Optimal Resource Rent

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ABSTRACT

This paper develops the first systematic attempt to model and empirically estimate the concept of optimal resource renting. Optimal rent is found to be positively affected by increases in the recession buffer and resource endowment, and negatively affected by the opportunity cost of hoarding. The model is then tested empirically on Norway, an oil-rich state, and actual renting is found to be systematically diverging from the optimal rent series. At least a third of the variation in actual renting is always left unexplained by the economic variables of the model, and should be attributed to the institutional and political factors that lie beyond the scope of our analysis.

Keywords: Rent-Seeking, Resources Policy, Public Finance

JEL Codes: D72, L71, O17

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"Transactions intervene between the labor of the classic economists and the pleasures of the hedonic economists, simply because it is society that controls access to the forces of nature, and transactions are, not the "exchange of commodities," but the alienation and acquisition, between individuals, of the rights of property and liberty created by society," – *J.R. Commons*

1. Introduction

The importance of institutional design and competence has remained a focal point of scholarly attention for the good part of the past century. It has been demonstrated in a plethora of theoretical and empirical studies that a positive relationship exists between the quality of institutional governance and economic development [1]. Institutional deficiencies, much too common both in the developed and emerging economies, constitute an important source of economic and political fallacies that lead to sub-optimal allocation of resources and decline in general social welfare. This paper will focus on a particular type of such fallacies, often incurred in states enriched with natural resources as a result of rent-seeking interferences, namely the resource rent. In doing so, this study introduces a concept of "optimal resource renting", which has potentially far-reaching implications for policy.

Although the general literary interest in institutional economics has been exhaustive, the nexus between rent-seeking, institutions, and economic growth is yet to be established. In particular, the case of resource-rich economies is still very much a hot topic. Shaffer and Ziyadov (2012) provide a good review of contemporary studies on the interplay between rent-seeking and the resource curse, much in support of the seminal work by Sachs and Warner (1999, 2000). They claim that resource-generated income can act as an easy source for rent extraction of large proportions, especially in less developed states with imperfect institutional set-ups[2]. In turn, the fight for rents can turn into an explicit or implicit domestic conflict and threaten the existence of the democratic state itself. Mohtadi and Roe (2003) talk about the peculiar relationship between democracy and rent-seeking.

In order to mitigate the frictions arising between the clans of powerful renters, be it physical or institutional agents, some might consider as solution the establishment of a pragmatic patron, who would in dictatorial fashion distribute rent among the carnivorous rent-seekers, thus avoiding potential confrontation. Such an arrangement results in the so-called "rentier state" (Bjorvatn and Naghavi, 2011). Ideally, the rentier state (and rational monopolistic renting in general) should be targeted by an aware social opposition, as depicted in Epstein and Nitzan (2003). Fabella (1995) argues that the *number* of rent-seekers is also very important so as to determine the reaction of general welfare to the entry of opposition to a rentier transfer. Opposition when there is just a single rent-seeker is never welfare enhancing, whereas opposition entry when the quantity of renters is large increases social welfare[3].

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[1] Consider, for example, Mauro (1995, 1998), Acemoglu et al. (2001, 2002, 2003), Easterly and Levine (2003), Rodrik (2004), Shleifer and Vishny (1993) among many others.

[2] Interestingly, Djankov et al. (2008) showed that foreign aid can result in the same rent-seeking activities as the classical resource curse argument predicts. Svensson (2003) makes an even stronger assertion that the mere anticipations of potential aid inflows are enough to trigger rent search and hedging.

[3] The notions of renter grouping and *within-group* bargaining, as described in Cheikbossian (2008), are also important.

The predominantly theoretical nature of all studies on rent-seeking behaviors is lacking both originally empirical papers and quantitative validations of the established models. Our paper's attempt to surround the proposed theoretical model with an empirical strategy will therefore attempt to fill this important gap. Nevertheless, several existing studies do provide some empirical back-up for theory. For example, Angelopoulus *et al.* (2009) offer general empirical verification for the magnitude of rent extraction, suggesting that substantial proportions of GDP are available to be sought by rent-seekers throughout Europe. Considering that most countries around the Globe are still quite far from the development status of an average European state, it is therefore not hard to imagine how broadly penetrated rent-seeking is in the developing world[4].

None of the papers mentioned above ever explicitly considered rent-seeking to be socially desired or expected, at least at some predefined level. The harm and externalities resulting from rent dissipation are, of course, pejorative and equilibrium-distorting. However, combat of rent-seeking (presumably through legal enforcement) is costly to be expanded to its socially desirable maximum (Polinsky and Shavell, 2001). Moreover, previous research has called for at least some marginal quantity of renting to be necessary for conflict avoidance and survival of the political regime. The fundamental proposition of this paper is therefore that rent-seeking *can* be desirable. In better words, rent-seeking can be acceptable if a) the marginal costs of renter haunting and punishment outweigh economic and social harms incurred by the marginal renter, and b) the minor costs associated with rent dissipation and enrichment of key physical and institutional agents are the necessary sacrifice to prevent massive conflict, armed confrontation, or external invasion.

We call that desirable amount of rent "optimal", and emphasize that it is not the rent *itself* which is optimal, but some particular fraction of it which, for the two reasons outlined above, becomes acceptable (at least on economic grounds). The concept of optimal rent-seeking is then applied directly to the case of resource-rich economies for two reasons. First, it is quantitatively easier to measure exact amounts of resource renting when applied to a particular resource product, such as oil, rather than succumbing to gruesome micro-data of some industry-specific renting symptoms. In our scenario, resource rent is simply the differential between the currency value of the marginal unit of resources extracted and the marginal price collected on the commodities markets. Second, the challenge or rent minimization is an everlasting priority for practically *all* resource-abundant states regardless of the qualities of their respective institutional frameworks, and this paper could contribute well to the general discourse on resources policy.

In Section 2, the concept of optimal resource renting is furnished with a simple theoretical foundation. Section 3 lays out the solution of the model and its general implications. Section 4 proposes an empirical strategy on how to estimate optimal rent-seeking and compare it with the actual rent series. Finally, Section 5 provides closure with final comments and conclusions.

[4] Across-country heterogeneity in the degree of rent-seeking penetration can be explained by various determinants, including but not limited to, legal origins and capital market development (La Porta et al., 1998), country size and economies of scale in the provision of public goods (Aseina and Wacziarg, 1997), government centralization (Fisman and Gatti, 2002; Rajan and Zingales, 2001), economic and political uncertainty (Caballero and Yared, 2010).

2. Model Set-up

The baseline model assumes a standard revenue function RR, according to which resource income flows into the country under a certain probability of economic prosperity π. In the event of positive economic growth, the economy is facing a prosperity dilemma, α_0, of either hoarding up the stock of resource revenues or investing them on financial markets for an interest gain. When the country is going through an economic slowdown, a scenario occurring with an *a priori* probability $1-\pi$, the recession buffer α_1 is being leaned upon as a cushion against potential distress. RR will therefore take on the following general form, which is a conventional starting-point for many single-period macroeconomic models[5]:

$$RR = \pi\alpha_0 + (1-\pi)\alpha_1 \tag{1}$$

π does not determine whether resource-generated income is received (the supply chain is assumed to be stable and safe) but describes the behavior of macroeconomic fundamentals which either augment or attenuate the expanding resource endowment. In our case, these fundamentals are the liquidity and regime sustainability factors. The former is represented by $\frac{O}{M}$ - the ratio of gross resource revenues to total imports. It is believed that a country, which relies substantially on resource revenues, will face *short-run* liquidity problems in case of a persistent trade deficit since the state will be forced to subsidize the deficit with external borrowing or strategic reserves depletion. Both actions would have a negative net effect on prospects of positive growth.

Whether the resource-oriented regime is sustainable in the *long run* is determined by $\frac{\rho}{V}$ - the ratio of resource rent to foreign exchange reserves. Such formulation implies that renting is an inevitable notion for any resource-rich state, as either a fixed or floating percentage of the resource revenue must go for the support of relevant institutions. Strategic reserves must therefore be managed as a *de facto* endogenous sustainer of the inevitable rent. It is *a priori* expected that the impact from the liquidity and sustainability factors on economic prosperity are positive and negative, respectively. Probability can therefore be represented by a following general functional form:

$$\pi = \pi(\frac{O}{M}, \frac{\rho}{V}, x_i) \tag{2}$$

Where x_i is a set of all other exogenous macroeconomic variables affecting the growth outlook. Subject to the event that recession is successfully avoided with probability π, the resource state is facing a prosperity dilemma of either hoarding up the revenues or investing them on domestic or foreign capital markets under an exogenously determined interest rate.

$$\alpha_0 = Or \tag{3}$$

$$r = d - i$$

[5] See Ben-Bassat and Gottlieb (1992) for a resembling modeling strategy applied to the question of optimal international reserves.

Here, O is again gross oil revenue inflow, and r is the opportunity cost of hoarding. This cost is itself endogenous, taken as the differential between d, the rate that the resource state (or its formal sovereign wealth fund) can earn by investing at home or abroad, and the interest rate on an alternative risk-free investment – i, e.g. triple-A government bonds. Such representation conveys well the choice that a typical government faces when investing (or hoarding) resource income.

When the economy is not having a period of prosperity, i.e. is recessing with probability $1 - \pi$, the country must rely upon the previously accumulated recession buffer - α_1. The recession buffer is directly proportional to "excessive" Gross National Product – Y – and the stock of strategic reserves – V. Excessive can be defined here as a differential between actual and potential (or forecasted) growth. If the differential is positive, then the country has "spare" output to deplete until the economy returns to its projected long-run growth path of, say, 3% or so. Both the GNP excess and the stock of reserves should theoretically have a positive effect on the overall buffer.

$$\alpha_1 = \alpha_1(Y, V) \tag{4}$$

The final component of the resource flow function is the wealth constraint which can be represented as:

$$K + O + V = \rho + W + D$$

Where K is gross non-resource capital, O is the resource endowment, V is the stock of strategic reserves, W – aggregate net wealth, D – gross national debt, and ρ is again the resource rent. All left-hand side variables collectively represent the asset side of the national balance sheet, and the right-hand side represents national liabilities. Rent extraction is thus modeled as an exogenous liability. The constraint can also be rewritten for simplicity and technical convenience as:

$$O = \rho + W + D - K - V = \rho - O_n \tag{5}$$

So, oil revenue becomes endogenous to the resource rent and "net resources" – resource-generated gain net of all non-resource, fiscal, and monetary components. Resource rent is still exogenous and can thus be comfortably solved for within an optimization framework.

3. Model Solution

The solution of the model will require us is to maximize resource revenues under the presence of certain constraining conditions, namely the exogenous rent, the probability of prosperity, and the general resource constraint. The objective function, achieved by substituting (3) for α_0 and maximizing (1) with respect to rent, takes on the following form:

$$\max_{\rho} RR = \pi O r + (1 - \pi)\alpha_1(Y, V) \tag{6}$$

Subject to the probability of prosperity:

$$\pi = \pi\left(\frac{O}{M}, \frac{\rho}{V}, x_i\right)$$

And the resource constraint:

$$O = \rho - O_n$$

We now substitute the resource wealth constraint for O. Optimization of the objective function will yield the following first order condition:

$$\frac{dRR}{d\rho} = \pi_\rho(\rho r - O_n - \alpha_1) + \pi r = 0 \tag{7}$$

From the FOC it is easy to derive the general formula for the optimal resource rent, ρ^*, which is a function of net resource revenues, the opportunity cost of hoarding, the recession buffer, and the determinants of the prosperity probability. We will drop the parameter x_i and focus exclusively on the liquidity and sustainability factors:

$$\rho^* = \rho\left(O_n, r, \alpha_1, \frac{O}{M}, \frac{\rho}{V}\right) \tag{8}$$

It is possible to derive a more concrete formula for the optimal rent, but that will require us to simultaneously solve the probability of prosperity constraint. Consequent solution steps will therefore demand a simplification of the probability parameter. For technical purposes, I assume here that it abides by the following logistic process, which forces π to vary between 0 and 1:

$$\pi = \frac{e^k}{1 + e^k} \tag{9}$$

Where k is a functional representation of our liquidity and sustainability factors:

$$k = \beta_0 + \beta_1 e^{O/M} + \beta_2 \ln(\frac{\rho}{V}) \tag{10}$$

The exponentiation of liquidity, $e^{O/M}$, implies that complete confidence with liquidity abundance occurs only after some certain threshold; small marginal increases in resource gains will not be particularly helpful in case of a persistent and deteriorating trade deficit. However, under large flows of resource income, the liquidity buffer is presumed to be maintained with a higher degree of ease. The logarithmic transform of the sustainability factor, $\ln(\frac{\rho}{V})$, suggests a decreasing marginal benefit from renting. Some portions of resource gains that are extracted for renting purposes are assumed to be always necessary for the survival of the institutional design. However, as rent-seekers begin to abuse their powers, resource rent starts to distort income distribution and lead to a sub-par, non-optimal strategy with regards to wealth dissemination. Coefficients of both parameters are expected to have a positive sign.

Differentiating (10) with respect to rent will yield:

$$k_\rho = \frac{\beta_1}{M} e^{O/M} + \frac{\beta_2}{\rho} \tag{11}$$

The first component, which is positive, improves prosperity prospects at an exponentially increasing pace, and the second element improves it at a diminishing rate. Now, it is easy to show from (9) that the function k can also be written as:

$$k = \ln[\pi/(1-\pi)]$$

Differentiating for ρ yields:

$$k_\rho = \frac{\pi_\rho}{\pi(1-\pi)}$$

And placing π_ρ to the left-hand side for convenience we get the following formulation for the first derivative with respect to rent of the prosperity probability function:

$$\pi_\rho = k_\rho \pi(1-\pi) \tag{12}$$

Now, from the first order condition (7) it is possible to show that optimal rent can be derived from the following more specific formula:

$$\rho^* = \alpha_1 r^{-1} + O_n - \pi\pi_\rho^{-1} \tag{13}$$

By substituting (11) for π_ρ we obtain the following simpler version of the same equation:

$$\rho^* = \alpha_1 r^{-1} + O_n - \frac{\pi}{k_\rho(1-\pi)} \tag{14}$$

We can stop here, but for technical simplicity, I propose to assume that any *a priori* probability of prosperity is 50%, i.e. π is 0.5. Of course, it is a stretched belief that macroeconomic conditions simply follow a random walk process, especially in resource-rich economies where growth is predominantly upward-trending, and especially considering that asset (including oil and energy) prices are usually bullish. However, there is a substantial amount of exogenous factors which lie outside the model and which could have a potentially strong impact on economic performance of a resource-rich state. For example, resource prices are not included into the model explicitly and are not necessarily always rising (as demonstrated by the recent Financial Crisis), geopolitical aspects and territorial disputes such as external war or internal turbulence threats are not discussed, and our assumption of supply chain stability is rather strict (sudden breakdown of even a small supply chain component could lead to significant macro consequences). Thus, granted that the intuition above holds true, the baseline formula can be re-written as[6]:

$$\rho^* = \alpha_1 r^{-1} + O_n - \frac{2}{k_\rho}, if\ \pi = 0.5 \tag{15}$$

By treating the coefficients β_1 and β_2 as simple constants, such as unity, and by substituting the previously obtained first order condition (11) for k_ρ we get:

[6] Regardless, this simplification will be avoided in the empirical phase where the probability parameter is estimated directly.

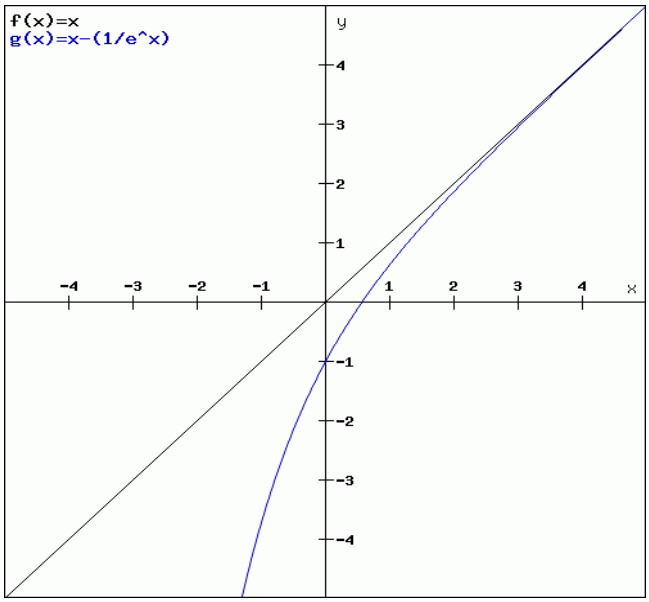
$$\rho^* = \alpha_1 r^{-1} + O_n - \frac{2M\rho}{\rho e^{O/M} + M} \tag{16}$$

This is the full version of the optimal resource rent formula, where all right-hand side variables are determined exogenously. Since the resource income parameter O_n appears twice in the equation, it is possible to simplify it even further and re-write in the following way[7]. (Figure 1 illustrates the approximation with a simple graphical example):

$$\rho^* \approx \alpha_1 r^{-1} + O_n \tag{17}$$

Thus, optimal resource rent is a direct linear function of the recession buffer and resource income, and an inverse function of the opportunity cost of hoarding. First, the formula predicts that rent-seeking should rise when the recession buffer is sufficient; large stocks of foreign exchange reserves and bigger values of excess GNP are likely to serve as a calming cushion for rent-seekers. Second, as the opportunity cost of hoarding increases, rent optimality goes down implying that rent-seekers are forgoing financially lucrative projects for the probably less profitable rent itself. This finding is rather substantive, since in an environment where the opportunity cost parameter is high enough (where capital markets are developed, the banking sector is vibrant, and access to foreign finances is unrestricted) optimal rent-seeking should approach zero, or at least some minimum floor required for regime maintenance. Finally, interpretation for the linear relationship with resource income is rather straightforward: rent-seekers are greedy in their quest for rent, and their appetite rises one-in-one with the growth of the national resource endowment.

Figure 1: Optimal Rent Formula Illustration



[7] The total derivative of ρ^* with respect to O_n has an ambiguous and tedious interpretation, but the simplified formula is a solid approximation; the second and third terms of the full equation diverge for all negative values of $O_n$but converge into a linear form when O_n gets large enough. Considering that we would rarely, if ever, expect resource income to be negative, the approximation should work well for any big marginal changes in O_n.

Note: Black and blue line represent the second and third terms, respectively, of the equation (16). The independent variable, x, is resource endowment, and the dependent variable, y, is the optimal rent parameter.

4. Optimal Rent Estimation

This section will develop a strategy for estimating the optimal resource rent in a resource-abundant state by applying the general theoretical model developed earlier in the paper. Of course, empirical results will not be perfect, since this is the first such attempt in literature, and future research endeavors are likely to improve on this paper's precision and methodological efficiency. However, we can argue that our method is quite robust since final results are consistent and intuitive.

The estimation strategy requires us to first measure each component of the optimal rent formula, namely the recession buffer, probability of prosperity, and the opportunity cost of hoarding. With the obtained estimates, we will be able to simulate optimal rent-seeking. We will be using Norway as the case-country throughout the estimation phase. Norway is an oil-rich economy with trustable and extensive data provision, which is a primary reason for our selection. In addition, Norway is conventionally considered to be one of the most advanced societies in the world, where any form of corruptive behavior (be it resource rent or plain bribery) would be very uncommon. By extrapolating our findings from Norway to other, less advanced oil-rich states, we can comfortably expect that any divergence between actual renting and our simulated optimal rent series present in the case of Norway will be significantly broader in the less developed societies, chiefly due to the presence of institutional imperfections and juridical gaps. So, if we manage to obtain at least marginally interesting results, it would therefore make a lot of sense to prolong this research stream by looking at the case of other resource-rich economies.

a. The Recession Buffer

Resource renters, be it physical individuals or institutional agents, are not modeled to be economically blind and irrational with respect to rent search and extraction. General macroeconomic trends and conditions play an important role in rent-seekers' decision-making, as renting hunger is either muted or augmented by the current state of the economy. Moreover, economic cycles also affect the size of the aggregate pie, and thus the maximum available capacity of resources to be distributed (or extracted). In order to capture the factor of general business cycles and long-run trends, the recession buffer parameter is measured as the ratio of current to potential Gross Domestic Product:

$$\alpha_1 = Y/Y_p \tag{17}$$

Where Y and Y_p are variables of GDP and expected GDP, respectively. There are multiple alternatives for measuring Y_p, but I propose to use the Hodrick-Prescott filter on the GDP series in order to obtain the long-run trend parameter. The economy is said to be ahead of the curve, or sitting on a recession buffer, if the ratio in (17) is larger than unity. Otherwise, the economy is recessing, or liquidating its priory accumulated buffer. The net effect of α_1 on rent-seeking is projected to be positive, as renting should in theory be pro-cyclical, assuming that renters are not self-destructive.

In order to obtain the estimate of the recession buffer, the ratio in (17) is regressed on the ratio of gross reserves (international exchange plus gold) to GDP. A lag of the independent variable is included as well, since it is possible to expect that the degree of *present* economic stability and recession resistance will better associate with economic decisions of the nearest *past*. The buffer is estimated using Ordinary Least Squares (OLS) on Norwegian annual data for the 1960-2011 period. Regression results are reported below:

$$\underset{}{\frac{Y}{Y_p}} = \underset{(26.26)}{1.06} - \underset{(-2.30)}{1.54} * \left(\frac{V}{Y}\right) + \underset{(1.61)}{1.06} * \left(\frac{V}{Y}\right)_{-1} \tag{18}$$

Where in lower parentheses are t-values of the respective coefficient parameters. Both the constant and the first coefficient are significant at the 5% level, while the lagged variable is significant at the 11% level. The recession buffer is positively affected by the stock of strategic reserves, but only for the lagged variable. The negative and significant impact on the buffer from reserves in level form is quite surprising. The constant suggests that on average over the 1961-2011 period, Norway has been outgrowing its long-term growth trend by 6%[8]. Some additional diagnostic test results are available in Table 1.

Table 1: Recession Buffer Diagnostics

Test	Estimate	Test	Estimate
F-stat	3.01	Stability	Stable
R-Squared	11%	Linearity	0.02
Autocorrelation	0.55	Homoskedasticity	1.55
Serial Correlation	21.26	Normality	Normal

Where the F-stat is the general F-test statistic on collective inclusion of the independent variables, Autocorrelation is tested by the Durbin Watson statistic, Serial Correlation estimate is the Breusch-Godfrey LM-based F-statistic for a regression with 8 lags, Stability is measured by the CUSUM and CUSUMSQ tests, Linearity is the Likelihood ratio of the Ramsey's RESET test for functional optimality, Heteroskedasticity estimate is the F-statistic from the Breusch-Pagan-Godfrey test, and Normality is a visual check of the residual histogram.

From Table 1 we can conclude that the recession buffer regression in (18) is properly fitted, explains up to 11% of the variation in the output differential (which is quite substantial considering the plethora of other potential explanatory factors), does not exhibit signs of heteroskedasticity, non-normality, serial correlation, or functional misspecification. The only hindering factor is the symptom of positive autocorrelation, something that should be improved upon by future studies. By and large, regression results are robust, the coefficients are significant enough, and we are therefore able to use the equation to obtain an estimate of the recession buffer for the optimal rent simulation phase.

[8] I have also experimented with an alternative specification of the expected GDP, Y_p, by generating a series of growth figures that would have occurred if the economy grew by 5% every year over the whole period. Regression results were not affected.

b. The Probability of Prosperity

We will be building on equations (9) and (10) in our attempt to estimate the probability of prosperity π. It is possible to represent π as a dynamic interplay between risky and riskless borrowing incurred by domestic financial agents[9]. Feder and Just (1977) propose to approximate π with a risk premium paid by risky borrowers. Basing on this logic, I rewrite equation (9) in the following manner:

$$i - i_n = \beta_0 + \beta_1 e^{O/M} + \beta_2 \ln(\frac{\rho}{V}) \tag{19}$$

Where i is the standardized 3-month LIBOR rate, and i_n is the 3-month Norwegian Inter Bank Offer Rate (NIBOR). Collapse in the differential between the two yields would signal market composure, decreasing risk premiums paid by Norwegian agents, and thus a rising probability of economic prosperity and general recession avoidance. On other hand, an increase in risk premia (decline in the $i - i_n$) would point at recessive tendencies. Equation (19) is estimated via OLS on annual observations for the 1991-2010 period. The sample was limited by availability of the data of our interest. We continue to confine ourselves to the two baseline components of probability ($\frac{O}{M}$ and $\frac{\rho}{V}$) and leave aside the x_i. Regression results are reported below:

$$i - i_n = \underset{(-2.53)}{-13.47} + \underset{(2.18)}{4.93} * e^{O/M} - \underset{(-2.04)}{6.98} * \ln(\frac{\rho}{V}) \tag{20}$$

Where t-statistics are again in lower parentheses. All coefficients, including the constant, are statistically significant at least at the 6% level, which is very robust considering the small sample size. The constant has a natural interpretation: the expected differential between NIBOR and LIBOR yields, on average for the analyzed period, is approximately 13.5%, which reflects the market-priced risk premium assigned to Norwegian borrowers. The value might be biased upward due to some potentially omitted variable. The impact of the regime sustainability factor, $\frac{\rho}{V}$, is negative while the liquidity component has a significant positive effect on the risk differential. Both findings are largely in line with our theoretical expectations; imports compensated by oil revenues as well as rent-seeking counterbalanced with strategic reserves improve the economic environment and reduce the risks of a recession. Table 2 presents some additional diagnostic tests results for the prosperity regression.

Table 2: Prosperity Regression Diagnostics

Test	Estimate	Test	Estimate
F-stat	2.58	Stability	Stable
R-Squared	23%	Linearity	3.30
Autocorrelation	0.82	Homoskedasticity	0.26
Serial Correlation	2.03	Normality	Normal

[9] This concept is very different from the opportunity cost of hoarding, which is the investment dilemma faced by the resource wealth fund.

Where the F-stat is the general F-test statistic on collective inclusion of the independent variables, Autocorrelation is tested by the Durbin Watson statistic, Serial Correlation estimate is the Breusch-Godfrey LM-based F-statistic for a regression with 8 lags, Stability is measured by the CUSUM and CUSUMSQ tests, Linearity is the Log Likelihood ratio of the Ramsey's RESET test for functional form optimality, Heteroskedasticity estimate is the F-statistic from the Breusch-Pagan-Godfrey test, and Normality is a visual check of the residual histogram.

Our regression set-up is able to explain up to 23% of the variation in the risk premium function, does not suffer from functional misspecification, non-normality, non-stability of parameters, and serial or auto-correlation of the residuals. The F-statistic suggests that our coefficients are jointly significant at the 10% level. The overall results of the probability regression could be considered as robust, statistically significant, intuitive and therefore appropriate for the usage in the estimation of the optimal resource rent formula.

c. The Opportunity Cost of Hoarding

As discussed in the theoretical section, the opportunity cost of hoarding is treated as a differential between the interest on high- and low-yield assets traded on secondary financial markets. The formulation captures idiosyncratic risk-averseness by individual resource wealth funds; some would tolerate higher risk and invest in more remunerative vehicles, while others restrict themselves to maximum security riskless ventures. The latter can occur either by management discretion or national legal mandate. The low-yield asset is represented by the 1-year constant maturity rate U.S. Treasury bill. It is harder to proxy the riskier instrument, since wealth funds typically have unrestricted access to emerging markets finance throughout the world, and arbitrarily selecting one developing country's or institution's yield as a benchmark would be too much of a simplification. I therefore use the BofA Merrill Lynch High Yield Emerging Markets Index as an approximation for all general high-risk investments. This is a realistic proposition since the index represents assets that are both remunerative and safe enough, so we could realistically expect a risk-seeking wealth fund to get attracted by its high yield but not detracted by an unacceptably (for a sovereign fund, not a hedge fund) high probability of default. The opportunity cost of hoarding can be entered straight into the optimal rent simulation model without much additional action on our behalf.

d. Optimal Resource Rent

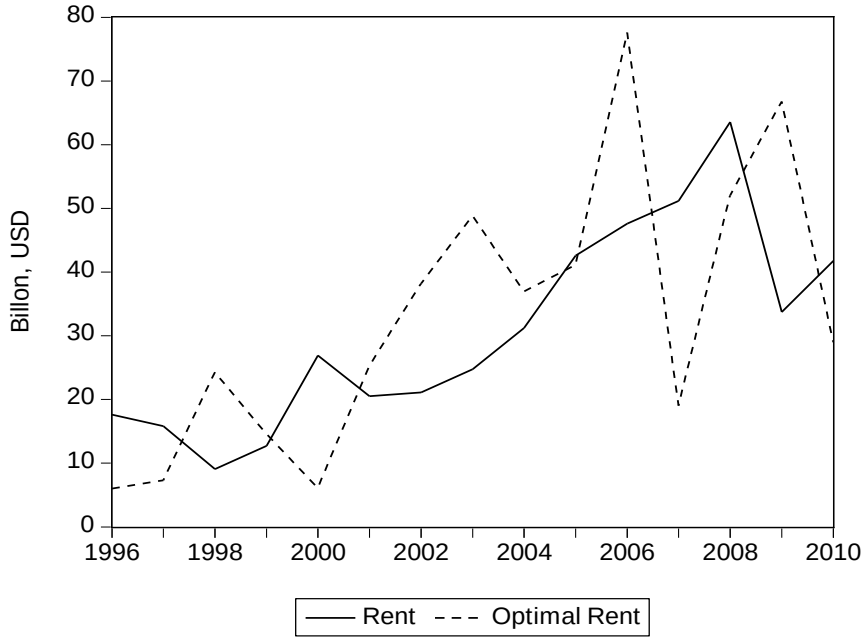
Our strategy for estimating the optimal resource rent consists of a simulatenous solution of the rent function and the probability of prosperity regression. It is not possible to calculate ρ^* explicitly, however, a simulation for ρ within the system of two equations will yield a robust approximation. The rent equation is modeled using the estimate of the recession buffer obtained in 4.a., the opportunity cost of hoarding explained in 4.c., and the determinants of prosperity probability (liquidity and sustainability). In particular, the coefficient estimates obtained in 4.b. were retained and used for this purpose. The relationship between actual and optimal rent is captured by a regression of ρ on ρ^*. The regression results are below:

$$\rho_t = \underset{(2.71)}{1.81E10} + \underset{(2.24)}{0.38}\rho_t^*, \quad R^2 = 28\%$$

Where the constant is in billions, USD, and t-statistics are in lower parentheses. The impact of the optimal resource rent on actual renting is positive and significantly different from zero at the 5% level as well as statistically different from unity at all levels of significance. The constant is positive and significant, with an intuitive interpretation of a minimum expected value of rent extracted regardless of the impact of such economic factors like the risk premium, opportunity cost of hoarding, and the recession buffer. The value of $18.11 billion (the constant) is equal to approximately 45% of the amounted of total rent extracted in 2010. The R-squared suggests that 28% of the variation in resource renting can be explained by the model proposed in this paper. Another rough interpretation is such that for every $1 of resource rent, 72 cents cannot be explained by our set of economic variables, and could thus be attributed to non-economic phenomena such as institutional and/or political factors.

We now display the over-time behavior of both the actual and optimal values of the resource rent in Figure 2. Although there is a clear long-run congruence between the two series, there are periods of noticeable divergence. In particular, during the 2 years prior to the Global Financial Crisis, actual renting exceeded the optimal value by a substantial margin; a similar tendency can also be observed for the two prior crises when actual rent overshot the optimal limit both in 1997 and 2000. The average discrepancy between the two series over the whole time period is roughly 16% of the amount of actual rent.

Figure 2: Actual and Optimal Resource Rent



In order to more properly capture the crisis effect, we now devise a simple dummy variable CR which takes on the values of 1 for years 1997, 1998, 2001, 2002, 2009, and 2010, and 0 otherwise. The constant represents the non-crisis periods. The result of the baseline regression with the crisis dummy is:

$$\rho_t = 2.29E10 + 0.37\rho_t^* - 1.10E10CR, \quad R^2 = 40\%$$

(3.28) (2.30) (−1.59)

Both the constant and the optimal rent coefficient are positive and strongly significant, while the crisis dummy is significant only at the 14% level. But this is still a fairly robust outcome given the very small sample size. The interpretation of the result is quite intuitive. During the times of economic crises rent-seekers are finding it more difficult to search for rent opportunities, probably due to the declining overall size of the economic pie. In normal times, however, as evidenced by a constant which is larger than in the baseline case, renters extract more than their normal share of rent. This suggests that renters are indeed rational and patient in their quest for rent gains, as they cut on renting during economic slowdowns but rush to capitalize on prosperous periods with higher rents. Once again, a substantial portion of rent variation, namely 60% cannot be explained by the economic factors of our model.

As noted earlier in the paper, energy prices (in the case of Norway it is the spot price on crude oil) have not been explicitly analyzed in this model. We therefore ran another regression with oil prices, OP, as another addition to the set of covariates. The regression results are:

$$\rho_t = 1.34E10 + 0.2\rho_t^* - 1.01E10 * CR + 3.50E08 * OP, \quad R^2 = 69\%$$

(2.21) (1.49) (−1.91) (3.15)

The impact from the inclusion of the oil price variable can be easily visible from the now much higher R-squared. The coefficient on OP is positive and strongly significant, implying that a $1 rise in the spot price on oil leads to a $350 mln increase in renting activity. The coefficient of the optimal rent is now significant only at the 14% level, suggesting that actual rent depends more on the price of the energy unit rather than on some formula of economic optimality; if prices are bullish, renting will rise, regardless of whether the outcome will actually surpass the optimal ceiling. Although the predictive power of the regression is high, still up to 30% of the variation in actual rent cannot be explained by the variables included, and this should be attributed to various institutional factors that are beyond our economic prism of analysis.

Two general points for discussion are worth our emphasis. First, a good critique could claim that rent is simply an endogenous *fixed* proportion of gross resource output, and thus the variation of renting is not interesting *per se*. And secondly, that renting is actually completely endogenous to cyclical institutional demands, which rise and fall depending on economic conditions such as crisis or non-crisis times. With regards to the first claim, even if renting is indeed linked with the volume of resource production (in the case of Norway it is crude and refined oil), this does not justify any discrepancies between actual rent and optimal rent. Assuming that our concept of optimal rent is durable and correctly estimated, regardless of whether actual rent is simply resource-related or not, deviation from optimality is still deviation from optimality. In other words, it is not the *general* volatility of renting that we are interested in but its volatility *conditional* on the existence of some optimal (and thus preferred) value at which the resource flow function is maximized as in (6). When discrepancies arise, as is often the case in Figure 1, the lingering question is on the driving reasons of that divergence, something that our economic model is not built to address. It is precisely in the inability of the *economic* model to explain some of the variation in actual renting with the optimal rent formula that this research becomes interesting; what *are* those reasons for divergence?

With regards to the second claim, it is quite hard to believe that institutions are changing so rapidly that the necessary volume of rent that goes to sustain their functioning is equally volatile and non-stationary. In other words, fixed institutional demands, if they existed, would not drop so dramatically during a crisis period so as to reflect some sell-off of institutional assets or capital etc., only to get reinstated the year after. In particular, it is hard to believe that regime maintenance costs (transaction costs necessary to sustain institutions) in Norway were so high in 2006 and 2007, as suggested by the mammoth values of actual renting in those years, and suddenly almost twice as small in 2009. If some fixed amount of rent necessary to maintain institutions existed, then it would be static over time or at least not as volatile as the actual rent. Plus, there is good reason to speculate that if some fixed rent demand existed, whatever it is in terms of measurement, then it would probably differ from the optimal rent concept introduced in this model, since never more than 70% of actual rent deviation can be explained by our economic variables. Resource renting could therefore drift along and between some distinct optimal *economic* and optimal *institutional* rent parameters! But this is something that shall be left for future studies to address.

5. Conclusion

This paper has introduced the concept of resource rent optimality. A simple theoretical model has been built around the conceptual intuition, and optimal rent was estimated empirically for Norway – an oil-rich state. The interest that this study has raised is in the systematic and substantial divergence between the actual and optimal rent parameters. Attempts to extend the explanatory power of the baseline regression with additional covariates brought the goodness of fit to seventy per cent. The component which is still left unexplained can be attributed to the factors which lie beyond the economic focus of our model, i.e. institutional and political aspects. Whether the core of the optimal rent concept is economical, as implied by this paper's approach, or purely institutional and political is the task to be investigated by future research.

Appendix: Data Description

Gross Domestic Product (Y): The GDP for Norway is in current U.S. Dollars and was taken from the World Bank.

Potential GDP (Y_p): Obtained by applying the Hodrick-Prescott filter to the GDP series.

Strategic Reserves (V): Gross total strategic reserves, including gold, measured in current U.S. Dollars, taken from the World Bank.

London Inter Bank Offer Rate (i): The 3-month LIBOR yield fix, taken from the St. Louis Federal Reserve Bank.

Norwegian Inter Bank Offer Rate (i_n): The 3-month NIBOR yield fix, taken from the Norges Bank.

Resource Rent (ρ): The World Bank's DataBank provides an estimate for oil rents, measured in percentage of annual national GDP. The actual amount of rent is then computed for each year.

Resource Income (O): Original series is measured by the gross value of oil production in Norwegian Kronas. Converted to current U.S. dollars through the spot exchange rate. Data was taken from the Norwegian Statistical Office.

Total Imports (M): Imports of goods and services, in current U.S. Dollars, obtained from the World Bank.

High-yield Opportunity Cost of Hoarding: Measured by the Bank of America Merrill Lynch High Yield Emerging Markets Index, taken from Bloomberg.

Low-yield Opportunity Cost of Hoarding: One-year U.S. Treasury Bill spot rate, taken from the St. Louis Federal Reserve Bank.

Oil Price (OP): The spot U.S. Dollar market price on crude oil, Brent blend, taken from the St. Louis Federal Reserve Bank.

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