ferretti (1997) as the sum of assets and liabilities as a fraction of GDP. We calculate these from international investment positions data provided by the IMF database from 1980 to 2010.
- iii. The Chin-Ito (2006) de-jure financial openness measure which captures the degree of capital restrictions with countries that have more capital restrictions getting a lower score.

Table 10 captures the mitigating effects of financial institutions in the presence of these openness controls. The table repeats the previous benchmark regressions in columns 1-3, followed by interaction effects in the presence of different measures of openness as controls. As can be seen, the estimates indicate the same dramatic reduction in the size of the oil shock effect when in the presence of strong financial institutions, and now also economic openness, pointing to the robustness of the previous findings.

[Insert Table 10 here]

3.3.4. Distinguishing Institutions at large from Financial Institutions

One counter argument is that countries with better financial institutions are those with better *overall* institutions and it is this latent variable that leads to these findings. In fact, several papers have argued

that for financial institutions to thrive, there must be a suitable institutional environment within the country. For example, Qian and Strahan (2007) suggest that the differences between institutions (especially legal differentials) drive the ownership of banks and terms of loans issued by said banks. The same focus on legal differentials is echoed by Chinn and Ito (2006) as they suggest that financial openness only leads to equity market development as long as the country has reached a certain level of legal development. To separate the effects of financial depth from other institutional measures, we turn again to the creation of the Fraser chained link index by Gwartney et al. (2015). In this index, several aspects of institutional quality are aggregated to create an overall measure of institutions.

We therefore test for the differential dampening effects of financial institutions and overall institutions by running the same set of regressions for the overall institutional measure and comparing its degree of mitigation to that of finance. Whichever variable shows a greater degree of mitigation when compared to our baseline, has the higher mitigating effect in the long run and the degree to which the mitigation differs is how much better (or worse) one variable is, when compared to the other.

[Insert Table 11 here]

Columns 1 to 3 of Table 11 present our baseline and columns 4 to 6 re-states the effectiveness of the financial depth measure. Columns 7 to 9 of Table 11 shows results of regressions run for institutions as opposed to financial depth. With the exception of the second lag specification, we see that the financial depth measure marginally outperforms the overall institutional measure in its ability to mitigate price volatility even though the latter has a stronger direct positive effect on long-run growth. Given the compositional nature of the Fraser chain linked index, the question remains, why is the mitigating effect of overall institutions less than that of one of its composite measures? To answer this question, we examine the correlation between the overall index and some of its components. From Table 12 we see that the financial measures have a high degree of correlation with the overall measure, while the non-financial components exhibit mostly large negative correlation with the overall measure (with only one showing a small positive correlation). All this strongly suggests that it is the dampening effect of finance, as opposed to other factors, that drives the mitigation effect of the overall Fraser chains index on oil price growth volatility.²⁷

[Insert Table 12 here]

²⁷ In an earlier version of this paper, we found that countries with high marks for court impartiality are also able to mitigate oil price volatility. Impartial courts matter probably because they reduce contract uncertainties in financial and property rights transactions and therefore are indirectly relevant, which is why we do not claim that the results are solely driven by financial depth but depending on the institutional measure under consideration, could go either way.

4. Conclusions and Policy Implications

Recent studies of the resource curse have discovered that the curse is driven, not so much by abundance itself, but by the volatility of the resource revenue. As a result, it has been suggested that better institutions may mitigate the negative growth effects of resource volatility. In this paper, which focuses on oil price volatility, we use this opportunity to develop a quasi-natural experiment in order to study the impact of financial depth by offering a more precise channel through which this mitigation of volatility is achieved. We investigate this proposition using first a synthetic control (counterfactual) method to capture the degree to which financial depth mitigates the negative effects of oil volatility and then panel CS-ARDL regressions (thereby, as opposed to much of the literature, taking into account all three key features of the panel: dynamics, heterogeneity and cross-sectional dependence).

The counterfactual exercise provides support to the idea that financial depth does indeed mitigate the negative effects oil price volatility. This is evidenced by the fact that the counterfactuals which posit an alternative scenario, where treated countries have higher financial depth measures, show a significant decrease in output volatility and higher growth rates in 2015, corroborating the idea that financial depth contributes positively to growth directly and indirectly through output and growth volatility mitigation. We also find evidence which suggests that better financial depth is required as the degree of dependence on oil increases.

Next, we verify and generalize our findings using the CS-ARDL approach for about 30 oil producing countries over three decades (1980-2016), that it is in fact oil price volatility that contributes to the oil curse, and that good financial institutions can help mitigate the negative effects of oil price volatility. We find that this is especially true during periods of unexpected negative oil price shocks. In all cases, we also find direct positive contribution of financial depth to growth. We are also able to separate the effect of financial institutions from institutions in general, addressing the endogeneity and causality problems that exists in such studies, and we show that it is indeed financial depth that drives the oil price volatility mitigation, providing some much-needed clarity in the literature. Finally, we find that in the presence of more openness via trade and finance, financial institutions are still able to mitigate oil price fluctuations and that better institutions overall (especially legal) improve the ability of a country to better mitigate oil price fluctuations.

The policy implications of this paper are quite clear, the adverse consequences of the volatility of natural resource income in general and oil in particular, can be mitigated with better financial institutions. For resource-rich countries (especially Middle East and North African countries) better financial institutions will go a long way in reducing the volatility curse when it comes to commodity price

fluctuations. This also serves as a lesson for Asian countries who are ramping up commodity production in general, as well as the Asian countries in our sub-sample such as Indonesia, Malaysia, Pakistan, Philippines, and Thailand; growth in oil production has to be accompanied with deeper financial institutions that are less centrally controlled. The flexibility of a freer financial system here allows for quicker market adaptation to oil and commodity price fluctuations so as to better allocate capital, leading to steady growth. In addition, countries must be sure to diversify their focus so as not to remain beholden to the whims of a volatile commodities market. As the experiment in Nigeria shows, growing other sectors as oil (and commodity) production increases, decreases the degree of dependence which leads to steadier growth and much less economy wide volatility. Finally, better developed institutions increase the ability of countries to better mitigate the negative effects of commodity price fluctuations. Armed with this knowledge, developing countries looking to natural resources to grow their economy can succeed where others have failed.

References

- Abadie, A. and J. Gardeazabal (2003). "The Economic Costs of Conflict: A case Study of the Basque Country". *American Economic Review* Volume 93, No. 1, pp. 112-132.
- Abadie, A. A. Diamond and J. Hainmueller (2010). "Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program". *Journal of the American Statistical Association* 105 (490).
- Acemoglu, D. and F. Zilibotti (1997). "Was Prometheus unbound by chance? Risk, diversification, and growth". *Journal of Political Economy* 105 (4).
- Acemoglu, D., S. Johnson, J. Robinson, and Y. Thaicharoen (2003). "Institutional Cause, Macroeconomic Symptoms: Volatility, Crises, and Growth". *Journal of Monetary Economics* (50):49-123.
- Alexeev, M. and R. Conrad (2009). "The Elusive Curse of Oil". *Review of Economics and Statistics* 91(3), 586-598.
- Arellano, M. and O. Bover (1995). "Another Look at the Instrumental Variable Estimation of Error-components Models". *Journal of Econometrics* 68(1): 29-51.
- Arezki, R., V. A. Ramey, and L. Sheng (2017). "News Shocks in Open Economies: Evidence from Giant Oil Discoveries". *Quarterly Journal of Economics* 132 (1): 103-155.
- Beck, T., M. Lundberg, and G. Majnoni (2006). "Financial Intermediary Development and Growth Volatility: Do Intermediaries Dampen or Magnify Shocks". *Journal of International Money and Finance* (25): 1146-1167.
- Beck, T., and S. Poelhekke (2017). "Follow the money: Does the financial sector intermediate natural resource windfalls?". *DNB Working Paper* No. 545.
- Bjørnland, Hilde C., and Leif A. Thorsrud (2016). "Boom or Gloom? Examining the Dutch Disease in Two-speed Economies". *The Economic Journal* 126.598: 2219-2256.
- Braun, M., and B. Larrain (2005). "Finance and the Business Cycle: International, Inter-Industry Evidence". *The Journal of Finance*, Vol. 60(3), pp. 1097-1128.
- Bayoumi, T., D. Coe and E. Helpman (1999). "R&D Spillovers and Global Growth". *Journal of International Economics* 47:399-428.
- Blundell, R. and S. Bond (1998). "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models". *Journal of Econometrics* 87(1): 115 -143.
- Boschini, A. D., J. Pettersson, and J. Roine (2007). "Resource Curse or Not: A Question of Appropriability". *Scandinavian Journal of Economics* 109(3): 593-617.
- Boileau, M. and T. Zheng (2015). "Financial Integration, Consumption Volatility, and Home Production," Manuscript, University of Colorado.

- Cavalcanti, T. V. d. V., K. Mohaddes, and M. Raissi (2011). Growth, Development and Natural Resources: New Evidence Using a Heterogeneous Panel Analysis. *The Quarterly Review of Economics and Finance* 51 (4), 305-318.
- Cavalcanti, T. V. D. V., K. Mohaddes, and M. Raissi (2015). Commodity Price Volatility and the Sources of Growth. *Journal of Applied Econometrics* 30 (6), 857-873
- Cavallo, Eduardo A. and J. A. Frankel (2008). "Does openness to trade make countries more vulnerable to sudden stops, or less? Using gravity to establish causality". *Journal of International Money and Finance* 27: 1430–1452
- Chang, T. (1945). "International Comparison of Demand for Imports. *The Review of Economic Studies* 13(2):53-67
- Cecchetti S. G. and E Kharroubi (2012). "Reassessing the impact of finance on growth". *BIS Working Papers*, No 381
- Chinn, M. D., and H. Ito (2006). "What Matters for Financial Development? Capital Controls, Institutions, and Interactions". *Journal of Development Economics* 81(1):163-192.
- Chudik, A. and M. H. Pesaran (2015). "Common Correlated Effects Estimation of Heterogeneous Dynamic Panel Data Models with Weakly Exogenous Regressors". *Journal of Econometrics* 188(2): 393-420.
- Chudik, A., K. Mohaddes, M. H. Pesaran, and M. Raissi (2016). Long-Run Effects in Large Heterogeneous Panel Data Models with Cross-Sectionally Correlated Errors. In R. C. Hill, G. Gonzalez-Rivera, and T.-H. Lee (Eds.), *Advances in Econometrics* (Volume 36): Essays in Honor of Aman Ullah, Chapter 4, pp. 85-135. Emerald Publishing.
- Chudik, A., K. Mohaddes, M. H. Pesaran, and M. Raissi (2017). Is There a Debt-threshold Effect on Output Growth? *Review of Economics and Statistics* 99 (1), 135-150.
- Classens, Stijn, G. Dell’Ariccia, D. Igan, and L. Laeven (2010). "Cross-Country experiences and Policy implications from the global financial crisis". *Economic Policy* 25(62) pp. 267-293
- Classens, Stijn, H. Tong and S-J. Wei (2012). "From the financial crisis to the real economy: Using firm-level data to identify transmission channels". *Journal of International Economics* 88: 375-387.
- Datta, A. and H. Mohtadi (2006). "Endogenous Imitation and Technology Absorption In a Model of North-South Trade". *International Economic Journal* 20: 431-459
- Dabla-Norris, E and N. Srivisal (2013). "Revisiting the Link Between Finance and Macroeconomic Volatility". *IMF Working Paper* WP/13/19.
- Denizer, C., M. Iyigun, and A. Owen (2002). "Finance and Macroeconomic Volatility". *Contribution to Macroeconomics* Vol. 2.
- Easterly, W., R. Islam, and J. Stiglitz (2000). "Shaken and Stirred: Explaining Growth Volatility" Annual World Bank Conference on Development Economics, ed. By B. Pleskovic and N. Stern (Washington: World Bank).

- Egorov, G., S. Guriev and K. Sonin (2009). "Why resource-poor dictators allow freer media: A theory and evidence from panel data". *American Political Science Review* 103(4): 645.
- El-Anshasy, A., K. Mohaddes, and J. B. Nugent (2015). "Oil, Volatility and Institutions: Cross-Country Evidence from Major Oil Producers". *Cambridge Working Papers in Economics* 1523
- Esfahani, H. S., K. Mohaddes, and M. H. Pesaran (2014). An Empirical Growth Model for Major Oil Exporters. *Journal of Applied Econometrics* 29 (1), 1-21.
- Fan, P., H. Mohtadi and R. Neumann (2016). "Financial Integration and Macroeconomic Volatility: The Importance of the Type and Direction of Capital Flows". Working Paper, University of Wisconsin.
- Frankel, Jeffrey A. (2010). "The Natural Resource Curse: A survey". *NBER Working Paper* 15836.
- Gwartney, J., R. Lawson, and J. Hall (2015). "Economic Freedom Dataset", published in *Economic Freedom of the World: 2015 Annual Report*.
- Jarrett, U. and H. Mohtadi (2017). "The Transmission of Great Recession: A Counterfactual Approach". University of Wisconsin and University of Nebraska working paper
- Golub, S. (1983). "Oil Prices and Exchange Rates". *The Economic Journal* 83(371): 576-593.
- Lane, P. R., and G. M. Milesi-Ferretti (2007). "The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970-2004". *Journal of International Economics* 73(2):223-50.
- Lane, P. R. and A. Tornell (1996). "Power, Growth, and the Voracity Effect," *Journal of Economic Growth* 1:213–241.
- Levine, R. (1997), "Financial Development and Economic Growth: Views and Agenda". *Journal of Economic Literature* 35(2): 688-726.
- Levine, R. (2005), "Finance and Growth: Theory and Evidence" in Handbook of Economic Growth, ed. by P. Aghion, and S. Durlauf, pp. 865–934 (Amsterdam: Elsevier).
- Leong, W. and K. Mohaddes (2011) "Institutions and the Volatility Curse", Cambridge Working Papers in Economics No. 1145
- Mehlum, H., K. Moene, and R. Torvik (2006), "Institutions and the Resource Curse", *The Economic Journal* 116(508):1–20.
- Mohaddes, K. and M. H. Pesaran (2014). "One Hundred Years of Oil Income and the Iranian Economy: A Curse or a Blessing?" In P. Alizadeh and H. Hakimian (Eds.), *Iran and the Global Economy: Petro Populism, Islam and Economic Sanctions*. Routledge, London.
- Mohaddes, K. and M. H. Pesaran (2016). "Country-Specific Oil Supply Shocks and the Global Economy: A Counterfactual Analysis." *Energy Economics* 59, 382-399
- Mohaddes, K. and M. H. Pesaran (2017). "Oil Prices and the Global Economy: Is it Different this Time Around?" *Energy Economics* 65, 315-325.

- Mohaddes, K. and M. Raissi (2018). "The U.S. Oil Supply Revolution and the Global Economy". forthcoming in *Empirical Economics*.
- Mohaddes, K. and M. Raissi (2017). "Do sovereign wealth funds dampen the negative effects of commodity price volatility?" *Journal of Commodity Markets*, 8, 18-27.
- Mohtadi, H., M. Ross and S. Ruediger (2014). "Do Natural Resources Inhibit Transparency?" ERF working paper 906, and Working Paper, University of Wisconsin-Milwaukee, University of Minnesota, UCLA, and Arizona State University.
- Mohtadi, H. M. Ross, S. Ruediger and U. Jarrett (2014). "Oil, Taxation and Transparency" Working Paper, University of Wisconsin and UCLA.
- Obstfeld, M. and K. Rogoff (1996). "Foundations of International Macroeconomics", Cambridge, MA: The MIT Press.
- Ozkan, F. G. and D. F. Unsal (2012). "Global Financial Crisis, Financial Contagion and Emerging Markets". *IMF Working Paper WP/12/293*
- Pesaran, M. H. (1997). "The Role of Economic Theory in Modelling the Long Run". *The Economic Journal* 107, 178-191.
- Pesaran, M. H. and Y. Shin (1999). "An Autoregressive Distributed Lag Modelling Approach to Cointegration Analysis". In S. Strom (Ed.), *Econometrics and Economic Theory in 20th Century: The Ragnar Frisch Centennial Symposium*, Chapter 11, pp. 371-413. Cambridge: Cambridge University Press.
- Pesaran, M. H., Y. Shin and R. P. Smith (1999). "Pooled mean group estimation of dynamic heterogeneous panels". *Journal of the American Statistical Association* 94(446), 621-634.
- Pesaran, M. H. and R. Smith (1995). "Estimating Long-run Relationships from Dynamic Heterogeneous Panels". *Journal of Econometrics* 68 (1), 79-113.
- Qian, J. and P. E. Strahan (2007). "How laws and institutions shape financial contracts: The case of bank loans". *The Journal of Finance*, 62(6), 2803-2834.
- Raddatz, C. (2006) "Liquidity Needs and Vulnerability to Financial Underdevelopment". *Journal of Financial Economics* (80):677-722.
- Ranciere, R., A. Tornell and F. Westermann (2006). "Decomposing the effects of financial liberalization: Crises versus growth". *Journal of Banking and Finance* (30): 3331-3348.
- Robinson, J. A., R. Torvik, and T. Verdier (2006). "Political Foundations of the Resource Curse". *Journal of Development Economics* (79):447-468.
- Ross, M. (1999). "The Political Economy of the Resource Curse." *World Politics* 51(2):297-322.
- Ross, M. (2011). "Mineral Wealth and Budget Transparency Working paper". UCLA, Department of Political Science.
- Ross, M. (2013). "Oil and Gas Data, 1932-2011". Available at <http://thedata.harvard.edu/dvn/dv/mlross>

- Ross, M. (2015). "What have we learned about the resource curse?". *Annual Review of Political Science* 18: 239-259.
- Schmukler, Sergio, L. (2004). "Benefits and Risks of Financial Globalization: Challenges for Developing Countries". *Economic Review Federal Reserve Bank of Atlanta*, Issue Q2 pp. 39–66.
- Shinohara, M. (1957). "The Multiplier and the Marginal Propensity to Import". *The American Economic Review* 47 (5):608-624.
- Singhal, S. and R. Nilakantan (2016). "The economic effects of a counterinsurgency policy in India: A synthetic control analysis". *European Journal of Political Economy* 45: 1-17.
- Smith, B. (2015). "The Resource Curse Exorcised: Evidence from a Panel of Countries." *Journal of Development Economics* 116:57--73.
- Stevens, P. and E. Dietsche (2008). "Resource curse: An analysis of Causes, Experiences and Possible Ways Forward." *Energy Policy* 36(1):56-65.
- The Economist (April 12, 2014). "Nigeria's GDP Step Change". www.economist.com/news/finance-and-economics/21600734-revised-figures-show-nigeria-africas-largest-economy-step-change
- Wick, K. and E. Bulte (2009). "The curse of natural resources". *Annual Review of Resource Economics* 1(1):139-156.
- Williams, A. (2011). "Shining a light on the resource curse: An empirical analysis of the relationship between natural resources, transparency, and economic growth". *World Development* 39(4):490-505.
- Zhang, D. (2017). "Oil shocks and stock markets revisited: Measuring connectedness from a global perspective," *Energy Economics* 62: 323-333.
- Zheng, Tianxiao (2015). "Financial Integration, Financial Frictions and Business Cycles in Emerging Market Economies," Manuscript, University of Colorado.

Table 1: Optimal weights of potential control countries

	Brunei	Kuwait	Oman	Qatar	Kazakhstan	Malaysia	Mexico	Norway	Trinidad
Algeria	0	0	0	0.266	0.628	0.009	0	0.097	0
Angola	0	0	0	0.039	0.267	0	0	0.693	0
Azerbaijan	0	0	0	0.244	0	0	0	0.756	0
Cameroon	0	0	0	0.833	0	0	0	0.167	0
Congo^{\$}	0	0	0	0.376	0	0	0	0.624	0
Ecuador	0	0	0	0.438	0	0.124	0	0.439	0
Gabon^{\$}	0	0	0	0	0	0	0	1	0
Indonesia	0	0	0	0.304	0	0.696	0	0	0
Iran.	0	0.401	0	0.012	0	0.587	0	0	0
Russia^{\$}	0	0	0	0.008	0	0.992	0	0	0
UAE	0.457	0	0	0	0.133	0.409	0	0	0.457

Notes: Each ijth cell is the weight assigned to the potential control country j in creating the synthetic control for the treated country i. Numbers sum up horizontally to 1. Each row is therefore the resulting optimal weight vector W^* for each treated country i. \$ represents countries estimated differently as the resulting Hessian matrix during the minimization process (nested option on stata) was asymmetric and could not be inverted. The non-nested option in stata was thus used to generate the counterfactual for these countries which resulted in one country matches.

Table 2: Predictor Variable comparison

	Algeria		Angola		Azerbaijan		Cameroon		Congo^{\$}		Ecuador	
	TC	SC	TC	SC	TC	SC	TC	SC	TC	SC	TC	SC
Capital Stock	14.11	13.77	13.30	12.76	11.49	12.46	11.65	13.11	11.03	12.61	13.06	13.10
Imports	23.01	23.66	22.20	22.18	21.33	21.65	20.92	22.42	20.64	21.82	22.29	22.40
Exports	23.47	24.07	23.22	22.82	22.20	22.45	20.84	23.22	21.55	22.62	22.24	23.09
Trade to GDP	0.69	1.35	1.09	1.15	0.84	0.93	0.46	0.82	1.37	0.90	0.61	0.85
GDP 2006: Q1	23.80	23.71	22.54	22.63	21.54	22.28	21.94	22.90	20.34	22.42	22.96	23.02
Oil Value	0.17	0.13	0.47	0.15	0.36	0.19	0.09	0.22	0.47	0.19	0.14	0.19
Ka_open	0.16	0.35	0.02	0.79	0.36	0.80	0.16	0.30	0.16	0.69	0.77	0.60
Population	17.40	16.72	16.86	15.00	16.02	14.71	16.83	16.19	15.21	15.04	16.51	15.77
SWF 2014:Q3	1.52	2.16	0.33	1.01	4.05	2.30	0.00	5.68	0.00	3.06	0.00	3.31
	Gabon^{\$}		Indonesia		Iran		Russia^{\$}		UAE			
	TC	SC	TC	SC	TC	SC	TC	SC	TC	SC		
Capital Stock	11.16	12.20	16.16	14.86	14.97	14.42	15.69	15.52	14.44	14.09		
Imports	20.46	21.32	24.16	24.40	23.51	24.02	24.77	25.15	24.60	23.83		
Exports	21.33	22.13	24.33	24.57	23.88	24.19	25.34	25.04	24.56	24.30		
Trade to GDP	0.88	0.97	0.51	0.66	0.47	0.78	0.50	0.61	1.54	0.90		
GDP 2006: Q1	21.15	22.02	24.69	25.21	24.45	24.73	25.42	26.12	24.78	24.63		
Oil Value	0.38	0.17	0.09	0.12	0.22	0.20	0.15	0.08	0.23	0.22		
Ka_open	0.16	1.00	0.58	0.54	0.40	0.81	0.54	0.69	1.00	0.65		
Population	14.24	14.10	19.30	17.98	18.12	17.10	18.78	18.57	15.84	16.70		
SWF 2014:Q3	0.10	0.90	0.00	2.03	0.48	0.57	0.52	0.07	11.92	7.19		

Notes: The table shows the average estimates of the predictor variables used to determine the optimal weights required to create the counterfactuals for each treated country. The average of all variables for each treated country is reported as well as the average for its corresponding synthetic control. TC represents the data for the treated country and SC represents the data for its corresponding synthetic control. \$ represents countries estimated differently as the resulting Hessian matrix during the minimization process (nested option on stata) was asymmetric and could not be inverted. The non-nested option in stata was thus used to generate the counterfactual for these countries which resulted in one country matches.

Table 3: Annualized regressions with post-treatment years 2014, 2015 and 2016

	All treated countries				Treated countries with >10% oil-to-GDP			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Output Volatility Ratio								
Oil price decline	1.486** (0.636)	2.291** (1.013)	1.486** (0.664)	2.291** (1.062)	1.777** (0.747)	2.736** (1.203)	1.777** (0.780)	2.736** (1.262)
Growth Volatility Ratio								
Oil price decline	1.503* (0.796)	3.303** (1.385)	1.503* (0.832)	3.303** (1.452)	1.767* (0.953)	3.860** (1.646)	1.767* (0.995)	3.860** (1.727)
Differences in Output								
Oil price decline	-0.0128 (0.114)	-0.134 (0.171)	-0.0128 (0.119)	-0.134 (0.180)	0.0138 (0.122)	-0.0941 (0.184)	0.0138 (0.128)	-0.0941 (0.193)
Countries	11	11	11	11	9	9	9	9
Observations	121	121	121	121	99	99	99	99
Differences in Growth								
Oil price decline	-0.111 (0.0788)	-0.0350 (0.177)	-0.111 (0.0827)	-0.0350 (0.186)	-0.0894 (0.0862)	0.00370 (0.193)	-0.0894 (0.0904)	0.00370 (0.203)
Countries	11	11	11	11	9	9	9	9
Observations	110	110	110	110	90	90	90	90
Year FE	NO	YES	NO	YES	NO	YES	NO	YES
Country FE	NO	NO	YES	YES	NO	NO	YES	YES

Notes: *,**,*** represent levels of significance at the 10%, 5% and 1% levels respectively. Oil price decline is a dummy variable that represents the cutoff point when the treatment takes place: 0 if before oil price decline and 1 after oil price decline. Output (growth) volatility ratio is annual output (growth) volatility of the treated country divided by the output (growth) volatility of the corresponding synthetic control. For these two measures, a positive estimate suggests that post oil price decline, the treated countries show more volatility than their counterfactual with better financial depth measures (from 0 to 1, ratio increases). Differences in output (growth) is the output (growth) of the treated country minus the output (growth) of the synthetic control. For these measures, a negative estimate suggests that as we move from pre to post oil price decline, output (growth) is lower in the treated country than in their synthetic control suggesting better performance for countries with better financial depth measures (from 0 to 1, the difference gets smaller).

Table 4: Annualized regressions with post-treatment years 2014 and 2015

	All treated countries				Treated countries with >10% oil-to-GDP			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Differences in Output								
Oil price decline	-0.0151 (0.0613)	-0.139*** (0.0485)	-0.0151 (0.0643)	-0.139*** (0.0512)	-0.00452 (0.0707)	-0.131** (0.0573)	-0.00452 (0.0742)	-0.131** (0.0604)
Countries	11	11	11	11	9	9	9	9
Observations	110	110	110	110	90	90	90	90
Differences in Growth								
Oil price decline	-0.183*** (0.0508)	-0.179*** (0.0651)	-0.183*** (0.0537)	-0.179*** (0.0691)	-0.173*** (0.0616)	-0.164** (0.0719)	-0.173*** (0.0649)	-0.164** (0.0762)
Countries	11	11	11	11	9	9	9	9
Observations	99	99	99	99	81	81	81	81
Year FE	NO	YES	NO	YES	NO	YES	NO	YES
Country FE	NO	NO	YES	YES	NO	NO	YES	YES

Notes: See Table 3.

Table 5: Annualized regressions with post-treatment years being 2014, 2015 and 2016 (placebo)

	All control countries				Control countries with better fits			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Output Volatility Ratio								
Oil price decline	0.417* (0.247)	0.245 (0.513)	0.417 (0.258)	0.245 (0.538)	0.530* (0.300)	0.415 (0.655)	0.530* (0.313)	0.415 (0.687)
Growth Volatility Ratio								
Oil price decline	0.430 (0.660)	1.185 (1.071)	0.430 (0.689)	1.185 (1.124)	-0.0251 (0.705)	0.340 (0.979)	-0.0251 (0.735)	0.340 (1.027)
Differences in Output								
Oil price decline	0.0321 (0.108)	0.0685 (0.146)	0.0321 (0.113)	0.0685 (0.154)	0.0333 (0.118)	0.165 (0.173)	0.0333 (0.123)	0.165 (0.181)
Countries	9	9	9	9	7	7	7	7
Observations	99	99	99	99	77	77	77	77
Differences in Growth								
Oil price decline	0.0339 (0.0682)	0.0807 (0.244)	0.0339 (0.0716)	0.0807 (0.257)	0.0866 (0.076)	0.209 (0.302)	0.0866 (0.0791)	0.209 (0.318)
Countries	9	9	9	9	7	7	7	7
Observations	90	90	90	90	70	70	70	70
Year FE	NO	YES	NO	YES	NO	YES	NO	YES
Country FE	NO	NO	YES	YES	NO	NO	YES	YES

Notes: See Table 3 but note that columns 5 to 8 in this table excludes control countries with poor fits.

Table 6: Annualized regressions with post-treatment years being 2014 and 2015 (placebo)

	All control countries				Control countries with better fits			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Differences in Output								
Oil price decline	-0.00448 (0.162)	-0.0046 (0.142)	-0.00448 (0.170)	-0.0046 (0.150)	-0.0554 (0.193)	-0.0119 (0.189)	-0.0554 (0.203)	-0.0119 (0.200)
Countries	9	9	9	9	7	7	7	7
Observations	90	90	90	90	70	70	70	70
Differences in Growth								
Oil price decline	-0.00493 (0.136)	0.00298 (0.157)	-0.00493 (0.144)	0.00298 (0.166)	-0.00799 (0.178)	0.0200 (0.207)	-0.00799 (0.187)	0.0200 (0.219)
Countries	9	9	9	9	7	7	7	7
Observations	81	81	81	81	63	63	63	63
Year FE	NO	YES	NO	YES	NO	YES	NO	YES
Country FE	NO	NO	YES	YES	NO	NO	YES	YES

Notes: See Table 3 but note that columns 5 to 8 in this table excludes control countries with poor fits.

Table 7: Results from the Special case of Nigeria

	Pre 2014: Q3			Post 2014: Q3		
	1	2	3	4	5	6
	TC	SC	TC/SC	TC	SC	TC/SC
Output volatility	0.55	0.18	3.06***	0.11	0.11	1.00
Growth Volatility	0.19	0.14	1.38**	0.08	0.14	0.57*
	TC	SC	TC-SC	TC	SC	TC-SC
Average Output level	24.85	24.86	-0.01	25.57	25.1	0.47***
Average Growth level	0.05	0.02	0.03	0.03	0.04	-0.01

Notes: *,**,*** represent levels of significance at the 10%, 5% and 1% levels respectively TC is treated country and SC is the corresponding synthetic control

Table 8: CS-ARDL using PMG: Baseline, Domestic Financial measures and Isolating unexpected negative shocks

	Growth Rates								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Oil price Growth	2.398*** (0.575)	1.314* (0.728)	3.469*** (0.971)	1.283* (0.672)	-1.424* (0.765)	-1.469 (0.943)	1.358** (0.654)	-0.648 (0.793)	-0.537 (1.010)
Oil price Growth Volatility	-2.161** (0.984)	-3.71*** (1.088)	-4.86*** (1.445)						
Negative Oil Shocks				-5.009*** (1.708)	-8.625*** (1.664)	-11.04*** (2.080)			
Negative Oil Shocks × Finance							-0.309 (0.200)	-0.893*** (0.230)	-0.868*** (0.295)
Finance							0.546*** (0.134)	0.763*** (0.120)	0.513*** (0.114)
Error correction	-0.76*** (0.0457)	-0.81*** (0.0585)	-0.75*** (0.0690)	-0.745*** (0.0452)	-0.815*** (0.0571)	-0.794*** (0.0677)	-0.773*** (0.0438)	-0.837*** (0.0613)	-0.880*** (0.0747)
Countries	30	30	30	30	30	30	30	30	30
Observations	990	960	930	960	930	900	990	960	930

Notes: Regressions are run using the pooled mean group estimator. The ARDL is cross sectionally adjusted using average output, but this variable is not reported. Standard errors in parentheses with *,** and *** representing significance at the 90, 95 and 99% confidence intervals. Columns 1, 4, and 7 represent an empirical model specification of one lag; columns 2, 5, and 8 have two lags and columns 3, 6, and 9 have three lags. Short-run estimates were included but not reported. Finance is the aggregate measure of financial institutions used in this analysis, which is a combination of bank ownership measures, private sector credit and interest rate controls. Negative oil shocks are constructed by the interaction of oil price growth volatility with a dummy variable which takes the value of 1, when oil price growth is negative *beyond* one standard deviation of the mean, and 0 otherwise, signifying unexpected negative oil price shocks. Comparing columns 4-6 to columns 7-9, the mitigating role of financial depth in cushioning the effect of the negative oil shock is quite evident: The coefficient of Finance X Oil shock although still negative, is less than one tenth the of the negative effect of oil shock without finance. This suggests the benefit of strong financial institutions (see table 9 for more on this effect). A versions of this table where the level of finance was introduced to columns 4-6 still showed significant reductions in coefficients of the interaction terms suggesting the reduction stems primarily from the interaction between finance and oil price volatility as opposed to just the level of financial depth. Results of this analysis are available from the authors upon request.

Table 9: CS-ARDL using PMG: Effect of financial measure subcomponents

	Growth Rates											
				Ownership of banks			Private sector credit			Interest rate controls		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Oil price	1.283*	-1.424*	-1.469	1.608***	0.529	0.873	1.391**	-0.679	-0.945	1.629**	-0.585	0.0805
Growth	(0.672)	(0.765)	(0.943)	(0.615)	(0.702)	(0.916)	(0.661)	(0.804)	(0.921)	(0.679)	(0.796)	(0.922)
Negative Oil Shocks	-5.009***	-8.625***	-11.04***									
	(1.708)	(1.664)	(2.080)									
Negative Oil Shocks × OOB				-0.399**	-0.603***	-0.925***						
				(0.186)	(0.177)	(0.245)						
OOB				0.313***	0.318***	0.286***						
				(0.0736)	(0.0604)	(0.0515)						
Negative Oil Shocks × PSC							-0.410*	-0.879***	-1.559***			
							(0.220)	(0.262)	(0.331)			
PSC							0.264**	0.480***	0.0757			
							(0.103)	(0.0834)	(0.0782)			
Negative Oil Shocks × IRC										-0.448**	-0.689***	-0.865***
										(0.186)	(0.187)	(0.239)
IRC										0.0463	-0.0520	0.222***
										(0.103)	(0.0912)	(0.0844)
Error Correction	-0.745***	-0.815***	-0.794***	-0.784***	-0.895***	-0.877***	-0.780***	-0.857***	-0.855***	-0.765***	-0.866***	-0.900***
	(0.0452)	(0.0571)	(0.0677)	(0.0472)	(0.0658)	(0.0786)	(0.0439)	(0.0628)	(0.0813)	(0.0438)	(0.0587)	(0.0731)
Countries	30	30	30	30	30	30	30	30	30	30	30	30
Observations	990	960	930	960	930	900	960	930	900	960	930	900

Notes: Regressions are run using the pooled mean group estimator. The ARDL is cross sectionally adjusted using average output, but this variable is not reported. Standard errors in parentheses with *, ** and *** representing significance at the 90, 95 and 99% confidence intervals. Columns 1, 4, 7 and 10 represent an empirical model specification of one lag; columns 2, 5, 8 and 11 have two lags and columns 3, 6, 9 and 12 have three lags. Short-run estimates were included but not reported. OOB is the ownership of banks measure, PSC is a measure of private sector credit and IRC is a measure of interest rate control. Negative oil shocks are constructed by the interaction of oil price growth volatility with a dummy variable which takes the value of 1, when oil price growth is negative *beyond* one standard deviation of the mean, and 0 otherwise, signifying unexpected negative oil price shocks. Comparing columns 4- 6, 7-9 and 10 to 12 to columns 1 – 3, the interaction between all sub components of the financial measure, and negative oil shocks is also much less negative, suggesting that better financial institutions as measured by each component, better mitigates the unexpected negative effects of oil price volatility.

Table 10: CS-ARDL using PMG: Robustness to inclusion of Trade and financial openness measures

	Growth Rates											
				Trade Openness			De-facto financial openness			De-jure financial openness		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Oil price Growth	1.283*	-1.424*	-1.469	1.417**	-1.062	-1.076	1.019	-1.237	-0.810	1.306**	0.242	0.318
	(0.672)	(0.765)	(0.943)	(0.646)	(0.754)	(0.788)	(0.637)	(0.759)	(0.817)	(0.648)	(0.752)	(0.866)
Negative Oil Shocks	-5.009***	-8.625***	-11.04***									
	(1.708)	(1.664)	(2.080)									
Negative Oil Shocks× Finance				-0.327	-0.845***	-0.716***	-0.370*	-0.917***	-0.836***	-0.347*	-0.763***	-0.692***
				(0.199)	(0.219)	(0.258)	(0.193)	(0.218)	(0.239)	(0.198)	(0.205)	(0.240)
Finance				0.575***	0.810***	0.493***	0.533***	0.725***	0.481***	0.639***	0.688***	0.612***
				(0.134)	(0.124)	(0.109)	(0.127)	(0.117)	(0.0929)	(0.149)	(0.126)	(0.107)
Trade Openness				0.0142	0.631***	1.106***						
				(0.144)	(0.180)	(0.221)						
De-facto fin Openness							-0.0186	0.00971	-0.0201			
							(0.141)	(0.109)	(0.0934)			
De-jure fin Openness										-0.396	1.307	1.462*
										(1.000)	(0.898)	(0.789)
Error Correction	-0.745***	-0.815***	-0.794***	-0.770***	-0.789***	-0.875***	-0.780***	-0.830***	-0.962***	-0.773***	-0.857***	-0.962***
	(0.0452)	(0.0571)	(0.0677)	(0.0389)	(0.0489)	(0.0819)	(0.0431)	(0.0599)	(0.0938)	(0.0444)	(0.0618)	(0.0835)
Countries	30	30	30	30	30	30	30	30	30	30	30	30
Observations	990	960	930	960	930	900	960	930	900	955	925	895

Notes: Regressions are run using the pooled mean group estimator. The ARDL is cross sectionally adjusted using average output, but this variable is not reported. Standard errors in parentheses with *, ** and *** representing significance at the 90, 95 and 99% confidence intervals. Columns 1, 4, 7 and 10 represent an empirical model specification of one lag; columns 2, 5, 8 and 11 have two lags and columns 3, 6, 9 and 12 have three lags. Short-run estimates were included but not reported. Negative oil shocks are constructed by the interaction of oil price growth volatility with a dummy variable which takes the value of 1, when oil price growth is negative *beyond* one standard deviation of the mean, and 0 otherwise, signifying unexpected negative oil price shocks. All columns show that financial depth mitigates volatility in the presence of different measures of openness.

Table 11: CS-ARDL using PMG: Separating financial institutions from aggregate institutional measures

	Growth Rates								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Oil price Growth	1.283* (0.672)	-1.424* (0.765)	-1.469 (0.943)	1.358** (0.654)	-0.648 (0.793)	-0.537 (1.010)	1.270** (0.641)	-0.141 (0.761)	-1.670** (0.729)
Negative Oil Shocks	-5.009*** (1.708)	-8.625*** (1.664)	-11.04*** (2.080)						
Negative Oil Shocks × Finance				-0.309 (0.200)	-0.893*** (0.230)	-0.868*** (0.295)			
Finance				0.546*** (0.134)	0.763*** (0.120)	0.513*** (0.114)			
Fraser							1.544*** (0.319)	2.174*** (0.303)	1.851*** (0.234)
Negative Oil Shocks × Fraser							-0.595*** (0.230)	-0.778*** (0.235)	-0.948*** (0.215)
Error Correction	-0.745*** (0.0452)	-0.815*** (0.0571)	-0.794*** (0.0677)	-0.773*** (0.0438)	-0.837*** (0.0613)	-0.880*** (0.0747)	-0.763*** (0.0438)	-0.822*** (0.0622)	-0.887*** (0.0859)
Countries	30	30	30	30	30	30	30	30	30
Observations	990	960	930	990	960	930	960	930	900

Notes: Regressions are run using the pooled mean group estimator. The ARDL is cross sectionally adjusted using average output, but this variable is not reported. Standard errors in parentheses with *, ** and *** representing significance at the 90, 95 and 99% confidence intervals. Columns 1, 4, and 10 represent an empirical model specification of one lag; columns 2, 5, 8 and 11 have two lags and columns 3, 6, 9 and 12 have three lags. Short-run estimates were included but not reported. Negative oil shocks are constructed by the interaction of oil price growth volatility with a dummy variable which takes the value of 1, when oil price growth is negative *beyond* one standard deviation of the mean, and 0 otherwise, signifying unexpected negative oil price shocks. Columns 4-6 show that financial institutions still mitigate volatility in the presence of the overall measure 7- 9 verify the mitigating strength of the aggregate institutional measure (Fraser chain linked index) and 10 -12 show that a combination of financial institutions and other institutional measures better mitigate the effect of oil price growth volatility. See section 3.3.4 for more details.

Table 12: Correlation coefficients between some components of the Fraser chain link index and the overall index

Sub components	Correlation with overall index
Financial Measures	
Ownership of Banks	0.9313
Private Sector Credit	0.7819
Interest Rate Controls	0.9597
Non-Financial Measures	
Hiring and Firing regulations	-0.4196
Gov. consumption	-0.5598
Transfers and subsidies	-0.3308
Judicial independence	-0.8283
Military interference in rule of law	-0.5156
Business costs of crime	0.1154

Appendix

Table 13: Data Sources

Variables	Sources
Ownership of banks	Fraser chain linked index data set
Private sector credit	Fraser chain linked index data set
Interest rate controls negative	Fraser chain linked index data set
Population	Penn World Tables
Government Consumption	Fraser chain linked index data set
Transfers and subsidies	Fraser chain linked index data set
Judicial independence	Fraser chain linked index data set
Impartial courts	Fraser chain linked index data set
Fraser chain linked Summary Index	Fraser chain linked index data set
Total assets and Liabilities	IMF International Financial Statistics Database
Seasonally adjusted quarterly GDP (for measure verification)	OECD Statistical database
GDP	World Bank World Development Indicator Database
Capital stock at constant 2011 national prices (in mil. 2011US\$)	Penn World Tables
Chinn-Ito Dejure measure of financial openness	http://web.pdx.edu/~ito/Chinn-Ito_website.htm
oil value to GDP ratio	Oil and Gas data Ross(2013) http://thedata.harvard.edu/dvn/dv/mlross
Trade to GDP ratio	World Bank World Development Indicator Database
Import to GDP ratio	World Bank World Development Indicator Database
Oil Price	United States department of energy via quandl.com and OPEC (opec.org)
Exports	IMF International Financial Statistics Database
Imports	IMF International Financial Statistics Database
Sovereign wealth funds	Sovereign wealth funds Institute

Table 14: List of control and treated countries

Treated Countries	% of oil value to GDP	Control countries	% of oil value to GDP
Angola	59.40%	Brunei Darussalam	33.20%
Azerbaijan	43.70%	Kuwait	48.20%
Congo, Rep.	59.40%	Oman	44.30%
Gabon	45.60%	Qatar	37.80%
Algeria	18.50%	Kazakhstan	25.30%
Cameroon	9.80%	Malaysia	8.50%
Ecuador	15.50%	Mexico	8.30%
Indonesia	9.10%	Norway	12.40%
Iran, Islamic Rep.	24.90%	Trinidad and Tobago	19.10%
Russian Federation	16.50%		
United Arab Emirates	26.01%		

Table 15: List of countries in the CS-ARDL sample

Country	Finance Measure	percent oil value of GDP
Argentina	6.90	4.37%
Australia	9.63	1.48%
Austria	9.03	0.16%
Benin	8.50	1.40%
Brazil	5.98	1.79%
Canada	9.84	3.44%
Chile	9.01	0.51%
Denmark	9.77	1.26%
Ecuador	8.00	15.46%
Egypt	6.04	14.42%
Ghana	6.79	0.48%
Greece	6.84	0.12%
Guatemala	8.93	0.74%
Hungary	7.98	0.82%
India	6.62	1.52%
Indonesia	7.33	9.13%
Iran	4.78	24.89%
Malaysia	8.60	8.48%
Mexico	8.37	8.29%
Netherlands	9.48	0.14%
New Zealand	9.44	0.57%
Norway	9.49	12.38%
Pakistan	7.29	0.75%
Philippines	8.75	0.20%
Thailand	8.70	0.78%
Tunisia	7.47	6.32%
Turkey	6.63	0.37%
United Kingdom	8.84	1.64%
United States	9.14	1.19%
Venezuela	7.56	28.52%