Accounting for Vietnam's Wealth: The Role of Natural Resources

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Table of Contents

Tables and Figures

1. Introduction

The *Doi Moi* economic reforms in Vietnam have resulted in a period of high GDP growth rate. In the past decade, the Vietnamese economy maintained annual growth rates above 7 percent. Significant poverty reduction has been accomplished during this period of high economic growth. The poverty rate, measured by per capita consumption, fell from 58 percent in 1993 to just below 20 percent in 2004. Sustaining these impressive growth and poverty reduction achievements, however, requires a long term perspective—one where the concept of sustainable development plays a central role. As the World Bank noted, "growth will be illusory if it is based on mining soils and depleting fisheries and forests" (World Bank, 2006).

Is Vietnam on a sustainable development path? Before we can answer this question, it is important to understand, as David Pearce noted, that sustainable development can not be captured by an income like concept, but instead needs to be measured by a wealth like concept (Maaler, 2007). Thus, to gain a better understanding of the sustainability of a country's development, what is needed is a way to account for the value of all of its productive resources, physical, human and natural capital, and how these change overtime. However, most standard measures of wealth accumulation and savings ignore the depletion of, and damage to, natural resources such as mineral deposits, land, and forests.

This study estimates the capital or stock value of Vietnam's natural resources. Natural resources are special economic goods because they are not produced. As a consequence, natural resources yield economic profits—rents—if properly managed. These rents can be an important source of development finance for poor countries (World Bank, 2006). The value of natural resources is estimated based on the net present value of income flows that can be generated from these resources (resource rents). Thus the capital value of natural resources is the based on the value an investor would pay for the resource based on its income flow potential. Together with measures of the value from Vietnam's other important resources, human and produced capital, one could then assess whether Vietnam is on a sustainable development path by monitoring the value of its wealth overtime.

The report is organized as follows. Chapter 2 describes the methodology used in the study. It reviews the background and motivation for the approach chosen to value natural resources, presents the underlying model used in the valuation of natural resources and briefly discusses the data used in the analysis. Chapter 3 presents an overview of the results and compares Vietnam's natural wealth with relevant estimates from other countries. Chapter 4 presents a detailed discussion of the valuation of land resources, including specific data sources used and assumptions made. Similarly, Chapters 5 and 6 present the detailed discussion of the valuation of minerals and forest resources. Chapter 7 concludes.

2. Methodology

Background

The estimates of Vietnam's natural resource wealth in this analysis take as a starting point the methodology to value wealth employed in the "*Where is the Wealth of Nations?*" study, published by the Word Bank in 2006. This publication estimated the value of produced, human, and natural capital for nearly 120 countries in the world. However, Vietnam was not one of the included countries, most likely due to data constraints. The present study thus aims to fill in the gap of information regarding Vietnam's natural wealth. In the *Wealth of Nations* study the various forms of capital are considered "factors of production", or wealth endowments, which economies use to produce goods and services for the wellbeing of their citizens. These wealth endowments consist of natural capital resources, such as agriculture and forest lands, as well as mineral deposits such as oil, gas, coal, iron, chrome and other important subsoil assets; produced capital, the machinery, buildings, equipment, and other infrastructure assets; and finally what is called "intangible assets", the stock of human capital, social capital, and quality of institutions.

Economic development, from this perspective, can then be viewed as the process by which countries manage their portfolio of assets to expand the income flow generated by these assets. Concerns regarding the depletion and degradation of natural resources in the historical course of development of many economies motivated the undertaking of the wealth estimates. If economic development is the result of a "running down" of natural capital assets, then future welfare is compromised. Economic development can only be sustainable[1] if assets are managed in a way that total wealth is not decreasing.

[1] The precise meaning of "sustainable" development is intensely debated among environmental and resource economists. This has been captured in the debate between the notions of "weak" and "strong" sustainability criteria. The first asserts that physical capital can be a perfect substitute for natural capital, thus consumption of natural resources can be sustainable as long as investments in physical capital make up for the loss of the value of natural capital consumed. The strong sustainability criteria, on the other hand, asserts that a minimum amount of natural capital must be conserved and cannot be replaced by physical or human capital. For further details, see, Pearce and Atkinson (1995), Pearce et al (1996), and Brekke (1997).

Model

Economic theory suggests that the value of an asset is given by the present discounted value of income flows generated by the asset over time. This principle applies not only to financial and produced assets, but to natural resource assets as well. But whereas markets to trade and value financial and produced assets exist, the same is not generally true for most natural resources since these are generally owned and managed by governments. Another important distinction is the fact that the stock value of natural resources depends on prevalent economic conditions, such as the cost of extraction, which in turn depend on technology and prices, among other things. With changing technological and price conditions, some natural resource reserves which were previously not profitable to explore (and thus had no economic value) may become so. Therefore the economically relevant stock of natural resource assets is not a fixed concept determined by the physical quantity of the resource available.

To estimate the value of a particular resource at time period t , the following model is used (as specified in the World Bank (2006)):

(1) $$V_t = \sum_{i=t}^{t+T-1} \pi_i q_i / (1+r)^{i-t}$$

where π_i is the unit rent on the resource at time i and q_i denotes the amount of resource produced, so that $\pi_i q_i$ gives the economic profit or total rent generated at time i, r is the social discount rate and T is the lifetime of the resource. Estimating resource rents in each future time period up to time T represents a difficult task. Therefore a simplification to the above equation is made so that future rents are implicitly based on current rents. Assuming unit rents π grow at rate g, then:

(2) $$\frac{\dot{\pi}}{\pi} = g = \frac{r}{1+(\varepsilon-1)(1+r)^T}$$

where ε is the curvature of the cost function. Assuming the cost curve is isoelastic, then the effective discount rate r^*, is given by:

(3) $$r^* = \frac{r-g}{1+g}$$

and the value of the resource stock can be expressed as:

(4) $$V_t = \pi_t q_t \left(1+\frac{1}{r^*}\right)\left(1-\frac{1}{(1+r^*)^T}\right)$$

Assuming a constant rate of growth for rents, equation (4), for example, has been used to value subsoil mineral natural resources. However, the assumptions regarding future rents can be made less or more restrictive depending on the type of resource in question, such that rents can be assumed to be constant in the future or follow the path of optimal extraction. The assumptions used for the different types of natural resources will be presented in the discussion of the valuation of the particular resource.

An important parameter in the determination of the value of natural resource assets is the lifetime of the resource, *T*. In the case of non-renewable natural resources, the time to exhaustion must be determined. However, as noted earlier, the economically relevant amount of a resource depends not just on physical quantities, but also on economic conditions. Estimating the time to exhaustion is thus more complicated than simply estimating the reserves to production ratio. A simplification is adopted and all resources are estimated to last up to 25 years, as is the case in the World Bank's wealth estimates.[2] This timeframe is chosen for two reasons. First, for many non-renewable resources considered in the analysis, the reserves to production ratios are between 20 and 30 years.[3] Assuming a longer lifetime for these resources would necessitate increasing the time horizon for future rents estimation. The level of uncertainty regarding future rent values would thus increase, but because of the impacts of discounting the effects on results would be much dampened . Second, this time horizon roughly represents a generation and as such can be used as representative of time

[2] In some scenarios, the lifetime of the resource can be less than 20 years, if significant production increases are assumed to occur.
[3] Coal, bauxite, and iron are the exception. These are very abundant resources, with reserve production ratios of over 100 years.

frame for planning decisions. For these reasons, all resources, including renewable resources, are estimated to last up to a maximum of 25 years.[4]

We express the estimated natural resources capital value as a percentage of total wealth and on a per capita basis, as appropriate. Total wealth can be calculated as (World Bank, 2006):

$$W_t = \int_t^\infty C(s) \cdot e^{-r(s-t)} ds \quad (5)$$

Where W_t is the total wealth, or capital, in year t; $C(s)$ is consumption in year s; r is the social rate of return from investments. It is assumed that the elasticity of consumption is one and that consumption grows a constant rate, which is a function of the pure rate of time preference (assumed to be 1.5). To take into account the volatility of consumption measures, we average out, in constant dollars, Vietnam's 3 most recent values of the per capita GNI. The time horizon is set to 25 years, as discussed earlier. This gives us a total wealth figure, in present value terms, of US$9,909 per person.

Data

Natural resource wealth is estimated based on the rents from subsoil mineral resources (energy and mineral resources), forest resources (timber, non-timber forest products, and protected areas) and land resources (agriculture cropland and pasture land devoted to livestock production). The World Bank analysis seeks to make comparisons across countries and therefore estimates the value of a representative basket of valuable natural resources belonging to each of these categories.[5] Not all of the natural resources assets chosen will be relevant for any given country, and some important natural assets for a particular country may also not be included.

[4] Renewable resources can in principle be exploited indefinitely, if sustainably managed. However, most renewable resources are not managed sustainable, particularly not in poor developing countries. Also, assuming a fixed lifetime for renewable resources makes comparisons between resources more meaningful. Given the uncertainties regarding future rent and the effects of discounting future benefits, little would be gained in terms of precision by extending the time horizon for renewable resources.

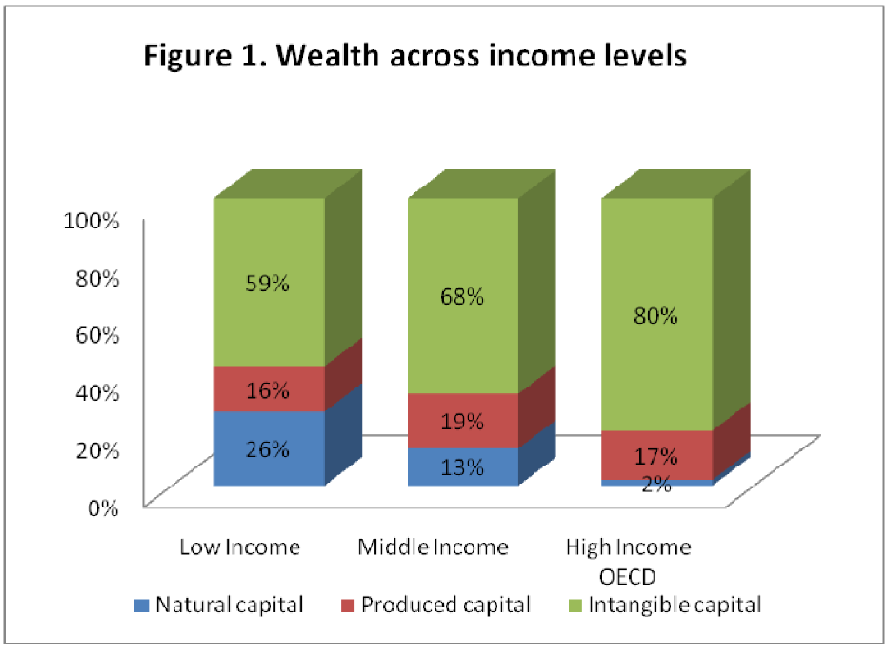
[5] Natural resources included in the World Bank analysis are as follows. Subsoil assets are: oil, natural gas, coal, bauxite, copper, gold, iron, lead, nickel, phosphate rocks, silver, tin, and zinc. Timber products include roundwood and fuelwood. Cropland values are based on value for the following crops: maize, rice, wheat, bananas, apples grapes, oranges, soybean, and coffee. Pasture land values are based on value of beef, lamb, milk, and wool production. Only some of these assets will be relevant for any given country.

For the purpose of this analysis, the most relevant natural resources for Vietnam were considered and chosen accordingly. Therefore in some of the natural resource categories, such as minerals, agriculture cropland, and pasture land, the resources considered differ from the resources valued in the World Bank analysis. In addition, although we follow the same approach and methods as in the World Bank study, in some instances we make different assumptions for the valuation of specific resources. By making these changes, the analysis better reflects the actual conditions for some of the important natural resources of Vietnam. Direct comparison of natural resource wealth values between Vietnam and other countries, therefore, must be done with care and take these differences into account. It is also important to note that our study estimates natural resources values for Vietnam using more recent data (up to 2005) than the World Bank study. Thus our valuation of natural resources value takes into account some of the developing trends in natural resources prices, particular the rising price for some mineral (oil, gas and coal) and food crops since 2000.

For most natural resources valued, the basic data needs for estimation of current rents are: quantity of the resources produced or extracted, price of the resources, and cost of production. World prices are used to value the resources, since these prices reflect the opportunity costs of the resources consumed domestically. Production costs are based on local costs of production, to the extent that such data is available. If no local production cost data is available for a specific resource, the analysis uses cost estimates obtained from a survey of literature, giving preference to cost estimates of similar countries in the region. A detailed discussion of how each resource was valued and data sources used is presented in the later chapters. Next we present an overview of the main results of the analysis.

3. Vietnam's Natural Resources Wealth

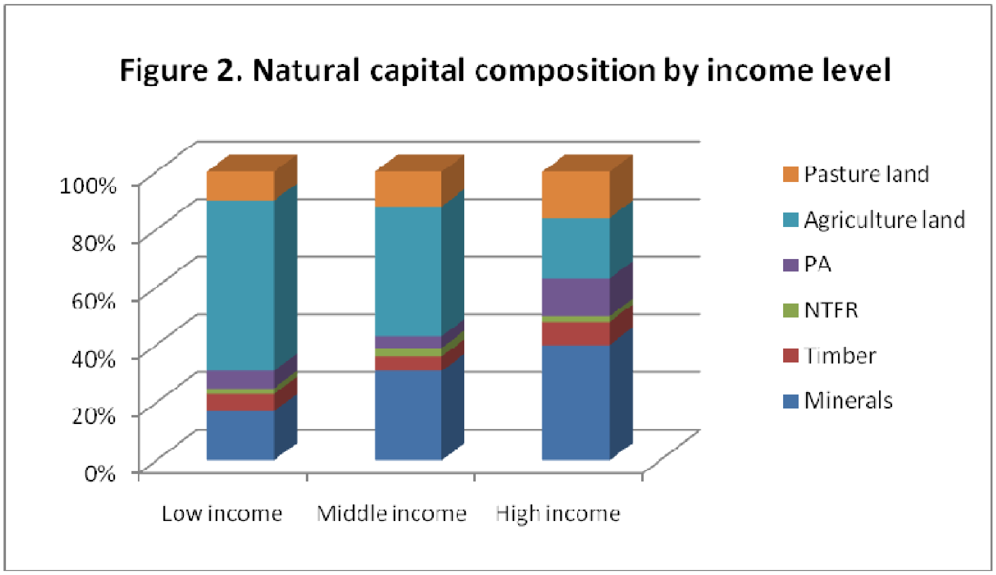
Before we examine Vietnam's natural resource wealth, it is useful to begin with an overview of how natural resource wealth is distributed among countries at different levels of development. Figure 1 shows the share of wealth among natural capital, produced capital and intangible capital across countries at different income levels.



Source: World Bank, 2006

Natural capital represents a larger share of wealth for low income countries. Although natural capital shares fall as income increases, because total wealth increases with higher income levels, the total value of natural resources increases as income increases. Produced capital shares remain relatively constant across income groups, whereas the share of intangible capital increases with income. In our estimates of natural capital wealth for Vietnam, natural capital accounts for 27 percent of total wealth, very similar to the share of natural capital for low income countries, the income group Vietnam belongs to according to the World Bank classification system.

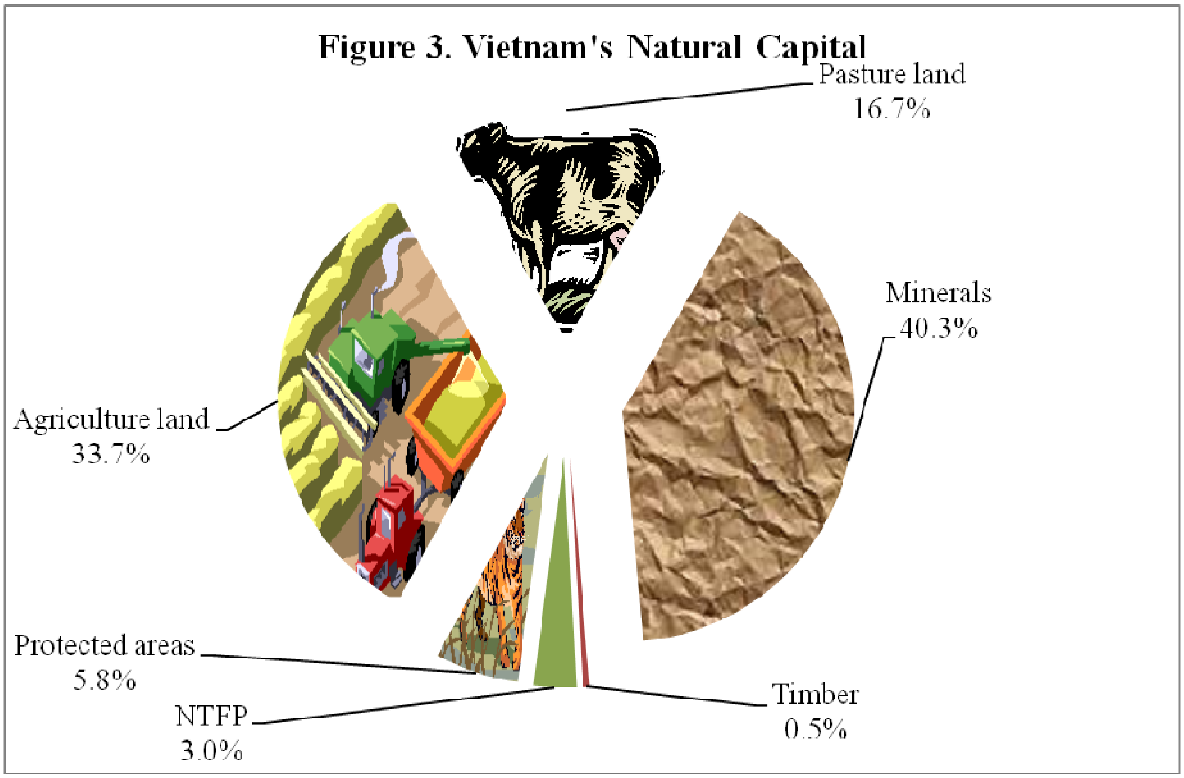
Next we consider how natural capital wealth is distributed among the different types of natural resources for countries at different income levels. Figure 2 shows that for low income countries land resources (agriculture and pasture land) account for the largest share of natural wealth. As countries develop, the share of land resources in natural capital wealth tends to fall, as the share of value from mineral resources increases.



Source: World Bank, 2006

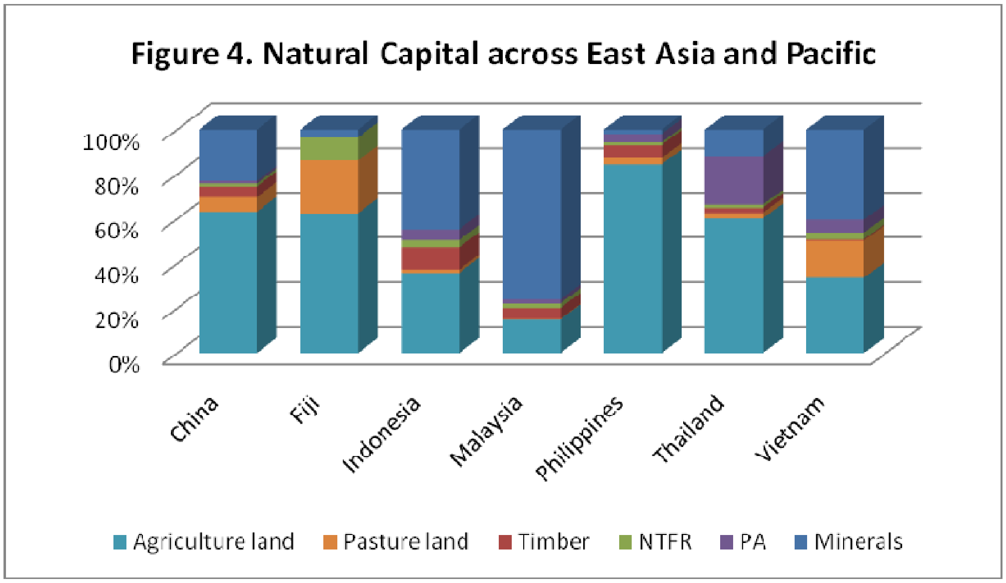
Figure 3 presents our estimates of natural resource wealth for Vietnam, using the same broad categories of natural resources as the World Bank studies. Although there are differences in our calculations,[6] at the broad level, the results suggest Vietnam's natural resources wealth composition is somewhere in between that of low income countries and middle income countries. The share of land wealth in natural capital wealth is somewhat lower than lower income countries, whereas the share of mineral resources is somewhat higher than middle income countries. The latter is probably a reflection of higher mineral prices since 2000, which is incorporated into our analysis, but not the World Bank's analysis. The detailed calculations of the components of natural resource wealth are presented in the chapters that follow.

[6] Note that because we make different assumptions in the estimations, sometimes use different resources, and value resources at different time period, the results are not directly comparable to World Bank's estimates for other countries.



Source: Author's own calculations.

We also compare Vietnam's natural wealth composition to that of other countries in the East Asia and Pacific region. Figure 4 shows that natural capital composition varies significantly among countries in East Asia. Mineral wealth represents the most important natural resource for Malaysia and Indonesia, whereas agriculture land is generally the most important natural resource for the other countries. For Vietnam, as shown above, agriculture land and minerals account for approximately the same share of total natural wealth.



Source: World Bank, 2006.

4. Mineral Resources

Overview of Vietnam's mineral resources

Vietnam is well endowed with a wide variety of mineral resources. Among the most important mineral resources are phosphates, bauxites, oil, coal, gold, copper, zinc, tin, chromite, manganese, and titanium. Some metallic minerals, such as copper, zinc, tin, and gold, have been mined since the Bronze age. The exploration of other mineral resources, such as oil and gas, has taken place mostly since the country's independence and reunification, when many important deposits have been discovered and exploration activities boosted (Kusnir, 2000). Vietnam is one of the world's largest producer of anthracite (hard coal) and the sixth largest producer of crude oil in the Asia Pacific region. However, most of Vietnam's mineral resources remain largely unexploited—with only 3 resources, oil, gas, and coal, accounting for approximately 90 percent of output value from the mining and quarrying sector, but only 5.75 percent of GDP (Wu, 2006). The lack of infrastructure, modern mining equipment, and technology have been attributed as factors influencing the development of the mineral sector.

Despite its rich mineral endowments and being a major oil producer in Asia, Vietnam is a net mineral importer. Most of the crude oil output is exported, accounting for 21 percent of total exports in 2006 (Wu, 2006). Vietnam imports refined oil, since the country lacks refining capacity. The first oil refining facility is expected to be operational in 2009 and will reduce Vietnam's reliance on imported refined oil products. (EIA, 2007). Along with refined oil, iron and steel products are the main minerals imported, accounting for 21.4 percent of imports in 2006.

The mining and quarrying sector has long been dominated by state owned companies, which accounted for more than half of the companies operating in the sector. All oil production is carried out by the national company itself, PetroVietnam, or through production sharing contracts or joint ventures in which the PetroVietnam has an equity stake. Recent reorganization of the institutions responsible for the mining sector and revisions to the mining law and petroleum law regulations have aimed at opening up the way for increasing involvement of private companies, both foreign and domestic, in the development of the sector. However, a number of concerns for investors remain, such as requirements of infrastructure upgrading, no exclusive mining rights awarded with exploration licences, a separate processing license for processing minerals, and the possibility of restriction or banning of specific mineral for exports at any time (Truong, 2007).

Mineral Fuels

We begin the analysis with mineral fuels, mostly oil, coal, and natural gas, as these are the most important minerals currently being exploited in Vietnam.

Oil

Crude oil production peaked at 400,000 barrels a day in 2004, but has declined slightly as a result of declining output at mature oil fields. However, recent discoveries and new projects developing are expected to boost Vietnam's oil production, despite the decline from maturing oil fields. Analysts expected production will surpass the 400,000 barrel peak in the future years (EIA, 2007). Estimates of Vietnam's proven oil reserves vary from as low as 600 million barrels to as much as 3 billion barrels. PetroVietnam believes the country has substantial oil reserves yet to be found and thus with continued exploration and discovery of offshore oil fields current output levels could be extended well into the future. However, to reflect the uncertainty of reserves, we also present results where current oil output levels can only be maintained for a 15 year time period.

The net present value of all natural resources depends crucially on how prices for these resources develop overtime. In the case oil, the volatility of prices is particularly important. Over the last few years, the price of oil has increased considerably. From 2000 to 2006, the price of oil more than doubled from US$28.2 to US$64.3 per barrel (World Bank, 2007). Despite the increasing oil prices, many analysts predicted that in 2008 oil prices would fall back to around US$55 a barrel. Instead, by mid 2008, the oil price had already surpassed US$130 a barrel. Due to the difficulties inherent in predicting future price trends for volatile commodities such as oil, the approach adopted in this analysis simply focuses on rent values and how these grow overtime.[7]

The analysis of oil wealth is based on average prices, production, and cost figures for the 2000 to 2005 time period. Prices were obtained from the World Bank's *Global Economic Prospects Report* (2007). Production output was obtained from Vietnamese national statistics sources and confirmed by comparing to published international production statistics, as reported by the International Energy Association and others. Production cost figure were obtained from the World Bank (Bolt et al, 2002). Production costs are based on point estimates and adjusted to an annual basis based on US GDP deflators (but are assumed to remain constant, in real terms, overtime). In the cost of production estimation, when estimates of oil extraction costs are not available for a given country, a surrogate country's cost are then chosen. This choice is made based on geographical proximity and similarity of the ratio of offshore drilling. In the case of Vietnam, for which own oil extraction costs were not available, Malaysia is the closest surrogate, which also has a substantial share of oil production from offshore facilities, and its costs are therefore used in the estimation of production costs. The present value of oil wealth in Vietnam is thus estimated at US$942 per capita, accounting for approximately 80 percent of total mineral wealth.

Oil scenario analysis

[7] Non renewable resources rents are assumed to grow at a constant rate, as specified in equation 2 above. Further, it is assumed that the curvature of the cost curve, ε, equals 1.15.

Because oil wealth represents such as large share of total mineral wealth, we also carry out some alternative scenario analysis, where we vary some of the assumptions made above. First, we assume that no low oil discoveries which would only allow current production levels to last for 15 years, instead of 25 years as in the scenario above. In this case, the oil wealth amounts to US$596 per capita. This would also decrease total mineral wealth, and thus the share of oil in total mineral wealth would also fall to around 70 percent. Second, we consider at higher base price for oil in the calculation of rents. The average oil price between 2000 and 2005 was US$33 a barrel. However, by 2006, oil prices were close to double that price. If we base our estimates of oil wealth on 2006 prices, then per capita oil wealth increases to US$1,289, if oil reserves last for 15 years, or US$1,748, if oil reserves last for 25 years.

Table 1. Wealth from mineral resources: oil				
	Base Scenario		***Sensitivity Analysis***	
Production volume	17 million tons	17 million tons	17 million tons	17 million tons
Price	US$241/ton	US$482/ton	US$241/ton	US$482/ton
Time to exhaustion	25	25	15	15
Wealth per capita	**942**	**1,748**	**596**	**1,289**
Wealth ratio relative to base scenario		1.85	0.63	1.37

Note: Production volume and price in the base scenario are average values over 2000 to 2005

Natural gas

Natural gas production in Vietnam has increased rapidly since the early 2000's—with production quadrupling between 2000 and 2005 (Truong, 2007). A large fraction of natural gas produced is consumed domestically, to fuel electric power plants (Wu, 2006). Conservative estimates put proven natural gas reserves at around 190 billion cubic meters (Oil and Gas Journal, 2006). As with oil, further exploration and discoveries could increase proven reserves considerably. If so, natural gas would play an important role in Vietnam's development, meeting its growing energy needs.

To estimate the value of natural gas wealth in Vietnam, we use price and cost data obtained from the World Bank. The price data is based on several sources, such as the *Global Commodity Markets* and the *Statistical Review of World Energy* (Bolt et al, 2002). Cost data is estimated in a similar manner as described above for oil. We assume a time horizon of 25 years. Production volumes were obtained from national statistics and confirmed with international sources. Natural gas wealth is thus estimated at US$113 per capita—or about 10 percent of total mineral wealth in the base case scenario. Given the rapid development in the natural gas industry in Vietnam in the recent couple of years, we also estimate a high production volume scenario. In the base case scenario, production volumes (as well as price and cost data) are averaged over the 2000 to 2005 time period to smooth volatility in natural gas markets. However, when we consider only 2005 as the base year for estimation, then the natural wealth from natural gas more than doubles to US$257 per capita.

Coal

Coal is the second most important mineral fuel produced in Vietnam. It is the main fuel used in thermal power plants and in manufacturing, as well as a cooking fuel for urban and rural populations. Coal is also an important export commodity. Vietnamese anthracite coal accounts for about a third of total anthracite coal traded in the world. Japan and Western Europe are the main importers of Vietnamese coal, which has high heat content and low ash, nitrogen, phosphorous, and sulphur content, thus meeting strict environmental protection rules in these countries. Most of the mining, distribution, and export of coal is controlled by the Vietnamese National Coal Corporation, Vinacol (Wu, 2006). Between 2002 and 2005, coal output doubled from 16 Mts to 32 Mts and demand is expected to grow strongly, for both internal use and for exports. In fact, it is estimated to that Vietnam would start importing coal as early as 2015 (VietnamNet, 2006).

As with oil and natural gas, price and cost data used in the estimation of coal wealth is obtained from the World Bank. Production volumes are from national statistics. The base line estimated value of coal is US$115 per capita. As with other mineral fuels, the trends over the last five years show prices increasing considerably. Average coal prices have doubled between 2001 and 2005. Thus, given strong demand and likely price scenarios, we also consider a high price high production volume scenario for coal, which takes 2005 prices and values as basis of future rents. In this high price and volume scenario, coal wealth triples in value to US$305 per capita.

Table 2. Wealth from mineral resources: natural gas and coal

	Natural gas		***Coal (anthracite)***	
Production volume	127,000 TJ	241,000 TJ	20 million ton	32 million ton
Price	US$4,025/ton	US$6,000/ton	US$53/ton	US$81/ton
Time to exhaustion	20	20	20	20
Wealth per capita	**113**	**257**	**115**	**305**
Wealth ratio relative to base scenario		2.27		2.65

Note: Production volume and price in the base scenario are average values over 2000 to 2005

Other Minerals

The analysis of mineral wealth also included other important minerals in Vietnam, such as chromium, iron, lead, copper, tin, zinc and phosphate. However, the results show that these minerals make little or no contribution to natural wealth. In most cases, the results are in the order of only a few dollars per capita. We therefore do not present the detailed results for these minerals.

One possible reason for the low values obtained could be that costs of extraction are overestimated. In the absence of cost of extraction data for Vietnam, we must use international cost data from other countries, which may not be as representative of the geographical and social economic conditions of Vietnam. Also, we sometimes only have a few reference years upon which to base the estimates of extraction costs and how they change overtime. The uncertainty surrounding the cost estimates is therefore high. On the demand side, many of these minerals have alternative substitutes, meaning they are less scarce, which will tend to result in lower demand and lower prices overtime.

However, it is worth noting that the outlook for the mining sector in Vietnam is one of continued growth. Although oil, gas, and coal will continue to be the most important mineral resources, the expansion of mining for ferrous, nonferrous, and industrial minerals is also expected (Wu, 2006). New discoveries and high levels of investment in the sector suggest that wealth from other mineral resources is likely to increase and become more significant in the future. Therefore it is important that Vietnam manage these resources rents sustainably, in order to ensure wealth is not diminished. The estimated mineral resource rents generated and accrued should thus be compared, and how these resource rents are spent tracked. It is also important to recognize these rents are finite, due to the non-renewable nature of mineral resources.

5. Land Resources

Overview of land resources

In the 1990's Vietnam experienced a period of high growth in the agriculture sector. Food production increased from 21.5 million tons in 1990 to 34.2 million tons in 1999—equivalent to an average growth of about 5 percent a year. Some industrial food crops saw even stronger development, with recent growth rates as high as 10 percent a year. Rice, however, remains the most important agriculture product, accounting for 90 percent of total food production (Ministry of Agriculture and Rural Development). With food production growing at a faster rate than population growth, Vietnam achieved not only food self sufficiency, but also became a leading exporter of crops such as rice, coffee, rubber and black pepper. Export turn over of agriculture products reached US$4 billion in 2004 (Ministry to Foreign Affairs, 2005). This development in the agriculture sector followed, to some extent, from the economic reforms during renovation period. This resulted in a series of reforms in the agriculture sector, such as the allocation land to farm households, improvement of farmer's incentives and access to markets, among other things.

In addition to food and industrial crops, Vietnam also experienced high growth in vegetable and fruit production. More land has been allocated to the cultivation of these high value crops. The livestock sector also experienced significant development, increasing per capita meat consumption from 15 kg in 1990 to 22.4 kg in 1999. The increases in livestock production came primarily from the growth of pig and poultry herds, which increased an average of 5 and 6 per cent a year, respectively. Productivity in livestock production also improved during the time period, particularly for pigs (Ministry of Agriculture and Rural Development).

In this chapter we estimate the value of land resources allocated to agriculture and livestock production. This is based on the value of crops and livestock produced, rather than land prices, as land price data are often not available or unreliable due to distortions in land markets. We depart from the World Bank Wealth of Nation's methodology, to the extent that we consider the most important crops and livestock relevant for Vietnam. This is particularly important in the case of livestock production, where the most important livestock resources for Vietnam, pigs and chicken, are not included in the World Bank's estimation of pasture land values. The crops included in the analysis are listed in Table 3.

Cropland Resources

Land values are estimated based on the present discounted value of land rents, which are the difference between market value of output agricultural crops and crop specific production costs. We base the value of agricultural crop products at world prices[8], whereas crop production costs are based on local costs. The agricultural crops used to obtain land values are chosen from Vietnam's 20 most important agricultural crops, as measured in terms of value and also in terms of land allocation. The crops chosen for the analysis are: paddy rice, coffee, peppers, cassava, maize, rubber, bananas, orange, sweet potatoes, tea, and pineapple.

For each crop, the amount of land of area cultivated, production output, and production costs were obtained from Vietnamese production statistics, as well as a number of other Vietnamese sources. The average amount of land cultivated and total crop output produced between 2002 and 2005 was used in order to smooth out normal short term production variations. Using local production costs estimates and local prices, we estimate the rental rate for each type of crop. The crop output was valued using average unit export value prices from 2002 to 2005, obtained from the FAO core database, FAOSTAT.[9] The average crop output and crop values are then used to calculate average revenues for each crop. Using crop revenues, crop rental rates, and area cultivated, we can then calculate per hectare land rents for each type of crop. These are summarized below in Table 3.

[8] World market prices used to value crops do not include transportation costs, which can affect the price received by producers in local markets.
[9] In cases where there was substantial difference between local prices and unit export prices (ie, more than 50% price difference), we use an average of both prices. This was the case for cassava, tea, and pineapples.

Table 3. Agriculture output, revenue and rents for selected crops

Crop	*Land Area (1000 ha)*	*Output (1000 tons)*	*Revenue (1000 $)*	*Average yearly land Rent ($/ha)*
Paddy Rice	7,411	35,365	6,482,036	394
Maize	961	3,321	472,378	177
Coffee	507	829	646,258	381
Rubber	464	422	489,634	337
Cassava	400	6,000	683,350	588
Sweet Potatoes	205	1,538	716,222	105
Tea	118	514	504,036	1,022
Bananas	105	1,365	233,074	930
Orange	53	519	264,716	2,081
Peppers	50	89	127,425	753
Pineapple	34	413	273,897	1,503

Source: Author's own calculations

Rice is the main agriculture crop produced in Vietnam. Table 1 shows that rice accounts for about two thirds of land area cultivated and about 60 percent of estimated total agricultural value generated. The estimated land rent for rice is $394 per hectare. The overall land rent, of $393 per hectare, is calculated as the weighted average (by cultivated area) of the rents from all crops and used to project future land rents. The importance of rice in estimating land rents is thus reflected in the average land rent. Some of the highest land rents are generated by pineapples, oranges, and tea. Land rents can vary for different crops, reflecting different crop's suitability given local differences in climatic and soil conditions. In the case of some crops, land rents may also be partly driven by the price chosen to value the crop. Therefore, where international and local prices differed substantially (i.e., by more than 50%), we use an average of export and local prices to diminish potential biases in land rent values.

In estimating the development of future land rents from crop cultivation, we need to consider the amount of land area cultivated and likely developments in agriculture technology that impact productivity. The FAO estimates the amount of arable land in Vietnam is about 11 million hectares. The total land area accounted for by the crops considered in this analysis is about 10.5 million hectares. We assume the remaining 0.5 million hectares of cultivated area generate average rents.

Area allocated to crop cultivation is assumed to be constant. Productivity is assumed to grow at a rate of 1.94 percent for 20 years, and for the remaining 5 years it stays constant. These follow the assumptions used in the Wealth of Nations analysis (World Bank, 2006). The present value of cropland rents over the 25 year period was discounted using a 4 percent social discount rate. The per capita wealth from crop land resources is thus estimated at US$982 per capita (Table 4).

Next Table 4 considers various alternative scenarios, where agricultural productivity growth is not as high—namely 0.97 and 0.07 percent growth per year. The moderate growth scenario could represent a case where, for example, continuing land degradation may affect agriculture productivity in the future. In such a scenario, the per capita wealth falls to US$1.027 per capita. Assuming a low growth scenario, where growth is minimal at 0.07 percent per year, per capita wealth falls to $940 per capita. It is important to note that in these alternative scenarios, the impact of productivity growth affects total rent, rather than output directly. Thus the impact on output is moderated by constant prices and vice versa. We also consider a scenario where we assume doubling of average land rents. This could be the case, for example, if farmers are able to improve efficiency or switch production to higher value crops. This may or may not be a feasible scenario for Vietnam, given existing priorities given to rice production and potential limitations of quality of agriculture products for export markets. But it highlights the potential from adoption of high value crops (where suitable) and from improvements in quality standards and access to export markets. The simulations show that if average agriculture rents could be doubled, then wealth per capita from crop land resources would also double.

Pastureland Resources

The value of pasture land is estimated following the same approach outlined above for cropland. The analysis considers the returns to land from production of beef, chicken, pig, buffalo meat, and fresh milk. Production costs for animal production in Vietnam were difficult to obtain, therefore we use the World Bank estimated cost of production of 55 percent of revenues. This implies a rental rate of 45 percent. The value of output is based on international prices obtained from the same FAOSTAT core price database discussed above. In case export prices were not available, such as in the case of fresh milk, import prices were used instead. As in the case of cropland, we assume the amount of land devoted stays constant in future years. However, because livestock is often raised in same land as agriculture, the amount of land allocated to pasture cannot be precisely estimated to generate rents per hectare. Pasture land rents are estimated to grow at a 2.95 percent rate per year for the first 20 years, then remain constant for the last five years. The present value of pasture land rents over a 25 year period were discounted using a 4 percent social discount rate. The per capita value of pasture land activities were thus estimated at US$486 per capita. Currently, pig production accounts for 80 percent of this value. This reflects primarily the sheer volume of pig production relative to other pasture products.

Table 4. Wealth from agriculture cropland

	Base Scenario	***Sensitivity Analysis***		
Area cultivated	11 mil ha	11 mil ha	11 mil ha	11 mil ha
Productivity growth (%/yr)	1.94	0.97	0.07	1.94
Average rent per ha ($)	454	454	454	907
Wealth per capita	**982**	**889**	**814**	**1,964**
Wealth ratio relative to base scenario		0.90	0.83	2

Note: All calculations are based on a 25 year time frame and assume a discount rate of 4 percent.

6. Forest Resources

Overview of Vietnam's forest resources

Forests represent an important resource for Vietnam, particularly as a source of livelihood for rural communities (Hieu, 2004). Forest cover in Vietnam diminished rapidly in the last half century, declining from about 43 percent of total land area in 1943 to 23 percent in 1981 (Hieu, 2004). From the late 1970's to 1990, Vietnam lost an estimated 185,000 hectares of forest annually (McNamara, 2006). There were many reasons for the loss of forest area, including logging and over harvesting of forest products, conversion of forest land into agriculture, and damages from chemical defoliants and intensive bombing during many years of war. The depletion of forest resources has affected water quality and supply, and exacerbated flooding and soil erosion problems. The loss of forests have also led to reduction of biodiversity and left many species facing potential extinction (Hieu, 2004). The depletion of forest resources also has income distribution implications for the sustainable development of Vietnam's economy, as forest resources provide subsistence opportunities for poor rural households.

As a response to the loss of forest area, beginning in the early 1990's Vietnam implemented a number of measures to reverse such trends, such as limiting harvest of timber from natural forest areas, promoting plantation forests, and establishing reforestation programs. The area under forest cover has gradually increased and now stands at close to 40 percent of land area. Forest land is divided into three categories. Production forests are managed for timber extraction. Protected forests are managed to protect soil and water quality, sequester carbon and provide other environmental benefits. Special use forests are designated for conservation. However, as much of 50 percent of land area classified as forest land has very low tree cover, and are thus significantly degraded (Gilmour, 2000).

Forests produce many types of goods and services. Timber resources are one important source of economic values generated from forests. However, timber revenues are not the only source of economic value from forest resources. In poor countries in particular, non timber forest products, such as fruits, nuts, berries, honey, hunted animals, among other things, provide sustenance and income generating opportunities for rural populations. Forests also provide other benefits, such as recreation, watershed protection, carbon sequestration, etc. In this analysis we examine the value of forest resources from three sources: timber resources, non timber forest resources, and protected areas.

Timber Resources

As forest area rapidly decreased in Vietnam, the Government of Vietnam introduced restrictions on harvest of timber products. Industrial roundwood output declined from about 3.7 million cubic meters in the mid 1980's to a stable level of around 2.5 million cubic meters since 2000. However, the extraction of fuelwood, rattan, and bamboo products are less regulated and the quantities extracted are not precisely known. Increasing demand for timber products has placed great pressure on Vietnam's natural forest. Vietnam has thus invested heavily into restoring degraded natural forest areas and increasing plantation forests to meet timber demands, among other things. The area under plantation forests, in particular, has increased rapidly—from less than 100,000 hectares in 1976 to just over a million hectares in 1995. Between 1995 and 2001, plantation forest area more than doubled (Hieu, 2004).

In order to estimate the wealth generated from timber resources, we must first establish the available timber supply in forested areas. The available timber supply is determined by amount of accessible forest area and the volume of standing trees in such area. For our analysis, we assume that all plantation forest areas in Vietnam are accessible for timber extraction. In Vietnam, as most other countries, timber is also extracted from natural forest areas. Not all of these areas may be *accessible* for timber extraction, since some may simply be too far way from existing infrastructure, such as roads, in order for timber extraction to be economically viable. Some of the existing natural forest area may also not have any commercially valuable tree species or be so degraded that profitable extraction is not possible. Therefore, we initially assume that only 50 percent of natural forest areas are accessible for timber extraction. The most recent *Global Forestry Resource Assessment* (FAO, 2005) estimates that the forest volume in Vietnam is approximately 66 cubic meters per hectare. Thus, the timber supply in accessible forests is given by the number of accessible forest hectares times the forest volume per hectare. Of course, timber supply can be expanded by expanding the forest area. In our analysis, we investigate the impact of increasing forest area, which is a goal of Vietnam's 5 million hectare program.

Timber extraction volumes could be in principle sustained indefinitely as long as the rate of extraction does not exceed growth in the timber supply stock. As noted above, the stock of timber can increase by increasing the forest area (or increasing its accessability). The stock of timber also increases every year due to tree growth and natural regeneration. Estimates obtained from various forest types in Vietnam suggest mean annual incremental (MAI) growth rates are on average 4 cubic meters per hectare per year. This regeneration growth rate is very low and reflects the low investment in forest productivity in Vietnam (Hieu, 2004). Managed forests usually have higher mean annual incremental growth rates than natural forest, due to management activities which promote such growth. Acacia plantations in Vietnam, for example, have achieved MAI growth rates of 6 to 45 cubic meters per hectare per year (McNamara, 2006) Therefore MAI growth rates are a parameter that can affect sustainable extraction volumes and in our analysis, we investigate the impact of increasing forest productivity on timber wealth.

Using estimated timber supply volumes and incremental growth, we can compare how current levels of extraction affect timber stock levels. The two main wood products extracted considered in this analysis are industrial roundwood and fuelwood. The volume of industrial wood and fuelwood extracted are obtained from the FAO (2005). In order to average normal market fluctuations in production volumes, we use the average extraction levels of roundwood and fuelwood from 2000 to 2005.

The analysis estimates the value of timber resources as the net present value of rents from wood products extracted. Ideally, these rents would be calculated on the basis of the stumpage price, which is the price received by the forest owner after taking into account the cost of growing the timber. Stumpage prices are thus the payments for the right to harvest the timber. Data on stumpage prices, however, is rarely available. Thus we must use market prices and estimate the share of production costs and subtract it from market prices to obtain the rental rate. The rental rate is defined as:

Rental rate = (market price-production costs)/market price

Since we have no estimates on timber production costs for Vietnam, we use literature estimates of timber rental rates. A Wold Bank survey of the literature shows an average 50 percent rental rate for the Southeast Asia region (reflects studies in Philippines, Thailand, and Indonesia).[10] This rental rate was multiplied by the price of roundwood and fuelwood (weighted by the share in production). Prices for industrial roundwood and fuelwood are obtained from FAO (2005). The prices are derived from the estimated value of these products by dividing value by the quantity extracted. In the case of Vietnam, 90 percent of the wood production volume is accounted by fuelwood. Yet, in value terms fuelwood accounts for less than 50 percent of the total value of wood products extracted.

Assuming current extraction levels are maintained, we can calculate how long it would take for the existing stock of forest resources to be exhausted. Given our initial assumptions of wood supply stock and current levels of extraction, Vietnam's wood supply would be exhausted in approximately 20 years. We thus calculate the present value of timber rents over this time period, using an interest rate of 4 percent, to reflect the social discount rate. Table 5 shows the present value of timber wealth amounts to $15 per capita.[11] Timber wealth amounts to a very small share of total Vietnamese wealth—only 0.15% of the total wealth.

Next we analyze some alternative scenarios to see how the value of timber wealth changes under different assumptions and policy developments.

Timber scenario analysis

It is Vietnam's forest policy goal to increase the area of production forests by 3 million hectares, so this is one of the scenarios analyzed. In order to calculate the impact of such development on timber wealth, we must make assumptions regarding: what proportion of wood extracted is higher value roundwood, time horizon for wood extraction, and whether these more commercially oriented forests are more productive than currently managed forest areas. We examine how each of these paremeters affect forest wealth per capita, and then set up a scenario with plausible simulatenous changes in several paremeters.

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[10] We also analyze the impact of other rental rates assumptions on the results. More efficient management of wood extraction activities or other types of investment that lower the cost of extraction, such as building roads and infrastructure, could reduce produce costs and thus increase the rental rate. If the rental rate is increased to 75 percent, then the per capita wealth from forestry doubles relative to the base scenario.

[11] The assumptions underlying the base scenario are summarized in Table 5.

Wood extraction pattern. Since the 1990's, fuelwood has accounted for 90 percent of wood extracted in Vietnam. Globally, the percentage of fuelwood in total wood extraction is 40 percent and industrial roundwood is 60 percent (FAO, 2005). Industrial roundwood extraction in Vietnam amounted to only 2.5 million cubic meters in 2005 (FAO, 2005). Industrial roundwood is more valuable than fuelwood, and thus despite the fact that a much lower volume of industrial roundwood is extracted, industrial roundwood generates more than 50 percent of the timber value generated. Table 5 reports the results of the scenarios where we analyze the impact of shifting towards roundwood production. Assuming the share of industrial roundwood increases to 50 percent of wood extraction, per capita wealth from the forestry sector would nearly quadruple. If we assume all wood extracted is industrial roundwood, per capital wealth from the forestry sector would increase 7 fold relative to the base scenario.

Table 5. Wealth from timber: wood production patterns

	Base Scenario	***Sensitivity Analysis***	
		Roundwood 50% total production	***Roundwood 100% total production***
Wood production			
Roundwood production (milion m^3)	2.44	12.74	25.48
Fuelwood production (million m^3)	23.04	12.74	0.0
Annual increment, plantation forest (million m^3)	8.99	8.99	8.99
Annual increment, natural forest (million m^3)	5.17	5.17	5.17
Net depletion (million m^3)	11.31	11.31	11.31
Time to exhaustion (years)	20	20	20
Rent and wealth			
Stumpage price (weighted avg)	3.48	10.25	18.63
Wealth per capita	**15**	**58**	**106**
Wealth ratio relative to base scenario		4	7

Notes: In all scenarios, we assume the forest volume available for wood supply is 230.3 million m^3, based on 2.2 million ha of plantation forests and 2.55 million ha of natural production forests.

Forest productivity. The aim of the 5 million hectares program, introduced in 1998, is to increase production forest area by 3 million hectares and protection forest area by 2 million hectares. A primary objective of the increase in production forest area is to meet the country's wood needs, particularly the substantial quantity of fuelwood demand. However, since 2000, production forest area has only increased by about 0.5 million hectares. This may be partly due to the fact that the financial returns from forestry are not sufficiently high to provide an incentive for landholders to expand their production forest area. Farmers prefer to convert their forest area to tea production, because the returns are higher (Hieu, 2004). Increasing productivity is thus the key to increasing the returns from forestry and expanding production forest area. Low investment has led to very low productivity levels of about 4 cubic meters per hectare per year, on average. Commercially managed plantation forests can reach productivity levels of over 15 cubic meters per ha per year (McNamara, 2006).

Table 6 reports the results of the analysis where we assume a doubling of productivity in production forest area is possible. Assuming that net forest depletion remains the same (so that stocks would be exhausted over a 20 year period as in the base scenario) and the wood extraction shares remain the same (10 percent industrial roundwood), per capita wealth from timber resources would double. If we assume productivity increases and all production is for industrial roundwood, per capita wealth would increase 11 fold. However, a more realistic scenario is one where the share of industrial roundwood increases such that fuelwood demand needs are still met. With increased productivity, this amounts to roundwood accounting for about 50 percent of total wood extraction. In such a scenario, per capita wealth increases 6 fold relative to the base scenario.

Table 6. Wealth from timber: forest productivity and production patterns				
	Base Scenario	***Sensitivity Analysis***		
		Double productivity and 10% share roundwood	***Double productivity and 50% share roundwood***	***Double productivity and 100% share roundwood***
Wood production				
Roundwood production (million m^3)	2.44	3.96	19.82	39.64
Fuelwood production (million m^3)	23.04	35.68	19.82	0.0
Annual increment, plantation forest (million m^3)	8.99	17.99	17.99	17.99
Annual increment, natural forest (million m^3)	5.17	10.34	10.34	10.34
Net depletion (million m^3)	11.31	11.31	11.31	11.31
Time to exhaustion (years)	20	20	20	20
Wealth per capita	**15**	**31**	**91**	**165**
Wealth ratio relative to base scenario		2	6	11

Notes: In all scenarios, we assume the forest volume available for wood supply is 230.3 million m^3, based on 2.2 million ha of plantation forests and 2.55 million ha of natural production forests.

Extraction time horizon. Relative to Vietnam's forest resources, current rates of extraction imply it would take 20 years for Vietnam to exhaust its current stock of wood supply available in productive forests. Table 7 reports the results of the analysis of the impact of increased wood extraction path on per capita wealth from forest resources. In this analysis, we assume wood extraction happens at a faster rate, so that current available stocks are exhausted in half the time (10 years). This would result in wealth per capita decreasing to 86 percent of wealth in the base scenario. Conversely, if Vietnam depletes its current stock of timber slower, then per capita wealth increases. However, the increase in per capita timber wealth from slower depletion is moderated by lower rents generated by lower production levels and the effects of discounting over a longer time period.

Table 7. Wealth from timber: extraction time horizon				
	Base Scenario	***Sensitivity analysis***		
		Slower forest depletion	***Faster forest depletion***	***Faster forest depletion and double productivity***
Wood production				
Roundwood production (million m^3)	2.44	1.98	3.68	5.09
Fuelwood production (million m^3)	23.04	17.84	33.1	45.86
Annual increment, plantation forest (million m^3)	8.99	8.99	8.99	17.99
Annual increment, natural forest (million m^3)	5.17	5.17	5.17	10.34
Net depletion (million m^3)	11.31	5.66	22.62	22.62
Time to exhaustion (years)	20	40	10	10
Wealth per capita	**15**	**16.4**	**12.6**	**17.4**
Wealth ratio relative to base scenario		1.13	0.86	1.20

Notes: In all scenarios, we assume the forest volume available for wood supply is 230.3 million m^3, based on 2.2 million ha of plantation forests and 2.55 million ha of natural production forests

Vietnam currently maintains strict controls on wood extraction volumes from natural forest to avoid depletion of its timber resources. However, illegal logging is known to take place to meet existing wood shortages. A more sustainable alternative to meet this wood shortage would be to increase forest productivity. Our analysis shows that per capita timber wealth could indeed be maintained, even with increased extraction volumes and/or faster extraction rates, as long as increased extraction is the result of improvements in productivity. This suggests that productivity improvements in the forest sector can be an important means of meeting timber needs without eroding Vietnam's timber asset base.

Case study: Forestry Policy Analysis

With an understanding of how each of the factors discussed above affect per capita wealth from the forestry sector, Table 8 reports the results of the analysis of the impact of increasing production forest area by 3 million hectares. It seems reasonable to assume that such an increase in productive forest area would be mostly met by commercially oriented forestry operations, such as forest plantations. Such operations would be more productive than existing small holder forestry farm operations, and most likely would gear their production to more valuable forest products, such as industrial roundwood. We thus assume that that the 3 million hectare increase in forest area amounts to 2 million hectare increase in plantation forest area and 1 million hectare increase in natural forest area (through regeneration efforts). We assume that productivity doubles to 8 cubic meters per hectare per year, but only in plantation forests. Finally, we assume that the share of roundwood in total wood production increases to 50 percent. In this case, the per capital wealth from forestry would increase 8 fold, amounting to $121 for each Vietnamese citizen.

In the above scenario, the additional 3 million hectares of forest area produce a substantially larger amount of industrial roundwood - an increase from the current 2.5 million cubic meters of roundwood to around 26 million cubic meters of roundwood. Clearly, there may not be an internal market for such an increase in industrial roundwood production, and the implications of such an increase in supply must be carefully considered, since it could decrease farm gate prices. However, the industrial roundwood export market in the Asia-Pacific region is a large one - 70 percent of all internationally traded tropical wood products originated in this region between 2001 and 2005 (ITTO, 2007). This is particularly fuelled by demand from China, whose import of roundwood more than doubled between 1993 and 2003 and now stands at well over 10 million cubic meters per year (ITTO, 2007). Although industrial roundwood is more valuable, there is still a large demand for fuelwood, in Vietnam and the Asia Pacific region. Almost of half of Vietnam's rural households depend on fuelwood as their primary energy for cooking. The percentage is much higher between 60 and 90 percent—for some Provinces in the Northern part of Vietnam (VARHS, 2007). Although it is decreasing, demand for fuelwood is estimated to be around 10 million cubic meters in 2010 (Hieu, 2004).[12]

[12] Increasing energy efficiency of wood cooking stoves could further decrease demand for fuelwood, until the shift to other fuel sources takes place in Vietnam.

We thus consider an alternative scenario with additional forest area as before, but which maintains fuelwood production at current levels of about 23 million cubic meters per year. In this scenario, there is no timber extraction from natural forest, only from productive plantation forests. In this scenario, per capita wealth would increase 7 fold relative to the base scenario. This suggests that Vietnam could meet its fuelwood needs and substantially increase production of industrial roundwood, without further exploitation of its natural forests. This can be accomplished by an increase the area of plantation forests by 2 million hectares and improving productivity levels in these plantation forests. Such a policy would not only preserve natural forests, but also substantially increase the wealth generated by timber resources from $15 per capita to $104 per capita. By contrast, without productivity improvements and a shift toward higher value industrial roundwood production, the 3 million hectare increase in forest area alone increase per capita timber wealth between 1.5 and 2 times relative the base scenario, depending on whether or not timber continues to be extracted from natural forests.

Another interesting policy scenario to consider is what would Vietnam's timber wealth amount to, if the country could meet its energy needs by other means than the use of fuelwood? In such a scenario, assuming plantation forests increase by 2 million hectares and plantation forests become twice as productive as before, if all wood extracted were roundwood (from plantation forests only), then Vietnam's forest wealth per capita would increase 15 fold relative to the base scenario. Although achieving the increase in plantation forest area of 2 million hectares and doubling of productivity in these plantation forests are ambitious goals and not without costs, the analysis suggests that the benefits from more sustainable development of Vietnam forestry sector are indeed substantial.

Table 8. Policy Analysis—Increasing forest area by 3 million hectares				
	Forest area increases by 3 mil ha	***+ 3 mil ha, increased productivity and 50% share roundwood***	***+ 3 mil ha, increased productivity and 100% share roundwood***	***+2 mil ha plantation only, increased productivity and 50% share roudnwood***
Forest stock available for wood supply				
Plantation production forest (million ha)	4.21	4.21	4.21	4.21
Natural production forests (million ha)	3.55	3.55	3.55	na
Forest volume available for wood supply (million m3)	395.27	395.27	395.27	278.19
Wood production				
Roundwood production (milion m3)	3.56	26.37	52.74	22.79
Fuelwood production (million m3)	32.07	26.37	0.0	22.79
Annual increment, plantation forest (million m^3)	17.11	34.22	34.22	34.22
Annual increment, natural forest (million m^3)	7.20	7.20	7.20	na
Net depletion (million m3)	11.31	11.31	11.31	11.31
Wealth per capita (in 2000$)	**28**	**121**	**219**	**104**
Ratio of wealth relative to base scenario	1.90	8.28	15.05	7.15

Notes: Time to exhaustion in these scenarios increases to 35 years (relative to 20 years in base scenario), as a result of increased forest volume available for wood supply.

Finally, we consider a scenario for Vietnam's forest management where the policy goal is to maintain productive forest stocks and harvest only incremental growth. Table 9 reports the results of the "sustainable yield" forest management scenario. The analysis shows that if current productive forest resources were managed according to the sustainable yield condition, Vietnam would not be able to harvest enough timber to meet its current needs, so a lot of wood would have to be imported. In this scenario, Vietnam's forest would never be exhausted as only additional increment would be harvested. However, the wealth accrued over the relevant time period is reduced by nearly 50 percent. The only alternative to raise forest output and wealth under the sustainable harvest criteria would then be to increase forest area and increase forest productivity, both of which requires investments be made. If productive forest area is increased by 3 million hectares, then the sustainable yield forest management approach would result in per capita wealth from timber resources increasing 1.7 times relative to the base scenario. With an additional 3 million hectares of forest area, Vietnam could meets its current wood needs, as well as increase wealth generated from forest resources. However, even higher wealth increases could be generated by increasing productivity of productive forests. If we assume productivity doubles, then per capita wealth would increase 3.5 times relative to the base scenario. This of course assumes that the additional output of the forestry sector does not affect market conditions and prices for roundwood and fuelwood. However, given that Vietnam's estimated fuelwood demand is expected to decline rather than increase, a more realistic scenario is to allow for a greater share of roundwood in timber production. Assuming that the share of roundwood increases to 50 percent, with the additional forest area and increased productivity, the per capita wealth from timber resources would increase 10 fold relative to the base scenario.

The economically optimal forest management policy would not require that harvest equal incremental growth. Therefore, the above scenario is just an extreme example to show that even under the most strict sustainability criteria, increasing forest area and improving forest management, so as to increase yield, can significantly increase the value of timber resources. It is beyond the scope of this analysis to consider the optimal forest management for timber resources in Vietnam. This would require much more detailed data than is used for the purpose of this broad analysis.

Table 9. Policy Analysis: Sustainable yield forest management—harvest equals incremental forest production

	Sustainable yield harvesting	***Sustainable yield and additional 3 million ha***	***Sustainable yield, 3 million ha and double productivity***	***Sustainable yield, 3 million ha, double product., and 50% roundwood***
Forest stock available for wood supply				
Plantation production forest (million ha)	2.21	4.21	4.21	4.21
Natural production forests	2.55	3.55	3.55	3.55

(million ha)				
Forest volume available for wood supply (million m3)	230.27	395.27	395.27	395.27
Wood production				
Industrial Roundwood production (milion m3)	1.42	2.43	4.86	24.3
Fuelwood production (million m3)	12.74	21.91	43.74	24.3
Annual increment, plantation forest (million m^3)	8.99	17.11	34.22	34.22
Annual increment, natural forest (million m^3)	5.17	7.20	14.40	14.40
Wealth per capita	**15**	**25**	**50**	**150**
Wealth ratio relative to base scenario	1	1.7	3.5	10

Notes: Net depletion is zero in the sustainable yield scenarios, as only incremental growth is harvested each year.

Next we examine the wealth generated from other forest resources, such as non timber forest products, as well as indirect forest benefits, such as soil and water protection, recreation, and other environmental benefits. These estimates are based on the amount forest area allocated for protective and special use purposes, since in these areas there is little or no timber extraction.

Non Timber Forest Resources

Forests in Vietnam contain an abundant and wide range of non timber forest products (NTFP), such as edible animal and plant products, medicinal and aromatic plants, and raw materials for handicraft and construction, among other things. The value of harvested NTFP in Vietnam has increased rapidly in the last 15 years, amounting to revenues of approximately $290 million (FAO, 2005). It is interesting to note that the estimated revenues generated from the harvest of NTFP actually exceed that of harvested wood products, which was approximately $170 million in 2005 (FAO, 2005). Commercial production of NTFP has become an important business in Vietnam, earning 3.6 percent of foreign exchange earnings in 1990). The most commercially important NTFP are exudates (natural resins), which account for 95 percent of the reported value of NTFP (Tien, 1994).

In our analysis, non timber forest benefits are valued using a benefit transfer approach. Although we have estimates for Vietnam of the gross value of NTFP harvested, these values only reflect the direct use values of NTFP from forest resources. There are, however, other important benefits provided by forested areas than just harvested products. Forests provide watershed protection, soil erosion protection, recreation benefits, etc.—values which are often not accounted for because these are indirect benefits. Their values, however, are just as important as the values of directly consumed forest products. In the absence of estimates of the indirect benefits of forest areas in Vietnam, we use values obtained in the literature of valuation of non timber forest benefits. These values are estimated to be about $159 per hectare (in 2005$) for developing countries of which NTFP account for approximately two thirds of the value (World Bank, 2006).

Assuming that 50 percent of non productive forest area is accessible for NTFP harvesting and provides other indirect benefits, we can then estimate the net present value of non timber forest resources for Vietnam. Non timber forest resources in Vietnam generate $87 per capita of wealth. Interestingly, that is more than the wealth generated by timber resources. Two thirds of this value, or about $58, would be the expected value generated from harvested NTFP. The order magnitude corresponds well with the estimated gross value of commercial NTFP for Vietnam, which amounts to $54 per capita.[13] However, these estimates are highly dependent on the amount of forest areas which is assumed to be accessible to NTFP harvesting and providing other indirect benefits. If we assume 75 percent of forest areas provide benefits instead, the total non timber forest wealth would be $131 per capita. Conversely, if only 25 percent of forest area is assumed to provide benefits, then the non timber forest wealth would amount to $44. If we assume that only 10 percent of the forested area in Vietnam provides such benefits, then non timber forest wealth is $17 per capita or about the same value as wealth from timber resources.

About 38 percent of the Vietnamese population live in or near forests and many depended on NTFP for subsistence and income generation. In the mountain areas of Vietnam, in particular, NTFP generate higher income potentials than rice production. NTFP also have important social benefits, as one hectare of forest area in NTFP cultivation requires 10 times more labor than one hectare of forest area in timber cultivation (Tien, 1994). To generate further benefits from its non productive forest areas, policies must aim at supporting the development of NTFP on a sustainable basis. A

[13] It is likely that the reported value of NTFP are an underestimate of the real value of NTFP, since many NTFP are not commercially traded.

recent study on the value of Vietnam's NTFP identifies 300 high economic value species of six groups of products for potential commercial development.[14] We therefore analyze the potential impact of increasing the harvest of NTFP on non timber forest wealth. Investments can be a combination of activities that increase the amount and number of harvest products and/or improve the productivity with which these products are harvested. If we assume that investments could generate twice as much value from harvested NTFP as is currently the case, then the total wealth from non timber forest resources could potentially increase from $87 per capita to $116 per capita.[15]

Protected Areas

The last set of wealth values derived from forest resources account for the benefits of protected areas. Vietnam has approximately 2 million hectares of forest area that are designated as special use forest areas. These special use forest areas are set aside for the purpose of conservation of biodiversity and other environmental benefits. Some of these special usage forests may have households living inside their designated areas and some of the forest land may be allocated for agricultural, forestry or fishery activities. Renting of special usage forest area may also be permitted in limited cases for ecological tourism and landscape businesses (Hieu, 2004).

The value of protected areas is generally measure by the willingness to pay for such benefits. However, in this study the value of protected areas is estimated from a "quasi opportunity cost"[16], which is measured by returns which could be generated from alternative use of the forest land set aside for protection. More specifically, we value protected areas at the lower of per hectare returns from pasture land and crop land. The value of protected area is then capitalized over a 25 year time horizon, using a 4 percent discount rate. This is the approach used in the *Wealth of Nations* report (World Bank, 2006). It should be noted that such approach, which reflects the opportunity cost of conservation, likely captures the minimum value of protected areas. This alternative is chosen because estimating the complete value of protected areas, which include many indirect benefits, existence and bequest values, is rather difficult to implement.

[14] The report on "Non Timber Forestest Products in Vietnam" was released in Hanoi on August 17, 2007. The research was carried out with support and funding from the Netherlands.

[15] This scenario assumes that net value of NTFP is 80 percent of gross value of NTFP reported in the FAO assessment. In other words, we assume that the rental rate for NTFP is 80 percent of market price.

[16] A quasi-opportunity cost is defined as the payment over the opportunity cost that is received by a resource, or factor of production, in the short run. The notion of quasi-rent is similar to economic rent which is payment or revenue received over opportunity cost. The key difference is that quasi-rent is a short-run phenomenon.

Using the present value of agricultural land rents to value Vietnam's protected areas, we obtain an estimated value of $196 per capita wealth. This amounts to 6 percent of total Vietnamese wealth. Protected areas are an asset for the future of Vietnam's development, to the extent that these preserved assets support growing industries such as ecotourism, bio-prospecting, and carbon sequestration trading. Establishing and maintaining protected areas is not without cost, as these estimates suggest. The adoption of policies and incentives to capture the values generated by protected areas are thus important to ensure proper financing and management of Vietnam's special use forest areas.

Since the 1990's Vietnam has increased its forest area considerably—from 9.36 million hectares to 12.92 million hectares in 2005. All of the increase in forest area has been in forest designated for the protection of soil and water and for conservation, as production forest area actually declined slightly during this time period. The analysis here shows that these conservation oriented forest uses generate higher wealth values per capita than production forests.[17] Thus the results of this analysis thus support Vietnam's policy of increasing forest area devoted to more conservation oriented purposes.

[17] However, it should be noted that values estimated for different forest uses to some extent depend on the methodology used in the valuation. Therefore, the more conservative valuation methodogy is generally preferred.

7. Conclusion

Vietnam has experienced rapid economic growth rates and substantial poverty reduction over the past decade. But is Vietnam's economy on a sustainable development path? This study sheds light on this issue by estimating the capital value of Vietnam's natural resource wealth based on the resource rents generated by natural resource assets. Included in the analysis are estimates of the contribution of agriculture, pasture, and forest land resources, and mineral resources to Vietnam's wealth. The estimate of resource values are based on the potential net income flow which could be generated from these resources over a 25 year period.

Natural capital accounts for a larger share of wealth in lower income countries. We find that in Vietnam, the natural resources considered in the analysis account for almost a third of total wealth (30%). As countries develop, natural resources share of total wealth generally decline, as the contribution from physical and human capital to wealth increases. However, even though natural resource share of wealth falls, their total value will generally increase if resources are managed sustainably. Thus the estimation of natural resource wealth for Vietnam provides a benchmark to evaluate the sustainability of its economic development efforts. Economic growth which is based on the mining of natural resources will not bring long lasting development benefits if not compensated by other increases in produced and human capital.

Agriculture crop and pasture land together account for the largest share of Vietnam's natural resource wealth, 34 and 17 percent respectively. This is in line with the findings of wealth from the agriculture sector for other low income countries, and the results are quite robust to alternative assumptions and scenarios.

Vietnam also derives an important share of its natural wealth from minerals (40 percent), particularly, oil, natural gas, and coal. The contribution of these mineral resources to Vietnamese wealth has increased not only as a result of increasing market prices for these resources, but also because of increased volumes extracted following investments leading to the discovery and exploration of new deposits. However, the results on mineral wealth are more sensitive to assumptions regarding the future stream of production volumes and prices. Uncertainty about extraction costs for Vietnam and existing stock levels for these minerals are also an important factor in the variability of potential future rents. Thus, it is important to remember that due to the finite nature of these non renewable resources, the rents generated from these resources should be invested in human and physical capital resources, in order to support future wealth growth.

Forest resources account for approximately 9 percent of Vietnam's natural wealth. Among the many alternative forest uses, forest land allocated for protection generates the highest share of this value (6 percent). Non timber forest products, surprisingly, account for a larger share of the wealth value as do timber resources. This is partly explained due to limits on timber extraction in Vietnam, and also the share of timber extracted which is accounted for by low value fuelwood. However, the analysis also shows that the wealth from timber resources could be increased considerably, without leading to depletion of forest resources. This can be accomplished by improving forest productivity through active forest management, as well as shifting the supply of timber production towards higher value industrial roundwood.

The forestry policy analysis case study presented the impact of alternative policy scenarios for forestry management. One such scenario analyzed is the Vietnamese policy goal of increasing production forest area by 3 million hectares. The results suggest that wealth from timber resources could be doubled by expanding the productive forest area - particularly if most of this expansion in production forests occurs in plantation forests. If the increase in forest area is also accompanied by increased productivity through active forest management and a shift towards higher value roundwood timber, then the wealth generated from timber resources could increase 7 to 8 fold. An alternative scenario considered is the sustainable yield management scenario. The results show that strict adherence to the sustainable yield criteria would reduce timber wealth. However, with implementation of the 3 million hectare program, improvements in forest productivity, and shift to higher valued roundwood timber, the total supply of timber and wealth generated from it could substantially increased even while meeting the sustainable yield criteria. Thus, the forestry analysis suggests much potential exists for increasing the wealth generated from productive forest resources.[18] It also confirms Vietnam's policy of increasing forest area for protective and conservation purposes, as these uses generate higher wealth values per capita.

The estimates of natural resources value provided in this analysis are based on data from 2000 to 2005, from a wide variety of sources—ranging from international publications to local estimates of production costs. The estimation of value is based on future rents, which requires a number of simplifying assumptions be made, in order for calculations to become tractable. As better information about the specific course of development for a particular resource becomes available, the precision of the estimates could be improved. Continuous updating of forecast rents, at about every 3 to 5 five years, should provide policy makers with good information upon which to evaluate past policy decisions and consider the impacts of proposed new policies affecting natural resources. Thus, the framework developed for this estimation of natural resource values should prove as valuable a tool of policy analysis as the estimates themselves.

[18] The potential benefits generated would of course need to be compared to the costs of achieving such outcomes, as well as with alternative land uses.

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