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Dutch Disease and the Oil and Boom and Bust

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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 value added increased significantly relative to non-oil dependent countries, along with wages, employment, and capital formation. These measures decreased, though to a lesser and more gradual extent, 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 procyclicality with respect to oil prices. The results suggest that increased local demand and investment spillovers induced by the oil revenue windfall resulted in increased manufacturing activity.

Keywords: Oil; Dutch Disease; Resource Curse; Manufacturing; Trade

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 centered on the concept of "Dutch Disease", a term coined by The Economist magazine in 1977 referring to the Netherlands gas boom and manufacturing decline. The Dutch Disease hypothesis 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, arguing 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 & Warner (1995) and several subsequent papers, although the existence of the curse has been called into question by a few recent papers including Brunnschweiler & Bulte (2008), Alexeev & Conrad (2009), and Smith (2013).

The core Dutch Disease theoretical model, provided by Corden & Neary (1982) and Corden (1984), posits a booming traded sector (assumed to be natural resources), a non-booming traded sector (manufacturing), and a non-traded sector (services). A boom in the resource sector can take three forms: a technology-induced rise in productivity, a windfall discovery, or a rise in the world price. For any of these cases, the model distinguishes two separate effects on manufacturing. The *resource movement effect* refers to mobile factors of production migrating to the booming sector away from other sectors. The *spending effect* occurs as the extra income from the booming sector is spent on the non-traded sector, thus raising the price of the non-traded sector relative to the non-booming traded sector, or the real exchange rate, and further drawing resources away from the non-booming traded sector.

In the simplest form of the model with only labor as a mobile factor, a resource boom unambiguously predicts a decrease in output of the non-booming traded sector. However, making more than one factor mobile between sectors can produce ambiguous implications for manufacturing. Further, Corden & Neary (1982) and Corden (1984) point out real-world factors beyond the core model that could lead to a resource boom being a boon for manufacturing. Since the increase in income will presumably be taxed, the government may invest the extra revenue in other sectors or in infrastructure that raises productively generally. If there is a non-booming traded sector besides manufacturing, say agriculture, then that sector could suffer the brunt of the negative effects. Perhaps most pertinently, since manufacturing will contain both traded and non-traded sub-sectors, the spending effect may be a net positive for manufacturing as a whole.

Thus, even accepting the core model, the question of how a resource boom affects manufacturing is 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. The methodology is adapted from 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. 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 80s are

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

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[2], but it is commonly argued that the rise of OPEC and other events associated with oil-dependent countries were strong contributors (see following section 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, and OPEC quotas were not introduced until 1982 (after the boom had ended) and were often ignored by member countries. Hence there does not appear to be an obvious consistent link between oil prices and individual countries' behavior before the fact, let alone a link to the manufacturing and agricultural sectors. One exception to this is the Iranian revolution, and the lengthy ware with Iraq that followed, so I exclude these two countries as a robustness check.

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 negative effect before leveling 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. I find similar effects for employment, wages and capital formation. Productivity growth effects are not statistically significant, but level effects are positive and significant for part of the boom period. The finding that wages and output

[2]See for example Barsky & Kilian (2004) and Hamilton(2008).

jointly increased during the boom runs counter to the core model. However, this is reconciled by the finding that capital formation and 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. Unsurprisingly, downstream sectors consisting of refined products experienced especially strong growth.

Other results are indicative of the presence of Dutch Disease mechanisms. Imports of all types of goods were strongly and positively associated with oil prices, and net imports of manufactured goods actually increased in 16 of the 19 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 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 core 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 in manufacturing, possibly through taxation and state-directed investment. This mechanism is not present in the theoretical model, but as mentioned above is discussed in Corden (1984) as a possible countering factor. Additionally, the exports results suggest that Dutch Disease mechanisms do appear to be present, but are borne primarily by the agriculture sector. The results altogether are indicative of the resource windfall spurring a push towards industrialization, whether state-directed or otherwise.

The empirical literature on Dutch Disease has traditionally been far less developed than the theoretical literature. Gelb (1988) and Sala-i-Martin (2003) use a case study approach, but do not find evidence of oil revenues harming the manufacturing sector. Stijns (2003) finds negative effects of oil revenues on manufacturing exports using a bilateral gravity model.

However, a number of empirical Dutch Disease papers have been produced more recently. Caselli & Michaels (2009) exploit differences in oil endowment across Brazilian municipalities, finding little effect on non-oil GDP. Allcott & Keniston (2013) use an approach similar to this paper and Black et al (2005) and finds that oil booms increase manufacturing output in oil-rich United States counties. In the cross-country literature, Rajan & Subramanian (2011) considers aid rather than resources as the windfall, and finds that aid-dependent countries experience slower growth in tradable manufacturing sectors relative to non-tradable sectors during the 1980s and 1990s. Ismail (2011) and Harding & Venables (2013) both find a negative relationship between price movements and manufacturing/non-oil value added and exports among oil-exporting countries. The results of the latter two papers contrast with this paper, but use a different source of resource windfall variation, as both rely on within-country variation in resource wealth among resource-rich countries. One problem with this approach is that variation stems from both price and production, but production levels are internal to countries and may be endogenously determined. This paper takes a quasi-experimental treatment-control approach, comparing oil-rich countries to non-oil-rich countries in the presence of external oil price shocks, providing a more rigorous causal test than has been heretofore performed in a cross-country setting.

The rest of this paper proceeds as follows: Section Two briefly describes the oil boom and bust and its causes. Section Three outlines my empirical strategy and describes the data. Section Four presents and discusses all empirical results. Section Five concludes.

2 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 U.S. and other rich nations supporting Israel. Oil prices quadrupled between 1973 and 1974, and although the actual embargo only lasted for six month, 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 real 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 1989-1995 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; if effects on manufacturing and other non-oil sectors take longer than one year to manifest, this is not captured in studies using year-to-year changes in prices.

Figures 1-3 demonstrate that fluctuations in countries' oil revenues were chiefly driven by enormous price changes rather than treatment group production. Figure 2 shows the average normalized[3] oil revenue of the treatment group over time. The shape of the revenue graph

[3]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 the largest producers would not solely drive the results.

almost precisely tracks that of the price graph. This is 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.

Figure 1: Oil price and Boom/Bust Periods

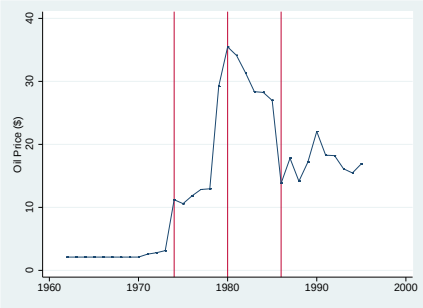
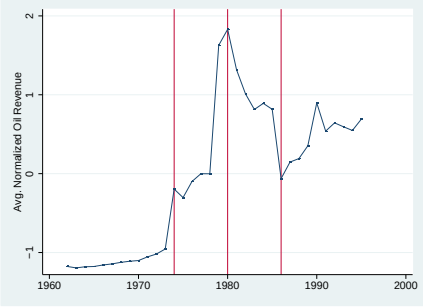
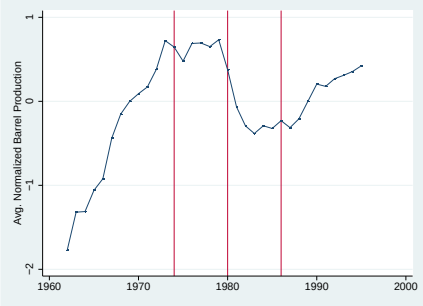


Figure 2: Treatment Group Oil Revenue



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

Figure 3: Treatment Group Oil Production



sector, and conversely for negative spillovers. If the effect were positive or negative only during 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, we should not expect significant differences between treatment and control countries unless some other mechanism is present.

3 Data and Methodology

I use the following equation to assess the impact of the boom and bust on several outcomes:

$$\Delta ln(Y_{ct}) = \beta_1(T_c * Boom_t) + \beta_2(T_c * Bust_t) + \beta_3(T_c * Valley_t) + \beta_4 Exports_{1970-72} + \gamma_t + \epsilon_{ct} \quad (1)$$

Where Y_{ct} is the outcome of interest for country c in year t. The dependent variable is thus the year-on-year growth rate of the outcome Y_{ct}. T_c is an indicator for being in the treatment group (defined below), $Boom_t$ is an indicator for being between the years 1974 and 1980, $Bust_t$ is an indicator for being between the years 1981 and 1986, and $Valley_t$ is an indicator for being between the years 1987 and 1995. Thus β_1 is the average difference in outcome growth rates between treatment and control countries during the boom period, conditional on year fixed effects, with β_2 and β_3 having similar interpretations for the bust and valley

periods. $Exports_{1970-72}$ is the average level of exports per capita from 1970-1972 in the relevant sector being analyzed (i.e. manufacturing, non-oil resource exports, or agriculture). This is included to control for the possibility of convergence in sector output (initial exports are used in all regressions rather than value added due to superior data coverage). This specification does not include country fixed effects on the right hand side because the dependent variable is a growth rate, and hence differences in levels across countries are controlled for. Robust standard errors clustered at the country level are used for all regressions.

I also use an alternative semi-parametric specification that describes level effects over time in resource dependent countries, which are presented graphically. This specification is as follows:

$$ln(Y_{ct}) = (\sum_{t} \beta_t * \gamma_t T_c) + \alpha_c + \gamma_t + \epsilon_{ct} \tag{2}$$

Where α_c is country fixed effects and γ_t is year fixed effects. This specification estimates a treatment effect β_t for every year in the sample, with 1972 as the reference year.

Treatment 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 three percent of GDP in 1972[4]. This rule yields a list of 19 treatment countries, listed in Table 1 along with their 1972 hydrocarbon dependence[5]. While all 19 treatment countries are covered in the trade data, the INDSTAT3 manufacturing data does not have suitable coverage for 5 of the 19 treatment countries, so the treatment group for this part of the analysis is only 14 countries.

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 his-

[4]Resource production data comes from UN Industrial Commodities Statistics, which provides production quantities of commodities for all countries and years from 1950-2001.

[5]Exact oil 1972 dependence is unknown for Libya and the United Arab Emirates because 1972 GDP data is 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?
Oman	72.4%	n
Saudi Arabia	65.1%	n
Gabon	27.1%	y
Venezuela	19.2%	y
Bahrain	15.1%	n
Trinidad and Tobago	15.0%	y
Algeria	14.0%	y
Nigeria	11.9%	y
Iraq	10.9%	y
Indonesia	9.8%	y
Qatar	9.4%	n
Kuwait	7.5%	y
Syria	4.8%	y
Ecuador	4.1%	y
Tunisia	3.6%	y
Bolivia	3.5%	y
Iran	3.3%	y
Libya	unknown	y
United Arab Emirates	unknown	n

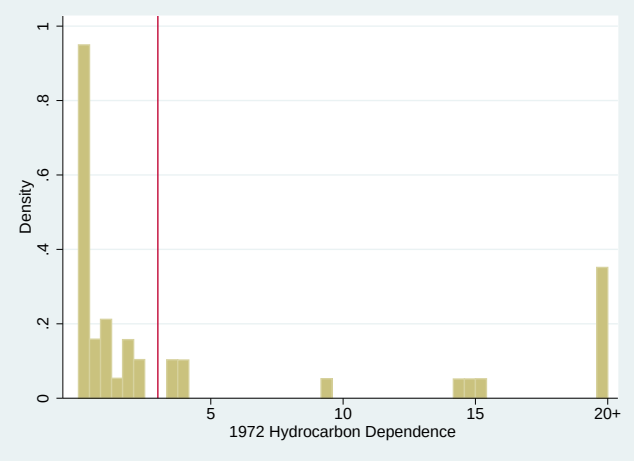
togram of each country's 1972 hydrocarbon dependence, among countries with non-zero oil production. The vertical line is the 3% treatment group threshold. The graph suggests that another natural choice for the threshold would be 5% dependence. However, using this definition does not alter the main results. 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 Congo).

Countries that are only slightly below the 3 percent threshold may still be affected by the price shock and are thus not desirable control countries. Therefore I only include countries in which oil and gas production accounted for less than 1 percent of 1972 GDP in the control group. Countries that are between 1 and 3 percent are dropped from the main specifications[6].

The binary treatment classification has appeal in that it allows for simple graphical

[6]These low dependence countries are Afghanistan, Albania, Canada, Colombia, Egypt, Malaysia, Mexico and the United States. These countries are included in the continuous dependence specification in the robustness checks section.

Figure 4: 1972 Oil Dependence Histogram



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 section 4.3.

I 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[7]. Former Soviet Union countries are also dropped from the sample, since for these countries data usually only begins 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.

Import and Export data comes from the NBER-UN World Trade Flows 1962-2000 data set. This data set gives complete bilateral and total export and import flows organized by the four-digit Standard International Trade Classification (SITC), Revision 2. To make the

[7]These countries are Yemen, Equatorial Guinea, Papua New Guinea, Cameroon, Norway, Suriname, United Kingdom, Republic of Congo, Israel.

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 4-digit SITC revision 2 categories into 40 3-digit ISIC revision 2 categories, including 29 manufacturing categories.

Data on manufacturing value added, employment, wages and capital formation are taken from the United Nations Industrial Development Organization (UNIDO) INDSTAT3 series covering the years 1963-2004. In all 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 because it offers the best data coverage, particularly in the case of the INDSTAT3 data, which becomes quite sparse outside this range. Both this and the World Trade Flows data 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 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, a restriction that 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 Results

4.1 Exports and Imports

I begin by examining the effect of the boom and bust on export and import activity. Column 1 of Table 2 shows the results of estimating equation 1 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. Manufacturing imports, shown in column 2 likewise grew significantly during the boom period, but also declined sharply thereafter.

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*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	3041	3040	2763	2762	3033	3009
Countries	109	109	107	107	109	109
R-sq	0.09	0.07	0.05	0.07	0.08	0.09

Notes: All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, **, *** indicates significance at a 10%, 5%, 1%, and .1% level respectively.

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 would be consistent with a version of the Corden & Neary (1982) model that

specifies manufacturing as an intra-industry sector (in which products from the same sector are both imported and exported). Intra-industry trade can arise from product differentiation within a sector. Of course, manufacturing is an extremely broad classification and is self-evidently an intra-traded sector. Hence the positive result for manufacturing exports does not contradict the Corden & Neary (1982) model, but rather serves as a caution against conflating manufacturing with the stylized "traded sector" of the model.

Columns 3 and 4 of Table 2 report the export and import results for non-oil mineral exports. For each country-year observation, I sum together the export values for the ISIC categories "Coal Mining", "Metal Ore Mining" and "Other Mining". During the boom there is a significant negative effect on non-oil resource export growth, and a positive significant effect on imports. However, in the level regressions that follow we will see that the pattern of non-oil resource exports and imports is in fact rather erratic. There is no significant effect on either exports or imports following the boom.

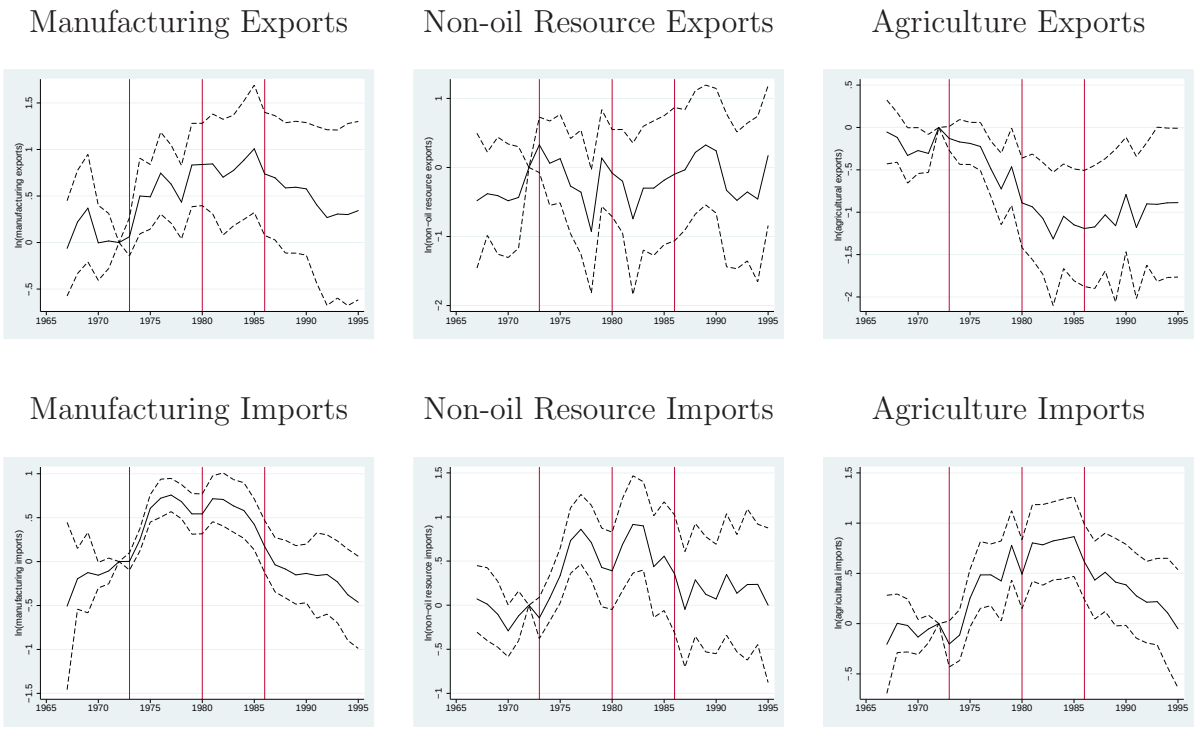
Columns 5 and 6 report the results for total agricultural exports [8]. Similarly to non-oil resources and consistent with Dutch Disease predictions, during the boom there is a large and significant negative effect on exports. After the boom the effects are smaller and insignificant. Interestingly, agricultural imports increased significantly during the boom. Since the demand for agricultural goods is presumably inelastic, the increase in imports suggest that during the boom resources used for food production shifted to other sectors of the economy, and local food production was displaced by imports. It is also important to note that, for various reasons, food prices were also rising during the oil boom period, so the effects on agricultural trade are likely affected by factors other than Dutch Disease mechanisms originating from the oil boom.

Figure 5 presents the graphical results of the exports/imports level regressions from equation (2), with vertical lines denoting the beginning of the boom, bust, and valley periods.

[8] All ISIC subcategories under "Agriculture, Hunting, Forestry and Fishing".

Each point on the graph represents the estimated treatment effect in the given year, with 1972 as the reference year. The dotted lines represent 95% confidence intervals. The rise in manufacturing exports begins in the first year of 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 steadily 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. While non-oil mineral exports 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. Agricultural exports significantly diminish throughout the bust period before stabilizing, and the negative effect persists in the long term. Import effects display similar behavior across all three categories, sharply rising during the boom and then steadily declining, with small and insignificant effects in the long-run.

Figure 5: Exports/Imports Effects



4.2 Manufacturing Outcomes

Column 1 of Table 3 reports the results of estimating Equation 1 with year-on-year difference in total log manufacturing value added as the dependent variable. The results are comparable to those for manufacturing exports, albeit not as large. There is a significant positive effect of .065 during the oil price boom on manufacturing output, and no significant growth rate effects during the bust and valley periods. Columns 2 and 3 of Table 3 report the effects on employment and wage. 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, with a smaller, insignificant negative effect during the bust. However, there is also a significant positive effect on manufacturing employment during the boom, and a negative but insignificant effect during the bust. This could reflect increased local demand for manufactured goods coupled with low labor intensity of the resource sector. It could also indicate that investment in the manufacturing sector increased during the boom, pushing up productivity and wages. This is supported by the economically large positive effect on capital formation reported in Column 4, which is significant at a 10% level (although again, due to limited data on this particular outcome, extra caution is warranted). The positive estimated effect on productivity[9] during the boom, reported in Column 5, is similar to the increase in wage, but is not statistically significant.

Figure 6 presents the graphical results of the level regressions from equation (2) for all outcomes shown in Table 3. Value added follows a similar pattern to that of exports, rising sharply at the start of the boom, 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. Most other outcomes follow a similar pattern with the exception of employment, which stays roughly flat after the initial rise. It is therefore primarily a fall in labor productivity that is responsible for the decreased output. This could be partially explained by the capital formation results;

[9]Labor productivity is not given directly in the INDSTAT3 data, so I construct it by dividing total value added by total employment.

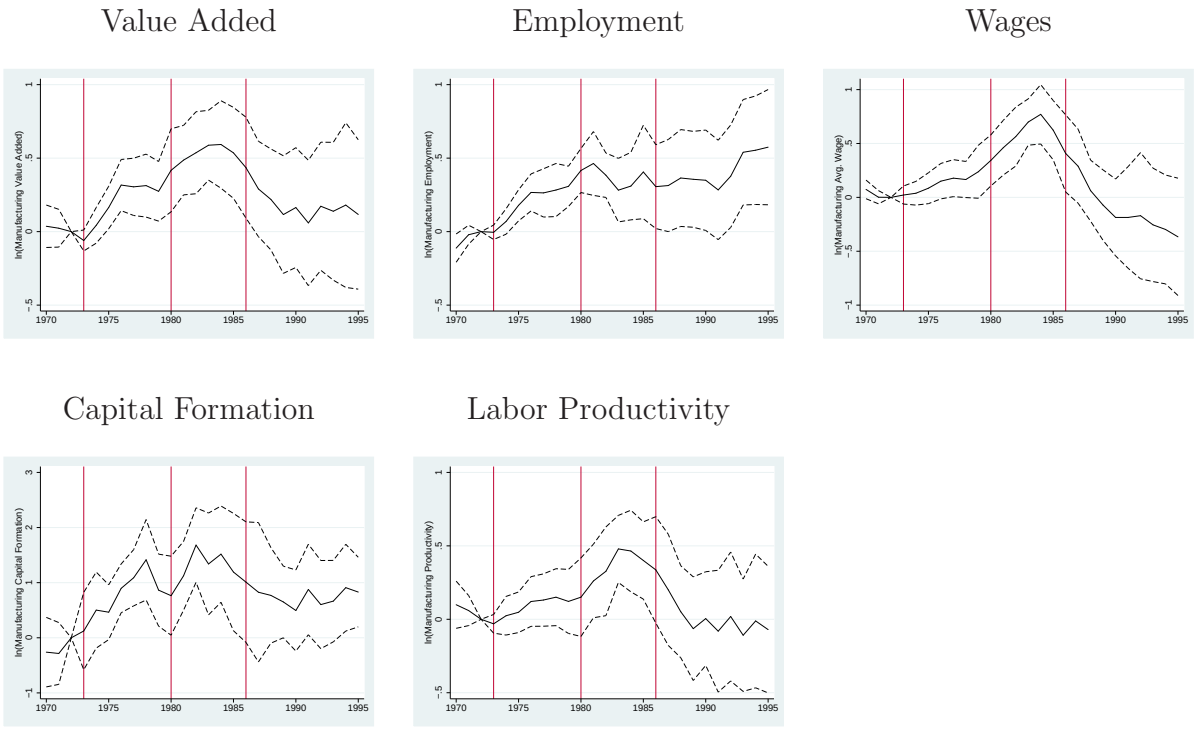
Table 3: Manufacturing Outcomes

	(1) Value Added	(2) Employment	(3) Wage	(4) Cap. formation	(5) Productivity
Treat*Boom	0.065**	0.043**	0.043**	0.080^{+}	0.029
	(0.021)	(0.008)	(0.011)	(0.041)	(0.018)
Treat*Bust	0.005	-0.024	0.015	0.027	0.035
	(0.033)	(0.018)	(0.030)	(0.058)	(0.040)
Treat*Valley	-0.019	0.017	-0.059*	0.002	-0.012
	(0.025)	(0.015)	(0.025)	(0.046)	(0.021)
Initial manuf. exports	0.003	-0.005**	0.008**	-0.006*	0.005*
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
N	1742	1808	1651	1133	1941
Countries	78	79	73	54	75
R-sq	0.11	0.08	0.09	0.05	0.08

Notes: All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, **, *** indicates significance at a 10%, 5%, 1%, and .1% level respectively.

the effect on capital formation begins falling just before the fall in productivity, so that lower relative levels of capital may have caused decreased labor productivity and hence output.

Figure 6: Manufacturing Effects



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. As a first pass I use the binary exportability classifications found in Rajan & Subramanian (2011), which are based on historical export to value-added ratios[10]. 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 index that excludes sectors that are classified as upstream or downstream from the oil sector (these are listed below). 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. 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.

Columns 3 and 4 report value-added results when only upstream and downstream sectors are included in the sample, respectively. Upstream sectors include chemicals, metals,

[10]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. This index corresponds well to industries with high export to value-added ratios as of 1972 using the data used in this paper.

Table 4: Subsector Manufacturing Results

	(1) Exp Index=1	(2) Exp Index=0	(3) Exp Index2=1	(4) Exp Index2=0	(5) Upstream	(6) Downstream	(7) Non-oil
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	-0.010	0.002	-0.011	-0.012	-0.046	-0.099*	-0.009
	(0.037)	(0.029)	(0.039)	(0.025)	(0.030)	(0.050)	(0.026)
Treat*Valley	-0.010	-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	0.002	0.000	0.003^{+}
	(0.002)	(0.005)	(0.002)	(0.006)	(0.003)	(0.003)	(0.002)
N	1723	1718	1711	1723	1702	1572	1723
Countries	76	76	75	76	75	68	76
R-sq	0.0824	0.0523	0.0631	0.0738	0.0935	0.0695	0.0843

Notes: All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, **, *** indicates significance at a 10%, 5%, 1%, and .1% level respectively.

machinery, and transport equipment[11]. Downstream sectors include refined petroleum products, rubbers and plastics[12]. Both upstream and downstream industries rise significantly during the boom period, with downstream sectors also significantly decreasing during the bust. Finally, Column 5 reports the results for sectors that are neither classified as 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.

4.3 Robustness Checks

I next subject the main results to several robustness checks and alternative specifications. Table 5 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 only comparing performance between developing countries. Column 2 omits treatment countries

[11]Upstream sectors are ISIC revision 2 codes 351,352,381,382,383,384.

[12]Downstream sectors are ISIC revision 2 codes 353,354,355,356.

Iran and Iraq, as these countries were extremely volatile during the period studied, which included a lengthy war with each other. 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[13]. Column 5 includes individual country trends. The results are similar and remain significant (though only at the 10 percent level in the case of country trends) across each specification.

Table 5: Manufacturing Exports Robustness

	(1) Non-OECD	(2) Iran/Iraq exc.	(3) Outliers Removed	(4) Region-year FEs	(5) Country Trends
Treat*Boom	0.113**	0.128**	0.110**	0.064^{+}	0.118^{+}
	(0.033)	(0.032)	(0.031)	(0.034)	(0.070)
Treat*Bust	0.011	-0.017	-0.016	-0.021	-0.007
	(0.037)	(0.033)	(0.034)	(0.057)	(0.065)
Treat*Valley	-0.045	-0.011	-0.045	-0.025	-0.035
	(0.042)	(0.020)	(0.040)	(0.032)	(0.072)
Initial manuf. exports	0.004	0.005	0.006^{+}	0.002	1.521
	(0.005)	(0.003)	(0.003)	(0.005)	(1.113)
N	2481	2985	3041	3041	3041
Countries	89	107	109	109	109
R-sq	0.0992	0.0907	0.0911	0.161	0.114

Notes: All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, **, *** indicates significance at a 10%, 5%, 1%, and .1% level respectively.

Table 6 repeats the exercise for the manufacturing value-added regressions. Columns 1-5 repeat the robustness checks discussed above, and the estimates are again fairly stable. Column 6 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 value added is 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

[13]See appendix 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.

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[14], 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.

Table 6: Manufacturing Value-Added Robustness

	(1) Non-OECD	(2) Iran/Iraq Exc.	(3) Outliers Removed	(4) Region-year FEs	(5) Country Trends	(6) RER adjusted
Treat*Boom	0.057**	0.060**	0.086**	0.072**	0.076*	0.042*
	(0.022)	(0.022)	(0.018)	(0.026)	(0.032)	(0.020)
Treat*Bust	0.004	0.006	0.003	-0.027	0.008	-0.005
	(0.034)	(0.033)	(0.025)	(0.024)	(0.039)	(0.037)
Treat*Valley	-0.017	-0.031	-0.010	-0.015	-0.009	0.133
	(0.027)	(0.027)	(0.026)	(0.023)	(0.036)	(0.120)
Initial manuf. exports	0.003	0.003	0.005*	0.000	0.223	-0.003
	(0.003)	(0.002)	(0.002)	(0.004)	(0.614)	(0.002)
N	1221	1699	1707	1742	1742	1695
Countries	59	76	78	78	78	77
R-sq	0.0689	0.115	0.150	0.264	0.162	0.0282

Notes: All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, **, *** indicates significance at a 10%, 5%, 1%, and .1% level respectively.

As a final robustness check 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:

$$\Delta ln(Y_{ct}) = \beta_1(Dep_{1972} * Boom_t) + \beta_2(Dep_{1972} * Bust_t) + \beta_3(Dep_{1972} * Valley_t) + \beta_4 Manuf\_exports_{1972} + \gamma_t + \epsilon_{ct} \quad (3)$$

Where Dep_{1972} is hydrocarbon revenues as a percentage of GDP in 1972[15]. Implicit in this specification is the assumption of a linear effect of pre-boom dependence. Table 7 reports the results of this specification for exports and imports, and Table 8 for value added and

[14]The exact formula for exchange rate adjusted value added growth is $((1+Growth_{VA})/(1+Growth_{RER}))-1$. Real exchange rates are from Penn World Tables 7.0.

[15]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.

other outcomes. The results are consistent with the binary treatment specification, with large and significant effects of dependence on manufacturing exports, output, investment and productivity. Likewise there are large positive effects on all types of imports, and strong negative effects on agricultural exports.

Table 7: 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*Boom	0.324**	0.147**	-0.088	0.152*	-0.232**	0.196**
	(0.072)	(0.044)	(0.091)	(0.067)	(0.086)	(0.054)
Dependence*Bust	0.011	-0.094**	0.130	0.053	-0.048	0.038
	(0.078)	(0.034)	(0.129)	(0.108)	(0.133)	(0.068)
Dependence*Valley	-0.031	-0.101*	-0.012	-0.030	0.090+	-0.148**
	(0.042)	(0.045)	(0.082)	(0.077)	(0.051)	(0.038)
Initial manuf. exports	0.005	0.006**				
	(0.003)	(0.002)				
Initial non-oil res. exports			-0.011+	-0.000		
			(0.006)	(0.003)		
Initial ag. exports					0.003	0.002
					(0.002)	(0.003)
N	2985	2984	2719	2707	2978	2953
Countries	107	107	105	105	107	107
R-sq	0.09	0.07	0.05	0.07	0.08	0.09

Notes: All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, **, *** indicates significance at a 10%, 5%, 1%, and .1% level respectively.

Table 8: Manufacturing Outcomes with Continuous Dependence

	(1) Value Added	(2) Employment	(3) Wage	(4) Cap. formation	(5) Productivity
Dependence*Boom	0.164*	0.108**	0.065	0.177**	0.098*
	(0.074)	(0.031)	(0.055)	(0.050)	(0.047)
Dependence*Bust	-0.068	0.006	0.005	0.176	-0.038
	(0.064)	(0.024)	(0.063)	(0.163)	(0.065)
Dependence*Valley	-0.064	0.050*	-0.193**	-0.157	-0.095*
	(0.056)	(0.022)	(0.070)	(0.122)	(0.038)
Initial manuf. exports	0.003	-0.006**	0.009**	-0.006*	0.007**
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
N	1729	1795	1638	1120	1629
Countries	77	78	72	53	72
R-sq	0.11	0.08	0.09	0.05	0.09

Notes: All regressions include year fixed effects. Robust standard errors clustered at the country level are reported in parenthesis. +, *, **, *** indicates significance at a 10%, 5%, 1%, and .1% level respectively.

5 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 and employment increased substantially in oil-rich countries relative to non-oil-rich countries. Manufacturing wages also increased, satisfying a necessary condition for the Dutch Disease phenomenon, but capital formation and productivity also increased, at least partially explaining the rise in output. 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 were 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.

These results do not 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 appear to have been overwhelmed by the positive investment spillovers, which are not considered in the core model.

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Appendix: 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		
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
Burundi		x
Central African Republic		x
Chad		
Congo, Dem. Rep.		
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