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DUCTH DISEASE ECONOMICS: A CASE STUDY OF INDONESIA

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Abstract

The term ‘Dutch disease’ was first used to describe the indirect effects of the boom in the gas sector in the Netherlands in the 1960s on other sectors. This paper applies this framework to analyse the impact of the 2007-2008 surge in oil and gas prices in Indonesia. It finds that this has induced a real appreciation of the Rupiah. In contrast to ‘Dutch disease’ theory, it has been accompanied by growth in agricultural and manufacturing exports. The simulation results suggest that the observed real appreciation due to the booming energy has inhibited the growth of Indonesian exports of agricultural and manufacturing products.

Keywords: Dutch disease, energy, agricultural and manufacturing exports
JEL classification numbers: O10, O13

Abstrak

Istilah 'Dutch disease’ pertama kali digunakan untuk menggambarkan pengaruh tidak langsung dari booming di sektor gas di Belanda pada tahun 1960-an atas sektor-sektor lainnya. Tulisan ini mengaplikasikan kerangka tersebut untuk menganalisis dampak dari lonjakan harga minyak dan gas tahun 2007-2008 di Indonesia. Penelitian ini menemukan bahwa gejala tersebut telah menimbulkan peningkatan nilai yang nyata dalam Rupiah. Berbeda dengan teori dasar 'Dutch disease’, dalam kasus ini terjadi pula pertumbuhan ekspor pertanian dan manufaktur. Hasil simulasi menunjukkan bahwa peningkatan nyata karena booming energi tersebut telah menghambat pertumbuhan ekspor produk pertanian dan manufaktur Indonesia.

Keywords: Dutch disease, energi, ekspor pertanian dan manufaktur
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INTRODUCTION

It is easy to understand that natural resources can promote the development of a country. However, many empirical results show that in most cases boom in the natural resources sector may harm the economy by appreciating the real exchange rates and contracting other sectors, especially traded sectors (Corden and Neary (1982), Neary and Wijnbergen (1986), Rodriguez and Sachs (1999), Sachs and Warner (2001), Clements, et al. (2008)). This phenomenon is widely known as ‘Dutch Disease’, named after The Economist magazine in the 1970’s observed the gas boom in the Netherlands in the 1960’s that gave negative result to its development. An almost similar issue is called ‘Gregory Thesis’ explained by Gregory (1976), who states that a boom in the mineral sector in Australia is equivalent to doubling the export tariff, while for import-competing sector, it is equivalent to removing tariffs or subsidising imports.

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Following the theory of 'Dutch Disease', there are several studies referring to Indonesia as a case example for the impact of the oil price boom in the 1970's (Fardmanesh (1991), Usui (1996, 1997) and Basu and Datta (2007)). Their results are more similar, there is no evidence to suggest that during the 1970's oil price boom Indonesia suffered from 'Dutch Disease'. However, Fardmanesh (1991) offer an alternative result. He proposes that the boom only contracted the agricultural sector not manufacturing sector. The main reason why Indonesia could protect non-oil sectors was repeated devaluations, especially in 1973, 1978, and 1982 (Warr (1984), Usui (1996, 1997), Basu and Datta (2007)).

In 2007-2008, the oil price had risen to unprecedented levels. According to WTRG (2008a), crude oil prices had doubled from July 2007 to July 2008 from US$70 to US$145 respectively. The price of the closest substitute of oil, namely gas, had also increased substantially. According to WTRG (2008b), the price of natural gas had almost doubled in 12 months, from less than US$7 per MMBTU in mid 2007 to US$12 in mid 2008.

As an exporter of oil and gas, Indonesia gains more revenue from these price surges, even though the volume of oil export has dropped significantly in the past several years. In 2004, the revenue from oil and gas export was US$16 billion; by 2007 the value of oil and gas export is nearly US$25 billion, an increase of 56 percent.

The aims of this paper are; *first*, to test whether the increase in oil and gas export revenues affect the real exchange rate and the revenue of other sectors, namely the non oil and gas tradeable export sectors, which can be classified into agricultural and manufacturing commodities. The *second* purpose is to analyse the consequences of any real appreciation on the Indonesian economy.

There are a considerable number of studies relating to 'Dutch Disease'. Gregory (1976) says that a boom in the Australian mineral sector may hurt agricultural and import-competing sectors in much the same way as an imposition of trade barriers. Snape (1977) argues that the production of non-mineral sectors may decrease, however the production of particular goods may increase. Stoeckel (1979) finds a slightly different result than Gregory (1976), he concludes that the discovery of new mineral mines cause the traditional sectors to contract, however, the import-competing sectors expand marginally.

Sachs and Warner (1995, 1997) investigate the impact of resource abundance to economic growth. Using the cross country data during 1970-1989, they find that there is a negative relationship between economic growth and the ratio of resource exports. In 1999, using 'big-push' logic, they observe the impact of natural resource booms on growth in seven Latin America countries. Sachs and Warner find that in some cases, resource booms lead to a per capita income decline. This seems in contrast with the case of East Asian countries (before 1997), which experienced high growth because their economies were supported by labour-intensive exports initially, then followed by capital-intensive exports (Sachs and Warner, 1999). Similar results are also reported by Rodriguez and Sachs (1999), Sachs and Warner (2001), and Sachs and Vial (2001).

With respect to the exchange rate, many papers suggest that a boom in the resources sector may lead to appreciation. For example, Corden (1981) says that North Sea oil in Britain together with monetary contraction, would lead to an appreciation of the nominal exchange rate and squeeze the tradeable sectors. Corden (1982), in the case of Australia, explains the impact on investment and export booms using two options adjustment and non-adjustment. By way of the adjustment option, booms lead to real appreciation, while non-adjustment (which means accumulating foreign exchange reserves) can be used to avoid nominal appreciation and inflation.

Al-Mabrouk (1991) states that the oil revenue expansion in Saudi Arabia during the 1970's and 1980's, appreciated the Saudi Riyal in real terms. The real appreciation of the Riyal then induced the expansion of the non-traded sector, while the non-oil traded sector experienced a contraction. These results confirm the 'Dutch Disease' theory.

Akram (2004) finds that, in the Norwegian case, there is a negative non-linear relationship between oil prices and the Krone. The relationship's strength varies depending on the price of oil. The correlation seems to be strong when the price of oil is relatively low (below $14 per barrel). He also finds that when the price of oil tends to be falling, the relationship seems to be stronger. In the long run, however, he says that the price of oil becomes insignificantly correlated with the Norwegian exchange rate.

Other research by Stokke (2008) also suggests that the boom in gold prices in the 1970's affected the South African economy by a structural change and a real exchange rate appreciation. He explains that booms increase public consumption which then leads to a real appreciation and an expansion of the non-tradeable sector, but squeezes the tradeable sector. At this stage, structural change occurred by learning by doing process. He also claims that trade barriers increased at that time. Together, they decreased the relative productivity of the industrial sector, and led to real depreciation following the initial appreciation.

METHODS

According to Clements, et al. (2008) a boom in the resource sector appreciates both nominal and real exchange rates. They explain this by what is called 'commodity currency model'. The model implies that the value of local currency in terms of foreign currency appreciates when there is a boom in a commodity which is important to their export; on the other hand, when the market crashes, the local currency depreciates.

Clements, et al. (2008) provide a more detailed explanation of the commodity currency model as follows. Suppose there are two kinds of goods - traded goods and non-traded goods. The price can then be deconstructed into the price of tradeable and non-tradeable, where P_T is the price of tradeable and P_N is the price of non-tradeable goods. In terms of proportional changes, we can write this as

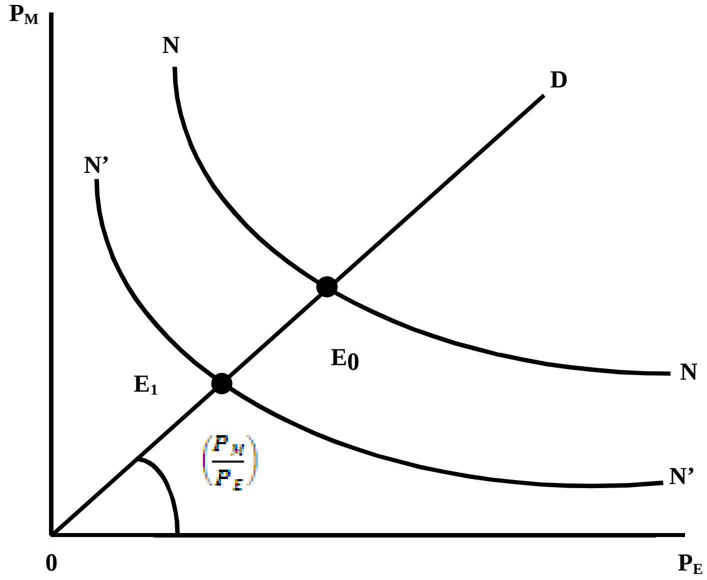
$$\hat{P} = \gamma_T \hat{P}_T + \lambda_N \hat{P}_N \tag{1}$$

where, γ_T and γ_N indicate the elasticity of the price of tradeable and non-tradeable goods respectively. $\gamma_T + \gamma_N = 1, \gamma_T > 0$, and $\gamma_N > 0$, or it also implies that

$$\hat{P} = \gamma_T \hat{P}_T + (1-\gamma_T)\hat{P}_N \tag{2}$$

The Figure 1 below is cited from Clements, et al. (2008) and explains the effect of a booming sector to the relative price of tradeable goods with respect to the price of non-tradeable goods.

Suppose there are three sectors of an economy - export sector, import sector, and non-traded sector. The price of exportable goods and importable goods are indicated by P_E and P_M, respectively. *NN* indicates the market of non-traded goods, which is downward sloping. The relative price of import goods over export goods is $\left(\frac{P_M}{P_E}\right)$ which is also known as 'the term of trade'. E_0 is the initial equilibrium point before the boom. After the boom, the *NN* schedule shifts to the down left side which is shown as *N'N'*. This shifts the equilibrium position from E_0 to E_1. The consequence is that the relative price of importable over exportable goods decreases. This squeezes the profitability of both the export and import sectors.



Source: Clements et al. (2008)

Figure 1: The Effects of a Booming Export Sector

How can we relate this notion to the exchange rate? Consider the relative price of tradeable goods with respect to the non-tradeable goods $\left(\frac{P_T}{P_N}\right)$ as α, or in the logarithm change we can write it as $\hat{P}_T - \hat{P}_N = \hat{\alpha}$. This also implies that if we substitute this equation into equation (2) we will get

$$\hat{P} = \gamma_T \hat{P}_T - (1-\gamma_T)(\hat{P}_T - \hat{\alpha}) \tag{3}$$

Assume that the general price does not change or $\hat{P} = 0$

$$\hat{P}_T = (1-\gamma_T)\hat{\alpha} \tag{4}$$

The purchasing power parity (PPP) theory defines the price of domestic tradeable goods is equal to the international price of tradeable goods multiplied by the nominal exchange rate, or $P_T = SP_T^*$, where P_T^* indicates the international price of traded goods and S indicates the nominal exchange rate. In logarithm terms, we can write this as:

$$\begin{aligned}\hat{P}_T &= \hat{S} + \hat{P}_T^* \\ \hat{S} &= \hat{P}_T - \hat{P}_T^*\end{aligned} \tag{5}$$

Assume again that the world price of traded goods is constant or $\hat{P}_T^* = 0$, so we have

$$\hat{S} = \hat{P}_T \tag{6}$$

Substitute (6) into (4), we will get

$$\hat{S} = (1-\gamma_T)\hat{\alpha} \tag{7}$$

We know that the boom in the mineral sector may lead to a decrease of traded goods relative price or $\hat{\alpha} < 0$, so we will also have $\hat{s} < 0$, or in other words, it implies that the nominal exchange rate appreciates. Clements et al. (2008) also explain that the nominal exchange rate appreciation will be followed by an appreciation in real term, because the overall price level is not affected by the export boom.

From our discussion above, we know that an expansion of the mineral sector can give several effects, namely (1) traded goods contraction, (2) non-traded goods expansion, and (3) exchange rates appreciation.

Suppose that the increase on oil and gas export revenue affects the Indonesian economy as suggested by 'Dutch Disease'. We can model the impact of revenue increases on traded goods and the exchange rate. Because the data on non-traded goods export is not available, we only focus this research on traded goods export which is divided into two broad sectors; agricultural and manufacturing products, and the real exchange rates. The functions are as follows:

$$X_A = X_A(X_{OG}) \quad (8)$$

$$X_M = X_M(X_{OG}) \quad (9)$$

$$r = r(X_{OG}) \quad (10)$$

where:

X_{OG} is the logarithm of oil and gas export revenue

X_A is the logarithm of agricultural product export revenue

X_M is the logarithm of manufacturing product export revenue

r is the logarithm of real exchange rate

As these regressions are time series regressions, the first test is Dickey-Fuller's unit root test. This test aims to determine whether or not the data are stationary. The second step is to run the regressions to know the relationship between oil and gas revenue to the Indonesian exchange rate and other export sectors. The equations will be as follows:

$$X_A = \alpha_1 + \beta_1 X_{OG} + \varepsilon_1 \quad (11)$$

$$X_M = \alpha_2 + \beta_2 X_{OG} + \varepsilon_2 \quad (12)$$

$$r = \alpha_3 + \beta_3 X_{OG} + \varepsilon_3 \quad (13)$$

Where α_i indicates the intercept coefficients, β_i represents oil and gas export revenue coefficients, and ε_i is the error term. The empirical evidence will support the 'Dutch Disease' hypothesis only if $\beta_1 < 0$, $\beta_2 < 0$, and $\beta_3 < 0$. This means that the increase in oil and gas export revenue reduces the agricultural and manufacturing traded sector and lead to a real appreciation of the local currency.

Data

The data are monthly data from 2002-1 to 2008-5 which are taken mainly from Indonesia financial statistics, Bank Indonesia and the US bureau of Labour statistics for the US consumer price indexes. The US price indexes have been recalculated to the different base year to match them to the Indonesian consumer price indexes (originally 1982-1984 to 2002).

RESULTS DISCUSSION

In short, our result suggests that we cannot reject the null hypothesis that all the variables have unit roots. However, our co-integration test suggests that all the variables are co-integrated. In other words, although all variables are non-stationary, they move together, it means that the regressions are meaningful. The results from the regressions are indicated as in table 1.

The 'Dutch Disease' hypothesis indicates that boom in the mineral sector may lead to traded sector contraction. However, the evidence from our data gives the opposite results. However, the result is convinced that an increase in oil and gas export revenues appreciate the real exchange rate, as suggested by 'Dutch Disease' theory.

Table 1: Result from the Regression

Variable	Constant	x_{OG}
x_A	-5.29	1.31
	(-4.28)	(15.09)
x_M	3.004	0.86
	(3.68)	(15.11)
r	13.05	-0.29
	(36.36)	(-11.34)

Source: Data estimation.

The numbers in the brackets indicate the t-statistics. All the coefficients are statistically significant at the 1% level. The results are not consistent with the 'Dutch Disease' theory. In the case of Indonesia, during the time observed, the increase of oil and gas export revenue has expanded the agricultural export sector and manufacturing export sector. These are indicated by the positive coefficient of oil and gas revenue for both the agricultural and manufacturing sectors. For agricultural product exports, an increase of 1% in the oil and gas sector may promote the agricultural sector by 1.3%. For the manufacturing export sector, a 1% increase in oil and gas revenue expands this sector by 0.9%.

In the contrary, oil and gas export revenue determine a negative impact on the real exchange rate. It means that higher revenue on oil and gas exports is responsible for the real exchange rate appreciation. The regression indicates that every 10% increase on oil and gas exports appreciates the rupiah real exchange rate by 2.9%. The numbers in the parentheses indicate the t-statistic. All confirm that the parameters are statistically significant at more than 1% degree of freedom.

Simulation Model

Contrary to the 'Dutch Disease' theory, we found that the boom in export revenue on oil and gas expands the export of tradeable goods and the agricultural and manufacturing sectors. The relationship between agricultural and oil and gas exports is strong - indicated by more than one to one positive relationship. While for the manufacturing sector, the relationship is less than one positive relationship.

This section will explain the existence of 'Dutch Disease' in Indonesia. We will use a simulation model to discover whether or not there is a symptom like 'Dutch Disease' in the Indonesian economy.

Assume that both sectors are explained by Dutch disease and non Dutch disease components, so that

$$\chi_i = \chi_i^D + \chi_i^{ND} \tag{14}$$

Where x_i is the value of export sector i, x_i^D is the export of sector i explained by the Dutch disease, and x_i^{ND} is the export element which is unexplained by the Dutch disease. If we derive an equation based on the changes we have

$$\hat{\chi}_i = \gamma_i \hat{\chi}_i^D + (1-\gamma_i)\hat{\chi}_i^{ND} \tag{15}$$

where i = A,M, and $\gamma_i \in [0,1]$ and γ_i is the fraction of sector i exposed to 'Dutch Disease'.

We also know that the 'Dutch Disease' implies that the boom gives a negative impact on the traded goods sector, so we know that $\gamma_i \hat{x}_i^D$ must be less than zero $(\gamma_i \hat{x}_i^D < 0)$. From the regression results derived in the previous section, we found that $\hat{x}_i$ for both agricultural and manufacturing sectors have positive numbers, so it will follows that $(1-\gamma_i)\hat{x}_i^{ND}$ should be a positive number larger than $\hat{x}_i$.

What is $\hat{x}_i^{ND}$ or component unexplained by Dutch disease? $\hat{x}_i^{ND}$ could be the non traded sector which possibly affects traded sector. In this case, we could consider $\hat{x}_i^{ND}$ as the service sector. Suppose that $\hat{x}_i^{ND}$ is driven by the GDP growth, so we will have

$$\hat{\chi}_i^{ND} = \delta_i \hat{q} \tag{16}$$

where $\hat{q}$ is the growth of GDP. Also consider that because $\hat{x}_i^{ND}$ is positive, it follows that $\delta_i \hat{q}$ must be positive, where δ_i indicates the elasticity of the non traded sector, $\hat{x}_i^{ND}$. Also supposing that the Dutch disease is a function of the real exchange rate, we can write

$$\hat{\chi}_i^D = \theta_i \hat{r} + \rho_i \hat{q} \tag{17}$$

where $\hat{r}$ is the logarithm change of real exchange rate and θ_i is the elasticity of the export variable of sector *i* explained by the "Dutch Disease'. 'Dutch Disease' implies that the boom in the mineral sector will contract sector *i*, other than the booming sector. 'Dutch Disease' theoretically is also followed by the real appreciation, or $\hat{r}$ is negative, so it should be true that θ_i is a positive number. Note also that $\hat{q}$ has a negative relationship with sector i explained by 'Dutch Disease', so ρ_i should be less than 0. If we insert equations (16) and (17) into equation (15) we will have a new equation as follow

$$\hat{\chi}_i = \gamma_i \theta_i \hat{r} + [\gamma_i \rho_i + (1-\gamma_i)\delta_i]\hat{q} \tag{18}$$

Suppose that instead of the observed value of the change in the real exchange rate, $\hat{r}$, it takes a hypothetical value $\hat{r}^*$, we can then apply equation (18) to obtain the corresponding hypothetical or simulated value of $\hat{x}_i$, $\hat{x}_i^*$.

$$\hat{\chi}_i = \gamma_i \theta_i \hat{r}^* + [\gamma_i \rho_i + (1-\gamma_i)\delta_i]\hat{q} \tag{19}$$

Subtracting equation (12) from (13) will give us a result as equation (14) below

$$\hat{\chi}_i^* - \hat{\chi}_i = \gamma_i \theta_i (\hat{r}^* - \hat{r}) \tag{20}$$

Now suppose that r^* is constant or $r^* = 0$, so will have

$$\hat{\chi}_i^* - \hat{\chi}_i = -\gamma_i \theta_i \hat{r} \tag{21}$$

Also suppose that γ_i and θ_i are given, and we already have $\hat{x}_i$ and $\hat{r}$, so we can calculate $\hat{x}_i^*$ as the simulation for $\hat{x}_i$.

Simulation Results

For simulation, we need to set the values of γ_i and θ_i. From equation (15) we can define γ_i as the exposure of $\hat{x}_i$ over the 'Dutch Disease' component or $\hat{x}_i^D$, the Dutch disease implies that $\hat{x}_i^D$ has a negative relationship with $\hat{x}_i^D$, so it will be true that the bigger the value of γ_i the smaller the value of $\hat{x}_i$. From equation (11) it is shown that θ_i is the elasticity of export growth explained by the Dutch disease $(\hat{x}_i^D)$ over the change of the real appreciation$(\hat{r})$. From equation (18), if we keep $\hat{q}$ constant or $\rho_i \hat{q}$ equal to zero, we find that $\hat{x}_i^D = \theta_i \hat{r}$, now if we define appreciation as $\hat{r} < 0$ and Dutch disease means that $\hat{x}_i^D < 0$, so we will have $\theta_i > 0$. From this relationship we find that the larger the θ_i, the larger the $\hat{x}_i^D$ will be or the smaller the $\hat{x}_i$.

The value of γ_i lies between 0 and 1; $\gamma_i = 0$ means the growth of export on commodity *i* does not have any connection with the 'Dutch Disease' component. If this is true, the growth of export for all commodities must increase as oil and gas exports increase. Even though commodity A and M have positive growth as oil and gas exports grow, the growth rates are slowing down, so γ_i must not be equal to 0. On the other hand, $\gamma_i = 1$ means export growth on commodity *i* is explained perfectly by the 'Dutch Disease' component. This cannot be true because from the regression results we found that export of commodities A and M relate positively with oil and gas exports.

We define θ_i as the elasticity of export growth on commodity i over real appreciation. The value lies somewhere between 0 and 1. If we take θ_i equals zero, it means that growth is not affected by the real appreciation. On the other hand, if we assume that the value of θ_i equals one, we allow that the growth of export is perfectly explained by the real appreciation.

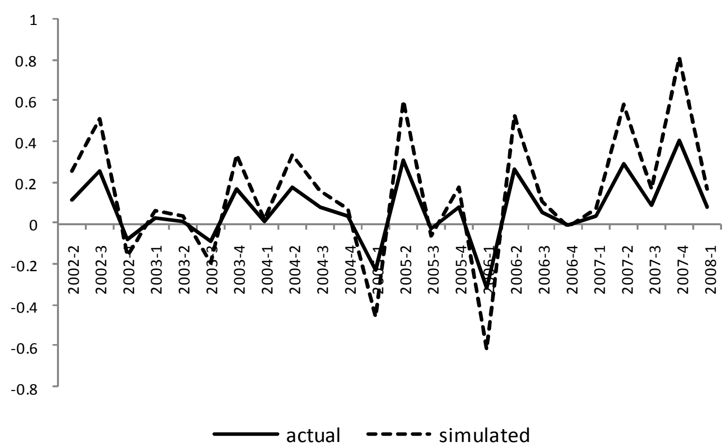
For our convenience, assume that γ_i is equal to 0.5 and θ_i is equal to 0.5. If we insert those numbers into equation (21), we will have $\hat{x}_i^* - \hat{x}_i = -0.25\hat{r}$.

We use this equation to find $\hat{x}_i^*$ or $\hat{x}_i$ simulation. From the data set, we have $\hat{x}_i$ which is equal to $\ln x_{it} - \ln x_{i(t-1)}$, we also know $\hat{r}$, where in this case is equal to $\ln r_t - \ln r_{t-1}$. Meanwhile, $\hat{x}_i$ is defined as the quarterly change in sector i export revenue and $\hat{r}$ is the change in the real exchange rate. By inserting $\hat{x}_i$ and $\hat{r}$ we can find the value of $\hat{x}_i^*$. All the data are quarterly data (recalculated from monthly data) taken from the Bank Indonesia (Central Bank of Indonesia) website.

Consider $\hat{x}_A^*$ as the simulation of the quarterly percentage change in agricultural export and $\hat{x}_A$ is the actual changes. Assume as above, we know that $\gamma_A = 0.5$ and $\theta_A = 0.5$, so we can derive the actual and simulation percentage growth of the agricultural sector based on quarterly data as indicated in the Figure 2 below.

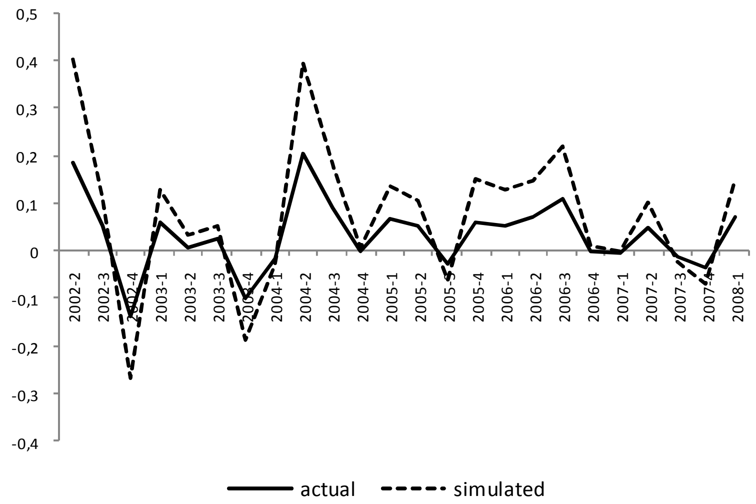
The broken line indicates the simulation growth, $\hat{x}_A^*$, while the solid line represents the actual growth or $\hat{x}_A$. The mean of $\hat{x}_A^*$ is 7.5%, while the mean of $\hat{x}_A$ is 7.1%. This suggests to us that our agricultural export simulation grows faster than the actual one. In other words, if we assume that there is no real exchange rate appreciation, the agricultural export may grow faster than if there is an appreciation.

We have an almost similar story for the manufacturing sector. Consider the broken line as the simulation growth and the solid line as the actual one, we find that the simulation export, which has a 4% mean, grows faster than the actual export which has the mean value 3.6%, as described in the Figure 3.



Source: Data estimation.

Figure 2: Simulation and Actual Growth on Agricultural Export



Source: Data estimation.

Figure 3: Simulation and Actual Growth on Manufacturing Export

Our findings confirm that if we take into account the exogenous component, which is the real exchange rate appreciation, we could have a lower level of export growth. In short, 'Dutch Disease' actually occurs in Indonesia in a form of slowing down the export growth for both, due to the mineral export boom via real appreciation.

The next step is to find the sensitivity of $\hat{x}_i$ over γ_i and θ_i. Table 2 indicates the changes in $\bar{\hat{x}}_A^*$, $\bar{\hat{x}}_M^*$, and mean of $\hat{x}_i^* - \hat{x}_i$ when we gradually reduce the value of γ_i and θ_i.

The table shows that every time $\gamma_i\theta_i$ decreases by 1%, the difference between $\hat{x}_i^*$ and $\hat{x}_i$ reduces by 0.017%. If we translate this into the average change of $\hat{x}_A^*$ and $\hat{x}_M^*$ we find that every 1% increase of $\gamma_i\theta_i$, the value of $\bar{\hat{x}}_A^*$ and $\bar{\hat{x}}_M^*$ will rise by 0.017%. In other words, it is shown that when the Indonesian rupiah appreciates by 1% against the US dollar in real terms, the average growth of agricultural and manufacturing exports decrease by 0.017%. In short, we can confirm that 'Dutch Disease' occurs in Indonesia - not in the form of export reducing, but in the form of slowing down the export growth via real exchange rate appreciation.

Table 2: Value of "Dutch Disease' Share and Real Exchange Rate Elasticity

Dutch Disease share, γ_i	Elasticity with respect to real exchange rate, θ_i				
	0.5	0.4	0.3	0.2	0.1
0.5	0.25	0.20	0.15	0.10	0.05
0.4	0.20	0.16	0.12	0.08	0.04
0.3	0.15	0.12	0.09	0.06	0.03
0.2	0.10	0.08	0.06	0.04	0.02
0.1	0.05	0.04	0.03	0.02	0.01

Source: Data estimation.

Table 3: Sensitivity of Simulation of Exports

Value of elasticity $\gamma_i\theta_i$ (1)	Mean of simulated value exports of: Difference between simulated and actual growth in export $\hat{x}_i^* - \hat{x}_i$ (%) (2)	Simulated growth in agricultural export $\hat{x}_A^*$ (%) (3)	Simulated growth in manufacturing export $\hat{x}_M^*$ (%) (4)
0.25	0.42	7.48	4.04
0.20	0.34	7.39	3.96
0.16	0.27	7.33	3.89
0.15	0.25	7.31	3.88
0.12	0.20	7.26	3.83
0.10	0.17	7.22	3.79
0.09	0.15	7.21	3.78
0.08	0.13	7.19	3.76
0.06	0.10	7.16	3.73
0.05	0.08	7.14	3.71
0.04	0.07	7.12	3.69
0.03	0.05	7.11	3.68
0.02	0.034	7.09	3.66
0.01	0.017	7.07	3.64

Note: $i = A, M$
Source: Data estimation

CONCLUSION

The term ‘Dutch disease’ is used to describe the condition when a boom in the mineral sector hinders the development of other sectors and appreciates the real exchange rate. In this paper we applied this framework to the Indonesian economy to analyse the oil and gas export boom from 2002 to 2008. The objective was to test for the impact of the increase in oil and gas export revenue on other trade able export sectors, namely the agricultural and manufacturing sectors, and to the real exchange rate.

The statistical results can be summarised as follows. *First*, even though the production of Indonesian oil has decreased in recent years, the increase in the world oil price, and the increase of the natural gas sector, the Indonesian oil and gas export sector have expanded export revenue. This expansion has induced a real appreciation of the Rupiah.

Second, in contrast to Dutch disease theory, the expansion of the oil and gas sector has been accompanied by growth in other exports, namely agricultural and manufacturing exports.

While this is in contrast to the prediction of Dutch disease theory, it seems to reflect other developments in the Indonesian economy that are not considered by the theory in its simplest form. Accordingly, we adopted the research strategy of using a simulation model, in which we simulated the role of the real exchange rate appreciation on the economy. The original version of Dutch disease considers the direct relationship between the booming sector and the growth of other sectors. Our simulation results suggest that the growth in oil and gas export revenue is linked indirectly to the growth of other sectors in a negative way (as suggested by Dutch disease) via a real exchange rate appreciation. The real appreciation due to the increase of oil and gas revenue has inhibited the growth of exports of agricultural and manufacturing products.

In Indonesia, the changes on revenue from oil and gas sectors are reflected in the change on government budget. The energy sector has a significant share in government income. However, a large portion of government expenditure is spent on the domestic oil program in the form of a subsidy. Unfortunately, this is a form of unproductive subsidy, which subsidises oil for consumption purposes. Oil subsidies place too much pressure on government spending, as the domestic consumption becomes larger and the price of oil becomes higher. While the increase of oil and gas export revenue is only temporary (from oil and gas price increases, not from the increase in production volume) it is difficult to use this extra money to promote other sectors. What the government can do is move away from subsidy regulation by demolishing, or at least reducing, the subsidy and use their assets on other productive sectors, such us human capital investment, as well as promoting the agricultural and manufacturing sectors. There are several ways which can be used to promote those sectors, such as providing loans, and subsidising the manufacturing and agricultural sectors, particularly small to medium scale industries in order to increase their competitiveness.

In respect to the real exchange rate, the only long-term way to stabilise the real exchange rate is by stabilising the domestic inflation. Although the nominal exchange rate does not appreciate significantly, high domestic inflation makes the real appreciation so much higher. Because Indonesia does not have the ability to invest the extra income from oil and gas into foreign investment (due to subsidy regulation and foreign debts), the rational way to stabilise the real exchange rate is to keep the domestic inflation at a moderate level.

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