Dutch disease and the oil boom and bust

Brock Smith
Department of Agricultural Economics and Economics, Montana State University

Abstract. This paper examines the impact of the oil price boom in the 1970s and the subsequent bust on non-oil economic activity in oil-dependent countries. During the boom, manufacturing exports and output increased significantly relative to non-oil countries. These measures decreased gradually during the bust and subsequent period of low prices, displaying a positive relationship with oil prices. However, exports of agricultural products sharply decreased during the boom. Imports of all types of goods displayed strong pro-cyclicality with respect to oil prices. The results suggest that increased local demand and investment spillovers from the windfall resulted in increased manufacturing activity.

Résumé. Syndrome hollandais, flambée et baisse des prix du pétrole. Cet article étudie l'incidence de la flambée du pétrole dans les années 1970 puis l'effondrement des prix qui suivit sur les activités économiques des pays pétroliers non liées à l'or noir. Pour ces pays, au cours de la période de flambée des prix, les exportations et la production augmentèrent de façon significative, contrairement à celles des pays non pétroliers, puis diminuèrent graduellement au cours de la période de bas prix subséquente, établissant ainsi un rapport direct entre production/exportations et prix du pétrole. Néanmoins, au cours de la période de flambée des prix, les exportations de produits agricoles des pays pétroliers diminuèrent sensiblement. Les importations de marchandises de tous types affichèrent une forte procyclicité corrélativement aux prix du pétrole. Les résultats suggèrent que l'augmentation de la demande locale ainsi que les investissements liés aux retombées de la manne pétrolière engendrèrent une augmentation de l'activité manufacturière.

JEL classification: F14, Q35, O14

1. Introduction

Commodity prices have long been notable for their volatility, creating special economic circumstances in major producing countries. One commonly studied relationship in such countries is the effect of natural resource booms on non-resource economic activity. The literature on this topic has almost exclusively centred on the concept of "Dutch disease," a term

Corresponding author: Alessandro Cigno, brock.smith1@montana.edu

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coined by *The Economist* magazine in 1977 and referring to the Netherlands gas boom and manufacturing decline. The Dutch disease theoretical model first outlined by Corden and Neary (1982) posits that a boom in the natural resource sector shrinks the manufacturing sector through crowding out and an appreciation of the real exchange rate. Krugman (1987), Matsuyama (1992) and Torvik (2001) have argued that this could have harmful long-term economic consequences, suggesting that growth is largely driven by learning-by-doing in the manufacturing and agricultural sectors. This mechanism has been cited as a possible culprit for the "resource curse" found by Sachs and Warner (1995) and several subsequent papers, although the existence of the curse has been called into question by a few recent papers including Brunnschweiler and Bulte (2008), Alexeev and Conrad (2009) and Smith (2015).

While the Dutch disease model describes two specific mechanisms that decrease manufacturing output (the "resource movement effect" and the "spending effect," discussed in section 2), it does not account for other possible factors, such as government policies favouring industrialization, and thus does not make aggregate sectoral predictions. The question of how a resource boom affects manufacturing is therefore ultimately an empirical one. In this paper, I use a quasi-experimental, treatment-control design to evaluate the effect of the 1970s oil price boom and subsequent bust on manufacturing levels of oil and gas-dependent countries. Treated countries are those where oil and gas revenues are at least 3% of GDP as of 1972. Countries where net oil and gas imports exceed 3% of GDP are dropped from the control group, so the comparison is between countries receiving a positive income shock (in the case of price increases) and those not significantly affected. The overall approach is similar to Black et al. (2005), which evaluates various economic outcomes for coal producing counties in the United States during the similarly timed coal boom and bust.[1]

The 1973 and 1979 energy crises caused real oil prices to more than quintuple between 1973 and 1980, creating an enormous surge in revenues for oil-exporting countries. However, over the following eight years, prices dropped back to nearly their pre-1973 levels (in real terms). These price shocks constitute a plausibly exogenous source of resource revenues and thus a suitable test of the Dutch disease hypothesis. The roughly symmetric nature of the boom and bust allows us to test if price increases and decreases have symmetric effects on manufacturing and also reduces the possibility that the observed effects are due to pre-existing trends.

The key assumption of this paper is that the oil price shocks of the 1970s and 1980s are exogenous to individual countries and their economic behavior in other sectors. The causes of these shocks and their relative importance are an ongoing debate in the literature, but it is commonly argued that the rise of OPEC and other events associated with oil-dependent countries were

1 This paper had inconclusive results for the effects on the manufacturing sector.

strong contributors (see section 3 for a brief discussion). This could pose a problem if strategic decisions that affect the oil price are also associated with industrial or trade policy. While this is a caveat for this paper, it should not be a major concern since the analysis takes place at the individual country level and, with few exceptions, individual countries are unable to significantly influence the global oil market and take prices as given. Further, the 1973 oil embargo that instigated the oil boom was a short-lived and primarily political rather than economic affair; in addition, OPEC quotas were not introduced until 1982 (after the boom had ended) and were often ignored by member countries. Kilian (2009) finds that changes in the oil price since 1975 were overwhelmingly driven by shifts in aggregate global demand and oil-specific "precautionary" demand driven by fears of future supply shocks, but not by supply shocks themselves, which would raise more concerns regarding the exogeneity of price variation in this paper. Hamilton (2009) disputes Kilian's view but nonetheless states that the supply shocks "were brought about by largely exogenous geopolitical events." Hence there does not appear to be an obvious causal link from individual countries' economic activity to world oil prices.[2]

I find a significant positive effect on manufacturing exports and value added in oil-dependent countries during the boom period. While the year-on-year growth effects are not significant after the boom, level regressions show a gradual decline before levelling off in the 90s era of steady and low prices, so that manufacturing activity is roughly pro-cyclical with respect to oil prices. The delayed negative response to the oil price bust may be indicative of a ratchet effect: a revenue windfall may bring about a surge in manufacturing investment, while a subsequent decrease would not cause capital destruction, but possibly restrained growth in the sector.[3] I find similar effects for employment, wages and capital formation and value added per worker. The finding that wages and output jointly increased during the boom runs counter to the Dutch disease theoretical model. However, this is reconciled by the finding that capital formation and labour productivity likewise increased, suggesting investment spillovers into manufacturing. I further analyze the performance of different manufacturing subsectors, focusing on differences between oil-linked and non-oil linked sectors and tradable vs. non-tradable sectors. I find that subsectors of all types experienced significant growth during the boom.

2 There are arguable exceptions to this. One is the Iranian revolution, and the lengthy war with Iraq that followed. Another is the Iraqi invasion of Kuwait. I exclude these three countries along with Saudi Arabia (which is a big enough producer to influence prices on its own) as a robustness check.

3 Dix-Carneiro and Kovak (2017) find that, following Brazil's trade liberalization in the early 1990s, relative effects on wages and employment in regions with larger tariff cuts actually grew over time, counter to the theory that these effects should converge due to spatial arbitrage. They find evidence that this result is due to imperfect labour mobility and capital adjustment, akin to a ratchet effect suggested in the present study.

Unsurprisingly, downstream sectors consisting of refined products experienced especially strong growth.

Other results are indicative of the presence of Dutch disease mechanisms. There was a strong positive effect on real exchange rates. Imports of all types of goods were strongly and positively associated with oil prices, and net imports of manufactured goods actually increased in the majority of treated countries. Further, exports of agricultural products are negatively associated with oil prices, indicating a shift towards industrialization.

The results suggest two complementary explanations for the rise in manufacturing activity during the boom: first, the strongly positive effects of prices on imports across all types of sectors, along with effects on overall household spending, imply a positive shock to local demand for all types of goods, and this demand was met through a combination of increased imports and local production. This mechanism does not contradict the core theoretical model but is simply a consequence of the fact that manufacturing and the "non-booming traded sector" of the model are not one in the same, as a substantial portion of manufactured goods are indeed locally consumed, even in developing countries. Second, part of the oil revenue windfall was reinvested into manufacturing, possibly through taxation and state-directed investment, a mechanism not present in the theoretical model. Effects on both overall and manufacturing-specific capital formation support this explanation, as does qualitative evidence indicating that oil-rich countries undertook extensive industrial policies during the boom. Additionally, the exports results suggest that Dutch disease mechanisms do appear to be present, but are borne primarily by the agricultural sector.

The empirical literature on Dutch disease has traditionally been far less developed than the theoretical literature. However, a number of recent papers have examined local effects resources on non-resource sectors within a single country. Caselli and Michaels (2009) exploit differences in oil endowment across Brazilian municipalities, finding little effect on non-oil GDP. Cavalcanti et al. (2016) also find that oil discoveries in Brazilian municipalities have positive spillovers for manufacturing and services. Allcott and Keniston (2018) use an approach similar to this paper and find that oil booms increase manufacturing output in oil-rich United States counties. Somewhat in contrast with these papers, Aragon et al. (2015) find that the closure of coal mines in the UK caused increases in manufacturing employment in mining counties, indicating "reverse Dutch disease." As mentioned above, Black et al. (2005) find inconclusive effects of coal booms on manufacturing. The contrast of these latter two studies from the rest of the local effects literature may be explained by the fact that they evaluate the effects of coal mining, which is far more labour intensive than oil.

The empirical cross-country Dutch disease literature is somewhat less well developed. Sala-i-Martin (2003) uses a case study approach but does not find evidence of oil revenues harming the manufacturing sector. Rajan and Subramanian (2011) consider aid rather than resources as the windfall and find that aid-dependent countries experience slower growth in tradable manufacturing sectors relative to non-tradable sectors during the 1980s and 1990s.

Three other cross-country papers find results that run counter to those found in this paper. Stijns (2003) uses an augmented bilateral gravity model and finds that changes in oil revenues reduced manufacturing exports to relatively less oil-dependent countries. This design therefore does not measure overall manufacturing export activity as this paper does, but rather an average effect on many bilateral relationships. Ismail (2010) finds that year-to-year changes in oil revenues cause reductions in manufacturing at the sector level (with about 150 sectors included). Like Stijns (2003), this is not a measure of overall manufacturing activity, but an average effect at the sector level. This could be skewed by certain sectors that have large growth effects but may not comprise a large share of manufacturing output. Finally, Harding and Venables (2013) find a negative relationship between resource wealth and non-oil output/exports among oil-exporting countries (non-exporting countries are not included in the analysis as in this paper). One way this study is different is that it groups all non-oil sectors rather than isolating manufacturing as I do. I find that the effect on agriculture is negative and, if manufacturing and agriculture are combined, the results are non-significant (not shown). Another difference is that Harding and Venables (2013) include GDP as a control variable, so that the observed effects could be interpreted as compositional outcomes, while eliminating correlations with overall economic growth. All three of these papers provide interesting results but due to differences in design offer different interpretations from this paper, which is the first to my knowledge to apply a difference-in-differences design directly comparing total manufacturing outcomes between oil-dependent and non-dependent countries.

The rest of this paper proceeds as follows. Section 2 provides a brief outline of the Dutch disease theoretical model and relates it to this paper's results. Section 3 briefly describes the oil boom and bust and its causes. Section 4 outlines my empirical strategy and describes the data. Section 5 presents and discusses the main empirical results. Section 6 presents evidence of mechanisms that may explain the results. Section 7 concludes.

2. The core Dutch disease model

The core Dutch disease theoretical model was developed by Corden and Neary (1982) and expanded on in Corden (1984). The model assumes an open three-sector economy: a booming traded sector (assumed to be energy), a non-booming traded sector (manufacturing) and a non-traded sector (services). The two traded sectors have exogenously given world prices, while the non-traded sector is determined by internal supply and demand. All three sector outputs are a function of labour and capital. Labour is mobile between all sectors and subject to a single wage.

In the base model, the only source of a change in income is through the energy sector, either through a Hicks-neutral change in energy productivity or a change in the energy price. Such a windfall produces two effects. First, the rise in energy productivity draws labour into energy and out of manufacturing and services. This "direct de-industrialization" is called the "resource movement effect." The price adjustment to compensate for the resulting shortfall in supply for services is an increase in the real exchange rate, defined in this model as the price ratio of non-traded goods to traded goods. The second effect from an energy boom arises from the increased overall income in the economy, which increases demand for services, raising the price (and thus also increasing the real exchange rate) and drawing labour from manufacturing to services. This "indirect de-industrialization" is called the "spending effect." The net effect of an energy boom is ambiguous for services output, but not for manufacturing, for which both effects are negative.

Nevertheless, this paper finds that the 1970s oil boom coincided with increases in manufacturing, raising the question of which model assumptions may be violated, or what other effects may exist that the model does not consider. First, in the base model, the resource movement effect is predicated on labour being mobile between sectors.[4] But, in reality, the oil sector is not labour intensive. Karl (2007) calls oil "the world's most capital-intensive industry." Saudi Arabia employs less than 2% of its labour force in oil according to the *Encyclopedia of the Nations*.

Second, for stylistic purposes, the model calls the non-booming traded sector "manufacturing," but in reality manufactured goods are imported and produced for local consumption as well as exported so that the spending effect theoretically impacts some manufactured goods negatively and others positively, with an ambiguous net effect. Hence the positive result for manufacturing does not necessarily contradict the core model but rather serves as a caution against conflating manufacturing entirely with the stylized "traded sector" of the model.

Third, Corden and Neary (1982) and Corden (1984) themselves point out that real-world factors not considered by the core model could lead to a resource boom being a boon for manufacturing. Since the increase in oil income will be taxed or go directly to the government, it may invest the extra revenue in other sectors or in infrastructure that raises productively generally. Positive effects on capital formation and labour productivity suggest that the boom indeed caused capital investment spillovers into manufacturing. Qualitative evidence also suggests that oil-rich governments implemented extensive industrial policies during the boom (discussed further in section 6.2). Development of a model that incorporates a forward-thinking government trying to induce learning-by-doing in manufacturing could be a useful addition to the literature but is beyond the scope of this paper.

4 In more complex iterations of the model where capital is mobile only between services and manufacturing, Corden and Neary (1982) find that the resource movement effect (though not the spending effect) can be positive for manufacturing for a specific set of assumptions.

3. The oil boom and bust

Prior to the 1970s, oil had long been abundant and relatively cheap. The era of low, stable oil prices came to an end in 1973, when Egypt and Syria launched a surprise attack on Israel. When the United States provided Israel with substantial military aid, the Organization of Arab Petroleum Exporting Countries (OAPEC) declared an oil embargo to punish the US and other rich nations supporting Israel. Oil prices quadrupled between 1973 and 1974, and, although the actual embargo lasted for only six months, prices remained high as fears of unreliable supply gripped the industrialized world. Prices soared again in 1979 as a result of the political fallout from the Iranian Revolution. Starting in 1981, oil prices crashed for several years due to a combination of oversupply, diminished economic activity in industrialized nations and a shift to alternative energy sources. After prices finally bottomed out in the late 1980s, they once again remained relatively low and stable until the mid-2000s.

Figure 1 shows a graph of oil prices in current US dollars from 1962 to 1995, with vertical lines representing the boom and bust periods. The boom period is defined as 1974–1980, the bust period as 1981–1986 and the years 1987–1995 are classified as "valley" years. Although prices are not going uniformly up or down during these periods, the idea is to examine non-oil outcomes during long periods of upheaval in the global oil market. This helps to mitigate the issue of uncertain time frames of Dutch disease mechanisms; effects on manufacturing and other non-oil sectors may take a number of years to manifest. The semi-parametric levels specification of equation (1) in section 4 explicitly shows how

FIGURE 1 Oil price and boom/bust periods

FIGURE 2 Treatment group oil revenue

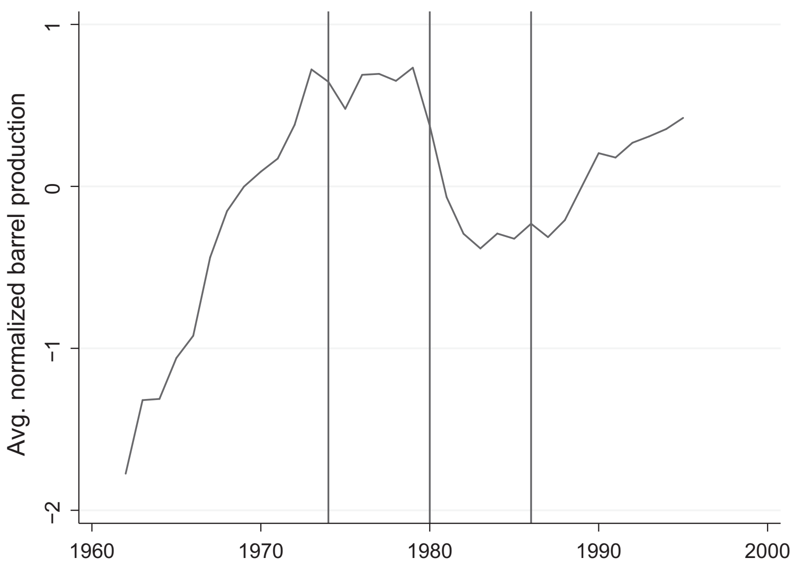

FIGURE 3 Treatment group oil production

differential outcomes evolved over time, and the specification of equation (2) analyzes average growth rate effects over the entire boom and bust periods.

Figures 1 to 3 demonstrate that fluctuations in countries' oil revenues were driven chiefly by price changes rather than treatment group production.

Figure 2 shows the average normalized[5] oil revenue of the treatment group over time. The shape of the revenue graph almost precisely tracks that of the price graph, in contrast to the average normalized oil production of the treatment group shown in figure 3. Production increases significantly prior to the price boom but actually flattens out during the boom period. Production does decrease at the beginning of the bust period. However, if production were driving prices, which would raise concerns about the exogeneity of price movements, we would expect prices to rise in response to the fall in production. Rather, the patterns in price and production are consistent with decreasing production as a response to a demand-driven fall in price. Further, there is no statistically significant correlation between annual changes in oil price and changes in aggregate production of the treatment group during the period studied.

This paper's strategy is to exploit the boom and bust as a test of a price-driven resource shock's effect on non-resource sectors. If the effects were positive during the boom years and negative during the bust years, it would be evidence of positive spillovers of the resource sector, and conversely for negative spillovers. If the effect were positive or negative during only one of the boom or bust periods but not the other, it would be evidence of asymmetric price effects. If effects are negative or positive during both boom and bust, it could be evidence of spurious or no effect of price. The "valley" period can arguably be interpreted as a kind of placebo test since prices are not significantly changing one way or the other. However, we will see that, for some outcomes, the trends that begin in the bust period carry over into part of the valley period.

4. Data and methodology

4.1. Data

Import and export data come from the NBER-UN World Trade Flows 1962–2000. This data set gives complete bilateral and total export and import flows organized by the four-digit Standard International Trade Classification (SITC), Revision 2.[6] Data on manufacturing value added, employment, wages and capital formation are taken from the United Nations Industrial Development Organization (UNIDO) INDSTAT3 series, which is organized by the two-digit International Standard Industrial Classification (ISIC), Revision 2. In all

5 Revenue was normalized by Z-score separately for each treatment country over the sample period. Figure 2 then shows the average Z-score by year. Figure 3 is similarly constructed. Normalization was used so that results were not driven solely by the largest producers.

6 To make the subsector export/import analysis comparable to the manufacturing analysis, I use the many-to-one SITC to ISIC crosswalk provided by Muendler (2009). This converts 784 four-digit SITC Revision 2 categories into 40 three-digit ISIC Revision 2 categories, including 29 manufacturing categories.

regressions (including exports/imports), the sample is restricted to cover the years 1968–1995 unless otherwise specified. This range is chosen first because it covers the relevant boom, bust and valley periods and also because it offers the best data coverage, particularly in the case of the INDSTAT3 data, which becomes quite sparse outside this range. Both data sources provide values in current US dollars. I deflate these values using the US Producer Price Index from International Financial Statistics (IFS).

The World Trade Flows and INDSTAT3 data sets offer different advantages and disadvantages. The major advantage for the trade data is excellent coverage during the sample period of 1968–1995, which covers all treatment countries and is very nearly a balanced panel for all trade outcomes analyzed. The advantage of INDSTAT3 data is that manufacturing value added is a more precise indicator of manufacturing activity and includes other useful outcomes to analyze as well. However, INDSTAT3 data coverage is incomplete for many countries, particularly developing countries. For all INDSTAT3 regressions, I restrict analysis to countries that have at least 10 observations over the sample period, which eliminates five of the 19 treated countries. Even after this restriction the panel is not balanced. Because of these limitations, I consider the estimates using trade data more reliable and present those first as the main results.

4.2. Methodology

Treatment country assignment is based on oil and gas dependence in 1972, the year prior to the oil embargo. For the main specifications, a country is assigned to the treatment group if oil and gas production exceeded 3% of GDP in 1972.[7] This rule yields a list of 19 treatment countries, listed in table 1 along with their 1972 hydrocarbon dependence.[8] Table 1 also indicates whether each country is covered in the UNIDO INDSTAT3 manufacturing data (all 19 countries are covered in the trade data).

Countries that are only slightly below the 3% threshold may still be affected by the price shock and are thus not desirable control countries. Therefore, I include only countries in which oil and gas production accounted for less than 1% of 1972 GDP in the control group. Countries that are between 1% and 3% are dropped from the main specifications. Additionally, to ensure that results are not driven by adverse effects on major oil importers, I drop countries with net oil and gas imports exceeding 3% of GDP as of 1972. I further address this concern by dropping all OECD countries as a robustness check.

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7 Resource production data come from UN Industrial Commodities Statistics, which provides production quantities of commodities for all countries and years from 1950–2001.

8 Exact 1972 oil dependence is unknown for Libya and the United Arab Emirates because 1972 GDP data are not available for those countries. But oil production was very significant for these countries in 1972 and there is no question of their inclusion in the treatment group.

TABLE 1
Treatment countries

Country	1972 dependence	UNIDO data?
Qatar	93.5%	N
Kuwait	74.9%	Y
Oman	72.4%	N
Saudi Arabia	65.1%	N
Iran	32.9%	Y
Gabon	27.1%	Y
Venezuela	19.2%	Y
Bahrain	15.0%	N
Trinidad and Tobago	15.0%	Y
Algeria	14.0%	Y
Nigeria	11.9%	Y
Iraq	10.9%	Y
Indonesia	9.8%	Y
Syria	4.8%	Y
Ecuador	4.1%	Y
Tunisia	3.6%	Y
Bolivia	3.5%	Y
Libya	Unknown	Y
United Arab Emirates	Unknown	N

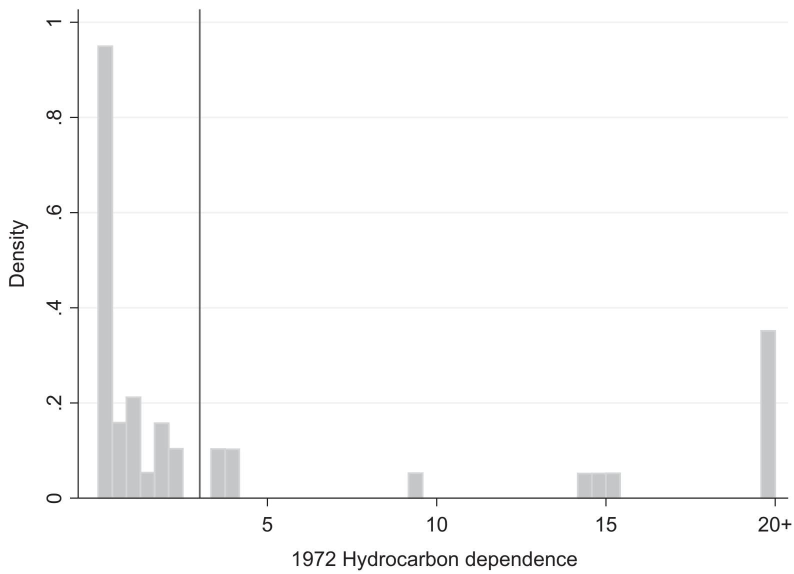

FIGURE 4 1972 oil dependence histogram

While necessarily arbitrary, the 3% threshold effectively separates the large mass of minor producers from more exceptional cases. This is shown in figure 4, which is a histogram of each country's 1972 hydrocarbon dependence, among countries with non-zero oil production. The vertical line is the 3% treatment group threshold. The graph suggests that another natural choice for the threshold would be 5% dependence. However, using this definition does not significantly alter the main results. Further justifying the threshold, the treatment group includes every country with non-trivial 1972 net exports of oil (with the arguable exception of the Republic of the Congo).

I also exclude from the sample countries that would be in the control group by the above definition but made significant oil discoveries during the period studied as this makes them inappropriate as controls.[9] Former Soviet Union countries are also dropped from the sample since, for these countries, data usually begin only after the collapse of the union, and there are other obvious confounding factors. Finally, I drop seven countries that experienced civil wars during the boom or bust periods (including one country, Angola, that would have qualified as a treatment country). These changes do not appreciably change the main results.

The binary treatment classification has appeal in that it allows for simple graphical representation of effects and does not rely on functional forms of hydrocarbon dependence. However, a fair amount of information on dependence is lost. I therefore additionally run an alternative specification that interacts 1972 hydrocarbon dependence with the boom, bust and valley periods, rather than binary treatment indicators. This specification and the results are shown in the robustness checks in section 5.5.4.

Summary statistics for treatment and control countries are shown in appendix table A1 for the year 1970, which is the earliest year that most fields are widely available and is shortly before the price boom. The treatment group has somewhat higher GDP per capita and smaller population, though in both cases the means are skewed by a few especially large countries and the medians are much closer. Manufacturing export levels and GDP shares are well balanced between the two groups, while the treatment group has a higher level of manufacturing imports. Also shown are exports for oil-related (upstream and downstream) and non-oil-related manufacturing exports (see the subsector analysis in section 5.3 for a list of oil-related sectors). Not surprisingly, oil-related sector exports are higher for treatment countries, while non-oil sector exports are lower.

The treatment group does have significantly lower manufacturing value-added levels. The reason this disparity is so different from that for manufacturing exports is that the INDSTAT3 data have less coverage than do the exports data. If the exports sample is limited to be the same as that for value added, a similar disparity results (not shown). This means that the difference is not driven by major relative differences in exports and value added within countries but merely by different sample compositions.

Finally, the average Polity IV democracy scores are measures of democratic institutions ranging from 1 to 10, with a score of 6 or higher roughly considered to be a democracy (Collier and Rohner 2008). While both groups have very low

9 These countries are Yemen, Equatorial Guinea, Papua New Guinea, Cameroon, Norway, Suriname, the United Kingdom, the Republic of the Congo and Israel.

average democracy values in 1970, the treatment group average is somewhat higher due to including some OECD countries. Partly for this reason, I remove OECD countries from the sample as a robustness check.

For the main outcomes, I estimate the following semi-parametric specification that describes level effects over time, which are presented graphically. This specification is meant to reveal how differential outcomes between the treatment and control groups evolved over the sample period:

$$ln(Y_{ct}) = (\sum_s \beta_s * I_s * T_c) + \alpha_c + \gamma_t + \epsilon_{ct}, \tag{1}$$

where Y_{ct} is the outcome of interest for country c in year t, I_s is a set of year indicators equal to one if $s = t$, and zero otherwise, T_c is an indicator for being in the treatment group (defined below), α_c is country fixed effects and γ_t is year fixed effects. This specification estimates a treatment effect β_s for every year in the sample, with 1972 as the reference year. β_s is thus the average difference in conditional outcome levels between treatment and control countries in year s, relative to the difference in 1972. Robust standard errors clustered at the country level are used for all regressions.

I also estimate the following specification, adapted from Black et al. (2005), to assess the impact of the boom and bust on annual growth rates. While the graphical level effects of equation (1) are meant to show broad trends in outcome effects over time, this alternative specification provides more concrete testing of hypotheses about growth rates during the boom and bust periods:

$$\begin{aligned}\Delta ln(Y_{ct}) = \beta_1(T_c * Preboom_t) + \beta_2(T_c * Boom_t) + \beta_3(T_c * Bust_t) \\ + \beta_4(T_c * Valley_t) + \beta_5 Exports_{1970-72} + \gamma_t + \epsilon_{ct},\end{aligned} \tag{2}$$

where the dependent variable is the year-on-year difference in natural logs of the outcome Y_{ct}, $Preboom_t$ is an indicator for years prior to 1974, $Boom_t$ is an indicator for being between the years 1974–1980, $Bust_t$ for the years 1981–1986 and $Valley_t$ for the years 1987–1995. Thus β_2 is the average difference in conditional outcome growth rates between treatment and control countries during the boom period, with β_1, β_3 and β_4 having similar interpretations for the pre-boom, bust and valley periods. $Exports_{1970-72}$ is the average level of exports per capita from 1970–1972 in the relevant sector being analyzed (initial exports are used in all regressions rather than value added due to superior data coverage). This is included to control for the possibility of convergence in sector output.

5. Results

5.1. Exports and imports

Figure 5 presents the graphical results of the exports/imports level regressions from equation (1), with vertical lines denoting the beginning of the boom, bust and valley periods. Each point on the graph represents the estimated treatment effect in the given year, with 1972 as the reference year. The dotted

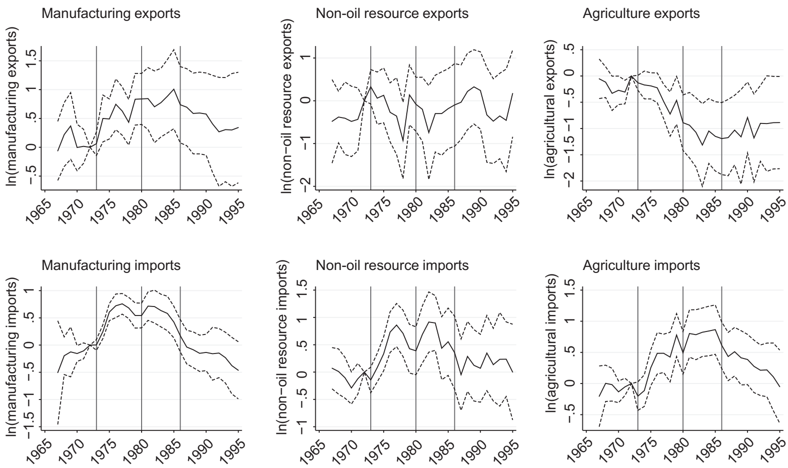

FIGURE 5 Exports/imports effects

lines represent 95% confidence intervals. Manufacturing exports rise sharply during the boom, and the effect is nearly .9 log points by the end of the period. Although effects stay generally steady during the bust period, they gradually decline thereafter before settling at a still positive but diminished level. Hence manufacturing exports exhibit generally pro-cyclical effects with respect to oil prices, albeit with delay following the bust. Manufacturing imports (and imports of all types) display similar behavior, sharply rising during the boom, indicating a sizable increase in demand for goods, then steadily declining thereafter, with small and insignificant effects in the long run.

More consistent with Dutch disease model predictions, agricultural exports[10] significantly decrease throughout the boom period before stabilizing, and the negative level effect persists in the long term. If demand for agricultural goods is inelastic, the increase in imports suggests that during the boom resources used for food production shifted to other sectors of the economy and local food production was displaced by imports. Alternatively, if agricultural supply is inelastic, increased local demand for food would keep more domestic production from being exported and may also raise imports. It is also important to note that, for various reasons, food prices were also rising during the oil boom period (Trostle 2008), so the effects on agricultural trade are likely affected by factors other than Dutch disease mechanisms originating from the oil boom.

While non-oil mineral exports[11] do decline during most of the boom period, the results are erratic throughout, which likely reflects that many countries have small mineral sectors prone to large swings.

10 All ISIC subcategories under "Agriculture, Hunting, Forestry and Fishing."

11 For each country–year observation, I sum together the export values for the ISIC categories "Coal Mining," "Metal Ore Mining" and "Other Mining."

TABLE 2
Total exports and imports

	(1) Manuf. exp	(2) Manuf. imp	(3) Non-oil res. exp	(4) Non-oil res. imp	(5) Ag. exp	(6) Ag. imp
Treat*Preboom	−0.004	0.076	0.144	−0.040	0.014	−0.019
	(0.054)	(0.082)	(0.100)	(0.042)	(0.028)	(0.044)
Treat*Boom	0.110**	0.076**	−0.083*	0.070*	−0.109**	0.095**
	(0.031)	(0.016)	(0.039)	(0.034)	(0.039)	(0.022)
Treat*Bust	−0.016	−0.063**	0.002	−0.002	−0.060	0.031
	(0.034)	(0.018)	(0.064)	(0.051)	(0.047)	(0.034)
Treat*Valley	−0.045	−0.071**	−0.000	−0.032	0.045	−0.074*
	(0.040)	(0.027)	(0.034)	(0.033)	(0.033)	(0.031)
Init. manuf. exports	0.006+	0.007**				
	(0.003)	(0.002)				
Init. non-oil res. exports			−0.012+	−0.000		
			(0.006)	(0.003)		
Init. ag. exports					0.003	0.003
					(0.002)	(0.003)
N.	3,041	3,040	2,763	2,762	3,033	3009
Countries	109	109	107	107	109	109
R-sq.	0.09	0.07	0.05	0.07	0.08	0.09

NOTES: The dependent variable is the year-on-year difference in logs of the outcome specified by the column header. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

Column 1 of table 2 presents the results of estimating equation (2) with year-on-year difference in the log of total manufacturing exports per capita as the dependent variable. During the boom, manufacturing exports grew by an average of .11 log points per year faster than in control countries. The effect is slightly negative but insignificant during the bust and valley periods and also insignificant in the pre-boom period. Manufacturing imports, shown in column 2, likewise grew significantly during the boom period and declined sharply thereafter.

It is important to note that although manufacturing exports grew at a higher rate than imports during the boom, net imports actually grew during this period in 16 of the 19 treatment countries, as would be expected given a rising exchange rate and an increase in local demand. This is because in all but two treatment countries imports of manufactured goods exceeded exports at the start of the boom period, often significantly so. Increasing net imports combined with increasing exports would be consistent with a version of the Corden and Neary (1982) model that specifies manufacturing as an intra-industry sector (in which products from the same sector are both imported and exported).

Columns 3 and 4 of table 2 report the export and import results for non-oil mineral exports. During the boom, there is a significant negative effect on non-oil resource export growth and a positive significant effect on imports.

However, the level regressions shown in figure 5 indicate that the pattern of non-oil resource exports is in fact rather erratic.

Consistent with the level effects in figure 5, during the boom there is a large and significant negative effect on agricultural exports, followed by small and insignificant effects. Agricultural imports grew significantly during the boom, with significant negative effects during the valley period.

5.2. Manufacturing outcomes

Figure 6 presents the graphical results of the level regressions from equation (1) for value added and other manufacturing outcomes from the UNIDO INDSTAT3 data set. Value added follows a similar pattern to that of exports, rising considerably during the boom (though not as much as exports on a percentage basis), peaking during the bust period and then gradually declining. For value added, there is very little long-run effect by the end of the sample period.

Dutch disease theory predicts that an oil boom should push up wages, which in turn reduces employment in the non-booming sector. We do indeed see a significant positive effect on manufacturing wages during the boom and part of the bust. However, there is also a positive effect on manufacturing employment during the boom. This could reflect increased local demand for manufactured goods coupled with low labour intensity of the resource sector. It could also indicate that investment in the manufacturing sector increased during the boom, pushing up labour productivity[12] and wages. This is supported by the large positive effect on capital formation (although due to limited data on this particular outcome, extra caution is warranted).

All outcome effects in figure 6 go into decline at some point after the boom with the exception of employment, which stays roughly flat after the initial rise. It is therefore primarily a fall in relative labour productivity that is responsible for the decreased output. This could again be partially explained by the capital formation results; the effect on capital formation begins falling just before the fall in productivity so that lower relative levels of capital may have caused decreased labour productivity and hence output.

Table 3 reports the results of estimating the growth specification of equation (2) for the UNIDO manufacturing outcomes. The results are similar for all outcomes and consistent with the graphical results of figure 6, with significant positive effects during the boom and generally negative but insignificant effects thereafter.

What is not clear from figures 5 and 6 is how much of the positive effect during the boom is due to increases within the treatment group and how much is due to decreases in the control group (and same for subsequent patterns). Appendix figure A1 offers clarification. This plots the mean residuals, separately for treatments and controls, from regressions of log manufacturing

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12 Labour productivity is not given directly in the INDSTAT3 data, so I construct it by dividing total value added by total employment.

FIGURE 6 Manufacturing outcomes

TABLE 3
Manufacturing outcomes

	(1) Value added	(2) Employment	(3) Wage	(4) Cap. formation	(5) Productivity
Treat*Preboom	−0.012	0.019	0.006	0.033	−0.016
	(0.020)	(0.012)	(0.011)	(0.055)	(0.020)
Treat*Boom	0.065**	0.045**	0.043**	0.080*	0.032+
	(0.021)	(0.009)	(0.011)	(0.041)	(0.018)
Treat*Bust	0.005	−0.022	0.015	0.027	0.037
	(0.033)	(0.018)	(0.030)	(0.057)	(0.040)
Treat*Valley	−0.019	0.019	−0.059*	0.002	−0.024
	(0.025)	(0.015)	(0.025)	(0.047)	(0.024)
N.	1,742	1,808	1,651	1,133	1,683
Countries	78	79	73	54	73
R-sq.	0.11	0.08	0.09	0.05	0.09

NOTES: The dependent variable is the year-on-year difference in logs of the outcome specified by the column header. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

exports and log manufacturing value added on year fixed effects only. This therefore shows how outcomes conditional on global trends actually evolved for both groups during the sample period. The results for export residuals show that the treatment and control groups had similar average levels of exports per capita immediately prior to the boom and, despite a short-lived spike in the middle of the pre-boom period, had similar overall trends. The control group was largely unaffected by the oil price swings (recall that significant oil importers are excluded), so the measured manufacturing effects come from large changes in oil-dependent countries.

The results for value-added residuals similarly show that control countries were largely unaffected by oil price swings, unlike treated countries. However, as discussed in section 4, there is a large disparity in pre-boom levels of value added per capita due to the differing sample composition,[13] although the pre-trends are similar. Therefore, for the value-added results, extra caution is warranted regarding the assumption that the two groups would have followed similar paths in the absence of price shocks, another reason the export results are preferred.

5.3. Manufacturing subsector outcomes

I next turn from total manufacturing to subsector analysis. The Dutch disease model predicts that the production of more tradable goods should decline relative to local goods. I test this proposition using value-added data for three-digit manufacturing subsectors given in the INDSTAT3 data set. I use the binary exportability classifications found in Rajan and Subramanian (2011), which are based on historical export to value-added ratios.[14] I separately sum together all exportable and non-exportable sectors and then run separate regressions for total value added for both indices (so the unit of observation remains at the country–year level). The results are shown in columns 1 and 2 of table 4. Both exportable and non-exportable subsectors experience significant positive effects during the boom period, and insignificant effects thereafter. Contrary to predictions of the core model, exportable sectors grew faster than non-exportables during the boom. However, a confounding factor with this exportability index is that sectors linked to the oil industry may be more prominent in exportable sectors, particularly refined products. Therefore, I use an alternative exportability index that excludes sectors that are classified as upstream or downstream from the oil sector (these are listed below).[15] The results in columns 3 and 4 using this alternative index similarly show significant effects for both exportables and non-exportables, with exportables growing somewhat faster. This is a curious result, however, for both indices the differences in coefficients are not statistically significant.

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13 The reason for this disparity is that the INDSTAT3 value-added data have less coverage than do the exports data. If the exports sample is limited to be the same as that for value added, there is a similar disparity. Therefore, the difference in pre-treatment levels is not driven by major relative differences in exports and value added, but merely by sample composition.

14 A subsector takes an exportability index value of one if it historically had an exports to value-added ratio above the median according to World Integrated Trade Solution (WITS) data.

15 To construct this index, first all oil-linked sectors are removed. Of those remaining, a sector is assigned an index value of one if the average export to value-added ratios across all sample countries as of 1972 is above the median, and zero otherwise.

TABLE 4
Subsector manufacturing results

	(1) Exp. index = 1	(2) Exp. index = 0	(3) Exp. index 2 = 1	(4) Exp. index 2 = 0	(5) Upstream	(6) Downstream	(7) Non-oil
Treat*Preboom	−0.014	−0.010	0.009	−0.014	0.031	0.004	0.005
	(0.023)	(0.021)	(0.018)	(0.021)	(0.025)	(0.057)	(0.015)
Treat*Boom	0.080**	0.048*	0.062**	0.044**	0.096**	0.146**	0.054**
	(0.025)	(0.021)	(0.018)	(0.016)	(0.022)	(0.050)	(0.014)
Treat*Bust	−0.011	0.002	−0.011	−0.012	−0.046	−0.099*	−0.009
	(0.037)	(0.029)	(0.039)	(0.025)	(0.031)	(0.050)	(0.026)
Treat*Valley	−0.011	−0.021	−0.003	−0.035	−0.011	0.052	−0.020
	(0.027)	(0.029)	(0.031)	(0.025)	(0.029)	(0.041)	(0.026)
Initial manuf. exports	0.003	0.000	0.003+	−0.002	0.003	0.000	0.003+
	(0.002)	(0.005)	(0.002)	(0.006)	(0.003)	(0.003)	(0.002)
N.	1,723	1,718	1,711	1,723	1,702	1,572	1,723
Countries	76	76	75	76	75	68	76
R-sq.	0.0826	0.0523	0.0632	0.0739	0.0942	0.0695	0.0843

NOTES: The dependent variable is the year-on-year difference in log value added for the subsector group specified in the column header. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

Columns 5 and 6 report value-added results when only upstream and downstream sectors are included in the sample, respectively.[16] Both upstream and downstream industries rise significantly during the boom period, with downstream sectors also significantly decreasing during the bust. Finally, column 7 reports the results for sectors that are classified as neither upstream nor downstream from the oil sector. While the effect during the boom is unsurprisingly lower than for oil-linked sectors, it is still positive and significant, indicating that the spillovers extend throughout the manufacturing industry.

5.4. Real exchange rates

The finding that high-exportability manufacturing sectors grew faster during the boom relative to low-exportability sectors is somewhat surprising. As discussed in section 2, both the resource movement and spending effects cause declines in the traded sector and an increase in the real exchange rate. Therefore, it is worthwhile to check if increases in the real exchange rate are detectable in the empirical setting of this paper as an indication for the presence of these effects. I evaluate equations (1) and (2) with two different measures of exchange rate appreciation as the dependent variable.[17] First, I use the year-on-year difference in price level of GDP given in Penn World Tables 7.0, which is the real exchange rate relative to the United States. However, real exchange rate movements could be a long-term trend associated with income levels, due to the Balassa–Samuelson effect. Therefore, I follow Rajan and Subramanian (2011) and Rodrik (2008) in constructing a measure of "excess appreciation," which estimates the deviation of the real exchange rate from what would be predicted by the Balassa–Samuelson model.[18]

Figure 7 presents the semi-parametric results for both measures. Real exchange rates indeed see a positive and significant effect during the boom. The excess appreciation measure increased by roughly the same amount, suggesting that all of the appreciation was so-called "excess" appreciation caused by the spike in export revenues. The effect does decrease to zero in the long run, but the fall does not begin until late in the bust period. Table 5 presents exchange rate results when estimating equation (2). The growth

16 Upstream sectors are industrial chemicals, other chemicals, fabricated metal products, machinery and transport equipment. Downstream sectors are refined petroleum products, rubbers and plastics.

17 Iran is excluded from this analysis as it displays highly erratic exchange rate behavior in the Penn World Tables Data that is not corroborated by other sources.

18 This is done through the following procedure: for each year, I run a regression at the country level of log price level on log PPP-adjusted GDP per capita. Excess appreciation is then the estimated residual from this regression. The procedure rests on the assumption of a long-run equilibrium relationship between income and exchange rates based on PPP.

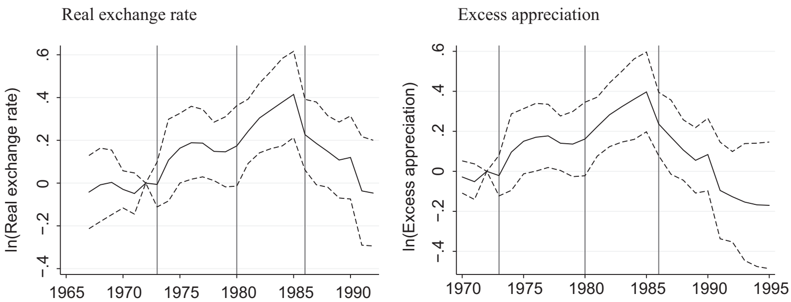

FIGURE 7 Real exchange rates

TABLE 5
Real exchange rates

	(1) Price level	(2) Excess apprec.
Treat*Preboom	0.014	0.002
	(0.013)	(0.015)
Treat*Boom	0.025+	0.025+
	(0.013)	(0.013)
Treat*Bust	0.020	0.017
	(0.013)	(0.013)
Treat*Valley	−0.043	−0.048+
	(0.029)	(0.028)
N.	3,098	2,746
Countries	112	112
R-sq.	0.0842	0.0164

NOTES: The dependent variable is the year-on-year difference in logs of the outcome specified by the column header. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

effects during the boom are significant only at the 10% level and negative only at the 10% significance level during the valley period.

These results are roughly consistent with the resource movement effect and/or spending effect, albeit with a delay in the decline of exchange rates following the end of the boom. There are a couple possible explanations for this delay. First, the delay may reflect a lag between the incidence of oil prices and their effect on exchange rates that has been documented in the literature. Rogoff (1996) argues that exchange rates should adjust in the long run to equalize purchasing power parity (PPP) across countries, but the exchange rate response to deviations in PPP is slow, estimating a half-life of three to five years. However, Cashin et al. (2004) challenge this estimate and find that commodity currency adjustments have a half-life of just 10 months. Whatever the actual lags, the bust period could contain a period of positive currency adjustment left over from the boom period, and the valley period could contain a period of negative adjustment left over from the bust period. However, the lag explanation does not explain all results as the exchange rate effect begins immediately in the boom period; in addition, the decrease continues long after the bust period, so it is likely that other factors are at play as well.

A second possible explanation is that exchange rates are driven partly by government policy responses and so may not always respond to shocks in predictable ways. Exchange rate regime data from Levy-Yeyati and Sturzenegger (2005) indicate that, as of 1974 (the earliest year available), all 14 treatment countries covered by the data had a fixed exchange rate regime while only one (Nigeria) had switched to a float by the beginning of the bust period. It is plausible that oil-rich governments tended to prop up overvalued currencies to protect against unpopular increases in costs of living until the extent of the price crash through the mid-1980s made continued overvaluation untenable. Gelb (1988) provides anecdotal support for this explanation. Further, the revenue shortfall during the bust forced some governments to abandon various subsidies and price controls, stoking inflation and increasing the real exchange rate.

5.5. Robustness checks

5.5.1 Export growth robustness

I next subject the main results to several robustness checks and alternative specifications. Table 6 reports these results for manufacturing export growth. In column 1, I remove all OECD countries from the specification. One concern with this paper's methodology is that the control group contains fully industrialized countries that are negatively affected by the oil price boom, and so the positive effects may be partially a reflection of poor performance of such countries. Removing OECD countries mitigates this concern by comparing performance only between developing countries. Column 2 omits four treatment countries that raise identification concerns: Iran and Iraq, as these countries were extremely volatile during the period studied, which included a lengthy war with each other; Kuwait, which was invaded by Iraq in 1990, and Saudi Arabia, which produces enough oil that it may single-handedly influence oil prices. Column 3 removes observations with extreme values of negative or positive export growth, specifically those falling below the first percentile or above the 99th percentile of the baseline specification. Column 4 includes region-by-year fixed effects, with regional classifications adapted from World Bank classifications.[19] The results are similar and remain significant during the boom (though only at the 10% level in the case of region–year fixed effects) across each specification. Appendix figure A2 presents the graphical

19 See appendix B, for a list of countries by region. One difficult region assignment is Australia and New Zealand. Because these are the only regions with data in the Oceania region, I assign them to Northern Europe. While obviously not a geographic match, it is a reasonable economic and institutional match. Dropping these two countries altogether does not affect the results.

TABLE 6
Manufacturing exports robustness

	(1) Non-OECD	(2) Reduced treatment group	(3) Outliers removed	(4) Region–year FEs
Treat*Preboom	−0.008	−0.004	−0.004	−0.009
	(0.058)	(0.065)	(0.054)	(0.050)
Treat*Boom	0.113**	0.126**	0.110**	0.064+
	(0.033)	(0.035)	(0.031)	(0.034)
Treat*Bust	0.011	−0.012	−0.016	−0.021
	(0.037)	(0.035)	(0.034)	(0.057)
Treat*Valley	−0.045	−0.012	−0.045	−0.025
	(0.042)	(0.022)	(0.040)	(0.032)
Initial manuf. exports	0.004	0.005	0.006+	0.002
	(0.005)	(0.003)	(0.003)	(0.005)
N.	2,481	2,929	3,041	3,041
Countries	89	105	109	109
R-sq.	0.0992	0.0867	0.0911	0.161

NOTES: The dependent variable is the year-on-year difference in log of manufacturing exports. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

results for these robustness checks from the semi-parametric specification of equation (1).[20]

5.5.2 Value-added growth robustness

Table 7 repeats the exercise from table 6 for the manufacturing value-added regressions. Columns 1 to 4 repeat the robustness checks discussed above, and the estimates are again fairly stable. Column 5 reports an additional robustness check that adjusts for changes in the real exchange rate. Rodrik (2012), which also uses UNIDO manufacturing data, points out that, in principle, local cost increases should be compensated by currency depreciation, leaving dollar values unchanged. But since UNIDO outcomes are reported in the country's home currency and then converted to dollars with nominal exchange rates, sustained trends in the real exchange rate could inflate the growth in reported value added. This is especially important to consider in this study, as oil-dependent countries indeed experience exchange rate increases during the boom. I follow Rodrik (2012) in correcting for this by deflating value added by one plus the percent change in the real exchange rate[21] so that increases in real exchange rates always reduce the growth in value added, and vice versa. As expected, this reduces the effect on growth during the boom period, but it is still positive and significant. Appendix figure A3 presents

20 The growth rate outlier specification is not included in these figures since these outlier observations have negligible impact on level effects.

21 The exact formula for exchange rate adjusted value-added growth is $((1+Growth_{VA})/(1+Growth_{RER}))-1$.

TABLE 7
Manufacturing value-added robustness

	(1) Non-OECD	(2) Reduced treatment group	(3) Outliers removed	(4) Region–year FEs	(5) RER adjustment
Treat*Preboom	−0.003	0.002	−0.009	0.024	−0.005
	(0.023)	(0.020)	(0.021)	(0.025)	(0.019)
Treat*Boom	0.057**	0.060*	0.086**	0.072**	0.042*
	(0.022)	(0.024)	(0.019)	(0.026)	(0.020)
Treat*Bust	0.004	0.010	0.002	−0.027	−0.005
	(0.034)	(0.037)	(0.025)	(0.024)	(0.037)
Treat*Valley	−0.017	−0.031	−0.011	−0.015	0.133
	(0.027)	(0.030)	(0.026)	(0.023)	(0.120)
Initial manuf.	0.003	0.004+	0.005*	0.000	−0.003
exports	(0.003)	(0.002)	(0.002)	(0.004)	(0.002)
N.	1,221	1,671	1,707	1,742	1,695
Countries	59	75	78	78	77
R-sq.	0.0689	0.119	0.150	0.265	0.0282

NOTES: The dependent variable is the year-on-year difference in log of manufacturing value added. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

the graphical results for these robustness checks from the semi-parametric specification of equation (1).

5.5.3 Oil price interaction specification

I next use an alternative specification to evaluate the effect of oil prices on manufacturing. One problem with the specification based on "boom" and "bust" periods is that there is no perfectly objective way to define these periods. I have followed the past literature on booms and busts in defining each period based on price changes (as in Black et al. 2005) or changes in drilling activity (as in Jacobsen and Parker 2014). However, one objection to this method is that it defines some years of the early 1980s as "bust" years despite having relatively high oil prices, and vice versa for the early boom years. To address this concern, I run an alternative more parametric specification that relates outcome levels directly with the price level of oil. This specification is below:

$$\Delta ln(Y_{ct}) = \beta_1(T_c * ln(oilprice_t)) + \alpha_c + \gamma_t + \epsilon_{ct}, \tag{3}$$

where T_c is again a treatment group indicator. β_1 then measures the effect on treatment country outcomes of a one log-point increase in oil prices.

The results of equation (3) for the main outcomes are presented in tables 8 and 9. Consistent with the main results, the effects of higher oil prices were positive for manufacturing exports, negative for agricultural exports and positive for all types of imports. All other manufacturing-specific measures were also positively affected. This supports the case that manufacturing and imports were generally pro-cyclical regardless of how boom and bust periods are defined.

TABLE 8
Exports/imports, price interaction

	(1) Manuf. exp.	(2) Manuf. imp.	(3) Non-oil res. exp.	(4) Non-oil res. imp.	(5) Ag. exp.	(6) Ag. imp.
Oil price*High dependence	0.419**	0.516**	0.036	0.411**	−0.315*	0.449**
	(0.116)	(0.106)	(0.179)	(0.117)	(0.123)	(0.078)
N.	3,151	3,150	2,954	2,965	3,145	3128
Countries	109	109	109	109	109	109
R-sq.	0.02	0.06	0.02	0.03	0.06	0.04

NOTES: The dependent variable is the year-on-year difference in logs of the outcome specified by the column header. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

TABLE 9
Manufacturing outcomes, price interaction

	(1) Value added	(2) Employment	(3) Wage	(4) Cap. formation	(5) Productivity
Oil price*High dependence	0.226**	0.176**	0.276**	0.609**	0.114*
	(0.060)	(0.046)	(0.059)	(0.139)	(0.049)
N.	1,946	2,059	1,907	1,336	1,885
Countries	85	88	84	62	83
R-sq.	0.00	0.00	0.00	0.00	0.03

NOTES: The dependent variable is the year-on-year difference in logs of the outcome specified by the column header. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

5.5.4 Hydrocarbon dependence specification

Next, I run the following specification that makes use of all pre-boom dependence information by interacting 1972 hydrocarbon dependence with the boom, bust and valley periods in lieu of the treatment country dummy variable:

$$\begin{aligned}\Delta ln(Y_{ct}) = {} & \beta_1(Dep_{1972} * Boom_t) + \beta_2(Dep_{1972} * Bust_t) \\ & + \beta_3(Dep_{1972} * Valley_t) + \beta_4 Manuf\_exports_{1972} + \gamma_t + \epsilon_{ct},\end{aligned} \tag{4}$$

where Dep_{1972} is hydrocarbon revenues as a percentage of GDP in 1972.[22,23] Implicit in this specification is the assumption of a linear effect of pre-boom dependence. Table 10 reports the results of this specification for exports and

22 Treatment countries Libya and United Arab Emirates are omitted from this specification since they lack 1972 GDP data and thus their exact dependence is unknown.

23 Countries that were previously dropped for having hydrocarbon dependence between 1% and 3% of GDP and for having net imports exceeding 3% of GDP are included in this specification.

TABLE 10
Exports/imports with continuous dependence

	(1) Manuf. exp	(2) Manuf. imp	(3) Non-oil res. exp	(4) Non-oil res. imp	(5) Ag. exp	(6) Ag. imp
Dependence*Preboom	−0.198	−0.019	0.165	−0.051	0.036	−0.097
	(0.178)	(0.043)	(0.189)	(0.119)	(0.092)	(0.076)
Dependence*Boom	0.248*	0.154**	−0.117	0.062	−0.187+	0.177**
	(0.098)	(0.043)	(0.102)	(0.079)	(0.112)	(0.049)
Dependence*Bust	0.074	−0.099*	−0.016	0.044	0.101	0.046
	(0.079)	(0.047)	(0.151)	(0.096)	(0.151)	(0.064)
Dependence*Valley	−0.025	−0.087	0.007	−0.051	−0.008	−0.142**
	(0.066)	(0.054)	(0.093)	(0.094)	(0.072)	(0.055)
Initial manuf. exports	0.002	0.005*				
	(0.004)	(0.002)				
Initial non-oil res. exports			−0.010	−0.001		
			(0.007)	(0.003)		
Initial ag. exports					0.004	−0.001
					(0.003)	(0.002)
N.	2,156	2,156	2,103	2,096	2,152	2,149
Countries	77	77	77	77	77	77
R-sq.	0.14	0.08	0.07	0.06	0.08	0.08

NOTES: The dependent variable is the year-on-year difference in logs of the outcome specified by the column header. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

TABLE 11
Manufacturing outcomes with continuous dependence

	(1) Value added	(2) Employment	(3) Wage	(4) Cap. formation	(5) Productivity
Dependence*Preboom	−0.096	0.072	0.019	−0.076	−0.123
	(0.090)	(0.055)	(0.043)	(0.229)	(0.101)
Dependence*Boom	0.146*	0.087**	0.062	0.221**	0.100*
	(0.067)	(0.030)	(0.057)	(0.064)	(0.050)
Dependence*Bust	−0.037	0.027	−0.022	0.186	−0.042
	(0.082)	(0.032)	(0.075)	(0.198)	(0.082)
Dependence*Valley	−0.044	0.026	−0.130*	−0.276*	−0.065
	(0.056)	(0.037)	(0.062)	(0.120)	(0.059)
Initial manuf. exports	0.002	−0.008**	0.008**	−0.005	0.006*
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
N.	1,431	1,469	1,358	956	1,357
Countries	61	61	58	43	58
R-sq.	0.11	0.11	0.08	0.06	0.08

NOTES: The dependent variable is the year-on-year difference in logs of the outcome specified by the column header. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

imports and table 11 reports for value added and other outcomes. The results are consistent with the binary treatment specification, with significant effects of dependence during the boom on manufacturing exports, output, investment and productivity.[24] Likewise, there are positive effects on all types of imports and strong negative effects on agricultural exports.

5.5.5 Inverse propensity score weighting

Finally, pre-boom summary statistics showing treatments and controls were broadly similar, and roughly parallel pre-boom trends in the main outcomes support the argument that the control group would plausibly have followed a similar development path absent oil price changes. But to further test this assumption, I perform an inverse propensity score weighting analysis. In the first stage, I estimate propensity scores using the pre-boom levels of manufacturing exports per capita, GDP per capita and democracy score. I limit it to these three variables because they cover most sample countries going back to 1970 and, together, they correspond roughly to, arguably, the most important predictive factors (i.e., overall economic performance, manufacturing performance and institutions). I then repeat the main specifications weighting observations by the inverse predicted probability of being included in the treatment group. The results are shown in tables 12 and 13. Because treatments and controls are similar in these predictive variables (as shown in the summary statistics), the average propensity scores of both groups are also similar and the main results are largely unchanged.[25] Appendix figures A4 and A5 present the graphical result for the semi-parametric specification of equation (1) when using inverse propensity score weighting.

6. Mechanisms

The results thus far have already been suggestive of multiple plausible mechanisms behind the rise in manufacturing. The surge in manufacturing imports suggests a rise in local demand for manufactured goods that likely also benefited domestic production, and the rise in manufacturing capital formation suggests investment spillovers. This section offers further complimentary

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24 One possibility suggested by this result is that the main results are driven only by very high-dependence countries. For the four countries with exceptionally high pre-boom dependence per table 1 (Saudi Arabia, Kuwait, Oman, Qatar), the main manufacturing effects are indeed especially large, but with these countries excluded effects are somewhat smaller but still significant.

25 I also run the same analysis using pre-boom manufacturing value added (where there is a large difference between treatments and controls due to the reduced sample) instead of exports to construct propensity scores, but this severely limits the available sample. Nevertheless, results are again similar in this specification, except the negative effects during the bust are large and significant (not shown).

TABLE 12
Exports/imports, propensity score results

	(1) Manuf. exp.	(2) Manuf. imp.	(3) Non-oil res. exp.	(4) Non-oil res. imp.	(5) Ag. exp.	(6) Ag. imp.
Treat*Preboom	−0.010	0.017	0.014	−0.041	−0.003	−0.036
	(0.050)	(0.019)	(0.051)	(0.039)	(0.031)	(0.029)
Treat*Boom	0.090**	0.077**	−0.051	0.068+	−0.111**	0.094**
	(0.031)	(0.015)	(0.040)	(0.037)	(0.040)	(0.023)
Treat*Bust	−0.021	−0.065**	0.005	0.016	−0.038	0.024
	(0.037)	(0.021)	(0.065)	(0.053)	(0.048)	(0.033)
Treat*Valley	−0.034	−0.064*	0.013	−0.012	0.043	−0.054
	(0.042)	(0.029)	(0.034)	(0.033)	(0.033)	(0.033)
Initial manuf. exports	0.001	0.002				
	(0.004)	(0.002)				
Initial non-oil res. exports			−0.007	0.002		
			(0.005)	(0.004)		
Initial ag. exports					0.002	−0.001
					(0.003)	(0.003)
N.	2,681	2,683	2,488	2,450	2,679	2,653
Countries	96	96	94	94	96	96
R-sq.	0.142	0.101	0.0743	0.0668	0.111	0.0970

NOTES: The dependent variable is the year-on-year difference in logs of the outcome specified by the column header. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

TABLE 13
Manufacturing outcomes, propensity score results

	(1) Value added	(2) Employment	(3) Wage	(4) Cap. formation	(5) Productivity
Treat*Preboom	−0.010	0.025*	−0.002	−0.003	−0.027
	(0.020)	(0.012)	(0.012)	(0.054)	(0.019)
Treat*Boom	0.068**	0.047**	0.040**	0.095*	0.030
	(0.020)	(0.009)	(0.011)	(0.043)	(0.018)
Treat*Bust	−0.000	−0.017	0.012	0.027	0.028
	(0.030)	(0.018)	(0.027)	(0.052)	(0.034)
Treat*Valley	−0.027	0.017	−0.065**	0.008	−0.030
	(0.025)	(0.014)	(0.022)	(0.050)	(0.022)
Initial manuf. exports	−0.004	−0.005+	0.002	−0.003	−0.000
	(0.003)	(0.002)	(0.003)	(0.004)	(0.003)
N.	1,564	1,630	1,499	1,035	1,475
Countries	68	70	65	49	64
R-sq.	0.10	0.12	0.08	0.09	0.07

NOTES: The dependent variable is the year-on-year difference in logs of the outcome specified by the column header. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

quantitative evidence on consumption and investment and also considers qualitative evidence on oil-rich economies during the boom and bust periods.

6.1. Consumption and investment

The UN keeps a "National Accounts Main Aggregates Database," which includes data for most countries on total household and government consumption and overall capital formation over the sample period of this study. The graphical results for the semi-parametric level specification using these outcomes are presented in figure 8, and the growth rate specification is shown in table 14. The effect on household expenditure is positive and significant during the boom then declines during the bust, with no long-run overall effect. Government consumption behaves somewhat similarly, but with smaller and insignificant effects during the boom. Effects on capital formation were also large and significant during the boom before declining sharply in the bust and valley periods.

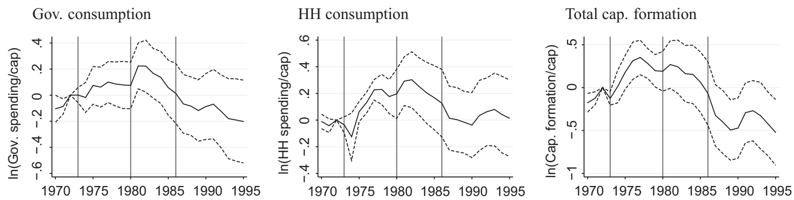

FIGURE 8 National consumption, capital formation

TABLE 14
National consumption, capital formation

	(1) Gov. spending	(2) HH spending	(3) Cap. formation
Treat*Preboom	0.033+	−0.009	0.015
	(0.019)	(0.013)	(0.017)
Treat*Boom	0.010	0.034*	0.042*
	(0.011)	(0.014)	(0.016)
Treat*Bust	−0.010	−0.011	−0.044*
	(0.014)	(0.015)	(0.020)
Treat*Valley	−0.024*	−0.011	−0.050**
	(0.011)	(0.008)	(0.017)
Initial gov. spending	0.002*		
	(0.001)		
Initial HH spending		0.002*	
		(0.001)	
Initial cap. form.			0.001
			(0.001)
N.	2,734	2,734	2,732
Countries	110	110	110
R-sq.	0.0262	0.0252	0.0352

NOTES: The dependent variable is the year-on-year difference in logs of the outcome specified by the column header. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

These results offer further evidence of more than one mechanism driving the increase in manufacturing. They suggest that the oil windfall raised both household and government income and consumption, which likely increased the demand for locally produced manufactured goods. Further, although the capital formation measure is general to the whole economy, this result along with the manufacturing-specific measure analyzed in figure 6 suggest that the boom caused significant capital investment and some of this reached the manufacturing sector.

6.2. Qualitative evidence on industrial policy

Industrial policies intended to promote industrial development and diversification were widespread among developing countries in the mid-20th century, and this was no less true for resource-rich countries (Mahroum and Al-Saleh 2016, Nabli et al. 2006, Owen 1981, Owen and Pamuk 1998). These policies include a wide range of laws and government activities, including protectionist measures like import tariffs and quotas, government subsidies for targeted sectors and direct government investment and control of enterprise. By the end of the 1970s, most oil-rich countries had nationalized their oil industries (a process that accelerated during the boom period), creating an enormous windfall in government revenues. All countries in this study's treatment group used this windfall to varying degrees on diversification and industrial policies, partly in recognition of the dangers posed to non-oil exportable sectors (Owen 1981).

These policies generally did not extend to the agricultural sector. Owen (1981) states that most Middle Eastern protectionist policies favoured urban regions, focusing investment on industry and actually subsidizing food imports. Gelb (1988) notes that labour was drawn largely from the agricultural sector for public construction projects. This is consistent with this study's results on agricultural exports and lends further evidence to the argument that industrial policies played a key role in the increase in manufacturing.

The 1980s bust put an end to the surge in aggressive industrial policies. Many oil-rich governments were forced to sharply cut public investment and subsidies. But this did not happen right away according to Gelb (1988), which describes a ratchet effect in public spending, particularly "since an increasing proportion consisted of recurrent expenditures to service the capital investments of earlier years and of subsidies to keep loss-making ventures in operation." Surpluses built up during the boom period could take years to wind down before contractionary measures became necessary (Owen and Pamuk 1998). These factors help explain the asymmetric delay in the fall of manufacturing outcomes found in this study.

Of course, each individual treatment country faced its own set of circumstances and implemented different policies that determined its reaction to the boom/bust cycle. But the qualitative literature suggests a useful generalized distinction between the Middle East and North African (MENA) and

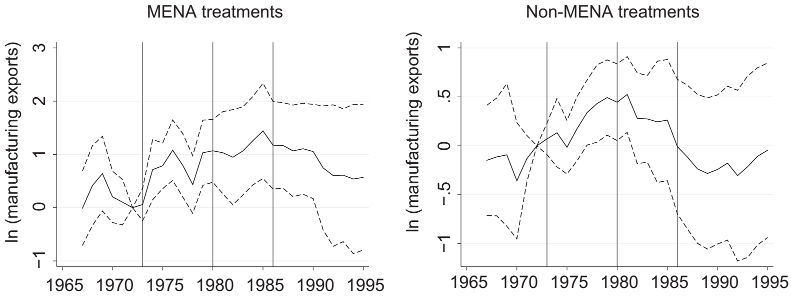

FIGURE 9 Manufacturing exports

non-MENA treatment countries. Nabli et al. (2006) explain that worldwide mainstream opinion had turned against industrial policy in the 1980s, but that the MENA region nevertheless continued to implement extensive industrial policies and government intervention in production decisions, though the 1980s were characterized by preservation of existing structures rather than the aggressive expansion seen during the boom. Meanwhile, Latin American and East Asian countries undertook extensive reform programs, dismantling tariff regimes and shifting to more market-based economies.[26]

To my knowledge, there is no industrial policy index that can be used to find heterogeneous effects for this study, but the generalization that all or nearly all treatment countries had strong industrial policies before and during the boom and only MENA countries maintained these policies during the bust suggests separately analyzing manufacturing results for these two groups. Figure 9 shows the effects on manufacturing exports when limiting the treatment group to those in the MENA region and those not in MENA.[27] The results support the argument that industrial policy was a key factor. For the MENA treatments, the effects on manufacturing exports after the boom remain roughly flat, retaining the gains made during the boom period (the drop seen late in the sample period is driven largely by Iraq following the First Gulf War). For non-MENA countries, the effects during the boom are smaller (owing to lower average oil dependence) and begin to fall shortly into the bust period. Since the treatment groups in this analysis are small, the results should

26 Nabli et al. (2006) offer two explanations for these differing responses. Several Latin American economies faced severe balance of payment crises that forced reform, while MENA countries did not face the same level of disruption, as oil revenues declined significantly but remained high enough to avoid similar crises. Also, MENA governments have generally been more socialist, and interest groups that were instrumental in reform movements in other regions did not have comparable influence in MENA countries.

27 The growth rate results from equation (2) for MENA and non-MENA treatments are shown in appendix table A2.

be viewed as merely suggestive, but they are consistent with the qualitative evidence on industrial policy in MENA and non-MENA countries.

7. Conclusion

This paper has analyzed the effect of the oil boom and bust on non-oil economic activity in oil-dependent countries, adding to the thin but emerging empirical evidence on the presence of Dutch disease or lack thereof. During the oil price spike of the 1970s, manufacturing exports, value added, employment, wages and capital formation increased substantially in oil-rich countries relative to non-oil-rich countries. These effects hold for sectors connected or unconnected to the oil industry and for both high- and low-exportability sectors. Manufacturing imports likewise increased significantly, causing an increase in net manufacturing imports in the majority of treated countries and reflecting an increase in local demand. However, agricultural exports experienced significant negative effects during the boom, suggesting that this sector may have been subject to Dutch disease mechanisms and did not receive the investment spillovers that the manufacturing sector did. The converse of most of these effects was observed during the oil price bust of the 1980s and subsequent period of low prices, albeit with some lag, suggesting a ratchet effect in manufacturing investment.

The results taken together suggest that manufacturing benefited from the oil boom in two ways. First, increased local demand for manufactured goods resulting from the revenue windfall was met partially by increased imports and partially by increased local production. Second, the windfall resulted in investment spillovers into manufacturing. That these spillovers do not appear to be present for non-hydrocarbon commodities and agricultural products (though I do not actually observe capital formation for these sectors) may be a result of higher perceived returns in manufacturing or a directed push towards industrialization by the government, which is supported by the qualitative literature on oil-rich economies during this period.

These results do not necessarily contradict the core Dutch disease model, which ultimately leaves the effect of an oil boom on other sectors ambiguous. Nor do they imply that Dutch disease mechanisms, namely the resource movement and spending effects, are not present. The spending effect is positive for the share of manufactured goods that are locally consumed, and whatever negative mechanisms exist, they appear to have been overwhelmed by investment spillovers, which are not considered in the core model.

This paper informs the question of whether oil booms can harm a country's long-run growth by way of a declining manufacturing sector but still leaves some open questions. If the boom comes by way of a price increase, the results suggest that existing oil producers should not be concerned about losing long-run competitiveness in manufacturing, although the gains may be reversed in the case of a bust. However, while the theoretical model does not make much distinction between booms coming by way of price increases or production booms, in reality these two cases may have different effects, especially if a production-led boom is more likely to divert inputs away from other sectors. An empirical analysis of the differing effects of production-led booms could be a useful extension of this study.

Appendix A: Additional tables and figures

TABLE A1
Summary statistics

Variable (1970)	Treatment	Control
Ln(Manuf. VA/Cap)	4.96	5.86
	(1.29)	(1.69)
	[14]	[54]
ln(Manuf. wage)	8.39	8.64
	(0.81)	(0.76)
	[12]	[46]
ln(Manuf. productivity)	9.65	9.63
	(0.84)	(0.62)
	[13]	[49]
ln(GDP, US$)	6.27	5.99
	(0.99)	(1.22)
	[17]	[89]
ln(Population)	14.98	15.42
	(1.93)	(1.75)
	[19]	[89]
ln(Manuf. exports/Cap)	4.31	4.28
	(1.92)	(2.19)
	[19]	[89]
ln(Oil-related manuf. exports/Cap)	2.92	2.12
	(2.74)	(2.73)
	[19]	[89]
ln(Non-oil related manuf. exports/Cap)	3.24	3.93
	(1.62)	(2.22)
	[19]	[89]
ln(Manuf. imports/Cap)	5.69	5.11
	(1.31)	(1.68)
	[19]	[89]
(Manuf. exports)/GDP	7.92%	8.24%
	12.36%	9.65%
	[17]	[89]
(Ag. exports)/GDP	3.55%	4.61%
	6.09%	4.88%
	[17]	[89]
(Resource exports)/GDP	33.21%	1.43%
	45.61%	3.20%
	[17]	[88]
Democracy score	1.31	3.39
	(2.98)	(4.11)
	[16]	[75]

NOTES: All statistics are from 1970. For each variable, the table shows sample means, standard deviations in parentheses and number of observations in brackets.

TABLE A2
Manufacturing outcomes, MENA and non-MENA treatments

	(1) MENA treatments	(2) Non-MENA treatments
Treat*Preboom	−0.015	0.013
	(0.076)	(0.048)
Treat*Boom	0.142**	0.055+
	(0.041)	(0.032)
Treat*Bust	0.017	−0.073+
	(0.040)	(0.040)
Treat*Valley	−0.069	−0.003
	(0.057)	(0.035)
Init. manuf. exports	0.007+	0.005
	(0.004)	(0.003)
N.	2,845	2,705
Countries	102	97
R-sq.	0.09	0.08

NOTES: The dependent variable is the year-on-year difference in logs of the outcome specified by the column header. All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, ** indicate significance at the 10%, 5% and 1% levels, respectively.

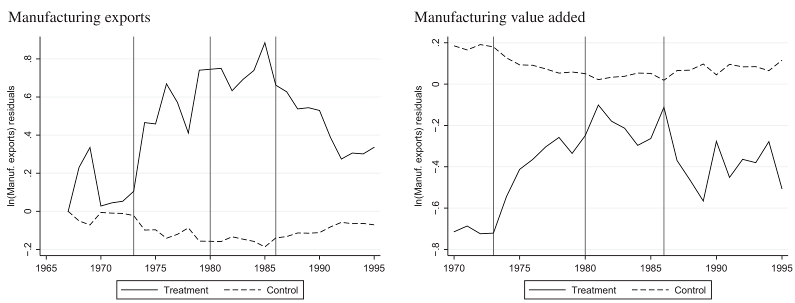

FIGURE A1 Treatment/control conditional manufacturing trends
NOTE: Both graphs show the mean residuals for the treatment and control groups from a regression of the (log) dependent variable on year fixed effects only.

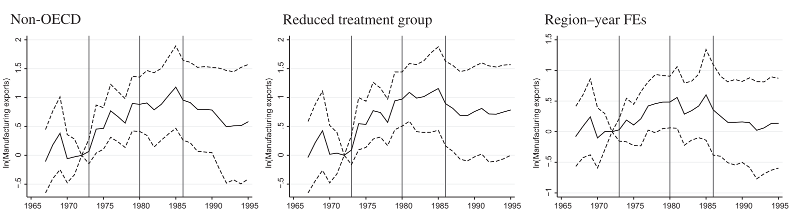

FIGURE A2 Manufacturing exports robustness

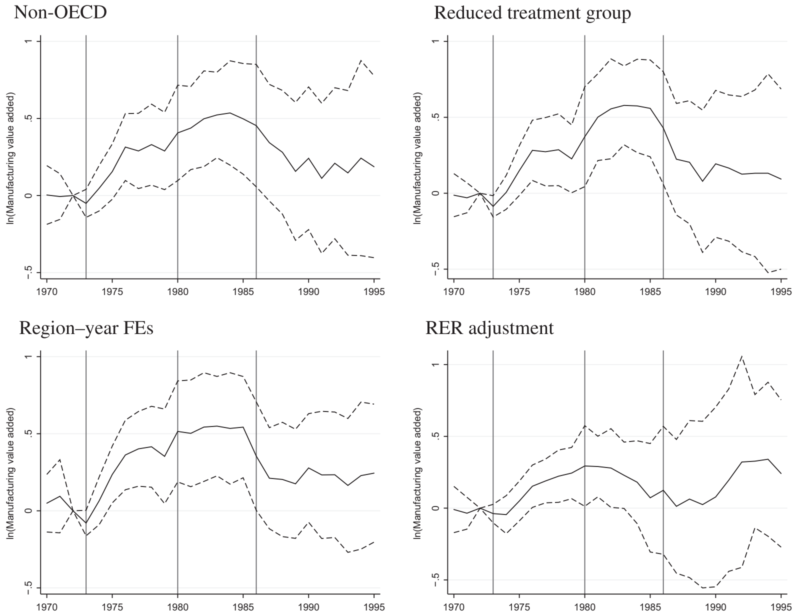

FIGURE A3 Manufacturing value-added robustness

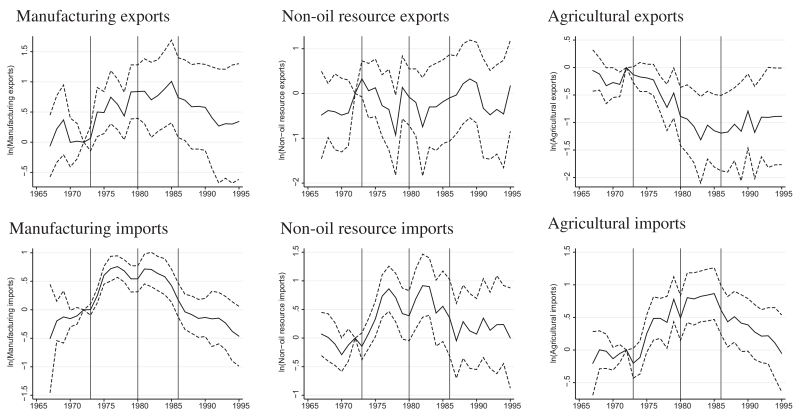

FIGURE A4 Exports/imports propensity score results

FIGURE A5 Manufacturing outcomes, propensity score results

Appendix B: List of countries in exports/imports regression samples

The following table lists the countries included in the main export/import regressions of table 2, separated by region. The export/import regressions are chosen because the coverage is superior and includes more countries than the INDSTAT3 manufacturing data. The second column indicates if the country is in the treatment group and the third column indicates if the country is also included in the main value-added regressions using INDSTAT3 data.

East Asia and Pacific	Treatment group	INDSTAT3 data
Cambodia		
China		x
Fiji		x
Hong Kong		x
Indonesia	x	x
Japan		x
Korea, Republic of		x
Laos		
Macao		x
Mongolia		
Philippines		x
Singapore		x
Thailand		x
Vietnam		
East Europe	Treatment group	INDSTAT3 data
Bulgaria		
Hungary		x
Poland		x
Romania		
Latin America and the Caribbean	Treatment group	INDSTAT3 data
Argentina		
Bahamas		x
Barbados		x
Belize		

	Treatment group	INDSTAT3 data
Bolivia	x	x
Brazil		
Chile		x
Costa Rica		x
Cuba		x
Dominican Republic		x
Ecuador	x	x
Guatemala		x
Guyana		
Haiti		
Honduras		x
Jamaica		x
Panama		x
Paraguay		x
Peru		x
Trinidad and Tobago	x	x
Uruguay		x
Venezuela	x	x
Middle East and North Africa	Treatment group	INDSTAT3 data
Algeria	x	x
Bahrain	x	
Djibouti		
Iran	x	x
Iraq	x	x
Jordan		x
Kuwait	x	x
Libya	x	x
Morocco		x
Oman	x	
Qatar	x	
Saudi Arabia	x	
Syria		x
Tunisia	x	x
Turkey		x
United Arab Emirates	x	
Northern Europe	Treatment group	INDSTAT3 data
Australia		x
Austria		x
Denmark		x
Finland		x
France		x
Iceland		x
Ireland		x
Netherlands		x
New Zealand		x
Sweden		x
Switzerland		x
South Asia	Treatment group	INDSTAT3 data
Bangladesh		x
India		x
Nepal		
Pakistan		x
Southern Europe	Treatment group	INDSTAT3 data
Cyprus		x
Greece		x
Italy		x
Malta		x
Portugal		x
Spain		x
Sub-Saharan Africa	Treatment group	INDSTAT3 data
Sub-Saharan Africa		
Benin		
Burkina Faso		x

	Treatment group	INDSTAT3 data
Burundi		x
Central African Republic		x
Chad		
Congo, Dem. Rep. of the		
Ethiopia		
Gabon	x	x
Gambia, The		x
Ghana		x
Guinea		
Guinea-Bissau		
Kenya		x
Liberia		
Madagascar		x
Malawi		x
Mali		
Mauritania		
Mauritius		x
Niger		
Nigeria	x	x
Rwanda		x
Senegal		x
Seychelles		x
Sierra Leone		x
Somalia		x
South Africa		
Tanzania		x
Togo		x
Uganda		
Zambia		x
Zimbabwe		x

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