AN EMPIRICAL TEST OF THE DUTCH DISEASE HYPOTHESIS
USING A GRAVITY MODEL OF TRADE

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Abstract

Although the core model of the Dutch Disease makes unambiguous predictions regarding the negative effect of a resource boom on a country's manufacturing exports, the empirical literature that has followed has not clearly identified such effect. Instead, I estimate that the world price of oil has statistically significant, economically important, and intuitive effect on a country's manufacturing exports. I attribute this to the failure of authors to combine enough data to produce a sufficiently powerful test. Instead, I use the World Trade Database to test this hypothesis in a gravity model of trade in the most generalized way. World energy prices are used to bypass issues of endogeneity regarding primary exports. While price-led mineral booms do not appear to have resulted in significant crowding out of manufacturing exports, a 1% increase of the real world price of energy is estimated to result in 0.6% decrease in real manufacturing exports, holding all its other determinants constant. The corresponding confidence interval is very tight.

"[…] in the words of Lord Kahn [1905-1989], 'when the flow of North Sea oil and gas begins to diminish, about the turn of the [21ˢᵗ] century, our island will become desolate.' Any disease which threatens that kind of apocalypse deserves close attention."

"The Dutch Disease," *The Economist,* November 26, 1977: pp-82-83.

1.   Introduction

It is widely assumed in the literature that natural resource booms tend to harm countries which witness them. Most famously, Sachs and Warner (1995) show that economies with a high ratio of natural resource exports to GDP in 1971 (their base year) tended to have low growth rates during the subsequent period 1971-89. This negative relationship holds true after controlling for other usual determinants of economic growth, such as initial per capita income, trade policy, government efficiency, and investment rates.

Jeffrey Sachs and Andrew Warner (1995) conclude that "one of the surprising features of modern economic growth is that economies abundant in natural resources have tended to grow slower than economies without substantial natural resources1." Such a statement deserves careful scrutiny if only because of its implications for both development policy and macroeconomic policy in industrialized countries. At the same time, there is a growing debate among academics, development and environment related lobbyists and policy makers regarding whether or not resource abundant countries should be refrained from exploiting their resource base.

There is an exploding literature dealing with an increasing number of aspects of the "resource curse." There are two main areas[1]. The first can be termed the "political economy of mineral rent generation and distribution." The second covers the "general equilibrium effects of a minerals boom", including the spending effects of the mineral rents. This paper focuses on this second literature and what is probably the best-known and the most classical formulation of the resource curse hypothesis, namely the Dutch Disease — hereafter DD — hypothesis .

The DD refers to a situation in which a booming export sector increases the prices of non-tradable goods and services, thus hurting the rest of the tradable goods sector. Its name arose from the effects attributed to the discoveries of North Sea gas on the Dutch manufacturing sector. Corden and Neary (1982) present what has come to be known as the "core model" of DD economics. In this paper I test

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[1] This terminology hereafter is adopted from Daniel (1986)

systematically one of its main unambiguous testable hypotheses, the one that has attracted most concerns from economists, *i.e.* the hypothesis that resource boom lead to reductions in manufacturing exports, controlling for all other determinants of trade.

There is a large literature on the empirics of the Dutch Disease. This literature is mostly a collection of country (sometimes comparative) case-studies for the OECD and developing countries. Spatafora and Warner (1999, 2001) is the only exception. Their dataset is composed of 18 oil-exporting LDCs covering a period running from the mid sixties until the eighties. They find that Dutch Disease effects are strikingly absent. There is no general cross-country econometric test of the consequences of resource booms on real manufacturing trade to the author's best knowledge.

The general conclusion of this literature is that there are symptoms of the Dutch Disease in most instances of commodity boom but that it is very difficult to disentangle DD effects from the domestic and international macroeconomic conditions prevailing at the time of the shock. For example, price led energy booms tend to be accompanied by world-wide recessions.

A gravity model of manufacturing trade allows me to control for those macro-economic circumstances, as well as other important geographic determinants of trade. The choice for this particular model is due to its excellent empirical track record and its theoretical consistency with a variety of different theoretical views of trade. This last characteristic will waive me from having to adhere to any particular such view. In doing so, I use the gravity model of trade as a reduced form of a potentially more complex structural model that I will leave unspecified.

In the light of the endogeneity of commodity exports to manufacturing trade, world real energy and mineral prices are used to identify price led resource booms. Indeed, world commodity prices can be safely assumed to be exogenous to any single country's manufacturing exports. With this identifying assumption in hand, the real energy price elasticity of manufacturing exports in net energy exporters is estimated to be around .6%. In other words, a one percent increase in the price of energy will, everything else held constant, decrease a net energy exporter's real manufacturing exports by 0.6%. This elasticity estimate is exceptionally significant.

Extensive sensitivity analysis is conducted. Neither segmenting the data based on effective exchange rate regime nor decomposing the variable of interests nor changing currency units of

measurement overturns results. However, it is learned from sensitivity analysis that exchange rate management might allow countries to partially offset some of the Dutch Disease effects resulting from an energy price led boom. It other words, exchange rate management may allow net energy exporters to export some of the Dutch Disease effects, as is thought to have worked successfully in Indonesia (Roemer, 1994). Also, DD effects are strongest with net energy exporters rather than net importers. Booms occurring in the destination country seem to have comparable effects (but of opposite sign, obviously) on manufacturing exports by the origin, than booms taking place in the origin country.

The main result found is this paper is in some way surprising in the state of the DD literature. I find strong evidence of the DD in the world trade data. Price-led resource booms, and particularly energy booms, have systematically tended to hurt energy exporters' manufacturing exports. So, in contrast with the existing literature, this paper casts away doubts about the empirical relevance of the DD, particularly regarding energy producers. It is intuitive, however, that by juxtaposing the marginally convincing evidence found in numerous countries, one be able to either reject or accept the DD hypothesis[2].

One should be careful in not over-interpreting these results reported in this paper, however. In most cases, booms result in increased GDP levels, and hence welfare, for energy producers. That's not the question at stake in this paper. Further, one only needs to worry about the DD insofar as there is indeed something desirable about having a large proportion of manufacturing exports. There is, however, evidence that productivity growth can sometimes be very strong in resource extraction industries, at least in industrialized countries. And the role of that manufacturing may play over the primary sector may vary from country to country, because of the possibility of factor intensity reversal, for example.

On the other hand, there is a widespread assumption in the structural tradition of the development literature that industrialization should be *per se* an economic development goal. More recently, Matsuyama (1992), Sachs and Warner (1995, 1999), and their followers, have explicitly modeled economic growth as a function of the relative size of the manufacturing sector. It is not the purpose of this paper to settle this issue.

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[2] If authors in the DD empirical literature systematically reported comparable estimates of the effect of resource shocks on manufacturing exports, it would be interesting to see if the same conclusion is reached through meta-analysis. Such is far from the case, unfortunately

Rather, the statistic and economic significance of the result found here lead me to argue in favor of careful future empirical testing of the effect of sectoral changes in output and exports, and more specifically those resulting from resource booms, on aggregate productivity and economic growth. Now that the effect of resource booms on energy exporters' manufacturing exports is established, there is urging need, in the author's view, to test whether, if, how and why this de-industrialization would result in slower technological progress.

As far as industrial, public finance, energy and development policy formulation is concerned, the results are unambiguous: **resource boom are very likely to result in de-industrialization**, and if this is an economic or political concern, or both, then energy net exporters (and to a less extent energy net importers, actually) should take account of this balance of payment constraint. I conjecture that careful exchange rate management may be able to help with these symptoms. Further investigation of this conjecture is needed, however.

This paper is organized as follows. Section 2 reviews the theory and empirics of the Dutch Disease. Section 3 exposes the methodology and the data used in this paper. Section 4 proceeds to exposition of the results. Section 5 undertakes sensibility analysis. Section 6 concludes and points to caveats and unresolved issues.

2.   Literature Review

2.1. The Dutch Disease theory

The DD refers to the situation in which a boom in an export sector leads to a shift on production factors towards the booming sector and an increase in the prices of non-tradable goods and services, thus hurting the rest of the tradable goods sector. Its name arose from the effects presumably caused by the discoveries of North Sea gas on the Dutch manufacturing sector. Corden (1984) notes that the term appears to have been coined in *The Economist* of November 26, 1977. The idea itself is traced back to Meade by Graeme Dorrance and Robert Leeson (1997).

Meade spent six months in Australia in 1956. While there, he observed the effect of the growth in Australia's resource exports, and identified what came to be called the DD (Corden, 1996). The first paper approaching this question is actually by Meade and Russell (1957). Corden (1984) reviews the early DD

literature and identifies other early papers as McKinnon (1976) on Kuwait, and Gregory (1976) and Snape (1977) on Australia, and an early paper on Norway, Eide (1973) in Norwegian. Following-up with Corden (1981) and Corden and Neary (1982), a vast DD literature developed on how a natural resource boom can trigger a process of de-industrialization.

W.M.Corden and J.Peter Neary (1982) present what they call and what has come to be known as the "core model" of Dutch Disease economics[3]. Let's assume a small open economy that produces three goods: two which are traded at exogenously given international prices, and a third, which is a non-traded good whose price is determined by domestic supply and demand. The traded goods sector includes a booming good, and a non-booming one. The non-traded good is typically thought to be produced by the service sector (but it can be extended to the construction sector etc). A resource boom affects the rest of the economy in two main ways: the resource movement effect and the spending effect.

On the supply-side, an exogenous increase in the value of output in the booming sector raises the marginal product of labor in that sector. This will cause a shift of labor to the booming sector from all other sectors. The result is a contraction of the tradable sector simply due to its reduced use of production factors. This is the *resource movement effect*. This factor movement also leads to an increase in the price of non-traded goods since, *ex ante*, it results it excess demand for non-tradables. Since the price of tradables is exogenously determined in world markets, the rise in the prices of non-tradables is equivalent to an appreciation of the real exchange rate.

On the demand side, the boom in the natural resource sector caused, say, by a rise in the world price of an already exploited resource or the discovery of a valuable resource, leads to increased income at home and, therefore to increased demand for *all* goods. Since the price of tradables is given by world markets, this extra spending raises the relative price of non-tradables, resulting in a further appreciation of the real exchange rate. In response, mobile factors shift from the tradables sector to the non-tradables sector. Here too results a contraction of the non-booming tradables sector results. That is the *spending effect*.

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[3] The presentation made in this section of the "core model" of the DD is inspired from two very clear presentations by Adolfo Meisel Roca (1999) and Karlygash Kuralbayeva, Ali M. Kutan and Michael L. Wyzan (2001).

When Corden and Neary (1982) set up their model with one specific non-mobile factor (capital) and one mobile factor (labor) in all sectors, they show that both the resource movement effect and the spending effect imply a shift of labor away from the manufacturing sector, resulting in an unambiguous decline in manufacturing output[4]. The booming sector's output increases since the value of output initially increases, and it absorbs *ex post* production factors coming from other sectors. There is ambiguity regarding the change in non-tradable output. The spending effect implies an expansion of this sector, yet the resource movement effect, a contraction.

The strength of the spending effect depends on the propensity to consume services. Typically, when a resource boom occurs, increased government spending on construction and public services is likely to be the main channel for use of mineral rents. Mineral states have been documented to lavishly spend their mineral revenues on numerous development projects and programs (see for example William Ascher, 1999). Hence, this marginal propensity to consume non-tradables will be high. The strength of the resource movement effect depends on the factor intensity of each sector. If the booming resource sector is the capital intensive sector (as is often the case in LDCs, but sometimes also in more industrialized countries), the spending effect will dominate the resource movement effect.

Corden and Neary (1982) call "direct deindustrialization." the movement of labor from the manufacturing sector to the booming sector is called The flow of labor out of the non-tradable sector, together with the demand increase for goods from that sector due to the spending effect, causes a further shift of labor from the manufacturing sector to the non-tradable sector. They refer to this "second" shift as "indirect de-industrialization". For reasons related to those mentioned above, indirect industrialization is expected to be more important than direct deindustrialization.

When the net effect of the spending and the resource movement effects are considered together we get the following 4 main types of results:

(R1)   The real exchange rate unambiguously appreciates[5];

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[4] Corden and Neary (1982) show the implications of two other sets of assumptions about the factor mobility between sectors. One can assume that capital is mobile between the manufacturing and services sectors, or that capital is mobile among all three sectors. In these cases, resource allocation cannot be determined without a prior knowledge of parameter values. In the rest of this paper, given the lack of unambiguous predictions from the models with mobile capital, the DD model will refer to the basic model with one specific non-mobile factor (capital) and one mobile factor (labor).

[5] This can take the form of a nominal appreciation or a change in the domestic : foreign aggregate price ratio.

(R2)   The there is a likely though theoretically ambiguous increase in non-traded output;

(R3)   Production in the manufacturing sector unambiguously falls;

(R4)   A fall in manufacturing exports results.

There are thus three unambiguous testable hypotheses. I do not test for R1. Instead I refer the reader to a recent contribution by Chen and Rogoff (2002). They show R1 holds for a few mineral-rich countries they select for their data availability (even though that's not enough to solve the PPP puzzle).

In theory, R2 is a testable hypothesis but sectoral production data is available for only a few countries. Further, there is in fact little doubt throughout the DD literature that service output rises in response to a resource boom (see Spatafora and Warner 1999 and 2001 for the most systematic results). In any case, testing an ambiguous implication of a model is unavoidably less attractive because it does not allow inferences regarding the general validity of the theoretical model itself. In other words, finding supportive and dismissive evidence regarding R2 would be both compatible with the DD model. Nonetheless, it would be interesting, if empirically possible, to clarify this in future work.

In this paper, I will only test explicitly for R4, principally because of the richness of trade data compared to the unhelpful corresponding scarcity and unreliability of sectorally disaggregated cross country data. Under the hypotheses of the DD model, R3 implies R4, but it possible to imagine R4 without R3. In other words, domestic production of manufactured goods *could* increase as a result of a resource boom while manufacturing exports decrease.

But, for this to happen, domestic demand for manufactured goods would have to grow more than exports would shrink *as a result of a resource boom*. The author's opinion is that exports will turn out to be too strongly affected by resource booms for this to be plausible, however. Had manufacturing exports only be marginal affected by resource booms, this would have been a valid concern.

Finally, many authors argue that international trade leads to firm-level learning about foreign technology and markets; and so, independently of production, manufacturing exports slumps are often perceived as a concern of their own. Recently, Megan MacGarvie (2002) provides evidence of such learning effects using patent data citations. Jeffrey Frankel and David Romer (1999) instrument trade across countries with geographic variables, and conclude that trade has a positive effect on income. This effect is economically significant and robust, albeit marginally significant.

Importantly, it should be noted that the effects of Dutch Disease discussed are of course working on top of the rest of the shocks affecting the economy. Specifically, declines in manufacturing exports in response to a resource boom have to be thought of against the background of their counterfactual. The importance of a "ceteris paribus" analysis will be illustrated when graphical evidence will be examined, and will be further justified by an examination of the empirical DD literature.

2.2. Existing Empirical evidence

What about the empirical relevance of the DD hypothesis? There are two branches to this literature. One of these branches covers resource-booms in OECD countries. Corden (1984) is the classical survey of the early empirical literature on industrialized countries. A general book referring to the "oil or industry" issue with respect to Canada, Mexico, the Netherlands, Norway, and Britain was edited by Barker and Brailovsky (1981). The other branch studies resources booms in developing countries. The second branche succeeded the other although there is some overlap. Gary McMahon (1997) reviews the results of eight different studies focused on developing countries.

In general, the development side of this literature tends to put more emphasis on rent-seeking behaviors and poor governance whereas the original literature focuses more on prices and structural issues. This can be explained by the differing concerns each group of authors have. In OECD countries, the concern is about 'de-industrialization' and the ballooning of the role of the state; many of these papers where also written in an era where economists were responding to the worry that Western economies where turning into nations of "hamburger flippers." On the other side, in the *relative* absence of industry, development economists are more concerned with 'de-agriculturization' and detrimental effects on burgeoning social and political infrastructures of newly decolonized nations in particular. Let's review briefly each literature in turn.

The Netherlands

In the late 1950s a very large deposit of natural gas was discovered in the north of The Netherlands. Development began in 1963 and by 1977 a country which had been a traditional energy importer became an energy exporter. For Ellman (1981), cheap domestic energy seemed wholly favorable to the economy, at least into the late 1960s and early 1970s. But during the 1970s, the guilder appreciated relative to most

currencies. The textiles and clothing industries almost vanished. There was a decline in metal manufacturing, mechanical engineering, vehicles, ships, and even construction and building materials. The service sector expanded noticeably, and seemed to be "taking over."

Corden (1984) argues that "the true DD in the Netherlands was not the adverse effects on manufacturing of real appreciation but rather the use of booming sector revenues for social service levels which are not sustainable, but which it has been politically difficult to reduce." Barker (1981) and Kremers (1985) conclude that it is difficult to "accuse" the gas discoveries for the severe decline in several Dutch manufacturing industries between 1973 and 1977. Most of Western Europe was sharing a similar experience, and more specifically Germany, the main trading partner of The Netherlands. These countries were also witnessing substantial growth in unemployment.

Figures I and II help compare the experience of The Netherlands with that of its trading partners. Generally, periods of increasing real energy price correspond to periods of shrinking of manufacturing exports as a share of GDP. Conversely, real energy price crunches correspond to periods of increases of the share of manufacturing trade intensity. However, the pattern observed in The Netherlands looks very similar to that of France and Germany which are not net energy exporters. Figure II plots manufacturing exports for the same four countries in real 1995 dollars, *i.e.* the real exchange rate index is applied to these series in order to capture the volume of manufacturing exports in local currency equivalent. Here again the Dutch experience is very similar to that of its main EC trading partners. In fact it is French manufacturing exports that takes the worse dip although France is not an energy exporter.

The United Kingdom

In the United Kingdom, Anthony Ross (1986) reminds us that commercial production of oil started in 1975 when the (first) recession had already began. The real exchange rate did appreciate by 51%-55% between 1977 and 1980. Manufacturing output dipped by 4% between 1973 and 1979 and by 14% between 1979 and 1982.

However, it is difficult to hold oil responsible for the pound's real appreciation. Simultaneously, monetary policy was tightened markedly with, consequently, high nominal interest rates prevailing between 1979 and 1981. Further, the status of the pound as a 'petrocurrency' concurrently to high oil prices turned it into a secure haven, especially given the government's tough deflationary stance.

Buiter and Miller (1981, 1983) document that, against a background of declining or stagnant output, labor productivity started to grow rapidly from 1980, especially in the manufacturing sector. For Sachs and Brandon (1983) a lot of these productivity gains (as well as of inflation taming) simply followed from the Thatcher government's tolerance towards unemployment. Accordingly, Jeffrey Sachs thinks that the UK government was simply playing with its "sacrifice ratio" (even though he acknowledged rational expectations issues.) Peter Forysth (1985) concludes that there is evidence of DD effects, but that it is impossible to measure the precise impact of the booms on structural change. In particular, North Sea oil was imposed on a poor macroeconomic background, and Forsyth thinks that, to some extent, the United Kingdom appeared to be exacerbating the structural effects by spending its oil revenues too fast.

Looking back to Figures I and II we can compare the experience of The United Kingdom during the early 1980s with that of other main European countries. While the share of manufacturing exports in GDP fell in the United Kingdom, this experience also bears a lot of resemblance with that of its main EC trading partners. However, manufacturing exports intensity seemed to have dipped stronger than in the other three countries, possibly reflecting the highest relative importance of mineral rents in the UK. In Figure II, manufacturing exports for the same four countries in real 1995 dollars also dips more markedly than in The Netherlands, Germany and France. This provide for a check on Figure I where it might be argued that the share of manufacturing exports in GDP declined precisely because rents boosted GDP with possibly no effects on exports *per se*. Figure II suggests that such is not the case. Yet, France, not a net energy exporter, also experienced a sharp dip in the early 1980s.

Developing countries

Gary McMahon (1997) reviews the results of eight different studies focused on developing countries. Regarding LDCs, there have also been numerous country case studies a few cross-country analyses; and even these are comparative case country studies. The main conclusion of this paper is that the DD is not a doom. Instead it is generated by economic policies that are inappropriate to begin with, or by inadequate policy responses to a resource boom.

Many authors simply find little evidence of a DD in many of their case studies (Gelb 1988, Cuddington 1989, Davis 1983) except in the sense that resource booms allow governments to go on with counter-productive policies for longer than otherwise (Auty 1993 and 1994, Collier and Gunning 1996). Most

governments were able to tax away the largest part of the resource rents[6]. The experience of these countries was, according to these authors, otherwise very analogous to that of other countries that had import substitution strategies in the 1970s.

Gelb (1988) and Spatafora and Warner (1999, 2001) analyze the performance of oil boom countries. Gelb (1988) case-studies these countries in parallel. Spatafora and Warner (1999, 2001) is the work that is closest to what is undertaken here. Their dataset in made of 18 oil countries observed between 1965 and 1989. These authors all find that favorable terms-of-trade shocks boost non-tradable output but that DD effects are remarkably lacking. This paper will reach opposite conclusions essentially because my dataset by including resource importers as well controls much better for the counterfactual case of absence of boom; in other words I propose a much more powerful test. I will return to this later.

In Kazakhstan (Kuralbayeva, Kutan, and Wyzan 2001), Kuwait (Looney 1991), Nigeria, Mexico, Venezuela (Roemer 1985) and Saudi Arabia (Looney 1988) exchange rate appreciation followed the oil boom. Authors generally argue that this appreciation possibly caused contraction of industrial output as compared to the no-boom counter-factual. However, in Kuwait, Nigeria, Indonesia and Mexico, the growth rate of the manufacturing sector was actually greater or equal to that of non-tradables. In Venezuela, all sectors grew slowly but with a non-tradable sector only growing at a yearly 5.5%, one cannot characterize these symptoms as typical of the DD, argues Roemer (1985).

The outcomes of both booms and slumps hang upon the government's policies, and hence upon the political process (Daniel 1986). Jazayeri (1986) reckons that in Iran and Nigeria, the manufacturing sector's growth rate is not fully consistent with the DD model, unless we take import substitution policies into account. As Roemer (1985) points out, trade protection can turn manufacturing activities into non-tradables.

On this account, Indonesia has been the "model pupil" (of the I.M.F.). Warr (1985) observes that in spite of distinctive effects on the domestic prices, it is not clear whether the economy's structure has been affected at all. Roemer (1994) explains that during the oil boom, the Indonesian government dodged the worst impacts of Dutch disease thanks to careful exchange rate management. Indonesia devalued its

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[6] In an other working paper entitled "Natural Resource Abundance and Human Capital Accumulation" in "review and resubmit" status at the *European Economic Review*, I expend on this phenomenon in greater detail. This paper is available from the author upon request.

exchange rate periodically during its petroleum boom. In 1986, a crawling peg was officially adopted and the rupiah kept its real value since then.

The effect of booms in other primary commodities has also been investigated. Most studies are inconclusive while Columbia seems to be the exception (Cuddington 1989, Davis 1983). Kamas (1986) and Roca (1999) examine the effects of large expansions in coffee (and illegal drug exports) revenues. As a result, the relative price of nontraded output soared and there was a real appreciation of the Columbian exchange rate. The nontraded sector's growth rate accelerated, while traded output slowed down. In the realm of metals, Spilimbergo (1999) makes no mention of DD effects and concludes that copper has actually helped the Chilean economy on various macroeconomic accounts.

Finally, the DD hypothesis has also been considered by economic historians. Forsyth and Nicholas (1983) consider the inflow of American treasures into the 16th century Spain. They interpret the consequences on the Spanish industry in DD terms. Cairnes (1859) considers the gold discoveries in Australia in the 1850s. He identified effects on some Australian industries that we would regard as DD effects nowadays[7]. This episode has also been studied more recently by Maddock and Ian McLean (1983).

Summary

The general impression that emerges from the empirical DD literature is that there is some evidence, although by no means strong evidence, that some countries, specifically oil producers, have shown symptoms of the DD. Most authors struggled to disentangle the pure DD effects on the manufacturing sector from the effects of trade crunches that follow recessions usually accompanying energy price spikes. In LDCs, authors struggle with disentangling manufacturing trade patterns due to DD effects from the general failure of development of competitive manufacturing sector, most often policy induced.

A major problem of current contributions to the literature is that by analyzing each country as an independent case study, or at best a subset of mineral countries, one is implicitly discarding very useful information, *i.*e. the controls offered by resource-scare countries. Further, there is the obvious need to control for the economic conditions prevailing in trade partners. The purpose of this paper is precisely to

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[7] There is the question of the original filiation of the DD concept. It is well possible that Meade was exposed to Cairnes' work while on his leave in Australia. This is only a conjecture on behalf of the author of this paper.

propose a generalized test of the DD. In a nutshell, I want to test for the DD hypothesis as a joint hypothesis for all countries.

Econometrically speaking, a bilateral trade flow setup naturally suggests itself. An additional advantage of working with manufacturing export data rather than production data becomes clear at this point. Many developing countries have long pursued import-substitution industrial policies, allowing inefficient industries to prosper or at least survive in spite of their poor productivity performance by global standards. Manufacturing exports, on the other hand, are much *less* amenable to protection. An increase in manufacturing exports is more likely to be indicative of productivity improvement than a mere increase in domestic production.

My empirical question is: controlling for the usual determinants of trade, do energy exporters tend to export less manufacturing in times of booms,(and vice versa)? To answer this question, I need to choose an empirical model for explaining trade flows. I have chosen the gravity model of trade because of its celebrated empirical success. I would not want to spuriously identify or fail to identify a DD effect for failing to model trade in an otherwise convincing manner. The data used in this paper, the gravity model of trade, and the details behind my empirical approach are presented in the following section.

3.   Methodology and Data

In this paper, I estimate the effect of price- led resource-booms on manufacturing trade exploiting time series (as well as some cross-sectional) variation. I use data that covers a large number of countries for fifty post-war years. During the time span covered in my sample, 1970-1997, there has been plenty of variability in the real price of energy as well as minerals. I exploit all this price variation, in times of boom as well as slump; I allow this variability to affect manufacturing exports of net energy exporters as well as of net energy importers.

The strategy of this paper is to link time-series variation in relevant world commodity prices to variations in international trade in manufactured goods at the country level. Of course, many things affect trade above and beyond price-led resource booms. While these other factor are not of direct interest here, I need to model their effects so as to be able to see if there is any remaining role for resource booms and slumps. Fortunately, the gravity model of international trade is a simple yet credible setup for this purpose.

The gravity model of international trade will allow me to implant my variables without having to worry about a general lack of explanatory power on behalf of the rest of the model.

The rest of this section is organized as follows. First, the methodology behind the gravity model of trade is presented (section 3.1). Next, I will discuss the construction of the variables that will allow testing for the DD (section 3.2). Finally, section 3.3 will acquaint the reader with the rich panel dataset used in this paper.

3.1.   Gravity Methodology[8]

The origin of the gravity model of trade is traced back to Tinbergen (1962) and Pöyhönen (1963) by Rose (2000). The gravity analogy comes from the fact that trade between two countries is modeled as a function of their GDP, that is their economic *mass*, and as a measure the distance between these countries. Leamer and Levinsohn (1995) survey recent empirical contributions to this literature. Results in this literature are systematically consistent, statistically significant and economically meaningful.

This paper relies on the unusual empirical credibility of the gravity model of trade. This model is very straightforward and is aimed at modeling empirically the size of international trade between countries. It amenable to extensions and it has been used to analyze a growing of issues: the emergence of a yen bloc (Frankel and Wei, 1993), the causal link between trade and growth (Frankel and Romer, 1999), departures from the law of one price (e.g., Engel and Rogers, 1996), and the effect of currency union membership trade (Rose, 2000, Glick and Rose ,2002).

Some authors have proceeded to providing theoretical justification to the gravity model of trade. There are in fact several ways to justify this approach that range from increasing returns goods differentiation across countries, monopolistic competition, reciprocal dumping, to cross-country differences in factor endowments or technology. I refer the reader to Evenett and Keller (1998) and Feenstra, Markusen and Rose (1998) for recent contributions and references to this question and to Anderson (1979) and Bergstrand (1985, 1989) for older contributions and references.

The objective of this paper is simply not to horse-race these different theoretical foundations against each other. The fact that, just as (Rose, 2000) argues, the fact that my results are not attached to a

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[8] This section's presentation of the gravity model of trade is strongly inspired by Rose (2000) and Glick and Rose (2002).

specific set of assumptions regarding international trade increases the results' generality. The trade-off is of course that this paper sheds no light on the relative merits of these different sets of assumptions

In this paper, I focus my attention to the manufacturing exports. This is not unusual at all in the literature; Bergstrand (1989), for example, estimates a similar model for single digit SITC industry groups. Feenstra, Markusen and Rose (1998) showed that the gravity model can also be derived from models of trade in differentiated products (see also Helpman 1984 and Bergstrand 1985). When they calibrate their model, they find that differentiated goods grant a more solid theoretical validation of the gravity model than commodities. Since I model manufacturing exports, my results are on the safe side. Finally, I augment the model with a number of extra controls suggested by Rose (2000) and Glick and Rose (2002):

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\ln\!\left(X_{ijt}\right) = b_0 + b_1\ln\!\left(Y_{it}\right) + b_2\ln\!\left(Y_{jt}\right) + b_3\ln\!\left(D_{ij}\right) + b_4 Lang_{ij} + b_5 Cont_{ij} + b_6 FTA_{ij}
$$
$$
+ b_7 Landl_{ij} + b_8 Island_{ij} + b_9 ComCol_{ij} + b_{10} CurCol_{ij} + b_{12} ComNat_{ij} + \tilde{\beta}\mathbf{DD}_t + e_{ijt}
$$

$$(1)$$

where i and j indicate countries, t indicates time, and the variables are defined as follows:

- X_{ijt} is the real manufacturing exports from i (referred later on as the "origin" country) to j (the "destination" country) at time t,
- Y is real GDP,
- D is the distance between i and j,
- $Lang$ is a dummy which is equal to 1 if i and j have a common language,
- $Cont$ is is a dummy which is equal to 1 if i and j share a land border,
- FTA is a dummy which is equal to 1 if i and j belong to the same regional trade agreement,
- $Landl$ is the number of landlocked countries in the country-pair (0, 1, or 2).
- $Island$ is the number of island nations in the pair (0, 1, or 2),
- $ComCol$ is a dummy which is equal to 1 if i and j were ever colonies after 1945 with the same colonizer,
- $CurCol$ is a dummy which is equal to 1 if i and j are colonies at time t,
- $ComNat$ is a dummy which is equal to 1 if i and j remained part of the same nation during the sample (e.g., France and Guadeloupe, or the UK and Bermuda),
- $\tilde{\beta}\mathbf{DD}_t$ is a vector of resource boom indicators and its corresponding vector of coefficients, to be defined below.
- e_{ijt} represents the myriad other influences on manufacturing exports, assumed to be well behaved.

3.2.   *The Dutch Disease term*

The coefficient vector of interest is $\tilde{\beta}$, the vector of estimated effects of a price-led resource boom on manufacturing trade. Let's now define $\mathbf{DD}_t$. The basic idea is to estimate the elasticity of manufacturing

exports to a change in real energy and mineral prices. Of course, we do not expect energy exporters and importers to be affected the same way by, say, a rise in the real price of energy. In fact, we expect them to be affected in opposite ways. In the case of a net importer, resource movement effects are not expected, but balance of payment driven expenditure effects should be similar, albeit of opposite direction and sign. In the case of energy at least, it has been argued above that we expect resource movement effects to dwarf expenditure effects.

Further, the effect of an energy price increase on manufacturing trade from country i to country j is going to depend on whether the exporting country, the importing country, or both countries are net energy exporters or net energy importers. For example, if both countries are energy exporters, their real exchange rate would not be affected (assuming that the importance of energy exports is the same for both economies.)

I restrict attention to energy and minerals price led resource booms. Price-led resource boom variables are constructed in this following way:

EPE_{it} = *energy price exposure*

= $[1(i\ is\ net\ energy\ exporter) - 1(i\ is\ net\ energy\ importer)]$ x log(*real price of energy*) (2.a)

$EPED_{ijt}$ = *energy price exposure difference* = *EPE* of origin - *EPE* of destination

= $EPE_{it} - EPE_{jt}$ (2.b)

Similarly,

MPE_{it} = *mineral price exposure*

= $[1(i\ is\ net\ mineral\ exporter) - 1(i\ is\ net\ mineral\ importer)]$ x log(*real price of minerals*) (3.a)

$MPED_{ijt}$ = *mineral price exposure difference* = *MPE* of origin - *MPE* of destination

= $MPE_{it} - MPE_{jt}$ (3.b)

Hence,
$$\tilde{ß}DD_t = b_{13}EPED_{ijt} + b_{14}MPED_{ijt}$$ (4)

So that (1) becomes:
$$\ln(X_{ijt}) = b_0 + b_1 \ln(Y_{it}) + b_2 \ln(Y_{jt}) + b_3 \ln(D_{ij}) + b_4 Lang_{ij} + b_5 Cont_{ij} + b_6 FTA_{ij}$$
$$+ b_7 Land_{ij} + b_8 Island_{ij} + b_9 ComCol_{ij} + b_{10} CurCol_{ij} + b_{12} ComNat_{ij}$$
$$+ b_{13} EPED_{ijt} + b_{14} MPED + e_{ijt}$$
(1')

The real energy and mineral price index are denominated in 1995 dollars. I take these US dollar world prices as exogenous to any single country. Very few exceptional countries such as Saudi Arabia for oil and Chile for copper may cast some doubt on this assumption. It turns out no single observation is exercising significant effect on the coefficient of interest according to DFBeta statitistics.

It could be argue that the real price of oil for example is not exogenous to a group of country like OPEC. The basic problem with the cartel story was pointed out by a number of people, but perhaps most forcefully by Cremer and Salehi-Isfahani (1989). Basically, OPEC did not to have the characteristics of an effective cartel. It was too uneven from a cultural and political perspective. This cartel organization did not even proceed to set output quotas until 1982, at a time when oil prices had already increased substantially.

How can we explain for the 12-years of rising oil prices? In the late 70s, according to Paul Krugman (2000), economists began to suggest a key element of the story was perverse supply responses. Cremer and Salehi-Isfahani (1989) pointed out that oil differs from ordinary commodities in three important ways: it's exhaustible, its production is under government control, and it is a major source of domestic revenue for the main oil exporters.

To reduce this potential endogeneity further, I use a world *energy* and *mineral* price index. In any case, it should be noted that our concern should be endogeneity to manufacturing exports, *i.e.* our dependent variable. It is unrealistically far fetched to assume material endogeneity of real world energy prices to the manufacturing export performance of any specific country or cartel of countries. Historical hindsight reveals that manufacturing export concerns have simply not been driving cartel price coordination.

The second necessary identifying assumption is that being a country's export "specialization" as an energy or mineral exporter is independent of its manufacturing exports. At the margin, the level or share of energy or mineral exports of a country is not exogenous to its manufacturing exports at all. What we are identifying here is year on year price changes, and it could be assumed that a year-on-year drop in manufacturing exports would drive a country into becoming a net exporter of energy, say. This is why I will not make use of this information.

However, it is much safer to assume that the overall status of country as a net exporter or importer of energy or mineral is rather exogenous to this country's manufacturing exports, and reflects to a large degree its geological endowment. As a further precaution against reverse causality, I only classifying as net exporters (respectively importers) of, say, energy countries which never reverted to being a net importer (respectively net exporter) over the period cover in my sample.

I followed the norm in the literature by first using ordinary least squares, albeit with standard errors which are robust to clustering (since pairs of countries are likely to be highly dependent across years). These results are available upon request but are not reported. They are not different in any meaningful way from reported results. My preferred estimation strategy lays in panel data techniques. I use both fixed and random effects estimators extensively below. I rely on the robust fixed effects "within" estimator, which essentially adds a set of country-pair specific intercepts to the equation, and thus exploits only the time series dimension of the data set around country-pair averages. I will also report all results with and without extra time-dummies aimed at controlling for time trends in the explained and explanatory variables.

3.3   The Data Set

The core of the data used in this paper comes from World Trade Data sets described in Feenstra, Lipsey and Bowen (1997). The World Trade Database (WTDB) put together by Statistics Canada contains bilateral trade flows for all countries over 1970-1992, recently updated up to 1997, classified according to the Standard International Trade Classification. 98% of all trade is considered to be covered by this database. Manufacturing exports are extracted by keeping exports falling under BEA 34-Industry Code 15-29, and 31 to 34. The technical reason behind this choice of industrial categories is that I want to BEA industry categories that are also classified as manufactured goods in the ISI classification. The economic rational behind this choice is that I want a non-arbitrary rule to exclude industries that lay too closely to the borderline between the primary and secondary sector.

The binary variables for common language, sharing a land border, belonging to the same regional trade agreement, being colonies at time *t*, having ever been colonies after 1945 with the same colonizer, remaining part of the same nation during the sample, the number of landlocked countries in the country-

pair, the number of island nations in the pair, and distance between counties are all taken from Glick and Rose (2002). Real GDP and population data are taken from the World Bank (2002).

The series for the world price of energy and metals come from the International Financial Statistics the I.M.F. (2002). These are nominal indexes with 1995 as base year. The real equivalent of these series is used after deflating the nominal series by the US CPI (oil and most minerals are priced in dollars). Shares of fuel and metals exports (respectively imports) in merchandise exports (respectively imports) are taken from the World Bank (2002). A country is defined as a net exporter of fuel (respectively metals) if its share of fuel exports (respectively metals) exceeds *in all observed years* its share of fuel imports in merchandise imports (respectively metals). Similarly, a country is defined as a net importer of fuel (respectively metals) if its share of fuel exports (respectively metals) exceeds *in all observed years* its share of fuel imports in merchandise imports (respectively metals). While recognizing that merchandise exports and imports are two different bases, no attempt is made at correcting this because the potential impact of this wedge is judged to be immaterial, and that alternative data are incomplete.

Hence, practically energy and mineral price exposition indicators are computed as:

$$E\tilde{P}E_{it} = [1(\text{i } net \underline{fuel} \, exporter) - 1(\text{i } net \, \underline{fuel} \, importer)] \times \log(real \, price \, of \, energy) \quad (2.a)'$$

$$M\tilde{P}E_{it} = [1(\text{i } net \, \underline{metals} \, exporter) - 1(\text{i } net \, \underline{metals} \, importer)] \times \log(real \, price \, of \, \underline{metals}) \quad (3.a)'$$

Finally, for purposes of sensitivity analysis, data on exchange rate regimes is taken from Ghosh, A., A.-M. Gulde, J.D. Ostry, and H. Wolf[9] (1996). They categorize regimes according to both the publicly stated commitment of the central bank (their *de jure* classification) and the observed behavior of the exchange rate (their *de facto* classification). Neither approach is fully adequate. A country that declares to have a pegged exchange rate might in fact proceed to frequent changes in parity. Conversely, a country might experience very small exchange rate movements, even though the central bank has no formal requirement to uphold a parity.

The approach I take is to mix both criteria and not to classify as either floaters or fixers countries that have a publicly stated commitment to some form currency rate fixing but there are infrequent parity adjustments. If a country has any publicly stated commitment (be it a peg to a single, a SDR, an official or

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[9] I am thankful to Professor Holger Wolf from Center for German and European Studies, School of Foreign Service at Georgetown University for sharing his data.

a secret basket peg, or a cooperative arrangement like the EMS) and there is no change in parity, I classify it as an effective fixer in that year. If a country has any publicly stated commitment but there are frequent changes in parity, it is classified as an effective floater in that year. Lightly managed and independent floats are classified as effective floaters, whereas heavily managed floats are classified as effective fixers in that year.

4.   Estimates

My preferred specification is that of country-pair fixed effects. Glick and Rose (2002) also recommend this approach. I have also computed OLS results. They do not differ significantly and do not bring about different conclusions from those derived here. However, fixed effects (and to a lesser extent random effects) allows me to set aside concerns about omitted country (pair) characteristics. For example, time invariant relative factor abundance characteristics of country pairs are implicitly controlled for the fixed effect specification. Hence, there is no need to worry about, for example, the relative energy price exposure variable simply picking up the effect of some country-pair specific omitted variable that would be highly associated with one of the components of this variable.

Fixed effects allows me to make inferences about the effect of resource *booms* on changes in manufacturing exports, rather than cross-country inferences regarding the effect of resource *abundance* on manufacturing export specialization. The standards interpretation of fixed effects estimates is that they measure the effect of a change in an explanatory variable, here the real energy price, on the steady-state of a net fuel exporter. Finally, I use time-dummies to control for trends in the dependent and independent variables. Whenever informative, I will report results with and without these time-dummies. It turns out that the hypothesis of joint significance of time-dummies can always be rejected with very high confidence. Their inclusion, however, does not alter results in any meaningful way. In the rest of this paper, I will report both country-pair fixed and very often random effects. Random effect estimates allows checking the coefficients for country pair characteristics. It is satisfying to check their consistency when changes in the set-up are introduced.

Table 1 displays estimates of the gravity model using my dataset but excluding energy exposure variables. The gravity model results are standard as well as intuitive. The model fits the data well,

explaining from half to two-thirds of the variation in manufacturing trade flows. The gravity coefficients are economically and statistically significant with sensible interpretations. For instance, economically larger and richer countries export more manufactured gooss; more distant countries do so less. A common language, land border and membership in a regional trade agreement encourage manufacturing exports, as does a common colonial history. Even the same nation coefficient is intuitively signed (contrary to Glick and Rose 2002).

Note that the coefficient on own-GDP is greater than one as also greater than the coefficient on partner-GDP as in Feenstra, Markusen and Rose's (1998) simulations for differentiated goods. These authors find that this is consistent rises as they move from homogenous to differentiated goods. This is consistent with a more pronounced home market effect for differentiated goods; manufacturing can move between more easily than production of resource-base homogenous goods (commodities.) Time dummies cannot be rejected and so will be kept around.

In Table 2, I introduce resource price exposure variables. First, the introduction of the resource price exposition variables does not affect the other coefficients. Linear fit is improved by 4-7 percent. The energy price exposition difference turns out to be economically and statistically significant. The elasticity of manufacturing exports to real energy price for a net fuel exporter is estimated to be .58-.65%. In other words, a 1% increase in the real energy price will shave off around 2/3 of a percent of manufacturing exports in net fuel exporters.

5.   Sensitivity analysis

The rest of the empirical results reported in this paper aim at showing that extensive sensitivity analysis does not materially undermine the reliability of the baseline results reported in Table 2. In particular, I want to pay particular attention to the policy context in which resource booms / shocks take place. And since, real exchange rate appreciation is thought to be the principal mechanism of operation of the Dutch Disease, it makes sense to take a look at exchange rate regime as a way to see if how the results are affected by policy.

Besides it often pointed out in the DD literature that regarding oil booms, one expects resource movement effects to be shadowed by spending effects because of the "enclave economy" characteristics

and high capital intensity of oil exploitation activities. Hence we expect the role of the real exchange rate to be important. Chen and Rogoff (2002) revisit the PPP puzzle in three OECD economies (Australia, Canada, and New Zealand) where primary commodities represent a significant portion of their exports. For Australia and New Zealand especially, they find that the price of their commodity exports — which they also take to be generally exogenous to these small economies — has a strong and stable influence on their real exchange rate, although this is not enough to explain for the PPP puzzle. Figure III shows evidence of this using my dataset.

Therefore, in Table 3a, I segment the sample according to whether the origin, the destination or both have effectively managed or unmanaged exchange rate regimes. It turns out that this type of data segmentation affects this coefficient in a non-negligible way. However, this segmentation affects other gravity model coefficients as well and this turns out to be true whether or not my resource price exposure variables are present or not (unreported). I will leave the general issue of the effect of exchange rate regimes on gravity estimates aside because it falls outside the scope of this paper. Instead, I will make here tentative observations regarding the role of exchange rate regimes on the effect of energy price booms or shocks. Obviously, these observations should be understood as a first rough cut at this question and with a reasonable amount of skepticism.

Diagram I helps picture the taxonomy that I employ here and its effect on the coefficient on resource price exposure. Let's leave the issue of statistical significance aside at first. In general, currency management by a country seems to mitigate DD effects keeping the trading partner's exchange rate policy constant. A country seems to be less subject to DD effects vis-à-vis a trade partner that floats. If the trading partner is heavily managing its currency, then the origin country will be less subject to DD effects if it manages its currency as well. Looking at things from the point of view of statistical significance, one is lead to conclude that DD effects don't seem to be a concern vis-à-vis countries that do not manage their currencies. Also, this also the case if both trading partners manage their currencies. The worst case scenario is that of a floater trading with a currency manager. And the best scenarios are when trading partners have similar exchange rate policies.

To check the sensibility of these observations to the method of estimation and to whether or not I include time-dummies in the set of explanatory variables, Table 3b shows a doubly entry taxonomy of

method of estimation *vs*. exchange rate regimes and gives the corresponding estimate for the coefficient on the energy price exposure variable. It turns out that the fixed effect with time-dummies is a bit of an acid test when combined with sample segmentation according to exchange rate regime. This is of course the consequence of opting for the most demanding specification as baseline results.

The flip side of this is that, naturally, other, less demanding, specifications use less degrees of freedom and allow estimating my coefficient of interest with more precision. The outcome is that when one relaxes the estimation method a little, the DD reappears more strongly in many cases where it looked like insignificant in the baseline results. Interestingly, if one were to rank the different coefficient estimates across exchange rate regimes for each different methods of estimation, our previous observations regarding the *relative* desirability of different exchange rate regime combinations are in general unchanged.

Finally, Table 3c, I take the reverse approach consisting in excluding observations belonging to the same combinations of exchange rate regimes. DFBetas indicate the extent to which the observed change in the coefficient on energy price exposure are statistically significant. This is the standard way to look for outliers, either individually or as a group.

If these results are confirmed by future research, they are indicative of the possibility for currency managers to "export" their DD. Recall that the effects of energy shock to a net energy importer has so far been modeled as the mirror effect of the effect of the same boom on a net energy exporter. This naturally begs for testing whether these effects indeed work in opposing direction. A DFBeta value above 2 is considered suspicion of an outlier or a group of outliers. Table 3c tabulates DFBetas across specifications and *excluded* combinations of exchange rate regime. Diagram II helps visualize the corresponding taxonomy of cases.

All DFBetas are negative indication that in all case the price exposure coefficient is *strengthened* (in absolute terms) by the exclusion of the proposed combinations of exchange rate regimes. In most cases, however, the effect on the energy coefficient is insignificant. The only combination that is systematically significant is the case where the origin fixes, again indicating that exchange rate management helps soothe DD effects. I will keep this observation as the main conclusion of this exercise in sensitivity analysis. Other combinations of exchange rates either have no significant effect on the coefficient of interest or only in some of the specifications. It is important to emphasize again that exclusion of any of the combinations

investigated would *strengthen* the magnitude on the energy price exposure variable. That is why, since the null hypothesis is the insignificance of this coefficient, none of these combinations is hereafter excluded from the sample.

In Table 4, I turn to another issue. Let's take again a look at (4) which defined our resource price exposure term, $\tilde{\beta}\mathbf{DD}$ and let's expand the term $EPED_{ijt}$. There are three ways to do so.

The first one is a straight application of (2.b).

$$EPED_{ijt} \quad = EPE_{it} - EPE_{jt}. \tag{5}$$

Let's expand these terms further by making use of (2.A)

$$\begin{aligned}
EPED_{ijt} = &\, [1(I\ net\ energy\ exporter) - 1(I\ net\ energy\ importer)] \text{ x } \log(real\ price\ of\ energy) - [1(J\ net\ energy \\
&\, exporter) - 1(J\ net\ energy\ importer)] \text{ x } \log(real\ price\ of\ energy) \\
= &\, [1(I\ net\ energy\ exporter) - 1(J\ net\ energy\ exporter)] \text{ x } \log(real\ price\ of\ energy) + (-1)[1(I\ net \\
&\, energy\ importer) - 1(J\ net\ energy\ importer)] \text{ x } \log(real\ price\ of\ energy) \\
= &\, EPE_t^X + (-1)\,EPE_t^M \tag{6}
\end{aligned}$$

Finally, I can of course fully decompose the term $EPED_{ijt}$ into its four original compotents, *i.e.*:

$$EPED_{ijt} = EPE_{it} - EPE_{jt} = EPE i_{it}^X + (-1)\,EPE_{jt}^M + EPE_{it}^X + (-1)\,EPE_{jt}^M \tag{7}$$

In essence the energy price exposure difference variable can be expanded according to whether the energy price boom affects the exporting country or the importing country as in (5), or according to whether the energy price boom is to a net exporter or a net importer of energy (6), or according to both criteria as in (7). Diagram III helps visualize the taxonomy proposed in Table 4 as the effect of decomposing real energy price exposure.

Disaggregating our exposure variable yields intuitive results. Energy price booms at the origin hurt its manufacturing exports while booms in the destination country (by inducing a real depreciation) actually boost manufacturing exports (in the origin country.) Perhaps surprisingly, energy boom at the destination are estimated to have a large impact than booms in the origin country (in absolute value.)

Booms affect net energy exporters' manufacturing exports a lot more than shocks help. net energy importers (even keeping GDP constant). Allowing these weaker reverse effects on energy importers to be lumped into the baseline energy price exposure difference variable, reassuringly works *against* my

conclusions. In other words, it is *not* the case that some hypothetical reverse Dutch disease effect is driving the side of the baseline coefficient, all the *opposite*. The effect on the component related to net exporters is in fact very strong, with a 1.63 energy price elasticity of manufacturing exports (in absolute value, of couse.)

Complete disagregation, intuitively combines the sign of results obtained from both types of partial disaggregating. Hence, logically the strongest, here positive, effect is obtained for an energy price boom when the destination is a net exporter. The smallest effect is obtained for a shock to an energy importing destination country. This is not consistent with the observation that shocks to the destination are larger than to the origin. However, a statistical hypothesis of this hypothesis can only reject the null hypothesis with a 10% significance level. Since we should not reject this hypothesis, we can satisfy ourselves with the intuitive character of the small effect for a shock to an energy importing destination country.

Tests show that one can reject the null hypothesis of no statistical significance for disaggregating effects on exporters from those on importers. In general, tests are all highly indicative of the statistical significance of the unrestricted model (4.3). This is perhaps pleading for disaggregating coefficient in the so-called baseline results, and then focusing on the coefficient on domestic booms in a net exporter. If I opted for this approach, I would actually strengthen my conclusions, and report a higher estimate of 1.63 for the energy price elasticity of manufacturing exports. Instead, I will report the aggregated coefficient for the sake of simplicity and consider it as a lower bound on the effect on would effect from on an energy boom in a net exporter.

Table 5 tabulates key results when instead of working is real US dollars, all economic variables are evaluated instead in the origin country's currency or the destination country's currency. Baseline results in US dollars are reproduced for comparison purposes. The transformation of the dollar figure is done using the real exchange rate index with 1995=100 as base year. So, foreign currency variables are evaluated in 1995 US dollar equivalent. In any case, country pair dummies would absorb the effect of differing currency units, so there is no concern about pooling observations in difference currency units.

Measuring economic variables in the origin's currency improves the linear fit and lowers the estimated real energy price elasticity. This coefficient remains highly significant, however. Measuring

economic variables in the destination's currency further improves the linear fit but strengthens estimated real energy price elasticity beyond that of baseline dollar estimates.

The coefficient changes are intuitive. Given the real appreciation of the domestic currency likely to follow a boom in a net energy exporter, destination's imports are likely to decrease all the more when expressed in destination's depreciated currency. Conversely, origin's exports are likely to deteriorate less all the more when expressed in origin's appreciated currency. Indeed, in all three cases the real exchange rate appreciation takes place; it is only the unit of measurement we are changing.

Generally, changing currency units for economic variables does not affect key results. The US dollar baseline results emphasized in this paper turn out to be an intermediary case. It is kept as baseline case because it is the standard approach in the gravity literature, and there are obvious benefits to working in a third country's currency as it avoids some of the interpretation problems associated with potentially volatile exchange rates.

6.   Conclusion (preliminary – too close to the end of the introduction)

In the light of the endogeneity of commodity exports to manufacturing trade, world real energy and mineral prices are used to identify price led resource booms. Indeed, world commodity prices can be safely assumed to be exogenous to any single country's manufacturing exports. With this identifying assumption in hand, the real energy price elasticity of manufacturing exports in net energy exporters is estimated to be around .6%. In other words, a one percent increase in the price of energy will, everything else held constant, decrease a net energy exporter's real manufacturing exports by 0.6%. This elasticity estimate is exceptionally significant and the corresponding confidence interval very small.

Neither segmenting the data based on effective exchange rate regime nor decomposing the variable of interests nor changing currency units of measurement overturns results. However, it is learned from sensitivity analysis that exchange rate management might allow countries to partially offset some of the Dutch Disease effects resulting from an energy price led boom. It other words, exchange rate management may allow net energy exporters to export some of the Dutch Disease effects, as is thought to have worked successfully in Indonesia (Roemer, 1994). Also, DD effects are strongest with net energy exporters rather than net importers. Booms occurring in the destination country seem to have comparable

effects (but of opposite sign, obviously) on manufacturing exports by the origin, than booms taking place in the origin country.

The main result found is this paper is in some way surprising in the state of the DD literature. I find strong evidence of the DD in the world trade data. Price-led resource booms, and particularly energy booms, have systematically tended to hurt energy exporters' manufacturing exports. So, in contrast with the existing literature, this paper casts away doubts about the empirical relevance of the DD, particularly regarding energy producers. It is intuitive, however, that by juxtaposing the marginally convincing evidence found in numerous countries, one be able to either reject or accept the DD hypothesis[10].

One should be careful in not over-interpreting these results reported in this paper, however. In most cases, booms result in increased GDP levels, and hence welfare, for energy producers. That's not the question at stake in this paper. Further, one only needs to worry about the DD insofar as there is indeed something desirable about having a large proportion of manufacturing exports. There is, however, evidence that productivity growth can sometimes be very strong in resource extraction industries, at least in industrialized countries. And the role of that manufacturing may play over the primary sector may vary from country to country, because of the possibility of factor intensity reversal, for example.

On the other hand, there is a widespread assumption in the structural tradition of the development literature that industrialization should be *per se* an economic development goal. More recently, Matsuyama (1992), Sachs and Warner (1995, 1999), and their followers, have explicitly modeled economic growth as a function of the relative size of the manufacturing sector. It is not the purpose of this paper to settle this issue. Rather, the statistic and economic significance of the result found here lead me to argue in favor of careful future empirical testing of the effect of sectoral changes in output and exports, and more specifically those resulting from resource booms, on aggregate productivity and economic growth.

Now that the effect of resource booms on energy exporters' manufacturing exports is established, there is urging need, in the author's view, to test whether, if, how and why this de-industrialization would result in slower technological progress. As far as industrial, public finance, energy and development policy formulation is concerned, the results are unambiguous: **resource boom are very likely to result in de-**

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[10] If authors in the DD empirical literature systematically reported comparable estimates of the effect of resource shocks on manufacturing exports, it would be interesting to see if the same conclusion is reached through meta-analysis. Such is far from the case, unfortunately

industrialization, and if this is an economic or political concern, or both, then energy net exporters (and to a less extent energy net importers, actually) should take account of this balance of payment constraint.

7.   References

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Table 1: Gravity model regressions

Dependent Variable: Real manufacturing trade between
country of origin and country of destination

Method of estimation	Random Effects	Fixed Effects	Random Effects	Fixed Effects
	(1.1)	(1.2)	(1.3)	(1.4)
Log real GDP of origin	1.31 (0.01)***	1.91 (0.02)***	1.34 (0.01)***	1.44 (0.02)***
Log real GDP of destination	0.80 (0.01)***	1.40 (0.02)***	0.83 (0.01)***	0.99 (0.02)***
Log of distance	−1.23 (0.03)***		−1.25 (0.03)***	
1 (Common Language)	0.63 (0.06)***		0.65 (0.06)***	
1 (Common Border)	0.37 (0.13)***		0.35 (0.13)***	
1 (Regional Trade Agreement)	0.83 (0.11)***		0.73 (0.11)***	
1 (Common colonizer)	1.06 (0.07)***		1.15 (0.07)***	
1 (Colonial relationship)	1.46 (0.16)***		1.41 (0.16)***	
1 (Same nation in the sample)	2.26 (0.43)***		2.34 (0.43)***	
# of land-locked countries in pair	−0.15 (0.04)***		−0.13 (0.04)***	
Constant	−39.32 (0.36)***	−77.74 (0.81)***	−40.44 (0.32)***	−56.62 (0.34)***
Time dummies	p(F)=.00	p(F)=.00	Excluded	Excluded
Observations	136,073	137,755	136,073	137,755
Country pairs	9,736	102,32	9,736	10,232
R-squared	0.64	0.51	0.64	0.52

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Estimated coefficients and standard errors are not reported for time dummies,
instead a the p-value of a joint significance test is reported.

Table 2: Benchmark estimates

Dependent Variable: Real manufacturing trade between country of origin and country of destination

Method of estimation	Random Effects	Fixed Effects	Random Effects	Fixed Effects
	(2.1)	(2.2)	(2.3)	(2.4)
Log real GDP of origin	1.31 (0.01)***	1.92 (0.02)***	1.34 (0.01)***	1.46 (0.02)***
Log real GDP of destination	0.80 (0.01)***	1.38 (0.02)***	0.83 (0.01)***	0.97 (0.02)***
Log of distance	-1.24 (0.03)***		-1.25 (0.03)***	
1 (Common Language)	0.59 (0.06)***		0.60 (0.06)***	
1 (Common Border)	0.38 (0.12)***		0.37 (0.13)***	
1 (Regional Trade Agreement)	0.79 (0.11)***		0.70 (0.11)***	
1 (Common colonizer)	1.14 (0.07)***		1.23 (0.07)***	
1 (Colonial relationship)	1.50 (0.16)***		1.45 (0.16)***	
1 (Same nation in the sample)	2.22 (0.43)***		2.30 (0.43)***	
# of land-locked countries in pair	-0.16 (0.04)***		-0.14 (0.04)***	
Metals price exposition difference	-0.02 (0.01)	-0.01 (0.01)	-0.02 (0.01)*	-0.03 (0.01)**
Energy price exposition difference	-0.65 (0.03)***	-0.58 (0.03)***	-0.67 (0.03)***	-0.61 (0.03)***
Constant	-39.31 (0.36)***	-77.61 (0.81)***	-40.42 (0.31)***	-56.61 (0.34)***
Time dummies	p(F)=.00	p(F)=.00	Excluded	Excluded
Observations	135,129	136,806	135,129	136,806
Country pairs	9,594	10,087	9,594	10,087
Adjusted R-squared	0.65	0.52	0.65	0.52

Standard errors in parentheses
*significant at 10%; ** significant at 5%; *** significant at 1%*
Estimated coefficients and standard errors are not reported for time dummies,
instead a the p-value of a joint significance test is reported.

Table 3a: Sub-sample regressions; floaters vs. fixers

Dependent Variable: Real manufacturing trade between country of origin and country of destination

	Both float (4.1)	Both fix (4.2)	Origin floats (4.3)	Origin fixes (4.4)	Destin. floats (4.3)	Destin. fixes (4.4)	O. fixes D. floats (4.5)	O. floats D. fixes (4.6)
Log real GDP of origin	0.51 (0.27)*	1.72 (0.16)***	0.57 (0.13)***	1.84 (0.08)***	1.55 (0.07)***	1.95 (0.06)***	1.54 (0.20)***	-0.15 (0.25)
Log real GDP of destination	1.43 (0.26)***	1.76 (0.13)***	1.61 (0.06)***	1.75 (0.05)***	1.41 (0.14)***	1.92 (0.08)***	1.45 (0.27)***	2.04 (0.16)***
Energy price exposure difference	-0.02 (0.22)	0.07 (0.14)	-0.47 (0.08)***	-0.36 (0.07)***	-0.07 (0.10)	-0.35 (0.08)***	-0.06 (0.21)	-0.93 (0.18)***
Constant	-44.55 (9.82)***	-81.21 (5.17)***	-49.01 (3.54)***	-84.13 (2.33)***	-70.16 (3.90)***	-91.81 (2.38)***	-70.87 (8.43)***	-41.78 (7.72)***
Time dummies	p(F)=.00	p(F)=.00	p(F)=.00	p(F)=.00	p(F)=.00	p(F)=.00	p(F)=.00	p(F)=.00
Observations	6,101	7,433	26,114	29,373	24,447	30,053	5,437	5,938
Country pairs	1,774	1,152	4,482	3,343	4,526	3,493	1,136	1,195
R-squared	0.32	0.54	0.30	0.56	0.52	0.51	0.59	0.09

Method of estimation: Country pair fixed-effects

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Estimated coefficients and standard errors are not reported for time dummies,
instead a the p-value of a joint significance test is reported.

Table 3b: Sample segmentation; floaters vs. fixers

Dependent Variable: Real manufacturing trade between country of origin and country of destination

Coefficient on real energy price exposure.

# Obs.	# Pairs	Estimation Method / Time dummies	Random Effects Yes	Random Effects No	Fixed Effects Yes	Fixed Effects No
5,978	1,717	Both float	-0.35*	-0.34*	-0.02	-0.04
7,398	1,137	Both fix	-0.10	-0.16	0.07	0.08
25,682	4,316	Origin floats	-0.65 ***	-0.72 ***	-0.47 ***	-0.53 ***
29,115	3,268	Origin fixes	-0.38 ***	-0.43 ***	-0.36 ***	-0.31 ***
24,112	4,366	Destination floats	-0.29 ***	-0.26 ***	-0.07	-0.09
29,836	3,412	Destination fixes	-0.59 ***	-0.63 ***	-0.35 ***	-0.42 ***
5,384	1,116	O. fixes & D. floats	0.02	-0.09	-0.06	-0.17
5,881	1,173	O. floats & D. fixes	-1.10 ***	-1.29 ***	-0.93 ***	-1.10 ***

*significant at 10%; ** significant at 5%; *** significant at 1%*

Table 3c: Outlier analysis; floaters vs. fixers

Dependent Variable: Real manufacturing trade between country of origin and country of destination

DFBeta on real energy price exposure.

# Obs.	# Pairs	Estimation Method / Time dummies	Random Effects Yes	Random Effects No	Fixed Effects Yes	Fixed Effects No
129,197	9,545	Both float	-0.84	-0.85	-0.81	-0.87
127,752	9,511	Both fix	-1.01	-1.06	-0.98	-1.06
109,660	9,396	Origin floats	-1.36	-1.37	-1.43	-0.93
106,154	9,211	Origin fixes	**-2.90**	**-3.65**	**-2.36**	**-2.70**
111,247	9,379	Destination floats	-1.80	**-2.18**	-1.22	**-2.24**
105,431	9,142	Destination fixes	-1.53	-1.17	-1.27	-1.42
131,408	10,045	O. fixes & D. floats	-.86	-1.00	**-2.65**	**-2.32**
130,900	10,041	O. floats & D. fixes	-.23	-.12	**-2.05**	-1.48

DFBetas values above 2 are in bold to indicate significant leverage on coefficient.

Table 4: Asymmetric effects of booms *vs.* crunches; Separate effects for origin *vs.* destination

Dependent Variable:	Real manufacturing trade between country of origin and country of destination		
Method of estimation	Fixed Effects	Fixed Effects	Fixed Effects
	(4.1)	(4.2)	(4.3)
Log real GDP of origin	1.92 (0.02)***	1.91 (0.02)***	1.92 (0.02)***
Log real GDP of destination	1.38 (0.02)***	1.38 (0.02)***	1.38 (0.02)***
Energy price shock (origin)	-0.52 (0.05)***		
Energy price shock (destination)	0.62 (0.04)***		
Energy price shock to energy exporter		-1.63 (0.08)***	
Energy price shock to energy importer		.17 (.04)	
Energy price shock to energy exporter (origin)			-1.29 (0.13)***
Energy price shock to energy importer (origin)			0.27 (0.06)***
Energy price shock to energy exporter (destination)			1.90 (0.11)***
Energy price shock to energy importer (destination)			-0.08 (0.06)
Time dummies	p(F)=.00	p(F)=.00	p(F)=.00
Observations	137,755	137,755	137,755
Country pairs	102,32	102,32	10,232
R-squared	0.52	0.52	0.52
H0: destination = - origin	0.11	N/A	0.00
H0: exporter = - importer	N/A	0.00	0.00
Joint Hypothesis	N/A	N/A	0.00
LR Test (H1 = (8.3))	0.00	0.00	N/A

Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Estimated coefficients and standard errors are not reported for time dummies, instead a the p-value of a joint significance test is reported.

Table 5: Reduced form gravity model regressions
Sensitivity analysis: currency definition

Dependent Variable: Real manufacturing trade between
country of origin and country of destination

	Estimation Method	Currency Definition	Metal price	Standard errors	Energy price	Standard errors	# Obs.	# Pairs	R²
(9.1)	RE + T Dummies	Dollars	−0.02	(0.01)	−0.65	(0.03)***	135,129	9,594	0.65
(9.2)	RE + T Dummies	Origin's currency.	−0.01	(0.01)	−0.59	(0.03)***	132,322	9,474	0.68
(9.3)	RE + T Dummies	Destination's currency	−0.03	(0.01)**	−0.72	(0.03)***	132,462	9,474	0.71
(9.4)	FE + T Dummies	Dollars	−0.01	(0.01)	−0.58	(0.03)***	136,806	10,087	0.52
(9.5)	FE + T Dummies	Origin's currency.	0.01	(0.01)	−0.46	(0.03)***	133,975	9,964	0.61
(9.6)	FE + T Dummies	Destination's currency	−0.04	(0.01)***	−0.68	(0.03)***	134,034	9,964	0.63
(9.7)	RE	Dollars	−0.02	(0.01)*	−0.67	(0.03)***	135,129	9,594	0.65
(9.8)	RE	Origin's currency.	0.01	(0.01)	−0.57	(0.03)***	132,322	9,474	0.68
(9.9)	RE	Destination's currency	−0.03	(0.01)*	−0.77	(0.03)***	132,462	9,474	0.71
(9.10)	FE	Dollars	−0.03	(0.01)**	−0.61	(0.03)***	136,806	10,087	0.52
(9.11)	FE	Origin's currency.	0.02	(0.01)	−0.42	(0.03)***	133,975	9,964	0.61
(9.12)	FE	Destination's currency	−0.06	(0.01)***	−0.81	(0.03)***	134,034	9,964	0.64

* significant at 10%; ** significant at 5%; *** significant at 1%

Notes: All currencies deflated by their own consumer price deflators. Real trade and GDP though unreported have also been converted to the same currency.
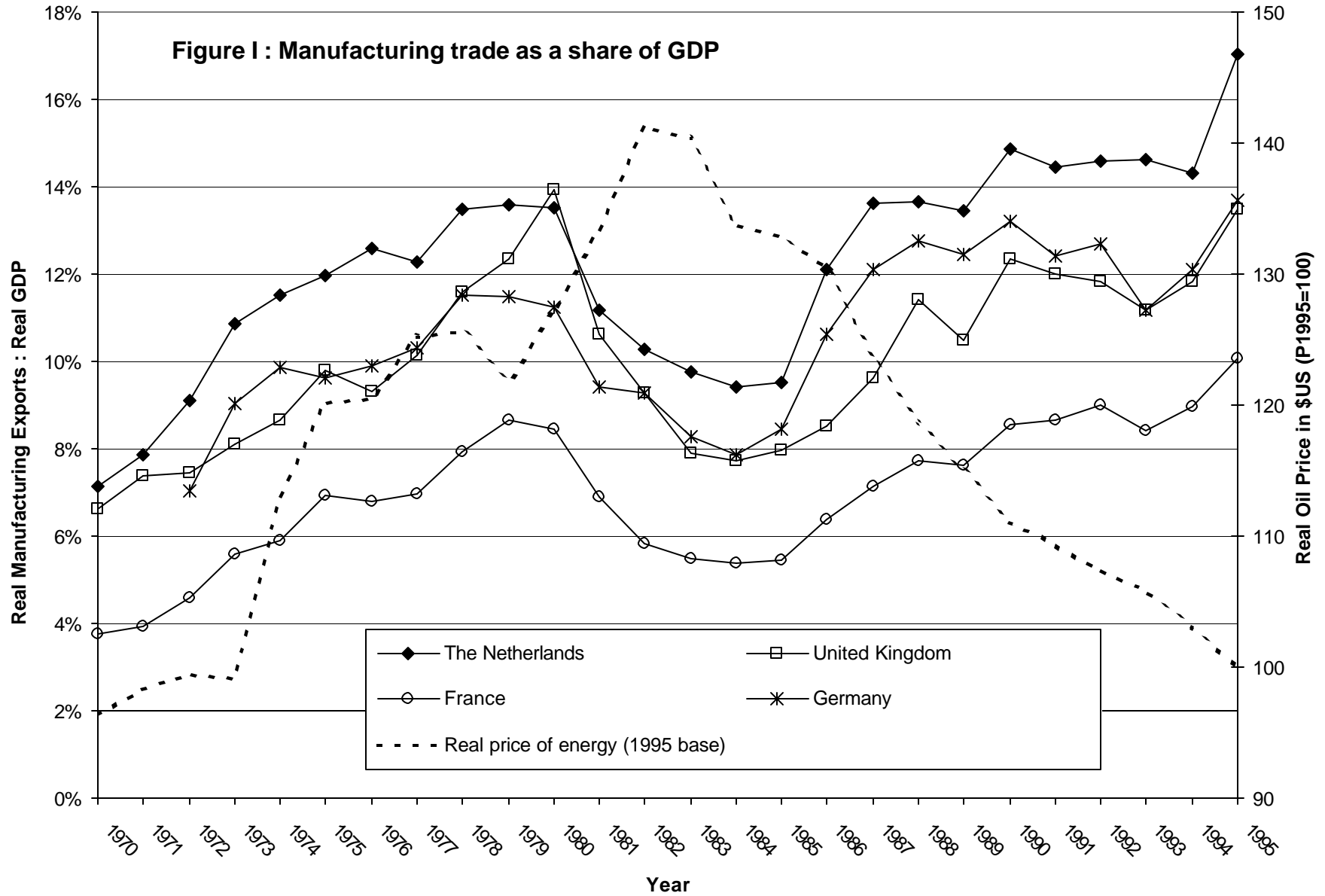
Figure I : Manufacturing trade as a share of GDP

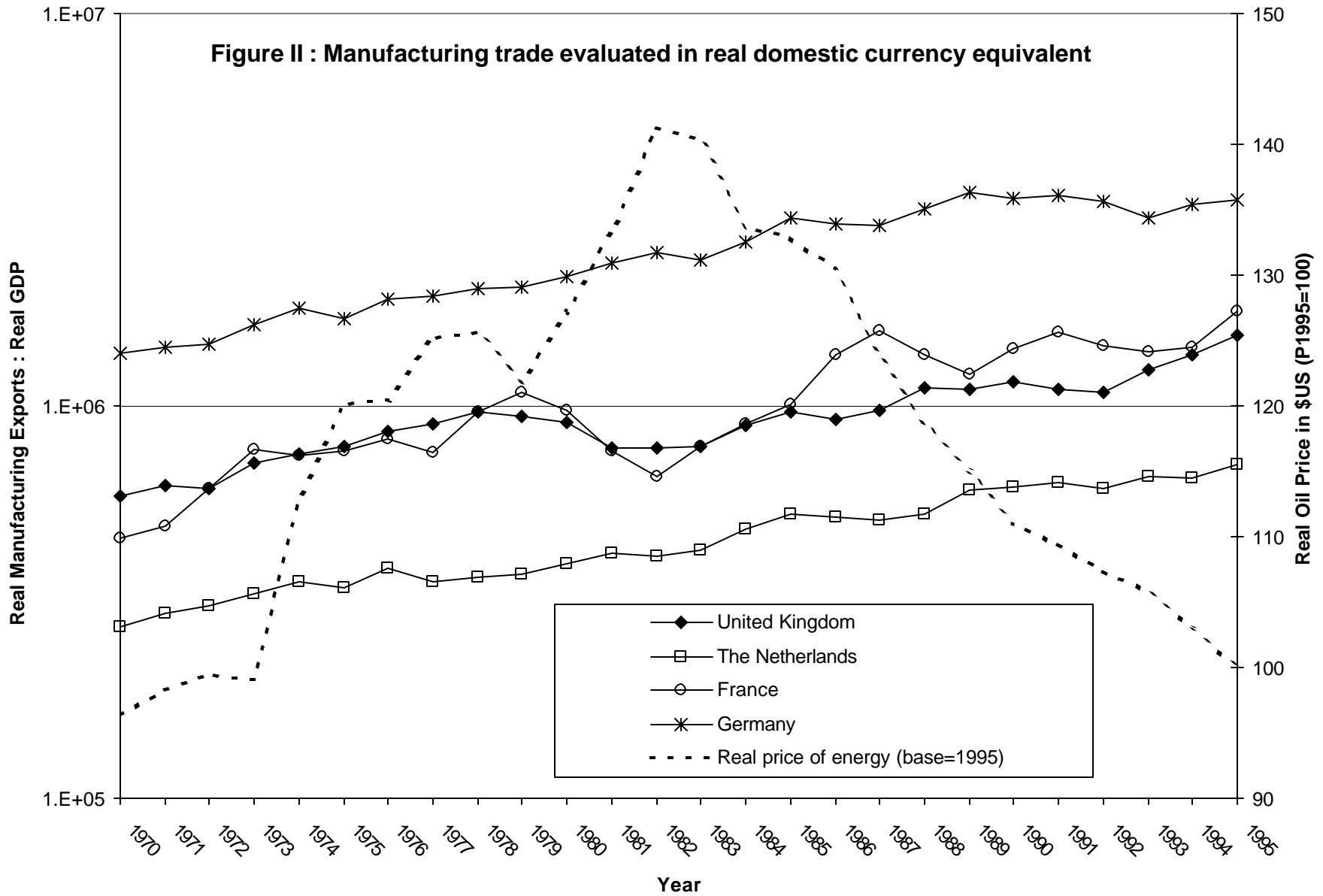Figure II : Manufacturing trade evaluated in real domestic currency equivalent

Figure III : Energy Prices and the (average) Real Exchange Rate of Energy Exporters
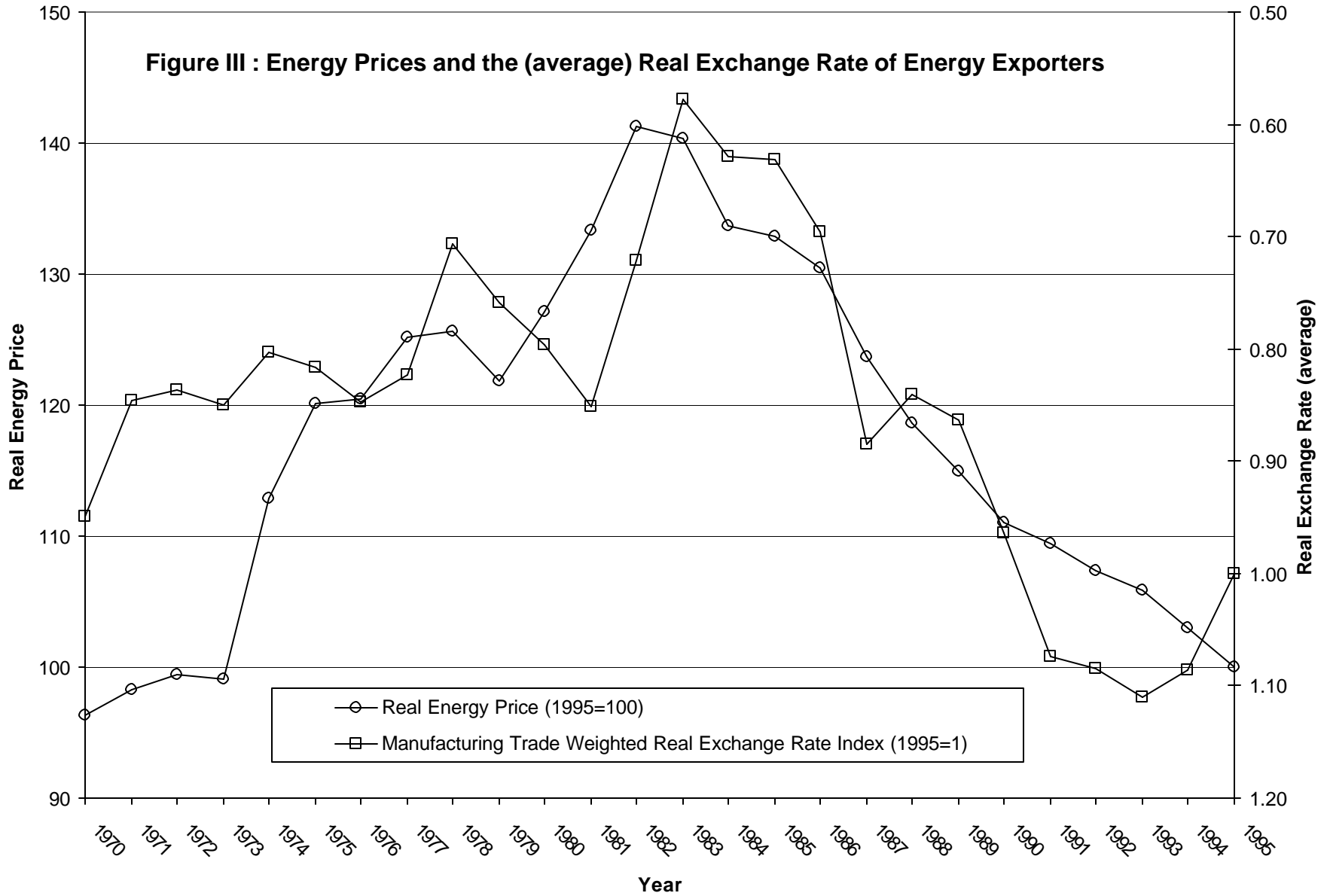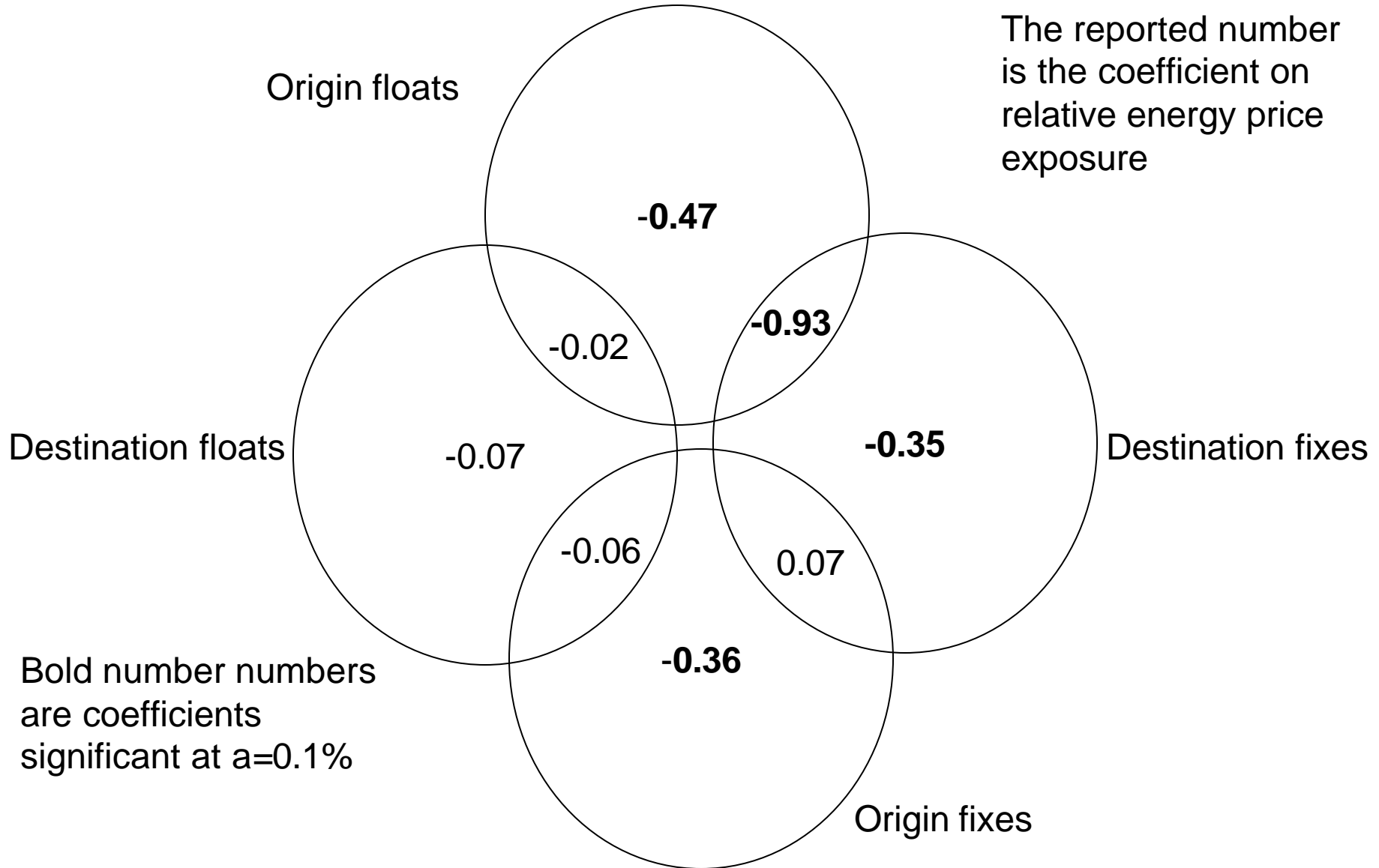
Diagram 1: Sensitivity Analysis

Segmenting the data according to effective exchange rate regime

Origin floats

The reported number is the coefficient on relative energy price exposure

-0.47

-0.93

-0.02

Destination floats

-0.07
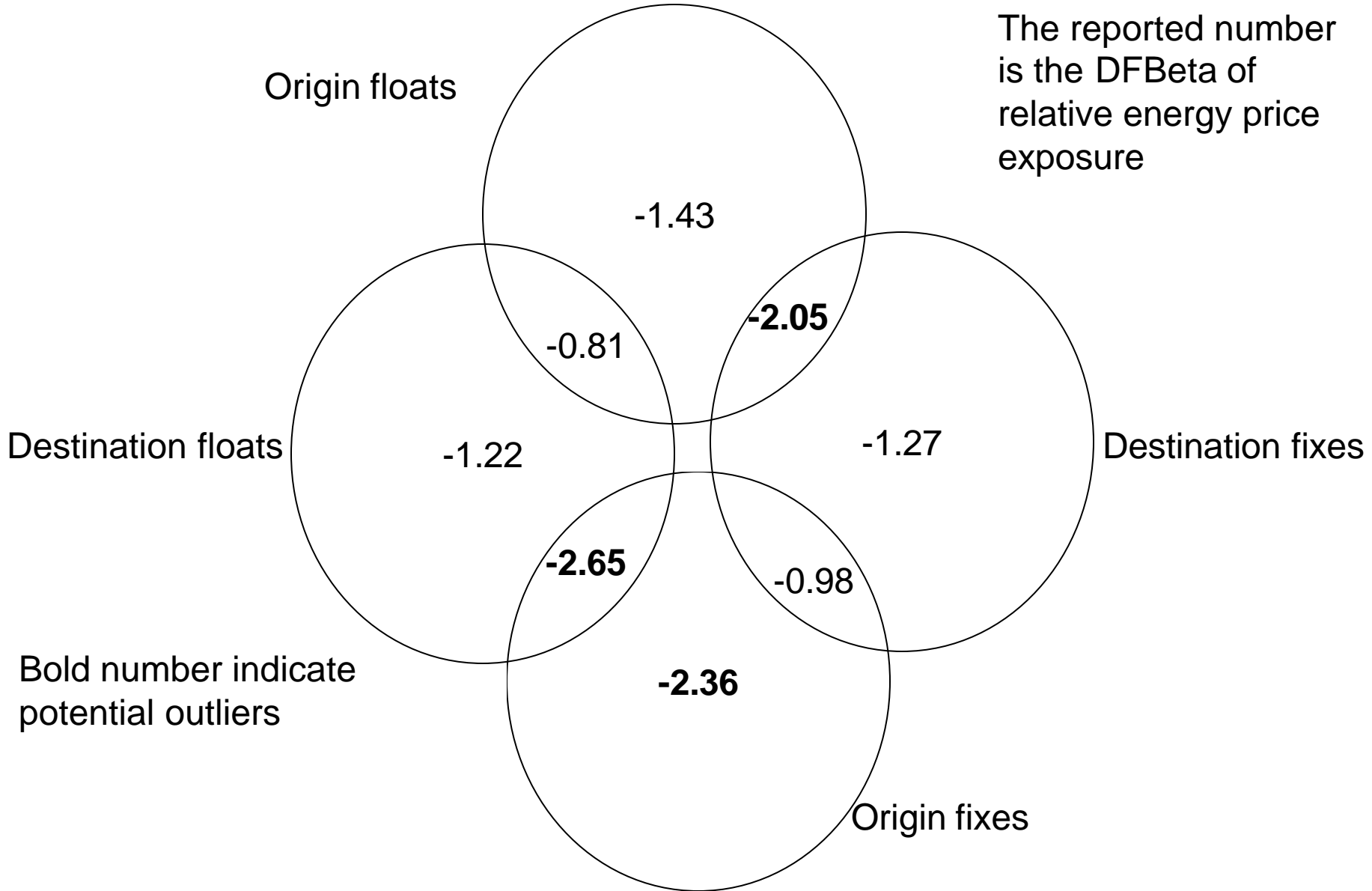
-0.35

Destination fixes

-0.06

0.07

-0.36

Bold number numbers are coefficients significant at a=0.1%

Origin fixes

Diagram 2: Outlier Analysis

Excluding data according to effective exchange rate regime

The reported number is the DFBeta of relative energy price exposure

Origin floats

-1.43

-2.05

Destination floats

-0.81

-1.22

-1.27

Destination fixes

-2.65

-0.98

Bold number indicate potential outliers

-2.36

Origin fixes

Diagram 3: Sensitivity Analysis
Segmenting according to exposure variable components

Shock
to origin

The reported number
is the coefficient on
relative energy price
exposure

-0.52

-1.29   **0.27**

Net energy
exporter

-1.63   .17

Net energy
importer

1.90   -0.08

Bold number numbers
are coefficients
significant at a=0.1%

0.62

Shock to destination