How And Why The Dutch Disease Affects Countries Differently

The Case of Oil Exporting Countries*

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Job Market Paper

November 27, 2008

Abstract

A key current policy issue for oil exporting economies is how much to spend domestically out of their windfall. The right answer depends in part on the size of the so-called 'Dutch Disease' effect, which measures the decline in non-oil tradable production due to spending out of resource income. This paper quantifies the Dutch disease in oil exporting countries in response to petroleum price shocks. This paper models the Dutch disease under open and closed capital markets. This paper shows that capital mobility offsets pressures on the real exchange rate while still resulting in a Dutch disease as windfall increases. This paper theoretically and empirically shows that the Dutch disease is stronger when capital markets are open and nontradables are labor intensive. The result stresses the importance of labor and capital movements in finding the Dutch disease impact. Previous studies have found ambiguous evidence on the size (and even existence) of the Dutch disease using aggregate data. This paper finds cross-country evidence of the Dutch disease using disaggregated data. In my data, manufacturing shrinks in output on average by 3.5 percent in response to a 10 percent increase in oil price. This paper also finds evidence of increased marginal productivity of labor in response to the Dutch disease as consistent with theory when nontradables are labor intensive.

JEL CLASSIFICATION:F20, F41, F43, O1, O2, O4, O57, Q32

Keywords: International Trade, Development, Dutch Disease, Resource Economics, Unbalanced Growth, Capital flows

*I am grateful to my advisors Christopher Carroll, Pravin Krishna, Louis Maccini and Mark Gersovitz for their insightful and stimulating discussions. I also thank Pierangelo De Pace, Olga Vaschuk, Wei Xaio and other participating members of the macro and microeconomic workshops at Johns Hopkins University for useful comments. I also want to thank Ketil Hviding, Dmitriy Kovtun and participating members of the seminar presentation at the Strategy, Policy and Review Department at the International Monetary Fund. All errors remain mine. Address: Department of Economics, the Johns Hopkins University, 3400 N. Charles St., Baltimore, MD, 21218, USA.

1 Introduction

The Dutch disease is the process by which a boom in a natural resource sector results in shrinking non-resource tradables[1]. This process leads to increased specialization in the resource and nontradable sectors leaving the economy more vulnerable to resource-specific shocks. This paper designs a flexible theoretical model to examine the Dutch disease effect under open and closed capital markets. The paper tests the propositions derived from the model empirically using disaggregated cross-country industrial data and offers strong evidence for the existence of the Dutch disease in response to oil booms.

The following is an example of how the Dutch disease takes place. Given a country that is a net resource exporter, and that a positive shock to the resource sector takes place (this can be resource price increase, discovery of resource stock or decrease in costs of extraction). As a result the resource wealth of the country effectively increases and more resource revenue is expected to be generated. Regardless of whether the resource windfall is appropriated by the public or private sectors, total spending on nontradables is expected to increase. This spending effect results in an appreciation in the price of nontradables, whilst the price of tradables remains fixed in a small open economy. This effectively appreciates the real exchange rate which is the relative price, and raises nominal factor prices. The appreciation in the real exchange rate combined with the rise in factor prices in turn moves factors of production from the non-resource tradables to nontradables, which leads to an expansion in nontradable services and shrinkage in tradable manufacturing and agriculture.

The most direct policy measure to counter the Dutch disease is either to decrease spending out of windfall income or to direct that spending towards imports. Mitigating the Dutch disease effect fiscally comes down to the degree of spending out of windfall on nontradable services. However, there are other structural policies to softening the impact of the disease. Some of these policies are related to the openness of the factors market to inflows of labor and capital. Easier immigration

[1] The Dutch disease is considered under an umbrella of models that explain the so called 'resource curse' which describes the relatively slower growth of resource rich economies. In the case of the Dutch disease, this explanation is through the observation that manufacturing sectors tend to grow the fastest in value added relative to non-tradable services. For instance, the Dutch disease can be used to explain how resource rich Latin American economies were overtaken by resource poor East Asian countries that shared similar initial GDP per capital following the second World War.

policies can offset the pressures on the exchange rate by drawing labor from outside to supply the increased demand for nontradables. Similarly more open capital accounts can mitigate the shortage of capital during windfall booms by allowing for capital inflow. However, as this paper shows later, how openness of capital accounts or the labor market affects the Dutch disease depends on the factor intensity of nontradables. We show in section 2 theoretically and in section 4 empirically, that openness of capital markets can lead to stronger Dutch disease effects when nontradables are labor intensive.

The Dutch disease mechanism, while termed 'disease', does not clearly have negative impact on welfare or efficiency. The Dutch disease is a resource re-allocation process away from less profitable tradable sectors to nontradables and by so is efficient and welfare improving when markets are complete. However the Dutch disease can exert a negative impact on growth when there are infant industries or learning-by-doing external to the firm in the shrinking tradable sector [2]. This learning-by-doing however is not only related to the size of the sector, but also to the mode of production in that sector. A sector following more capital intensive production may generate more positive spillover effects than a larger sector following a more labor intensive production. This can be very well associated with the Dutch disease when nontradables are labor intensive and thus resulting in an increase in the wage-rental ratio. This in turn gives the incentive for sectors to follow more capital intensive production as consistent with the Heckscher-Ohlin model. This paper shows that indeed we observe a significant increase in the capital to labor ratio in industries in response to oil shocks. This is the case while also observing shrinking labor force in manufacturing and shrinking size both in terms of value added and output.

A second negative aspect to the Dutch disease is that industries may accumulate costs of adjustments over time as capital and labor adjusts to bring the sector back to steady state following the resource boom. These costs of adjustment accumulate as the sector shrinks due to the Dutch disease and when the sector expands following a resource bust (decline in resource price, depletion of resource stock or increased extraction costs). This paper estimates these costs of adjustments in section 5 which in turn helps explain the long horizon of the Dutch disease as industries adjusts

[2] Warner and Sachs (1995b) makes this argument in its appendix by generlizing the endogenous growth two sector framework in Matsuyama(1992).

gradually to reduce the costs of adjustment.

The Dutch disease can be measured as the difference between the size of the sector (measured by value added or output) when there is a resource endowment and when there is none. The estimation of the size of the sector in the absence of resource income is usually done through panel estimation across countries to find the *normal* size of the sector given the country's level of development. One measure for the Dutch disease used in Gelb (1988) is the share of value added in manufacturing and agriculture in GDP compared to the norm value for a country of that GDP per capita (usually estimated over a panel of countries). This allows for a measure of the Dutch Disease without consideration of the value of natural resource wealth. In the case of resource shocks such as shocks to resource price, the Dutch Disease can be measured through the effect of changes in windfall on spending on nontradables, and thus on real exchange rate and wages and finally the size of the manufacturing sector. This is clearly problematic to estimate across countries due to the variation in spending habits and nontradable supply elasticities. This study uses a reduced form measure in estimating the response of output in the manufacturing sector to a permanent windfall shock. We take permanent resource shocks as exogenous and examine industrial data to allow us a reduced form partial equilibrium estimation that captures the effect on manufacturing sectors. For our case study we look specifically at oil exporting economies and oil price shocks.

First we introduce two models in section 2 that explain the Dutch disease and the structural factors affecting it. Through these models we derive a set of propositions which we test in empirically in section 4. Section 3 offers two country case studies, Norway and Russia, and compare them to the projections of the model. Finally In section 5 we explain the lagged effect of oil price shocks through costs of adjustment which we estimate to explain how much of the shrinkage in manufacturing is associated with it.

1.1 Related Literature

The Dutch disease has been mostly examined on a country case by case basis and usually based on the effect of extraction or discovery as a one time incident. The Dutch disease came first into the spotlight in the 1970s following the North Sea oil and gas discovery. It was coined as 'Dutch' in reference to the shrinking of manufacturing and rising unemployment in the Netherlands along with a bloated public sector. This phenomenon coincided however with the global stagflation that saw most of the Netherlands's European trading partners go through recession. While the fiscal expansion as a result of the extraction of natural gas is definitely a factor in what occurred in this case, it is still unclear to what extent the shrinkage of the non-oil tradable sector can be attributed to resource extraction. The experience of the Netherlands however spread fears of similar incidents to other exploiters of North sea hydrocarbons including the United Kingdom which saw a shrinkage in manufacturing in the late 70s. The possibility of a Dutch disease in the UK triggered interest which first started with the theoretical Heckscher-Ohlin framework of Codren and Neary (1982) and the empirical analysis of Bruno and Sachs (1982) on examining the Dutch disease in the UK.

The most extensive cross country study of the Dutch disease was covered in Gelb (1988) where the effect of windfall on oil exporters was examined for a group of oil exporting countries most of which have been suspected of mismanaging windfall. The study[3] found that Ecuador, Iran, Nigeria and Trinidad and Tobago suffered from the Dutch disease over the first and second oil booms of 1972-81 while Algeria, Indonesia and Venezuela went through a strengthening of their non-oil tradables. Virtually all countries in the study however faced no Dutch disease in manufacturing. One simple explanation for the missing Dutch disease was that these sectors were initially too small and that price controls by the government combined with active government promotion of the sector kept it from being affected. Services however did expand dramatically leading to most oil exporting countries accumulating debt during the oil price bust of 1983-1989 as fiscal policy failed to adjust quickly enough to the windfall drop. In estimating the Dutch disease we rely on a more recent sample 1980-2004 that incorporates two persistent oil booms (1979-1981 and 2001-present) and the oil bust of 1983-1989. Also by the start of 1980 most countries in the sample have developed a relatively sizable manufacturing sector compared to the case in 1972.

Only a limited number of studies attempted to test for the Dutch disease directly through movements in oil price. There are two caveats to this type of analysis. The first is that governments tend to adjust their fiscal policy slowly following the bad experience with the oil price bust of the 1980s. This makes it difficult to assess how much of the fiscal spending was due to windfall. The

[3]Gelb (1988), chap 6 page 80.

second is that many countries acquire most of their windfall revenues either through lump sum taxation of barrel exports, as the case in Russia, while others rely on royalties, as the case in Chad, that may not adjust quickly to reflect the movement in oil price. Spatafora and Warner (1995) finds a positive link between terms of trade shocks in oil exporting countries and their real exchange rate as well as public spending. public spending reaction to shocks was observed to be stronger than private spending reaction which is consistent with real exchange rate appreciation as public consumption falls more on nontradables than tradables[4]. This inexplicable absence of the Dutch disease in the sample could be attributed to a wide range of explanations including such conventional ones as small sample (most oil producing countries report key measures only annually), measurement bias in aggregate manufacturing output, and finally, the failure of the study to account for a cross country norm for sector size (i.e. even if manufacturing is booming due to technological innovation for example, the Dutch disease should be a measure of the gap between actual and normal sector size given each country's characteristics). The final possibility is of course that the Dutch disease might not even exist. So far in most of the instances where the disease has been viewed as a culprit for manufacturing shrinkage, there has been other factors involved that could explain these phenomena in its place. But then if that is the case, then the bulk of classical trade theory is inconsistent with reality as the Dutch disease provides what is probably among the most promising opportunities for testing standard trade analysis.

There are also problems in addressing the Dutch disease on a country case basis. Sala-i-Martin and Subramanian (2003) fails to find evidence of the Dutch disease in Nigeria due to oil price movement. Even the real exchange rate is found to be insensitive to oil price. They highlighted an issue that is all too common in analyzing the Dutch disease which is the importance of knowing not just how much oil windfall is being spent, but what it is being spent on. Spending of revenues on tradables bears no impact on the real exchange rate and thus does not result in a Dutch disease. On the other hand governments can spend windfall on nontradables while also using the revenues to maintain price controls thus sterilizing the inflationary pressures leading to a Dutch disease. The main advantage of cross country study is its ability in the case of a large sample to eliminate idiosyncrasies by pooling observation from different countries under different policy regimes. Thus

[4] Ostry (1994) and De Gregorio, Giovannini and Wolf (1994)

in this paper when testing for the Dutch disease we use the cross-country approach, but to enhance the chances of finding the Dutch disease if it exists we also use heavily disaggregated data on industries that expand our cross section significantly.

2 Model

The Dutch disease effect varies across oil exporting countries based on policy factors and structural factors. The first structural issue is the role of the resource sector in utilizing domestic factors of production. In the case when the resource sector actively absorbs domestic labor, the result is an additional effect during resource booms which moves factors of production away from non-mining sectors to the resource extraction activity. This effect which is known in the literature as the *resource effect* is thought to be generally small in the case of oil exporting countries. This is due to the oil sector mostly acting as an enclave sector where use of domestic labor and capital is limited and active investment in the sector is either centralized by government or dependent on foreign capital. In this paper we assume away the resource effect so as to focus on the nature of the relationship between non-resource tradable and non tradable production on Dutch disease outcomes. Hence we will focus solely on the spending effect of resource booms leading to the Dutch disease.

The primary policy issue is fiscal as governments determine the extent of spending out of windfall which in turn leads to the Dutch disease. Countries with high degree of windfall sterilization through sovereign wealth funds, such as Norway through its Government Pension Fund, are expected to show less signs of the disease than countries such as Venezuela and Russia that spend windfall domestically more actively. Also while data on export windfall is readily available, in most cases governments do not appropriate export windfall directly. Some governments such as Chad and Russia for instance do not appropriate windfall directly but only through taxes and royalties from oil extracting firms. Another issue is the possibility of clustered spending as governments tend to adjust spending infrequently as downward rigidity in fiscal policy due to ratchet effects keep spending from adjusting to price busts. This was largely the case during the oil bust of 1983-1989 as many oil exporting countries failed to adjust spending habits quickly to the loss in windfall.

As the resource windfall is spent, there is variation across countries in the degree that spending will induce appreciation of real exchange rate. This is due to variation in the infrastructure of non-tradable sectors and their demand's own price elasticity. One other primary factor is the degree of openness, not just in terms of trade, but in terms of capital and financial markets. This paper shows that when capital markets are open, the Dutch disease can have drastically different results in how its affects the real exchange rate and capital flow and this effect is linked to the industrial structure. The Industrial structure determines the extent to which a country is affected by the Dutch disease. The primary structural factors we examine are factor intensity and costs of adjustment. The relative factor intensity of nontradables affect the marginal productivity of labor in both sectors. Labor share across industries also determine which industry expands or shrinks within manufacturing in response to the Dutch disease. Costs of adjustments however have no impact on steady state, but rather affects the short term dynamics and how long it takes industries to adjust. For that reason we do not incorporate costs of adjustments into the static Dutch disease model, we however model it separately as a partial equilibrium model of a firm's investment which we use in turn to estimate cost

This paper demonstrates these points through two models of the Dutch disease. Both are two-sectors models with capital and labor as inputs and both mobile across sectors with labor immobile across countries. The oil sector is assumed to be an enclave sector that does not make use of factors of production and thus is modeled as an endowment. The first model however follows the classical assumption of international immobility of capital, while the second assumes perfectly mobile capital across borders.

2.1 The Dutch Disease With No Capital Mobility Across Borders

$$X_n = A_n K_n^{\alpha} L_n^{1-\alpha} \tag{1}$$

$$X_m = A_m K_m^{\beta} L_m^{1-\beta} \tag{2}$$

$$X_o = \Psi \tag{3}$$

This is a small open economy where X_n is nontradables and X_m is manufacturing and both follow Cobb-Douglas production. We abstract away from materials and factors used in the production of windfall such that X_o is the value added of the resource sector and is described by exogenous windfall Ψ. A_n and A_m are Hicks-neutral productivity in each sector. Price of tradables is normalized to 1 such that price of nontradables, p, corresponds to the real exchange rate. Wage and rent are both endogenous with labor and capital market clearing conditions given by the following.

$$\begin{aligned} r &= pA_n\alpha K_n^{\alpha-1}L_n^{1-\alpha} = A_m\beta K_m^{\beta-1}L_m^{1-\beta} \\ w &= pA_n(1-\alpha)K_n^{\alpha}L_n^{-\alpha} = A_m(1-\beta)K_m^{\beta}L_m^{-\beta} \end{aligned} \tag{4}$$

We logarithmically linearize the above with each variable $\tilde{x} = \ln x$ to get the following.

$$\begin{aligned} \tilde{r} &= \tilde{p} + \tilde{A}_n + \tilde{\alpha} + (\alpha-1)\tilde{K}_n + (1-\alpha)\tilde{L}_n = \tilde{A}_m + \tilde{\beta} + (\beta-1)\tilde{K}_m + (1-\beta)\tilde{L}_m \\ \tilde{w} &= \tilde{p} + \tilde{A}_n + \widetilde{(1-\alpha)} + \alpha\tilde{K}_n - \alpha\tilde{L}_n = \tilde{A}_m + \widetilde{(1-\beta)} + \beta\tilde{K}_m - \beta\tilde{L}_m \end{aligned} \tag{5}$$

Consumption out of windfall is modeled through a representative consumer following without loss of generality an additively separable Cobb-Douglas utility in none-tradable services and manufactured goods.

$$\max_{\{c_m,c_n\}} u = (1-\gamma)\log c_m + \gamma \log c_n$$

$$pc_n + c_m \leq y$$

$$\text{where } y = w(1+\varphi)$$

Where φ is the windfall per capita measured relative to non-resource income w such that $\varphi w = \frac{\Psi}{L}$. The problem results in the following first-order condition.

$$pc_n = \gamma y$$

Consumption of nontradables is by definition supplied domestically such that the non-tradable market clearing condition is given by.

$$pX_n = L\gamma y \tag{6}$$

Proposition 1 *A positive windfall shock results in the movement of labor away from manufacturing and to the non-tradable sector.*

We substitute the production function and log-linearize (6) to get

$$\tilde{p} + \tilde{A}_n + \alpha\tilde{K}_n + (1-\alpha)\tilde{L}_n = \tilde{L} + \tilde{\gamma} + \tilde{w} + \widetilde{(1+\varphi)}$$

We differentiate with respect to φ to get

$$\tilde{p}_\varphi + \alpha\tilde{K}_{n\varphi} + (1-\alpha)\tilde{L}_{n\varphi} = \tilde{w}_\varphi + \frac{1}{1+\varphi} \tag{7}$$

Through partial differentiation of (5) we get $\tilde{w}_\varphi = \tilde{p}_\varphi + \alpha\tilde{K}_{n\varphi} - \alpha\tilde{L}_{n\varphi}$ and by substitution in (7) we get

$$\tilde{w}_\varphi + \tilde{L}_{n\varphi} = \tilde{w}_\varphi + \frac{1}{1+\varphi} \tag{8}$$

From (8) $\tilde{L}_{n\varphi} = \frac{1}{1+\varphi} > 0$ (9), since $L_n + L_m = L$, $\tilde{L}_{m\varphi} = -\frac{L_n}{L_m}\tilde{L}_{n\varphi} = -\frac{L_n}{L_m}\frac{1}{1+\varphi} < 0$.

Proposition 2 *(The Dutch Disease) A positive windfall shock results in shrinking manufacturing and expanding the non-tradable sector.*

We differentiate the log-linearized factor market clearing conditions in (5) and together with (9) we form the following system of equations.

$$\begin{bmatrix} 1 & (\alpha-1)-(1-\beta)\frac{K_N}{K_M} & (1-\alpha)+(1-\beta)\frac{L_N}{L_M} \\ 1 & \alpha+\beta\frac{K_N}{K_M} & -(\alpha+\beta\frac{L_N}{L_M}) \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \tilde{p}_\varphi \\ \tilde{K}_{n\varphi} \\ \tilde{L}_{n\varphi} \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \frac{1}{1+\varphi} \end{bmatrix} \tag{9}$$

Where the Jacobian determinant $|J| = 1 + \frac{K_n}{K_m}$.

$|J|\,\tilde{K}_{n\varphi} = \frac{1+\frac{L_n}{L_m}}{1+\varphi}$, therefore $\tilde{K}_{n\varphi} = \frac{1+\frac{L_n}{L_m}}{(1+\varphi)(1+\frac{K_n}{K_m})} > 0$ and $\tilde{K}_{m\varphi} = -\frac{K_n}{K_m}\tilde{K}_{n\varphi} = -\frac{K_n}{K_m}\frac{1+\frac{L_n}{L_m}}{(1+\varphi)(1+\frac{K_n}{K_m})} < 0$. This means capital flows from manufacturing to nontradables. Along with proposition 1, this indicates a shrinking manufacturing and expanding nontradable sectors.

Proposition 3 *A positive windfall shock results in the appreciation of the real exchange rate.*

From the above system, $|J|\,\tilde{p}_\varphi = \frac{1}{1+\varphi}\left[(\beta-\alpha)(\frac{L_n}{L_m}-\frac{K_n}{K_m})\right]+1+\frac{K_n}{K_m}$, therefore $\tilde{p}_\varphi$ is positive since when $\beta > \alpha$, nontradables are labor intensive, meaning $(\frac{L_n}{L_m}-\frac{K_n}{K_m}) > 0$ and vice-versa.

Proposition 4 *A positive windfall shock results in increased/decreased marginal productivity of labor when nontradables are labor/capital-intensive.*

The marginal productivity of labor in each sector is fixed to the capita-labor ratio in each industry, $a_n = \frac{K_n}{L_n}$ and $a_m = \frac{K_m}{L_m}$. The effect of the windfall shock is given by

$$\begin{aligned} a_{n\varphi} &= \frac{K_n}{L_n}\tilde{a}_{n\varphi} = \frac{K_n}{L_n}\frac{1}{|J|}\frac{1}{(1+\varphi)}[\frac{L_n}{L_m}-\frac{K_n}{K_m}] \\ a_{m\varphi} &= \frac{K_m}{L_m}\tilde{a}_{m\varphi} = \frac{K_m}{L_m}\frac{1}{|J|}\frac{1}{(1+\varphi)}[\frac{L_n}{L_m}-\frac{K_n}{K_m}] \end{aligned} \tag{10}$$

This means that the capital-labor ratio increases/decreases due to the shock if tradables are labor/capital intensive. This is a direct result of the Stopler-Samuelson theorem applied to proposition 3. The explanation is that as nontradables expand due to windfall spending, the demand on the factor intensive in non-tradable production increases relative to the demand of the other factor thus appreciating the relative price. This in turn causes each sector to follow production more intensive in the relatively cheaper factor. When nontradables are labor intensive, this in turn means an appreciation in $\frac{w}{r}$ which in turn raises $\frac{K_n}{L_n}$ and $\frac{K_m}{L_m}$ and leads to higher marginal productivity of labor as.

$$\begin{aligned} \widetilde{MP}_{Ln\varphi} &= \alpha\tilde{a}_{n\varphi} \\ \widetilde{MP}_{Lm\varphi} &= \beta\tilde{a}_{m\varphi} \end{aligned} \tag{11}$$

The significance of this result is that learning-by-doing, which is considered one of the key reasons why the Dutch disease is considered a disease, depends not only on the size of the human capital generating sector, but also on its mode of production which is described her as the ratio of capital to labor units. Increased capital per worker generates spillover in terms of better training through more available tools of production to each worker which can offset the loss of spillover from the shrinking base of workers in manufacturing. The point here is that the affected sector is not only affected in terms of size, but also in terms of structure. This challenges the presumption that even with learning-by-doing that is external to the firm and localized to manufacturing sectors that the Dutch disease is a negative phenomenon on human capital accumulation.

This proposition does not hold however in the case of international mobility of capital as relative factor prices are exogenous in this case. However open capital markets yield interesting results in terms of capital flow as the possibility of capital inflow or flight as a response to the Dutch disease is investigated.

2.2 The Dutch Disease With Capital Mobility Across Borders

The key feature that distinguish a model with capital mobility from the previous case is that the interest rate is fixed to the world rate.

$$\begin{aligned} \tilde{r}_{\phi} &= \tilde{p}_{\varphi} + (\alpha - 1)\tilde{K}_{n\varphi} + (1 - \alpha)\tilde{L}_{n\varphi} \\ &= (\beta - 1)\tilde{K}_{m\varphi} + (1 - \beta)\tilde{L}_{m\varphi} \end{aligned} \tag{12}$$

The first equation yields the real exchange rate equilibrium growth rate.

$$\tilde{p}_{\varphi} = (1 - \alpha)[\tilde{K}_{n\varphi} - \tilde{L}_{n\varphi}] \tag{13}$$

The second equation results in

$$\tilde{K}_{m\varphi} = \tilde{L}_{m\varphi} \tag{14}$$

Proposition 5 *A positive windfall shock leaves marginal productivity in both sectors, wages and the real exchange rate unaffected.*

Through substitution in the log-linearized labor market clearing condition we find

$$\tilde{w}_{\varphi} = \tilde{p}_{\varphi} + \alpha\tilde{K}_{n\varphi} - \alpha\tilde{L}_{n\varphi} = \tilde{K}_{n\varphi} - \tilde{L}_{n\varphi} \tag{15}$$

$$= \beta\tilde{K}_{m\varphi} - \beta\tilde{L}_{m\varphi}$$

From (10) therefore $\tilde{w}_{\varphi} = 0$ Wages are unchanged as capital moves across borders to leave the marginal productivity of labor unaffected in both sectors.

The nontradables market clearing condition yields

$$\begin{aligned} \tilde{p}_{\varphi} + \alpha\tilde{K}_{n\varphi} + (1-\alpha)\tilde{L}_{n\varphi} &= \tilde{w}_{\varphi} + \frac{1}{1+\varphi} \quad (16a) \\ \tilde{L}_{n\varphi} &= \frac{1}{1+\varphi} \\ \tilde{K}_{n\varphi} &= \frac{1}{1+\varphi} \\ \tilde{L}_{m\varphi} &= -\frac{L_n}{L_m}\frac{1}{1+\varphi} \\ \tilde{K}_{m\varphi} &= -\frac{L_n}{L_m}\frac{1}{1+\varphi} \end{aligned}$$

Through substitution in (11) we get $\tilde{p}_{\varphi} = 0$.which means an unchanged real exchange rate as the influx of capital into nontradables compensates for the excess demand. Since $\tilde{L}_{n\varphi}, \tilde{K}_{n\varphi} > 0$ and $\tilde{L}_{m\varphi}, \tilde{K}_{m\varphi} < 0$ manufacturing shrinks while nontradables expand.

Proposition 6 *A positive windfall shock results in net capital inflow/outflow when nontradables are capital/labor intensive.*

When capital markets are open, the Dutch disease dynamic can have positive or negative impact on capital flow. The effect on total capital in the country is given as

$$\begin{aligned} K_{\varphi} &= K_{n\varphi} + K_{m\varphi} \quad (17) \\ &= K_n\tilde{K}_{n\varphi} + K_m\tilde{K}_{m\varphi} \\ &= \frac{L_n}{1+\varphi}[\frac{K_n}{L_n} - \frac{K_m}{L_m}] \end{aligned}$$

When nontradables are capital intensive, capital flows into the country to supply the excess the demand of nontradables. While when nontradables are labor intensive, the flow of labor out of manufacturing into nontradables lead to a drop in the marginal productivity of capital there. This in turn results in capital flight and a loss in the total capital stock.

Proposition(2) [The Dutch disease] holds in this case as well however the effect compared to the case of closed capital markets depends on the factor intensity of nontradables. If nontradables are labor intensive, then the case of open capital markets has a smaller Dutch disease impact. Nontradables still expand though not as much as capital moving out of manufacturing is free here to move across borders to compensate for the shock. As a result while nontradables expand and manufacturing shrink, neither sectors change by as much as they would have in the case of closed capital markets. This leads to the final proposition.

Proposition 7 *In the case of open capital markets, the Dutch disease results in manufacturing shrinking less/more than in the case of closed capital markets when nontradables are capital/labor intensive.*

$$\tilde{K}_{m\varphi,open} - \tilde{K}_{m\varphi,closed} = \frac{K_n}{K_m} - \frac{L_n}{L_m}$$

This proposition indicates that a policy of openness of capital markets can be effective in limiting the impact of the Dutch disease. When capital markets are open and nontradables are capital intensive, capital inflows allow nontradables to expand while absorbing less labor from manufacturing than would have been the case if capital markets were closed. A process of liberalization in this framework helps cushion the lagging sector, but does not eliminate the Dutch disease altogether. If nontradables are labor intensive instead, then the inverse is true as open markets amplify the Dutch disease leaving manufacturing smaller.

One way to summarize this result is through considering an economy that goes through three stages of development. First a closed capital market stage in which the effect on the real exchange rate is pronounced. This stage is synonymous with the situation of most oil exporting countries at the beginning of the first oil boom in 1972. In that stage real exchange rate appreciation along with emphasis on labor intensive nontradables such as construction lead to an appreciation of real wages. This led to the mass influx of expatriates to the Gulf and other petroleum exporting states at the time. The second stage is demand for capital intensive nontradables services as common in public infrastructure which in many cases resulted in opening up of capital markets resulting in capital inflow. In this stage the effect of the Dutch disease is cushioned by capital inflow. This case is synonymous with the experience of Russia following the most recent oil boom, but it is not synonymous with the case of Gulf oil exporters where domestic labor was largely untapped by capital intensive services which relied primarily on highly skilled expatriate labor. Finally once the means of producing physical capital and intermediary goods are developed and infrastructure is saturated, capital inflow slows as demand shifts back towards traditional labor intensive services (public services, restaurants, haircuts, etc.) which results in a stronger Dutch disease in the case of open capital markets. This case is synonymous with more developed resource exporters such as the Netherlands.

3 Case Study: Norway and Russia

3.1 Norway

Norway is among the most cautious oil exporting countries in terms of fiscal policy related to windfall. Oil windfall has been deposited directly into the Norwegian sovereign wealth fund, the Government Pension Fund since 1995. Before that the bulk of windfall spending was on improving the extractive infrastructure in the North Sea. The stated government fiscal policy since then has been to spend the equivalent of 4% of the fund annually as a proxy to long run yield on the fund's assets. As a result of such prudence, real exchange rate appreciation has been modest relative to other oil exporters (figure 1). Norway as part of the European trading bloc has very open capital markets[5] and as stated earlier it fits the case of an open capital market economy with labor intensive nontradables as public infrastructure is well developed.

However despite fiscal prudence, there has been significant spending out of the fund as it dramatically expanded over the most recent oil boom to become the second largest state pension fund in the world and about the size of Norway's GDP. There has been signs of shrinkage or slow down, though not significant, in manufacturing as a result of increased fiscal spending[6]. The weak Dutch disease can be explained in part by the openness of capital markets in Norway which as described in the model allowed for capital intensive nontradables to expand without absorbing as

[5] In the 2007 Melken Institure capital access index, Norway is ranked ninth globally and seventh in Europe.
[6] IMF, Norway country desk's selected issues (2007).

much capital and labor away from manufacturing as otherwise would have been the case.

3.2 Russia

Russia's fiscal spending out of windfall has been historically more aggressive than Norway's though in recent years with the formation of the stabilization fund in 2004 spending has become more prudent. In a span of only 4 years, 2004-2008, the Russian stabilization fund accumulated $157 billion. Yet despite this prudence, pro-cyclical fiscal policy combined with relaxed monetary policy has lead to high inflation averaging 12% between 2000 and 2008. The oil boom and its fiscal spending resulted in an appreciation in the real effective exchange rate by almost 60% between 2000 and 2008 (figure 3). Labor unit cost has been rising dramatically with labor shortage made worse by an ageing population. These factors are fertile ground for the Dutch disease, but manufacturing is yet to shrink. While agriculture has dropped significantly in value added share in GDP from 15% in 1990 to less than 5% in 2008, manufacturing has been held up by an influx of foreign direct investment which are due to structural reforms in the country's financial market

However there are signs that the Dutch disease has started to affect manufacturing as real interest rates are negative and the share of non-oil exports in GDP has shrunk from 30% in 2000 to about 15% in 2008 (figure 4). The slow down in growth can be attributed to a waning in easy growth opportunities which as it fades leaves the adverse effect of the appreciating real exchange rate unchecked.

4 Empirical Results on the Dutch Disease

We test the propositions of both models using cross-sectional reduced form estimation on the effect of permanent crude petroleum price shocks on the industries across country. We consider movements in oil price p_{oil} as a proxy for movement in φ from the model. We use disaggregated data from the UNIDO Industrial Statistic database[7]. This study constructs the gross capital stock time series from gross fixed capital formation data[8]. This study uses price levels of investment from

[7] The panel is unbalanced as typical of cross-country data. This study uses the more disaggregated rev 3 classification in INDSTAT when available. For countries missing in rev 3 we use rev 2 classification.

[8] This study uses the perpetual inventory method with a fixed capital depreciation rate of 10%. An issue here is the short time span of the cross section which makes estimates sensitive to assumptions made on initial capital stock.

the Penn World Tables[9] for the estimation of capital stock and as a proxy for the return on capital. The data[10] is annual and covers years 1977-2004 on 81 manufacturing sectors in each country. The data covers 21 oil exporting countries with oil as at least 20% of exports on average across periods. The data includes number of firms and wages which we use among our instruments in the section 5 when estimating costs of adjustments.

Algeria	Egypt	Nigeria
Azerbaijan	Gabon	Norway
Argentina	Indonesia	Russia
Bahrain	Iran	Trinidad and Tobago
Canada	Kuwait	UK
Columbia	Malaysia	Venezuela
Ecuador	Mexico	Yemen

Table 1: List of Oil Exporting Countries in Sample

The following specification accounts for country, industry and time effects through control dummies. We first examine the effect on output on the pooled sample of manufacturing in all countries in the database using

$$\Delta \ln y_{ijt}=\alpha + \alpha_{country}+\alpha_{industry}+\alpha_{time}+b_0\mathbf{1}(OPEC) + b_1 1(developing)+ \sum_{i=1}^{4} \eta_{t-i}\Delta \ln windfall_{t-i}+u_t \tag{18}$$

where $\alpha_{country}, \alpha_{industry}, \alpha_{time}$ are fixed effects associated with country, industry and time. $\mathbf{1}(OPEC)$ is a dummy that take the value of 1 when the country is an OPEC member, developing country oil producer and oil producer respectively. Since we use country dummies, these extra dummies do not help with identifying η, but we use them to observe different intercepts for OPEC and developing countries as a group. We use a horizon of 4 years which we find to produce the best fit using Akaike and Schwarz information criteria. This study justifies this horizon using costs of adjustments to capital which are estimated in section 4. Windfall shocks are the logarithmic additive of oil price shock and changes to volume of exports. This study uses permanent oil price shocks. Transitory shocks to oil price should have little impact on spending and by extension on

We assume here as standard in the literature that the time series of capital stock starts at steady-state.

[9] Alan Heston, Robert Summers and Bettina Aten, Penn World Table Version 6.2, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006.

[10] Industrial Statistics database (UNIDO INDTSTAT) Revision 2.

the Dutch disease. We use two different decompositions in our estimation of (18). We use Kalman filtered estimates from Arabtli (2007)[11] and HP-filtered Western Texas Intermediate (WTI) crude oil spot prices (figure 5). The η coefficients correspond to the impact of oil windfall shocks on industries in oil exporting countries. We estimate the above specification on output and value added.

The result in table(2) supports proposition 2 (The Dutch Disease) as both output and value added decrease significantly due to permanent oil shocks. In both cases we see an increasing then decreasing impact in lagged shocks. We consider the pooled specification as described above and a fixed-effect panel specification (with a fixed effect per industry per country). Both estimations yield close results; with the estimates of η indicating that a 10% increase in the permanent component of oil price decreases output and value added by a cumulative 3.5% and 3.3% respectively over four years using the Kalman filtered permanent oil price shocks.

We test the robustness of table(2) in table(3) by adding interaction dummies for industries and time, $\mathbf{1}(industry)\ X\ \mathbf{1}(year)$. This interaction dummy accounts for time varying industry specific changes in output including price shocks. We find that the estimates are almost identical to table(1). Table(2) also includes estimates of the specification using HP-filtered oil prices. The effect using HP-filtered oil prices is found to be a decrease in output and value added by a cumulative 1.6% and 1.3% respectively for a permanent oil price increase of 10%.

In order to estimate the effect of capital market openness on the shrinkage of manufacturing (proposition 7), we require an index of openness of the capital account. Here we use the simplest measure of capital market openness, capital inflow as a percent of GDP. We use the average of the index over the period in the sample for each country. We then estimate the following specification using the Kalman-Filtered permanent price shocks.

$$\begin{aligned}\Delta \ln y_{ijt} \quad = \quad & \alpha + \alpha_{country} + \alpha_{industry} + \alpha_{time} + b_0 \mathbf{1}(OPEC) + b_1 1(developing) + \qquad (19)\\ & \sum_{industry} \sum_{country} \gamma_{ij} \mathbf{1}(industry) X \mathbf{1}(year) + \sum_{i=1}^{4} \eta_{t-i} \Delta \ln windfall_{t-i} +\end{aligned}$$

[11] Arbatli (2007, dissertation) uses futures prices data to estimate the transitory component of spot prices through a Kalman smoother. A brief description of the permanent component is provided in appendix A.1.

$$\beta Openness + \sum_{i=1}^{4} \theta_{t-i} Openness\ X\ \Delta \ln windfall_{t-i} + \upsilon_t$$

In table(4) We find that while the interaction of openness and recent (one and two year lagged) windfall shocks is statistically insignificant, the interaction with older (three and four year lagged) windfall shocks has a significant negative impact on output and value added. This is consistent with proposition 7 when nontradables are labor intensive. As windfall rises, the increased demand for labor intensive nontradables lead to a scarcity of labor relative to capital which decreases the marginal return on capital. As capital flows out, the result is a stronger Dutch disease than what would have been in a more closed capital market.

In order to test proposition 4, we observe the effect of oil price shock on the ratio between wages in each sector and the price level of investment. Here instead of using the Rev .2 data set which has relatively scarce observations on wages and gross fixed capital formation, we use INDSTAT Rev. 3 which covers 1990-2004. The model predicts that the Dutch disease raises the capital-labor ratio in each sector as wages appreciate relative to rent when nontradables are labor intensive. We consider movements in P_k , the price level of investment, to follow movements in r from the model. We also consider the effect on capital-labor ratio directly using the following specification.

$$\begin{aligned} \Delta \ln \frac{w_{ijt}}{P_{k_{it}}} &= \alpha + \alpha_{country} + \alpha_{industry} + \alpha_{time} + \mathbf{1}(OPEC) + \mathbf{1}(developing) \\ &+ \mathbf{1}(oil\ producer) \sum_{i=1}^{4} \eta_{t-i} \Delta \ln p_{oil,t-i} + \varepsilon_t \end{aligned} \tag{20}$$

$$\begin{aligned} \Delta \ln(\frac{K}{L})_{ijt} &= \alpha + \alpha_{country} + \alpha_{industry} + \alpha_{time} + \mathbf{1}(OPEC) + \mathbf{1}(developing) \\ &+ \mathbf{1}(oil\ producer) \sum_{i=1}^{4} \eta_{t-i} \Delta \ln p_{oil,t-i} + \nu_t \end{aligned} \tag{21}$$

Table(5) shows the pooled sample estimation results which shows increasing wage-capital price ratio in response to oil price shocks. This effect is carried in turn onto the capital-labor ratio which rises as industries follow capital intensive production in response to the appreciating wage. This is consistent with the model when nontradables are labor intensive and when capital is immobile across borders, though only some cross country capital friction is needed for the model to be consistent with this result. The estimates show an increase in relative wages by 110% for a 10% permanent increase in oil price and an increase in the capital-labor intensity of 35%-60% for the same shock.

5 Costs of Adjustment

Costs of adjustment is a critical issue when measuring the Dutch disease. In the absence of costs of adjustments and capital and labor frictions we expect industries to adjust instantly. However costs of adjustment can explain the significant impact of oil price shocks up to 4 years after they have taken place as estimated in section 4. In order to estimate these costs we model each industry by a representative firm that is profit maximizing under quadratic costs of adjustment to capital. The firm hires worker and purchases capital goods. All inputs besides labor adjusts freely.

$$\max_{\{I_{s-1},L_s\}} E_t \sum_{s=t}^{\infty} \beta^{(s-t)} \left[(P_{ijs}.y_{ijs} - w_{js}L_{ijs})(1-\tau_{jt}) - P^k_{js}I_{ijs-1} \right] \tag{22}$$

such that

$$K_{ijs} = I_{ijs-1} + \Gamma K_{ijs-1}$$

where

y_{ijt} = real output in period t for industry i in country j

w_{js} = nominal wage in country j

P_{it} = price of output of industry in period t

P^k_{it} = price of investment goods of country j at period t

y_{ijt} = real output in period t for industry i in country j

τ_{jt} = corporate tax rate in country j at time t

y_{ijt} = real output in period t for industry i in country j

β = The discount rate which is $1/(1+r_t)$ where r_t is the real interest rate

$\Gamma = (1 - \delta)$ where δ is the rate of capital depreciation

The production function is linearly homogenous in its inputs for constant returns to scale and is given by

$$\ln(y_{ijt}) = \alpha_{ijt} + \mu l \ln K_{ijt} + (1 - \mu) \ln L_{ijt} - \frac{1}{2}\omega(\ln K_{ijt} - \ln K_{ijt-1})^2 \tag{23}$$

where α_{ijt} is the Hicks neutral technical change. μ is the capital intensity of production. ω is the costs of adjustment coefficient. When ω is positive, the adjustment costs are strictly convex.

The Euler equations of the firm's problem are

$$E_t \left\{ \begin{array}{c} (1 + r_t)(1 - \tau_{jt})(P_{it}y_{it}/K_{it})[\mu - \omega(\ln K_{ijt} - \ln K_{ijt-1})] + \\ (1 - \tau_{jt+1})(P_{it+1}y_{it+1}/K_{it})\omega(\ln K_{ijt+1} - \ln K_{ijt})] \end{array} \right\} = E_t \left\{ (1 + r_t)(P_{it}^k - \Gamma P_{it+1}^k) \right\} \tag{24}$$

$$(P_{it}y_{it}/L_{it})[1 - \mu] = w_{jt} \tag{25}$$

Each of the Euler equations states that expected marginal revenue of the factor of production is equal to its expected cost. We estimate the capital intensity parameter γ from the second equation then we substitute it in the second to estimate costs of adjustment parameter ω.We use value added as at time t as a measure of $P_{it}y_{it}$ to abstract away from material inputs which are not included in the model or the data.

5.1 Estimation

This is to the best of the author's knowledge the first attempt to estimate costs of adjustment through cross-country industrial data. While we benefit from a very wide cross section of industries spanning 117 countries, the time series is quite short relative to previous studies in the literature that estimated these parameters using US or OECD data. We estimate the parameters from (24) and (25) using Nonlinear 2SLS estimation. We use 1 and 2-year lagged value added, output, number of firms, price level of capital and number of workers as instrumental variables for a total of 14 instruments. While we only need two instruments for the orthogonality conditions needed to estimate the two parameters μ and ω, we find that with less instruments the results for ω are inconsistent and at times negative. We confirm this through monte carlo simulations on the model which shows the costs of adjustments parameter ω to be extremely sensitive to measurement error in investment. Introducing small shocks to investment in the model often results in implausibly high or negative estimates of ω.[12] We assume a fixed rate of capital depreciation across industries at $\delta = 0.1$. We fix the discount rate at $\beta = 0.96$ and we assume a marginal cooperate tax rate fixed across countries at $\tau = .2$.

5.2 Results

We estimate the model for four different manufacturing categories and the aggregate using nonlinear 2SLS. Literature on the estimation of the q-model of investment generally find costs of adjustments to be implausibly high due to insensitivity of investment to marginal productivity of capital. In table(6),We find the estimates of ω to be reasonable in the cross section. However we find that for some sectors, specially the food sector, estimates of capital share are implausibly high. The study finds that costs of adjustment vary significantly across different industrial categories, but there is no significant variation across country samples. However the significance of the estimates indicate that the costs of adjustment framework is consistent with the data, which in turn explains in part the slow adjustment observed in section 4.

We use these estimates to measure the total costs of adjustments incurred due to an oil price shock. We first estimate the effect of the shock on $\iota_t = \Delta \ln K_t$ using the following reduced form specification. We assume that investment decisions are made one year following the price shock.

$$\begin{aligned} \Delta \ln \iota_{ijt} &= \alpha + \alpha_{country} + \alpha_{industry} + \alpha_{time} + \mathbf{1}(OPEC) + \mathbf{1}(developing) \\ &\quad + \mathbf{1}(oil\ producer) + \mathbf{1}(oil\ producer) \sum_{i=2}^{4} \eta_{t-i} \Delta \ln windfall_{t-i} + \xi_t \end{aligned} \tag{26}$$

We then measure the costs of adjustment as $C = \frac{1}{2}\omega(\iota_{ijt})^2$ which is the share of loss in y_t. We measure the growth rate of costs of adjustment for each year in response to a 10% shock to oil price

[12] In Gordon (1992), which estimates costs of adjustment in Canadian manufacturing, uses 50 orthogonality conditions to estimate the same parameters and reducing the number of instruments led to implausible estimates.

in the following table.

The result in table(7) indicates that a 10 percent permanent increase in oil price results in costs of adjustment of .06 percent of output over a five year period. These costs are accumulated in part due to the Dutch disease mechanism as sectors shrink/expand in response to oil price bust/boom with capital stock adjusting to accommodate the shocks to the real exchange rate.

6 Conclusion

This study finds evidence that manufacturing sectors do shrink due to oil price booms in oil exporting countries. This paper also finds evidence that capital intensity in production rises in response to oil price shocks as wages increase relative to the price level of investment. The evidence is consistent with a Heckscher-Ohlin model with labor intensive nontradables and closed capital markets or imperfect mobility of capital across countries. We show theoretically that the Dutch disease takes place even when capital markets are open. However theory predicts that open capital markets reduces/aggravates the shrinking effect on manufacturing when nontradables are capital/labor intensive. We find evidence that the Dutch disease is stronger in countries with more open capital accounts. Additionally, The theory predicts that gross domestic capital stock shrinks in response to resource booms when capital markets are open and nontradables are labor intensive. The paper explains the slow response of manufacturing to oil price shocks found in the data through costs of adjustment. We estimate costs of adjustments from the cross-country panel and find the estimates to be consistent with slow adjustment, but we find the costs of adjustment incurred due to oil price shocks to be insignificant.

References

[1] Abel, A. and O. Blanchard, 1986. "The Present Value of Profits and Cyclical Movements in Investment," *Econometrica*, 54, pp. 249-273.

[2] Amemiya, T, 1974. "The Nonlinear Two-Stage Least-Squares Estimator," *Journal of Econometrics*, 2, pp.105-110.

[3] Arbatli E., 2007. "Permanent and Transitory Income Shocks and the Current Account", Dissertation, The Johns Hopkins University

[4] Benjamin, N., D. Shantaynanan and R. Weiner, 1989. "The 'Dutch' Disease in a Developing Country: Oil Reserves in Cameroon" *Journal of Development Economics*, 30, pp. 71-92.

[5] Bruno, M. and J. Sachs, 1982. "Energy and Resource Allocation: A Dynamic Model of the "Dutch Disease", *The Review of Economic Studies*, Vol. 49, No. 5, pp. 845-859.

[6] Corden W.M. and J. P. Neary,1982. "Booming Sector and De-industrialisation in a Small Open Economy," *The Economic Journal,* 92 (December): pp. 825-848.

[7] Corden, W.M.,1984. "Boom Sector and Dutch Disease Economics: Survey and Consolidation," *Oxford Economic Papers* 36: 362.

[8] Gelb, A. and Associates, 1988. *Oil Windfalls: Blessing or Curse?*, World Bank: Oxford University Press.

[9] Gordon, Stephen, 1992. "Costs of Adjustment, the Aggregation Problem and Investment," *The Review of Economics and Statistics,* MIT Press, vol. 74(3), pages 422-29.

[10] Hayashi, F., 1982. "Tobin's Marginal q and average q: A Neo-Classical Interpretation," *Econometrica* 50, pp. 213-224.

[11] Heston A., R. Summers and A. Bettina, *Penn World Table Version 6.2*, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, September 2006.

[12] International Monetary Fund, *World Economic Outlook* 2008, Washington D.C.

[13] International Monetary Fund, *International Financial Statistics* 2008, Washington D.C.

[14] Kilian, L., A. Rebucci and N. Spatafora, 2007. "Oil Shocks and External Balances" IMF Working paper WP/07/110, Washington D.C.

[15] Mastuyama, K.,1992. "Agricultural Productivity, Comparative Advantage, and Economic Growth," *Journal of Economic Theory*, 58, pp. 317-334.

[16] Matsen, E and R. Torvik, 2005. "Optimal Dutch Disease," *Journal of Development Economics*, 78, Issue 2, Pages 494-515.

[17] Sachs, J. and A. Warner, 1995. "Natural Resource Abundance and Economic Growth," NBER Working Paper 5398, Cambridge, MA.

[18] Sala-i-Martin, X. and A. Subramanian, 2003. "Addressing the Natural Resource Curse: An Illustration from Nigeria" IMF Working paper WP/03/139, Washington D.C.

[19] Shapiro, Matthew, 1986. "The Dynamic Demand for Capital and Labour," *Quarterly Journal of Economics*, pp. 513-542.

[20] Spatafora, Nikola & Warner, Andrew, 1995. "Macroeconomic effects of terms-of-trade shocks : the case of oil-exporting countries," Policy Research Working Paper Series 1410, The World Bank.

[21] Stijns, Jean-Philippe, 2001."Natural Resource Abundance And Economic Growth Revisited," Development and Comp Systems 0103001, EconWPA.

[22] Summers, L. H., 1981. "Taxation and Corporate Investment: A q-theory Approach," Brookings Papers on Economic Activity (1:1981), pp. 67-140.

[23] United Nations Industrial Development Organization. *Industrial statistics database, Rev. 2 and 3.* Vienna: United Nations Industrial Development Organization Press, 1997.

[24] van Wijnbergen, S., 1984. “The ‘Dutch Disease’: A Disease After All?” *The Economic Journal*, 94, pp. 373-41.

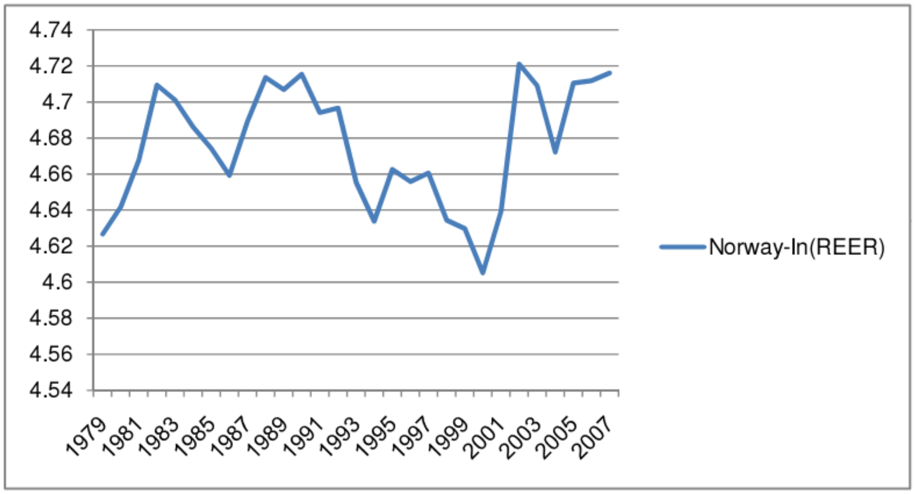

Figure 1: The Real Effective Exchange Rate - Norway

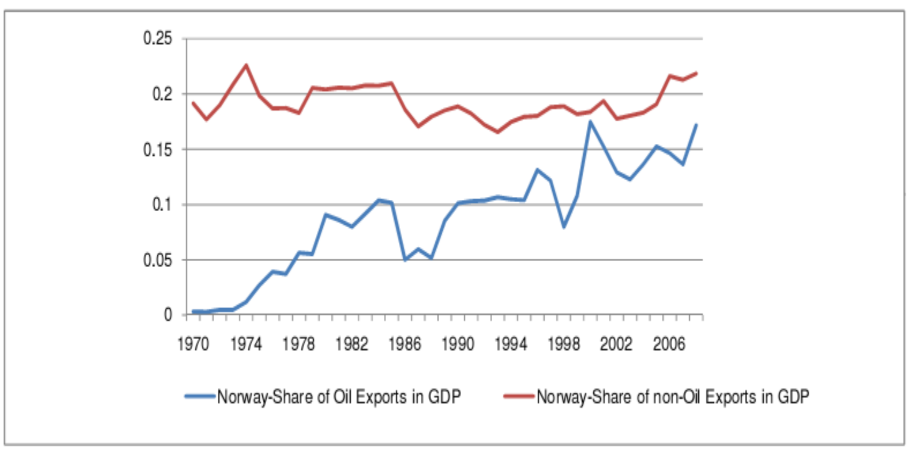

Figure 2: The share of oil and non-oil exports in GDP- Norway

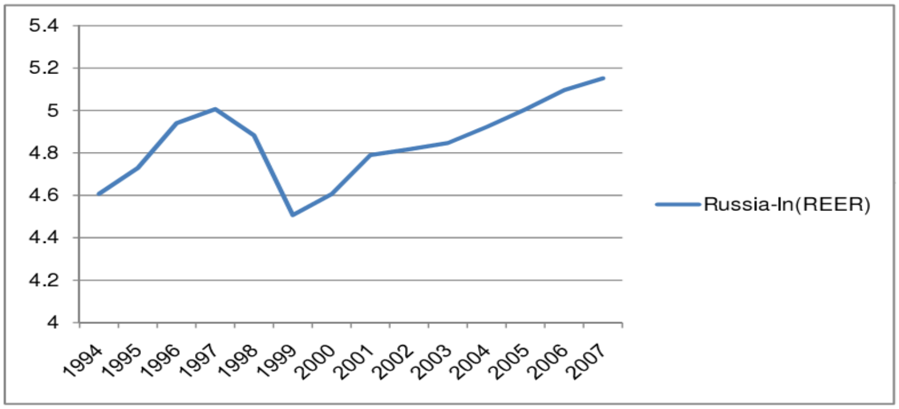

Figure 3: The Real Effective Exchange Rate - Russia

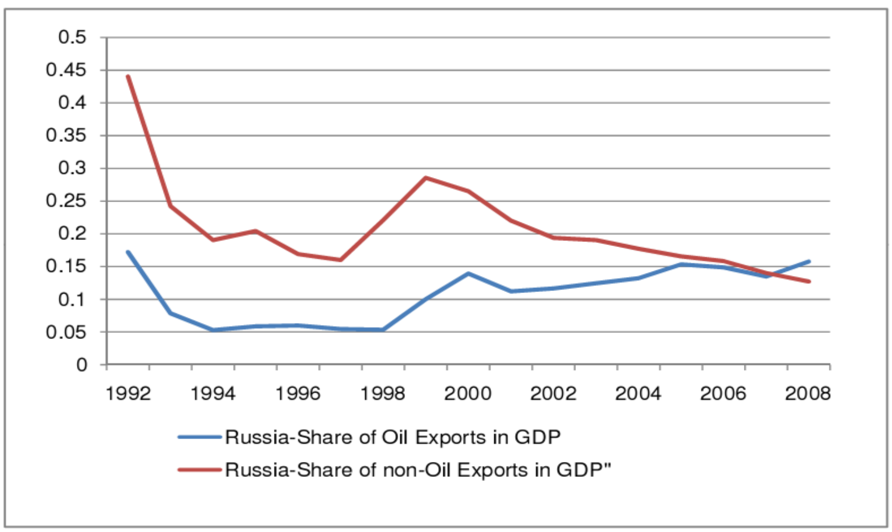

Figure 4: The share of oil and non-oil exports in GDP - Russia

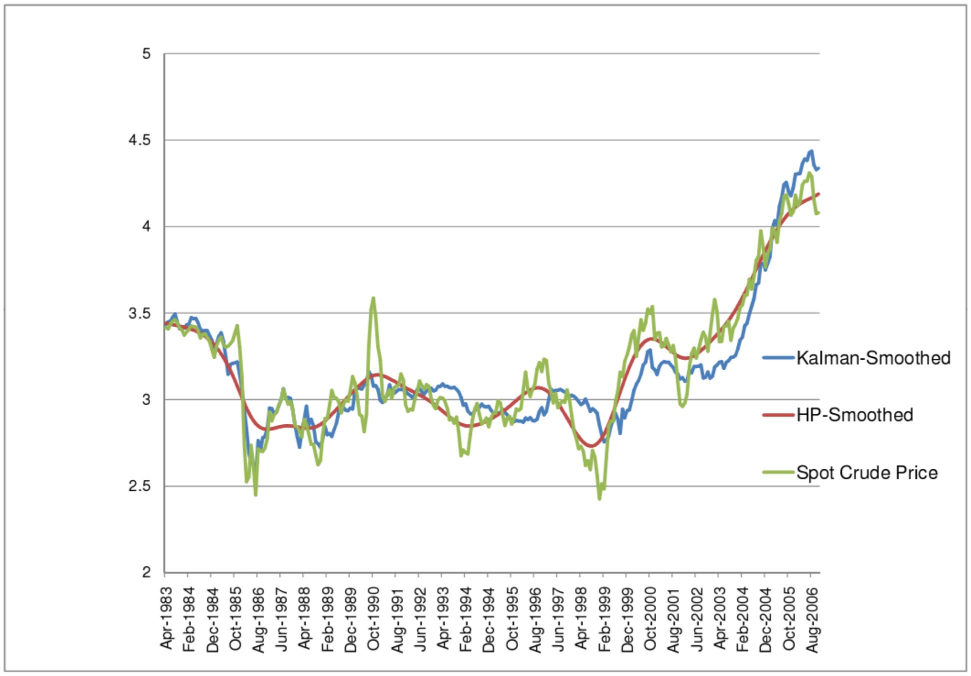

Figure 5: Oil price decompositions (logs) and the WTI crude oil spot price

	Output		Value Added	
	pooled	fixed-effect panel	pooled	fixed-effect panel
η_{t-1}	-.108*** (.0322)	-.106*** (.0201)	-.116 *** (.0361)	-.111*** (.0221)
η_{t-2}	-.0866 *** (.0193)	-.0891*** (.0196)	-.068*** (.0216)	-.0672*** (.0215)
η_{t-3}	-.0966 *** (.0138)	-.097*** (.0179)	-.104*** (.0211)	-.101*** (.0196)
η_{t-4}	-.0653*** (.0139)	-.0646*** (.0172)	-.0547*** (.0152)	-.0519*** (.0188)
$\sum_{i=1}^{4} \eta_{t-i}$	-.357*** (.0579)	-.356*** (.0466)	-.342*** (.0646)	-.331*** (.051)
Hausman-test stat		$\text{chi}^2(29)= 528.02^{***}$ prob>$\text{chi}^2 = 0.00$		$\text{chi}^2(29)= 388.33^{***}$ prob>$\text{chi}^2 = 0.00$

Table 2: The Dutch Disease Effect on Output and Value added

$\sum_{i=1}^{4} \eta_{t-i}$	Output	Value Added
Kalman-filtered Oil Spot Price	-.352***	-.336***
	(.0579)	(.0643)
HP-filtered Oil Spot Price	-.164 ***	-.127 ***
	(.05)	(.054)

Table 3: The Dutch Disease Effect on Output and Value added: Estimates of the cumulative impact of Kalman and HP-Filtered oil price shocks over 4 years

	Output	Value Added
θ_{t-1}	.041*	-.0429 *
	(.0238)	(0274)
θ_{t-2}	.0227	.0121
	(.018)	(.203)
θ_{t-3}	-.039 ***	-.0377**
	(.0153)	(.0178)
θ_{t-4}	-.0757***	-.0864***
	(.0154)	(.0172)

Table 4: The Effect of the interaction of Openness and Windfall shocks on Output and Value Added

	$\Delta \ln \frac{wages}{P_k}$		$\Delta \ln \frac{K}{L}$	
	pooled	fixed-effect panel	pooled	fixed-effect panel
η_{t-1}	3.52***	3.41***	-3.138***	-3.33***
	(.74)	(.5154)	(1.051)	(.809)
η_{t-2}	5.16***	5.127***	3.009***	2.196***
	(.64)	(.495)	(.992)	(.759)
η_{t-3}	1.171**	1.086**	.64	-.171
	(.591)	(.472)	(.863)	(.751)
η_{t-4}	1.965**	1.996**	5.856***	4.74***
	(.827)	(.666)	(1.448)	(1.00)
$\sum_{i=1}^{4} \eta_{t-i}$	11.82***	11.62***	6.371***	3.435***
	(1.63)	(1.336)	(2.446)	(2.031)
Hausman-test stat		$chi^2(17)=32.16^{**}$		$chi^2(17)=38.72^{***}$
		prob>$chi^2 = 0.056$		prob>$chi^2 = 0.002$

Table 5: The Dutch Disease Effect on relative wages and factor intensity

Sector	ω
Wood	$.788^{***}$
	.191
Food	$.84^{***}$
	.109
Chemical	$.544^{***}$
	.109
Metal	1.05^{***}
	.099
Total	1.72^{***}
	.1025

Table 6: Estimates of costs of adjustment parameters

	ι	C
η_{t-2}	$-.0179$	
	(.045)	
η_{t-3}	$-.243^{***}$	$5.078e-4$
	(.041)	
η_{t-4}	.0664	$3.79e-5$
	(.0467)	
η_{t-5}	$.0792^{***}$	$5.395e-5$
	(.0239)	
$\sum$		$6e-4$

Table 7: Estimates of size of costs of adjustment in response to a 10 percent shock in oil price