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Natural Resource Wealth: The challenge of managing a windfall

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Natural resource wealth:
the challenge of managing a windfall*

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Abstract

Many countries have failed to use natural resource wealth to promote growth and development. They have been damaged by volatility of revenues, have failed to save a sufficiently high proportion of their resource revenues and failed to make high return investments to support diversification of their economies. This paper explores the reasons for these failures and discusses policies to improve performance.

Keywords: resource curse, managing windfalls, fiscal rules, volatility, absorptive capacity, Dutch disease, public investment.

JEL codes: E60, F34, F35, F43, H21, H63, O11, Q33.

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1. Introduction

Natural resource rents exceed $4 trillion per annum, amounting to some 7 percent of world GDP. Non-renewable resource revenues are a dominant feature of 50 economies with a combined population of 1.4 billion people. There are 24 countries for which resources make up more than three quarters of their exports, 13 countries for which resources make up at least 40 percent of their GDP, and 18 countries in which resources provide more than half fiscal revenue (2000-5, IMF 2007). Some countries (e.g., Botswana, Malaysia, Chile or Norway) have grown fast on the basis of these revenues but others (Nigeria, Cameroon, Iran) have not, and have been labelled as victims of the 'resource curse'.

There is a huge literature on the resource curse emanating from the cross-country study by Sachs and Warner (1997a).[1] This classic study finds that, after controlling for initial income per capita, investments in physical and human capital, trade openness, and rule of law, natural resource dependence (measured by the ratio of natural resource exports to GDP) has a strong and significant negative effect on growth of GDP per capita (column 1, table 1). Re-estimation with institutional quality rather than the rule of law confirms the presence of a resource curse (column 2, table 1). These results suggest that, ceteris paribus, an increase in the ratio of resource exports to GDP of 10 percentage points depresses average growth in GDP per capita by 0.77 to 1.1 percent per annum. However, Mehlum et al. (2006) and Boschini et al. (2007) offer empirical support for the hypothesis that countries with good institutions receive a very modest growth effect from resource dependence, while those with bad institutions are adversely affected. Increasing the ratio of natural resource exports to GDP by 10 percentage points increases average growth by a mere 0.1 percent per annum in countries with good institutions (a weighted index of various indicators measured on a scale from zero to one) but decreases annual growth by 1.43 percent in countries with bad institutions (column 3, table 1).[2] The empirical results reported in

[1] Much of this type of cross-country empirical evidence should be treated with caution as there are many unresolved issues to do with endogeneity and omitted variables, and the data are not rich enough to adequately control for cross-country differences in quality of institutions, rule of law, openness, etc. Within-country studies of the resource curse are of more interest, since they need to control for fewer differences in institutional and policy factors. (eg Caselli and Michaels, 2011).

[2] Institutions are probably not exogenous to the stock of natural resources. For example, Dell (2010) shows that the extensive forced labour system operated in Peru's mines during 1573-1812 has implications to the present.

van der Ploeg and Poelhekke (2009) suggest that volatile commodity prices are a key element of the resource curse and that natural resource dependence, unrestricted international capital flows, being landlocked and ethnic tensions boost volatility of unanticipated per-capita growth and thus depress growth prospects.

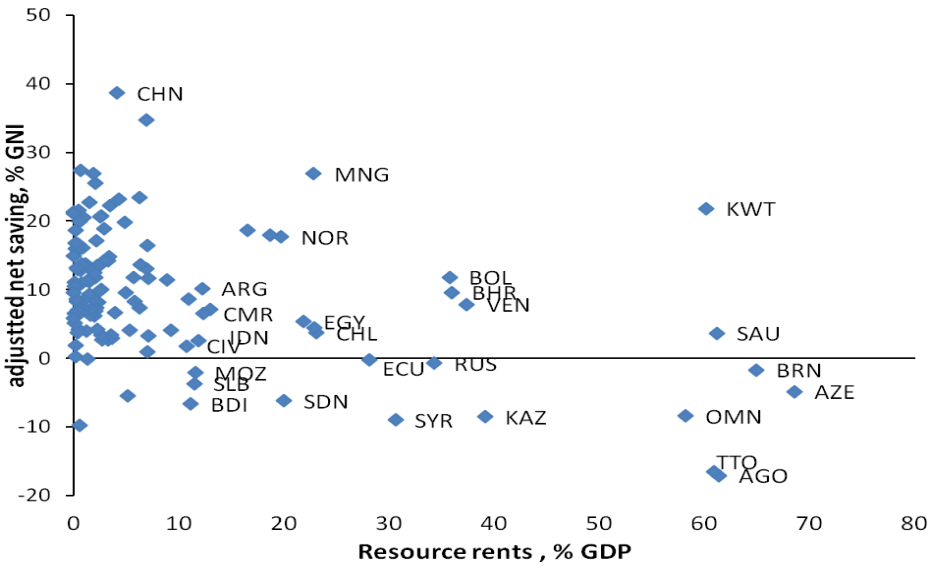
Table 1: Cross-country evidence for the natural resource curse

Annual growth in real GDP per capita	Sachs and Warner (1997a)	Based on data in Sachs and Warner (1997b)	Mehlum, Moene and Torvik (2006)
Initial income	-1.76 (8.56)	-1.28 (6.65)	-1.26 (6.70)
Openness	1.33 (3.35)	1.45 (3.36)	1.66 (3.87)
Resource dependence	-10.57 (7.01)	-6.69 (5.43)	-14.34 (4.21)
Rule of law	0.36 (3.54)	-	-
Institutional quality	-	0.6 (0.64)	-1.3 (1.13)
Investments	1.02 (3.45)	0.15 (6.73)	0.16 (7.15)
Interaction term	-	-	15.40 (2.40)
Number of countries	71	87	87
Adjusted R^2	0.72	0.69	0.71

The fundamental economic problem faced by resource rich economies is how to transform sub-soil assets into a portfolio of other assets – human capital, domestic physical capital (both private and public), and perhaps also foreign financial assets – that yield a continuing flow of income to citizens. The World Bank's (2006) estimates of *adjusted net* saving or *genuine* saving provide a measure of the extent to which many countries have failed to do this. These add to the usual definition of saving a measure of education spending to reflect investment in human capital and subtract depreciation of physical and human capital, the use of natural resources and the deterioration in environmental quality (mainly arising from CO2 and fine particles pollution). A resource rich country which was successfully transforming its sub-soil natural assets into physical, human or financial capital would not be running down its genuine natural wealth. However, the estimates calculated by the World Bank indicate that countries with a large percentage of mineral and energy rents of GNI have lower and, typically, negative genuine saving rates and are thus running down their wealth, as indicated on figure 1. The negative genuine saving rates shown have been quite persistent, especially for large parts of sub-Saharan Africa. Oil rich countries with negative genuine saving such as Nigeria or Venezuela

could have boosted their non-resource capital stocks by a factor of five or four if resource rents had been fully reinvested, as would oil/gas rich Trinidad and Tobago and copper rich Zambia.

Figure 1: Genuine saving and exhaustible resource rents



Adjusted net savings, excluding particulate emission damage (% of GNI)
Source: World Development Indicators:

This paper explores the reasons why countries have failed to transform resource wealth into assets that support sustained growth. We start in section 2 by outlining a theoretical framework, and using it to address the questions of how much countries should save from their resource rents, and how such savings should be invested. The benchmark case is the permanent income hypothesis but we argue that this needs modification, particularly in developing countries that are capital scarce. Savings decisions should take into account the relative prosperity of different generations and the effective management of volatility. The balance between investment in the domestic economy and saving in the form of offshore funds (Sovereign Wealth Funds) also depends on the developmental stage of the economy, as well as the effectiveness with which domestic investments can be made.

The remainder of the paper studies these choices in greater detail. Section 3 looks at the problems that countries encounter in achieving high levels of saving from resource revenues.

The political economy of public spending contributes to the observed low levels of saving, as does the interaction between public and private choices. Volatility is a particular problem. We discuss the prospects for fiscal rules that constrain spending during boom times and transfer revenue into a stabilisation fund.

Section 4 looks at how savings should be invested. Investment in the domestic economy is a route to growth, particularly for capital scarce developing countries. However, making efficient and high return investments has proved difficult, both because of short run absorption problems and because of the longer run problem of economic structure and the Dutch disease. The alternative to domestic investment is investment in foreign assets. Such investments can be undertaken to achieve long run wealth transfer (inter-generational funds), short run smoothing (stabilisation funds) or to deposit funds until they can be efficiently invested in the domestic economy ('parking' funds). Section 5 discusses some issues to do with the optimal rate of natural resource depletion and connects that with the saving and investment rules discussed in earlier sections. Section 6 concludes and draws out the main policy messages.[3]

2. Revenue management: theory

In this section we outline a highly simplified three period model and use it to analyse spending and saving responses to a resource windfall. The model also serves as a framework for the issues that are discussed in more detail later in the paper. In the first period the country receives a known amount of resource revenue; in the second, further revenue is received, but its level is uncertain; in the third period the resource is depleted. In the first two periods government chooses how to allocate revenue between current consumption, investment in domestic capital, and investment in foreign assets (or foreign debt reduction), taking into account both the second period uncertainty and the need to carry wealth into the third period when the resource has been depleted. In the third period the resource is exhausted and all remaining assets are consumed.

The first period budget constraint is $c_1 = N_1 + y(k_0 + k_1) - [k_1 + a(k_1)] + f_0 - f_1$, where c_1 is consumption, N_1 is resource income (exogenous), and non-resource output y is produced using

[3] We ignore issues of exploration, taxation, and contracts. For discussion of these issues, see Daniel et al. (2010). Other surveys include Barbier (2005, 2011), Collier (2010), van der Ploeg (2011) and Frankel (2011a). Ross (2004) reviews literature on conflict and resources. We focus primarily on revenue management.

inherited capital k_0 and period 1 investment k_1, with a concave production function, $y' > 0, y'' < 0$. The cost of this investment is $k_1 + a(k_1)$, where $a(k_1)$ captures adjustment costs: these are zero if the capital stock can be freely adjusted, and positive and increasing in k_1 if abrupt increases in investment encounter absorption problems. The country has initial foreign assets f_0 (liabilities if negative) and end of period 1 foreign assets f_1. In the second period resource income is uncertain, taking value N_2^{H} with probability ½, and N_2^{L} otherwise, where the superscript denotes high/ low state, $N_2^{\mathrm{H}} > N_2^{\mathrm{L}}$. The second period budget constraint for state i (= H, L) is $c_2^i = N_2^i + y\left((1-\delta)(k_0+k_1)+k_2^i\right) - k_2^i + \left[1+r(f_1)\right]f_1 - f_2^i$, where $0 < \delta < 1$ is the rate of depreciation of domestic capital and we assume that second period investment bears no adjustment costs. The value of foreign assets carried into period 2 is $\left[1+r(f_1)\right]f_1$. Importantly, we allow the interest rate to depend on the stock of assets/ liabilities that the country holds, in order to capture the idea that countries may be capital scarce and face high interest rates. In particular, if the country is indebted, $f_1 < 0$, then the interest rate may exceed the world interest rate r^*, with the interest premium increasing in debt, $r(f_1) \geq r^*$, $r'(f_1) \leq 0$ for $f_1 < 0$. The third and final period has no resource income (the resource is fully depleted); in this period there is no production and remaining assets are simply consumed, so $c_3^i = (1-\delta)\left[(1-\delta)(k_0+k_1)+k_2^i\right] + \left[1+r\left(f_2^i\right)\right]f_2^i$, where the superscript refers to the period 2 state.

The social planner's problem is to choose consumption and investment to maximise

$$u(c_1) + \frac{1}{2}\left[\frac{u(c_2^H)+u(c_2^L)}{1+\rho} + \frac{u(c_3^H)+u(c_3^L)}{(1+\rho)^2}\right] \tag{1}$$

where $u(.)$ is the instantaneous utility function and ρ is the rate of time preference. Choice of foreign investments yields the usual equalities of marginal rates of substitution of future for current consumption with marginal returns on the investments:

$$u'(c_1) = \frac{1+r(f_1)+f_1 r'(f_1)}{1+\rho} Eu'(c_2^i), \quad u'(c_2^i) = \frac{1+r(f_2^i)+f_2^i r'(f_2^i)}{1+\rho} u'(c_3^i), \ i = \mathrm{H, L}. \tag{2}$$

Choice of domestic investments gives, for the second period:

$$y'\left((1-\delta)(k_0+k_1)+k_2^i\right) + \frac{1-\delta}{1+r(f_2^i)+f_2^i r'(f_2^i)} = 1, \quad i = \mathrm{H, L} \tag{3}$$

where equations (2) have been used to simplify the first order condition. The period 2 marginal product of investment plus the present value of the fraction of investment remaining must thus equal the marginal cost of investment, unity. For first period investment, the first order condition (using (2) and (3)) is

$$y'(k_0 + k_1) + \frac{1-\delta}{1 + r(f_1) + f_1 r'(f_1)} = 1 + a'(k_1), \qquad (4)$$

simplified by noting that period 1 investment delivers $1 - \delta$ units of period 2 investment which has marginal value equal to its marginal cost, unity. On the right hand side, the marginal cost of first period investment is increased by the adjustment cost factor $a'(k_1)$. Given this framework, how do optimal consumption, saving, and investment decisions respond to a resource windfall?

2.1 Benchmark: Permanent income and future generations funds

The benchmark case is where the country is free to borrow or lend at constant world rate of interest, *so* $r = r^*$, $r' = 0$, there are no absorption issues, $a(k_1) = a'(k_1) = 0$ and no uncertainty, so $N_2^{\mathrm{H}} = N_2^{\mathrm{L}}$. Equations (3) and (4) are then simply

$$y'(k_0 + k_1) = y'\left((1-\delta)(k_0 + k_1) + k_2^i\right) = (\delta + r^*)/(1 + r^*), \quad i = \mathrm{H, L} \qquad (5)$$

This implies that domestic investment is completely independent of resource revenues and, consequently, any savings that are made should go into foreign assets. There is a complete separation between resource wealth and the production side of the economy. From equations (2), marginal rates of substitution in consumption are also unchanged, so levels of consumption in each period move up together (equi-proportionately if $u(.)$ is iso-elastic) according to shifts in budget constraints. Furthermore, if $r^* = \rho$, consumption is the same at all dates. This is the strict version of the permanent income hypothesis in which resource revenues are entirely invested in foreign assets at the level appropriate to maintain constant consumption through time. It is illustrated in the left panel of figure 2a, in which all series are changes from the situation with no resource wealth, expressed as a proportion of consumption in this initial situation.[4] The back

[4] The production function is Cobb-Douglas with capital share 0.3, the utility function is iso-elastic with elasticity of marginal utility –0.75. $r^* = 0.25$, $\delta = 0$, and, in the case of capital scarcity $r = r^* \exp[f/3]$ for

row gives the assumed resource revenues, with $N_1 = N$, $N_2 = N/2$, and $N_3 = 0$. In front of this, consumption is perfectly smoothed by the accumulation of foreign assets (shown in the front row), while domestic capital is unchanged. For a temporary windfall then, the prescription is to build up sufficient foreign assets and interest income after the windfall to sustain the permanent increase in consumption. This justifies a *future generations* fund.[5] [6]

2.2. Precautionary saving: case for a stabilisation fund

Adding uncertainty about period 2 resource revenues has no effect on the non-resource production side of the economy as equation (5) still holds, again implying that no resource revenue is invested in the domestic economy. Consumption levels in periods 2 and 3 depend on which state occurs, but is the same at both dates (see right panel of figure 2a, in which $N_1 = N$, $N_2^H = 0.75N$, $N_2^L = 0.25N$). What happens to period 1 consumption? From the first part of (2) we see that future uncertainty induces precautionary saving if $Eu'(c_2^i) > u'(Ec_2^i)$, i.e. if $u'(c)$ is convex, as explored by Kimball (1990). It is not risk aversion but 'prudence', a positive third derivative of u that induces precautionary saving. This justifies holding some of the windfall in a *stabilisation* fund. The magnitude of the change in period 1 is small (imperceptibly so in the figure). It also remains small if the coefficient of relative risk aversion and thus the coefficient of relative prudence are increased. This suggests that the true cost of volatility and thus the case for precautionary saving hinge on distortions in other parts of the economy rather than just on the curvature of marginal utility (e.g. Gelb, 2010). Alternatively, an extra parameter is needed to reflect the policy maker's attitude to prudence since one parameter fails to adequately capture relative risk aversion, intertemporal substitution and intergenerational inequity, and also prudence.

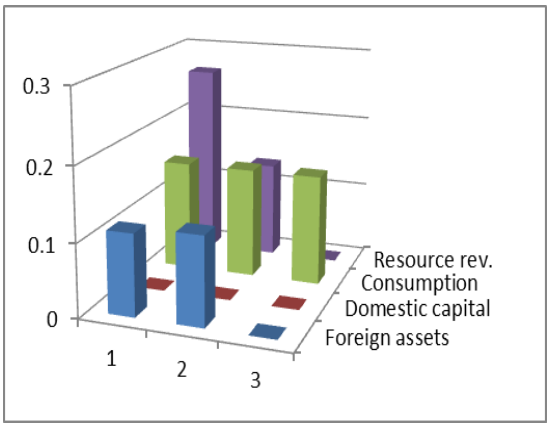
$f < 0$. Initial values are $k_0 = 1.5$ and $f_0 = -0.5$. Furthermore, $N_1 = 1$, $N_2^H = 0.75$ and $N_2^L = 0.25$.

[5] Norway has adopted a *bird in hand* rule which precludes using future windfall revenue as collateral for borrowing and thus put all revenue in a fund and only takes a certain percentage from this fund for the general government budget each year.

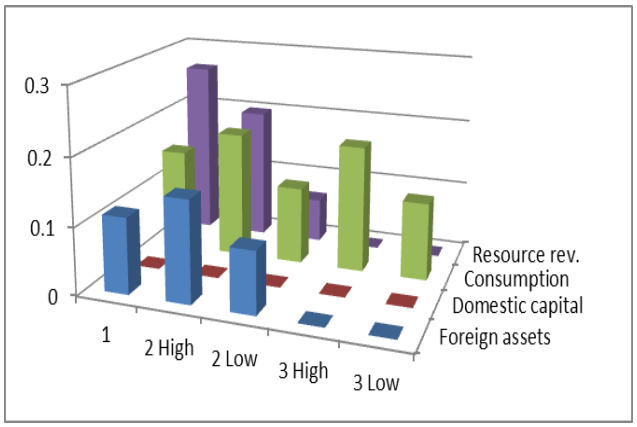
[6] The Hartwick (1977) rule states that all natural resource revenues should be reinvested in physical capital, infrastructure, human capital such that the genuine wealth of the nation is unchanged. The optimal policy in a closed economy thus corresponds to zero genuine saving (Dasgupta and Mäler, 2000). However, the rule is optimal only under strict conditions: max-min preferences; a constant population size; constant returns to scale in production; no technical progress (Dasgupta 2001).

Figure 2: Effects of a windfall on foreign assets, domestic capital, and consumption
(all expressed as a proportion of consumption in the absence of the windfall)

2a) Permanent income hypothesis

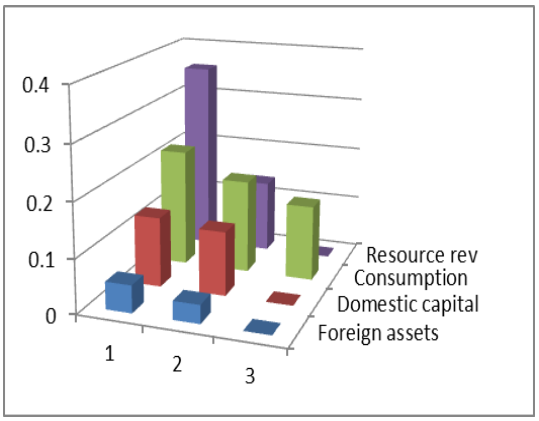


No uncertainty

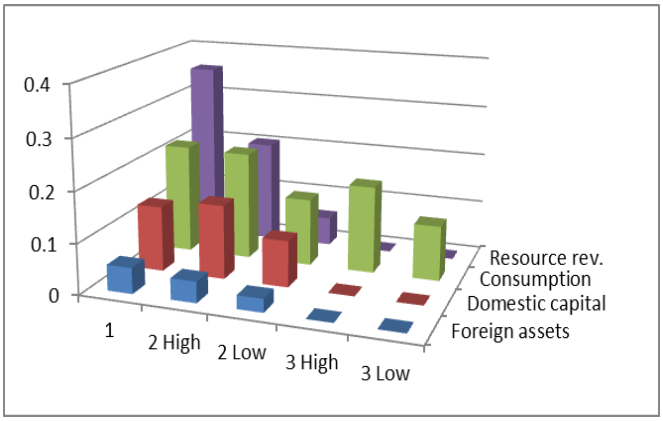


Uncertainty about period 2 windfall

2b) Capital scarcity



No uncertainty



Uncertainty about period 2 windfall

2.3. Capital scarcity: using windfalls to boost economic development

In sections 2.1 and 2.2 domestic investment decisions were completely separated from the resource windfall. Under what circumstances should some part of resource revenues be used to invest in domestic capital? One possible mechanism is that revenues relax a constraint on public funds, leading to a reduction in distortionary taxes or increase in public investment. Another is that resource wealth relaxes a constraint on access to capital. Suppose that the economy is capital scarce and faces a high cost of borrowing, modelled as $f < 0$ with $r(f)$ decreasing in f, so $r(f) > r^*$ and the country faces an upward sloping supply curve of foreign capital.[7] To see the implications of this, suppose first that there is no uncertainty ($N_2^H = N_2^L$) and no absorption issues ($a(k_1) = a'(k_1) = 0$). In the absence of resource revenues the economy is on a path of asset accumulation, rising consumption and falling interest rates. Resource revenues are now divided between consumption, an increase in f that brings down the marginal cost of capital, $r(f)+ f r'(f)$, and a consequent increase in investment in domestic capital (equations (3) and (4)). This is illustrated for a temporary known windfall in the left panel of figure 2b. The back row gives the same resource revenues as before, although now illustrated relative to a different consumption path. The next row illustrates that consumption is not perfectly smoothed, but instead the consumption increment is skewed toward the current, relatively poor generation. The front row gives the change in foreign assets, now much smaller as most saving goes into investment in domestic capital (second row). Notice that this is different from the permanent income hypothesis in two distinct ways. First, the consumption increase is largest in period 1, reflecting the fact that future generations in this economy are richer than the present, so consumption increments should be skewed towards the present. Second, since the economy is capital scarce (unable to borrow unlimited amounts to build domestic capital), some of the windfall is devoted to increasing the domestic capital stock.

The right hand panel of figure 2b gives the case where, additionally, the size of the second period windfall is uncertain, i.e., $N_1 = N$, $N_2^H = 0.75N$, $N_2^L = 0.25N$. Consumption levels

[7] This draws on van der Ploeg and Venables, 2011a who assume $r(f) \geq r^*$, $r'(f) \leq 0$ for $f < 0$ and $r(f) = r^*$, $r'(f) = 0$ for $f > 0$, thereby encompassing capital abundant (PIH) economies and capital scarce countries. An ad hoc specification of the risk premium is adopted, in contrast to literature on reneging sovereign debt (e.g., Bulow and Rogoff, 1989) and subsequent literature on political economy aspects of debt repudiation (Amador, 2008)

and accumulation of foreign assets and physical capital are greater in the high than in the low state, and first period consumption is very slightly reduced due to precautionary saving.

2.4. Absorption constraints: case for a parking fund

Now consider absorption constraints which occur if investment is difficult to scale up. We capture this with a rise in the marginal cost of investment, $a(k_1)$, $a'(k_1) > 0$. If there is no capital scarcity, then we have first and second period investment levels determined by $y'(k_0 + k_1) + \frac{1-\delta}{1+r^*} = 1 + a'(k_1)$ and $y'\left((1-\delta)(k_0 + k_1) + k_2^i\right) + \frac{1-\delta}{1+r^*} = 1$. Evidently, the effect of an absorption constraint is to reduce investment in the first period, k_1, and to fully offset this with higher second period investment. The implication is that more wealth is carried forward from the first period in the form of foreign assets. We refer to this as a '*parking*' motive for holding foreign assets. Since they cannot be effectively invested domestically in the first period, they have to be temporarily 'parked' in foreign funds instead. If there is also an absorption issue in the second period, then the domestic capital stock is lower in both periods, although the deferment of investment is slightly less.[8]

2.5. Summing up

Our highly stylised model illustrates a number of key points. The first is that a high fraction of the revenues created by an exhaustible resource should be saved. The benchmark case is the permanent income hypothesis, and uncertainty about future revenues might increase the savings rate still higher. However, for a developing country that is capital scarce and consequently on a rising consumption path, there is a case for the current (relatively poor) generation to consume more than is suggested than the permanent income hypothesis. Second, savings should be

[8] If there are adjustment costs in both the first and second periods, then (3) and (4) become:

$$y'(K_2^i) + \frac{1-\delta}{1 + r(f_2^i) + f_2^i r'(f_2^i)} = 1 + a'(k_2^i),$$

$$y'(K_1) + \frac{1-\delta}{1 + r(f_1) + f_1 r'(f_1)} \left\{ 1 + E\left[a'(k_2^i)\right] + \frac{\mathrm{cov}\left[u'(c_2^i)a'(k_2^i)\right]}{Eu'(c_2^i)} \right\} = 1 + a'(k_1).$$

The covariance term is negative, since if period 2 is in the good state its investment is expensive, but also its consumption has low marginal utility. This interaction tends to boost period 1 investment.

divided between investment in the domestic economy and acquisition of foreign assets (reduction in foreign liabilities). For the benchmark case of a capital abundant economy facing a given world interest rate all investment should be in foreign assets, while a capital scarce economy will want to invest a higher proportion domestically, subject to absorption constraints. This suggests three distinct reasons for use of foreign funds; the intergenerational motive of long term consumption smoothing; the stabilisation motive of smoothing short and medium run volatility; and the parking motive, of postponing domestic spending until the economy can make and implement efficient spending choices. The balance between these cases is, of course, country specific. Norway and the Netherlands are capital abundant and should build future generations funds[9], while for Nigeria it might be appropriate to invest heavily in the domestic economy, subject to ability to absorb investment efficiently and the need for such a resource dependent economy to stabilise spending in the domestic economy. With this framework in place, we now look in greater detail at the determinants of saving and investment choices in resource rich economies.

3. Saving resource revenues

In the previous section we derived criteria for how much of the windfall should be consumed or saved and showed how this depends on country characteristics. However, although many resource rich economies are saving more in the recent than in previous commodity booms, the concern is that there has often been too little saving and too little investment. To analyse the reasons for this we look first at public finance, and then at the responses of the private sector.

3.1. Public finance

A resource windfall creates both opportunities and demands for spending, even if it is low quality spending. On the supply side, the direct effect of resource revenues may be amplified by the fact that the presence of resources provides collateral for borrowing; newly resource rich economies are likely to find that international capital markets are suddenly opened to them and

[9] The Netherlands put its gas revenue into a Fund for Strengthening Economic Structure rather than into a Sovereign Wealth Fund. This is not necessarily optimal for an open economy that is well integrated into the world capital market. It created political economy distortions as regions and ministries bid for funds.

credit constraints are removed. This has led to surges in international borrowing; the spending may be unproductive and low return, but the collateral provided by the resource means that lenders are nevertheless willing to lend, especially when commodity prices are high (Mansoorian 1991, Mansano and Rigobon 2007).

On the demand side, increased availability of funds typically increases demand for spending. This is an aspect of 'deficit bias' that has been widely analysed in two broad sorts of models. One is based on the competing demands on an incumbent government for spending from a common pool of public funds. The other is based on political competition which may create incentives for current government spending. What do these approaches say about the effect of a resource boom?

The first approach is captured in economic models in which fiscal discipline is weak and groups are powerful enough to obtain public spending for their projects (e.g. Velasco 1999, Tornell and Lane, 1999). The groups concerned might include spending ministries, regional governors or city mayors, with legitimate claims on public funds. However, since the tax base is shared while benefits of these projects accrue disproportionately to members of a particular group, each will overbid for funds, even if they recognise that their own projects have low returns and displace higher return commonly owned public assets. Increased availability of public funds, such as arising from a resource boom, might be expected to increase bids approximately in proportion, but it is possible to construct cases where low return projects will come to take a much larger share of the whole, so that high return projects and hence income may actually be reduced. For example, Tornell and Lane (1999) analyse a model with an asset that is privately owned and another asset that is public. They assume that during a resource boom returns to public assets increase and, so in a Markov perfect equilibrium outcome of a differential game, groups 'voraciously' deplete the common pool asset and appropriate more than the increment to available funds, thereby lowering investment and the rate of economic growth. While this is an interesting possibility, its application to a resource boom seems limited by the assumption that the boom causes the return to the public asset to increase. Nevertheless, the common pool mechanism for deficit bias is important. Simpler mechanisms under which a resource boom would worsen this bias (such as decreasing costs to bidding from the pool) need to be examined.

The second type of model is based on competition between political groups. At its simplest, this is just the idea that public spending is distorted to favour partisan groups. If the probability of the incumbent government losing power is high, this becomes an intertemporal distortion, with the current government spending heavily on its favoured group, and passing on too little capital (or too high levels of debt) to the next government (Alesina and Tabellini, 1989, 1990, Alesina and Drazen, 1991). Resource revenues increase the scale at which this spending can take place, although do not add anything qualitatively additional to the argument.

More interesting is the idea that revenues are used by the incumbent government to increase the probability of staying in power or winning an election. While expenditures during the current government may influence voters (e.g. by building a reputation for partisanship), the important point is that if voters are forward looking, then government has to make credible commitments to future partisan expenditures. For example, the government (party A) must initiate spending which it can credibly commit to continue if it wins the election, but which the opposition party (B) would cancel. Public sector employment is a good example (Robinson, Torvik and Verdier 2006). The incumbent government hires its supporters and there is a fixed cost to firing them. If, after the election, this cost is less to party B than to party A, then the employees have an incentive to vote for party A. In this model it is possible that a substantial fraction of resource revenues are dissipated in this sort of expenditure and, if public employment is of lower social value than the alternative, real income is reduced by a resource windfall. Of course, public employment is not the only mechanism for making credible election promises. While public employment levels are high in many resource rich countries, so too are partisan motivated 'white elephant' construction projects (Robinson and Torvik 2005). Other inefficient transfer mechanisms include a variety of subsidies, especially those on fuel used by households and favoured industries.

Resource revenues can also be expropriated by dictators or 'kleptocrats', whose principal interest is in holding onto power. Numerous authors argue that resource wealth increases the probability that such leaders stay in power. This may be through the ability of the leader to buy off opposition or to fund oppression (e.g. Acemoglu et al., 2004). These activities may mean there are less funds (or less leader's time) left for economic development, although could also lead strategic leaders to promote the interests of citizens (Caselli and Cunningham, 2009). Also,

the windfall raises the stakes of the opposition to try to gain office and may thereby make the incumbent ruler more myopic.

There are thus political reasons why resource revenues are not put to productive use. How can such spending pressures be countered? There are three standard answers. The first is to have high levels of transparency; the president's spending spree is thereby visible and he can be held accountable for inefficient spending; spending agencies are accountable to parliament and the public this, possibly, placing a check on grossly inefficient spending. The second is to ensure that the political system has a centralised system of financial control and authority. The finance ministry is, in principle, the body that can trade-off the competing demands of spending ministries, regional authorities, or other lobby groups. It is best placed to internalise the free rider problem associated with a common pool of government revenues. However, to play this role effectively the finance ministry has to have control of incoming revenues, and the political will and power to be able to resist competing demands.

The third mechanism is to legislate a 'fiscal constitution' that imposes ceilings (and perhaps also floors) on public spending from resource revenues or public funds more generally (cf., Poterba and Von Haagen (1999) and Primo (2007) and the discussion about the balanced budget amendment in the US or Frankel (2011ab) on the fiscal constitution in Chile). Many countries now have such rules, although few are effective. To be so, they have to robust to changing political and economic circumstances, while at the same time not being so rigid as to rule out extraordinary responses in extraordinary times. We give more detail on fiscal rules in section 3.3 below, in the context of revenue volatility and stabilisation.

3.2. Private saving

Point source resource revenues accrue in the first instance to government, but their impact on total savings depends on the response of the private sector, as well as direct saving by government. Private sector behaviour may be altered through three main channels. The first is simply that revenues are handed over to citizens through citizen dividends or adjustments in taxes, subsidies, or social transfers; consumption and saving decisions are then taken by private individuals not the state. The second is that the government may alter its net domestic debt, perhaps by domestic debt reduction or by initiatives to lend resource revenues to the private

sector. The third arises as current government saving changes government solvency and may change household expectations of future taxes and transfers, thereby affecting current decisions. We discuss each of these, starting with the last.

Under the conditions necessary for Ricardian equivalence (i.e. altruistic infinitely lived dynasties, perfect capital markets) government saving behaviour could be completely offset by private responses. Government may behave prudently, for example putting resource revenues in an offshore savings fund. If consumers then anticipate higher future benefits (e.g. pensions), they save less and so public prudence is cancelled out by private spending. The recent experience of Kazakhstan may be a case in point. The government was prudent during the period 2004-8, saving about two thirds of its oil and gas revenues and building up sovereign wealth and reserves of around $50 billion. However, in the same period the private sector foreign debt increased by around $30 billion and the current account remained approximately in balance. Private borrowing was used to fuel a real estate and construction boom which eventually burst (Esanov and Kuralbayeva 2011). While it would be incorrect to infer that Kazakhstani households were perfectly Ricardian – there were other changes including a major financial market deregulation during the period – the case provides an example of how public prudence can be undermined by profligate private borrowing and spending.

A frequently expressed view of the best way to handle resource revenues is to hand them to private individuals through citizen dividends and, if government needs to raise funds for public expenditure, it should do so by taxing back some of the dividend. Some limited citizen dividend schemes are in operation (in Alaska and Alberta) and it is generally the case that taxes in resource rich regions are somewhat lower than they otherwise would have been. What are the pros and cons of transferring the proceeds directly to private individuals in this way?

The main advantage is that it establishes the principle that the resource belongs to citizens and is being used for the benefit of citizens as a whole rather than to enrich a small elite. In countries with bad governance it is important to get funds out of the reach of government as rapidly as possible, as has been argued for the case of Nigeria (Sala-i-Martin and Subramanian 2003). The relevance of the argument is of course questionable, since the countries with the worst governance are unlikely to implement such a scheme, and those most likely to implement it have least need of it. The scheme could however be a commitment mechanism; a well

intentioned government might introduce the scheme, knowing that it could be difficult for succeeding governments to reverse.

The second advantage of direct distribution to citizens is to do with the microeconomic detail of spending. Private individuals are better at identifying investment projects than are government officials, and have sharper incentives to implement them well and make sure they succeed. Underdeveloped credit markets mean that many high return investments do not get undertaken, and putting cash in the hands of individuals may remove credit constraints and cause such investments to be made. This argument is supported by the evidence that agricultural based resource booms have had more positive effects than booms in 'point resources' such as minerals or oil, in part because individual farmers have used additional income to increase investment in their smallholdings (Isham et al 2005, Boschini 2007).

There are some counterarguments. The first concerns the intergenerational distribution of the benefits. Will private choices lead to the optimal time profile of consumption versus investment that we discussed in section 2? Individuals currently alive may give too little weight to future generations and save too little. This spending bias may be exacerbated if people overestimate the size and duration of the revenues. The argument has particular force for the proceeds of a resource windfall, which the current generation has no particular claim to 'own' any more than does any other generation. Furthermore, the timing of individual spending decisions might contribute to short run booms and loss of macroeconomic stability, since private individuals do not internalise the effects of their decisions on prices and the level of activity. Even if individuals wanted to save a sufficiently large proportion of the windfall, they would not necessarily do so by undertaking their own investment projects. Efficiency therefore requires an effective system of financial intermediation which both rewards depositors and identifies investors who can best use the funds. Without such a system, the argument that the private sector has better information and incentives than the public sector is eroded. Of course, cutting in the other direction, substantial cash transfers to citizens would be a powerful force to promote development of a wider and deeper financial system.

The preceding arguments were couched in terms of a 'citizen dividend' or pure transfer. An example of such a fund is the Alaska Permanent Fund which receives a quarter of oil revenue received by the state government and gives a cash payment to all those who have been resident

for at least a year. The payment is based on interest earned on the funds, so has been growing gradually over the years. In practise, in most countries' transfers to the private sector are likely to take place through adjustment of taxes, subsidies, or social protection schemes, each of which has to be evaluated on its own merit. Evidence suggests that, on average, for each dollar of hydrocarbon resource revenue accruing to government, domestic tax revenue falls by around 20 cents (Bornhorst et al. 2009). These distribution channels will have their own incentive effects, which may be adverse or beneficial. Fuel subsidies are one way to make the transfer, and they have a superficial political attraction in an oil rich country; however, they are not only inefficient and wasteful but also, particularly in developing countries, likely to be regressive as the poor typically do not have a car and use less fuel (Coady et al., 2006; Baig et al., 2007; Coady et al., 2010).[10] Unproductive public sector jobs (including those in highly inefficient state owned refineries as in Mexico) and public pensions in countries as diverse as Kuwait and Bolivia are another way to make the transfer. Beneficial incentive effects can be generated if the transfers take the form of reductions in other distortionary taxes and charges, or if they are linked to some 'merit' activity. Conditional cash transfers (e.g. transfer programmes conditional on school or clinic attendance) have well documented benefits (Rawlings and Rubio 2005). Evidently, the balance of these arguments is country and expenditure channel specific. Overall, while there is a case for some direct distribution, the presence of multiple market failures means that there is no presumption that such distribution to citizens produces an efficient or equitable allocation either within or between generations.

A further alternative is that resource revenue is not given to the private sector, but lent to it. While there is no direct wealth effect, the asset/ debt structure of the private and public sectors can be changed either by government lending or by retiring domestic debt. Government lending could go through institutions such as Development Banks. The historical record of such banks has generally been poor, although it may be worthwhile for countries to revisit and rethink domestic lending options, either through reformed Development Banks, or perhaps through institutions that target particular needs, such as lending for residential construction. Domestic

[10] Coady et al (2010) estimate that petroleum subsidies amount to $250bn pa, and 'tax-inclusive subsidies' i.e. relative to 30c per liter gasoline tax, amount to $710bn pa or 1% of global GDP. Although Azerbaijan, Bolivia, Ecuador, Egypt, Indonesia, Jordan and Yemen have fuel subsidies varying from 3 to 13 percent of GDP, Iran has in 2010 decided to scrap fuel subsidies.

government debt reduction is, at the aggregate level, equivalent to new government lending. Using resource revenues to buy back government bonds should reduce domestic interest rates and induce asset holders to acquire other assets, domestic and foreign. One important mechanism may be that a reduction in government debt deprives commercial banks of the easy option of simply lending to government, and thereby induces them to be more pro-active in seeking out other lending opportunities. However, there is little evidence on the relationship between changes in government debt and lending to the private sector, and a commonly held view is that the response of private sector investment might be quite low.

3.3. Volatility and stabilisation

Resource revenue is often highly uncertain and volatile, and this is one of the most damaging aspects of resource dependence. The study by van der Ploeg and Poelhekke (2009) suggests that higher macroeconomic volatility swamps any positive direct effect of resources on economic growth, especially in landlocked, ethnically fractionalised countries with poor financial systems, unrestricted international capital flows and barriers to trade. Their estimates suggest that, if resource rich Africa could bring down its macroeconomic volatility to that of the South East Asian Tigers, it would get almost a 3 percentage points per annum growth increment. During the 1970's when commodity prices were high, resource rich countries used their reserves as collateral for borrowing but during the 1980's commodity prices fell significantly. Panel data estimation suggests that this has thrown many of these countries into debt crises. Indeed, if debt is also an explanatory variable in the panel data estimation, the effect of resource dependence disappears, suggesting that the effect of resource dependence has been driven mainly by boom bust cycles induced by volatile commodity prices, debt overhang and credit constraints (Mansano and Rigobon, 2001). Furthermore, government policy (both fiscal and monetary) and capital flows tend to be more pro-cyclical in resource rich countries (Frankel 2011a,b).

3.3.1 Hedging

There are several strategies for coping with volatility. Contracts with resource companies share risk, depending on the progressivity of the royalty and corporate tax regime (see Daniel et al 2010). There is a trade-off however, as tax regimes that share risk may be politically untenable;

if the share of revenues going to companies increases during a period of high prices, the country appears not to be receiving its share of a resource boom.

The most direct way to handle commodity price uncertainty is to sell the resource forward and/ or purchase options or other derivatives. A celebrated example of this strategy is Mexico's purchase in early 2008 (when oil was $120 per barrel) of an option to sell at $70 per barrel. The option cost $1.5 billion and, when it was exercised in 2009 (when the price had fallen to $40), earned Mexico some $8billion. There is scope for countries to engage more in hedging activities of this type, although they will not offer full stabilisation. Contracts are typically quite short. Politically, it is difficult for a government to repeatedly spend billions of dollars on options that will, usually, not be exercised. And use of such strategies by large producers would raise issues of market power and moral hazard.

3.3.2 Stabilisation funds

If revenue flow is not fully stabilised by hedging, then its impact on the domestic economy can be managed by a *Stabilisation Fund*, as suggested by our analysis of section 2. When prices (or total revenue flow) are high then revenues (above some 'normal') level are paid into the fund and held in foreign assets; when prices are low withdrawals from the fund are made. A number of issues surround the design of such funds (see also Frankel 2011a,b).

First, the criteria for depositing or withdrawing revenue from the fund could be linked to resource prices, total revenues, or to other macroeconomic considerations that reflect the economic cycle or the state of public finances. For example, in 2001 Chile instituted a fiscal rule whereby government expenditure is a function of structural revenues and is set to achieve a target structural fiscal balance, originally set at surplus of 1 percent of GDP (see Fuentes 2011). Structural revenues are computed on the basis of resource prices (copper and molybdenum) being at long run equilibrium and GDP being at long term trend level; judgements on both these variables are made by an independent committee. Differences between actual revenues and those needed to attain the target structural balance are paid into the Fund for Social and Economic Stabilisation (now supplemented also by the Pension Reserve Fund). The policy has been highly successful, with the funds attaining a value of nearly $20 billion in late 2008, and then being run

down to support government spending following the collapse of the copper price and the financial crisis.

The second issue concerns the optimal size of the Stabilisation Fund. While the size will vary over the economic cycle there needs to be some target fund size if it is to be able to smooth a downturn. The economic determinants of this are the persistence and standard deviation of the stochastic process driving the resource price, the marginal benefits and costs of increasing or decreasing spending in different phases of the cycle, the marginal returns to lending versus the marginal cost of borrowing in a downturn, and the degree of prudence of the policy maker. These are unknown parameters, so a judgement will inevitably be formed on some ad hoc basis

The third issue is to do with the legal status of the fund and the balance between rules and discretion. At one extreme are discretionary practises; virtually all resource rich countries have Central Bank monetary operations which use foreign exchange reserves as a stabilisation mechanism. At the other extreme are the formal rules, perhaps best exemplified by Chile. Formal rules have a number of advantages. Their credibility means that they stabilise private sector economic expectations, so facilitating economic management. Since they are binding on politicians, they constrain discretionary spending in the medium run as well as in the short run. They may help solve time consistency problems, since the legal structure will be inherited by future politicians. However, governments can repeal – or in some cases ignore – legislation. A stabilisation fund which is vulnerable to looting is worse than no fund at all. Nigeria's experience saw its stabilisation fund (the Excess Crude Account) rise to $30 billion in 2008 only to fall to zero by 2011, with most of the withdrawals unaccounted for. Essentially, this was a transfer from the well intentioned politicians who set up the fund to the less well intentioned who ran it down.

3.3.3 Macroeconomic management

Many developing resource rich countries will lack the hedging strategies or stabilisation funds that can completely insulate the domestic economy from commodity price movements. Furthermore, the direct revenue flows to government are not the only source of commodity induced instability. There are large private sector responses and international capital flows. The capital flows might be associated with investment in the oil sector (in Azerbaijan foreign direct

investment peaked at 30 percent of GDP in 2003) or with short run speculative flows, such as the purchases of Zambian government domestic debt at the height of the copper boom in 2006, which led to a near doubling in value of the currency. How should these sources of instability be managed?

First, active monetary management may be needed. Since these are foreign exchange flows – public or private – foreign exchange intervention will be needed to maintain stability of the exchange rate. Associated with this there will be a need to sterilise the monetary implications of flows. Eventually this will come apart and the liquidity in the economy will be boosted, thus leading to inflation. To avoid pro-cyclical monetary policy it helps to have a strong anchor for inflation expectations by targeting not the consumer price index (CPI) but the producer price index which has a much bigger weight of natural resource exports (Frankel, 2011a,b).[11] The advantage is that, compared to CPI targeting, this will tighten monetary policy and appreciate the currency when commodity prices go up and ease monetary policy and boost exports when commodity prices fall. Credible targeting requires an independent central bank, so as not to create a moral hazard problem for the fiscal authorities by having to contract monetary policy when insufficient amounts of the windfalls are saved and the currency becomes uncompetitive.

Second, it is particularly important that economies subject to these sources of volatility are flexible – with flexible labour markets and a minimum of other nominal or real rigidities so that the economy can quickly adjust to the imbalances caused by temporary, anticipated windfalls. For example, anticipation of resource windfalls in a small open economy with sluggish labour markets, rational expectations and perfect international capital markets will lead to an appreciation of the real exchange rate and thus to unemployment ahead of the windfall (Eastwood and Venables, 1982).

Third, independent fiscal authorities and strong ministers of finance (see discussion in section 3.1) can avoid the pitfalls of pro-cyclical fiscal policy and not saving or investing enough of the windfall. Crucial in this respect is to have a structural budget rule and an independent

[11] Exchange rate targeting has fallen from grace since the currency crises of the 1990s. With exchange rate targets one typically has (in the absence of sterilisation) excessive expansion of money and credit, overheating and inflation during the commodity boom and a currency crisis when commodity prices fall again. It is better from a macro perspective to adjust via exchange rate appreciation in booms and depreciation in busts.

committee of experts to produce official forecasts that cannot be manipulated for political purposes, and are less prone to over-optimism, especially in boom times when the scope for wishful thinking is greatest (Frankel, 2011b). The experience of Chile suggests that such institutions can ensure that a resource rich is more likely to run surpluses during a commodity boom and deficits during a bust. Contra-cyclical fiscal policies also help to avoid the destructive impact of pro-cyclical capital flows.

Finally, in so far as some of fluctuations are coming through public spending, government should form a view about what sorts of expenditure can be varied (increased and decreased) through time at little cost, and what are hard to reverse. For example, increases in the pay of government employees, given during a time of boom, are almost impossible to reverse. The over-generous Dutch benefit system installed during the natural gas boom of the 1970s took a generation to unwind. More generally, spending that leads to increases in consumption are hard to reverse, because habits are formed and political resistance will be high. By contrast, fluctuations in levels of investment are easier to manage; it is a characteristic of all economies that investment is less stable than consumption. Consequently, if variations in government spending cannot be completely separated from variations in resource revenues, it is probably better to have such variation impact on public investment rather than private consumption; too rapid increases are then more easily reversed.

4. Investment and growth

We now turn the focus from saving to investment, looking in particular at issues encountered in investing the domestic economy. We suggested, in section 2, that savings should generally be divided between foreign asset accumulation (or debt reduction) and investment in the domestic economy, with capital scarce developing economies emphasising the latter. Potentially, the rate of return on such investments is high and has potential to stimulate private investment (e.g. Spence 2009), yet in practise both returns and investment rates have often been low. We look first at public sector investment, focusing on some of the short and medium run issues to do with effective absorption of an increase in investment. We then turn to the private sector, looking at the longer run issues of structural change and the Dutch disease.

4.1. Public investment and absorptive capacity;

The shortage of public and publicly funded capital in low income countries is well documented by the Growth Commission (Spence 2009). Studies suggest that considerable growth benefits follow from increasing stocks of public infrastructure (e.g. Calderon and Serven, 2008) and that there are complementarities between public infrastructure and private investment. Resource revenues provide a way of meeting this shortage, but where attempts have been made to do this the efficiency of public spending has often been very low. Recent empirical evidence suggests that resource rents typically *reduce* the public sector capital stock, especially in ethnically fractionalised volatile countries with poor institutions (Bhattacharryya and Collier, 2011).

A major issue is the efficiency of public sector investment. Systematic measurement of this is now provided by the Public Investment Management Index (PIMI) constructed by Dabla-Norris et al. (2011) primarily on the basis of investment management, public procurement, and public expenditure and financial accountability databases compiled by the World Bank and IMF. Gupta et al (2011) use the index to estimate the fraction of public investment that translates into actual productive capital, and suggest that in developing countries on average, only about half of public investment translates into capital. Disaggregating the PIMI into the various stages of public investment shows that low income countries are slightly worse at project selection and evaluation but better at implementation than middle income countries. Oil exporters have, on average, significantly lower PIMI scores than do non-oil exporters. Gupta et al. (2011) also calculate the PIMI adjusted public capital stock. They find that, for their sample of 71 low and middle income countries, the stock of effective public capital has declined from 57 percent in the 1960s to 36 percent of GDP in recent years, despite a 20 percent increase in the unadjusted public capital stock during the same period. However, the stock of adjusted public capital has a sizeable significant positive effect on the rate of economic growth. Interestingly, the efficiency of public investment also significantly affects growth directly, especially for low income countries.

There are a number of reasons to think that the efficiency of public investment is likely to be particularly low in a country experiencing a resource boom and trying to scale up spending. Applying a conventional quadratic investment adjustment cost model to the PIMI framework, any increase in the investment rate will reduce the PIMI. One likely reason for this is limited

technical capacity and information. Ideally, the government will have a stock of spending plans, each of them subject to rigorous ex ante appraisal (a social cost-benefit analysis). However, assembling a set of prioritised spending plans and subjecting them to such analyses is hard, requiring information and technical expertise that is lacking even in countries with a large government economic service. The problem is acute in most developing countries, although it is noteworthy that projects put forwards for Botswana's National Development Plans have to pass a strict social cost benefit test.[12]

A further problem is to do with incentives. Even if information and technical skills are present, corruption is notoriously widespread in public procurement of investment projects. A recent study which shows how reported spending of oil revenue fails to translate into real outcomes is that of Caselli and Michaels (2011). Using variation in receipts from oil revenue among Brazilian municipalities they show that municipalities that receive higher revenues from oil royalties report correspondingly higher spending on public goods and services. However, survey data and administrative records indicate that this higher reported spending has led to little (if any) increase in social transfers, public good provision, infrastructure, and household income. To explain why some of the oil windfall has apparently gone missing, they show that large oil receipts increase instances of alleged illegal activities associated with mayors

Ramping up spending in an effective manner encounters not only political and administrative obstacles, but also economic ones. Depending on the economy's supply response, extra spending will be met by some combination of price and quantity change. The long run aspect of this is the Dutch disease (next sub-section). In the short and medium run the combination depends on the slope of supply curves for the goods and services demanded. For goods that are internationally traded supply curves will be close to flat: imports can be drawn in without significant increases in their prices (although they may encounter other constraints, such as port capacity). The relative price effects will be more severe for goods and services that are non-traded. Often the construction sector is the first sector in which supply problems show up. Resource funded infrastructure investment might coincide with private sector resource related investment (e.g. office construction) leading to a construction boom and a rapid increase in the price of non-tradable inputs including some labour skills. As a consequence the purchasing

[12] Botswana is heavily dependent on diamond revenues, and has been one of the fastest growing countries in the world over the last 50 years.

power of public expenditure is reduced and this brake on infrastructure investment creates other bottlenecks in the economy – in road capacity and traffic congestion for example. The price effects are likely to be most acute where there are sector specific inputs that are hard to replicate, or that take a long time to produce. For example, production of a non-traded good might require capital goods that are non-traded and which themselves require non-traded capital, and so on; if it takes local teachers to produce teachers, then expansion in supply is inevitably slow and price effects will be large.[13]

These points suggest several recommendations for government to increase the effectiveness of public spending. First, it is important that the economy is open to international trade; the windfall is incurred in foreign exchange, so drawing in extra imports directly is appropriate, and will mitigate price increases. Second, it is possible to anticipate many of the bottlenecks that will arise in trying to increase spending; ports and roads will become congested, and there will be shortages of particular goods and especially of some labour skills. This is an argument for acting early to invest in those activities that are needed to support a wider increase in investment in the economy. Third, the government needs to ensure that the business environment facilitates entry of new firms and an expansion of employment; restrictions to either of these will be particularly damaging during a resource boom and while government is seeking to increase spending in the domestic economy. Finally, the government might need to use a 'parking fund', as outlined in section 2, to postpone spending until these absorption constraints have been addressed.

4.2. Private investment and the Dutch disease: the long run

A resource boom will have general equilibrium effects that change the rate of return on different activities in the economy and lead to structural change. The well known phenomenon of the Dutch disease arises if part of the resource windfall is spent on non-tradable goods, increased production of which crowds out tradables sectors (e.g. Corden and Neary 1982). The mechanism is appreciation of the real exchange rate (the relative price of non-traded goods), and the counterpart in the balance of payments is a non-resource deficit, financed by resource exports.

[13] See van der Ploeg and Venables (2011b) for dynamics with this sort of absorption problem.

Several analytical points need to be made about this process. First, as noted above, the balance between price and quantity effects will vary through time, with price effects likely to be large in the short run and quantity effects larger in the long run (van der Ploeg and Venables 11b). Second, Dutch disease effects are mitigated if there are unemployed resources in the economy. In this case higher spending might draw unemployed labour into use, instead of drawing labour out of the traded goods sector. There is then an increase in income which draws in additional imports, rather than reducing non-resource exports. Third, the Dutch disease should only be a matter of concern if the activities that are crowded out have external benefits for the economy. This is often thought of as tradable sectors being prone to increasing returns to scale or learning by doing externalities (e.g., van Wijnbergen, 1984, Sachs and Warner, 1997a), in which case a temporary resource boom will lead to a temporary decline in the growth rate and thus to permanently lower levels of consumption and welfare. Finally, higher demand for non-tradables is not the only mechanism that may induce crowding out. For example, Mehlum et al. (2006) assume that a fixed number of individuals have entrepreneurial skills that can be used in either productive activities or unproductive rent seeking. If a resource boom makes rent seeking more attractive, entrepreneurs abandon modern production until private returns in the two pursuits are equalised. There is full dissipation of the rent and – if there are positive externalities associated with productive activities – a reduction in real income.

Early evidence for a shrinking manufacturing sector in response to terms of trade shocks and real appreciation has been mixed (e.g. Sala-i-Martin and Subramanian, 2003). However, more recent evidence for 135 countries for the period 1975-2007 indicates that the response to a resource windfall is to save about 30 percent, decrease non-resource exports by 35-70 percent, and increase non-resource imports by 0-35 percent (Harding and Venables 2011). Ismail (2010) uses disaggregated sectoral data for manufacturing and finds that a 10.0 percent oil windfall is on average associated with a 3.4 percent fall in value added across manufacturing, but less so in countries that have restrictions on capital flows and for sectors that are more capital intensive. Using as a counterfactual the Chenery-Syrquin (1975) norm for the size of tradables (manufacturing and agriculture), Brahmbhatt et al. (2010) find that countries in which the resource sector accounts for more than 30 percent of GDP have a tradables sector 15 percentage points lower than the norm. Macroeconomic and sectoral evidence thus seems to offer support

for Dutch disease effects. Interestingly, Kuralbayeva and Stefanski (2010) show that both cross-country and US county level evidence suggests that resource rich areas have relatively small but high productivity manufacturing, and large but low productivity non-manufacturing.

5. Resource depletion

In the analysis so far we have considered how to respond to exogenous natural resource windfalls. But these windfalls are, of course, not entirely exogenous, depending on the rate of resource discovery and resource depletion. An alternative way of managing resource wealth is to alter these rates.

Benchmark models of natural resource extraction follow some variant of the Hotelling (1931) rule. In its simplest form, this arbitrage rule requires that the return on keeping natural resources in the crust of the earth (i.e. the capital gains) should equal the return on depleting and selling the natural resources and investing the revenues. The expected rate of increase in oil and other exhaustible natural prices must thus rise at the market rate of interest, and the rate of total world resource extraction adjusts to bring this about. This result still holds if the natural resource owners have monopoly power provided demand is iso-elastic. Extensions of the Hotelling rule allow for stock-dependent extraction costs.[14] In that case, the Hotelling rule requires that the rate of increase in the scarcity rent (i.e. the revenue minus extraction cost) must equal the rate of interest. If oil extraction costs rises as reserves diminish, the Hotelling rule implies that oil prices rise less rapidly and exploration becomes more conservative Further work separates out the rate of depletion of fields from the date at which new fields are opened (Venables 2011). In this case the rate of price increase may be completely independent of the rate of interest, instead being determined by the costs and availability of new fields.

[14] Uncertainty concerning levels of demand and reserves affects resource depletion (Pindyck, 1980). For example, stochastic volatility of natural resource prices makes extraction more aggressive with prudent preferences (van der Ploeg, 2010). With uncertainty about reserves, it is prudent to deplete less fast to make reserves last longer, but to explore more aggressively to find out whether there are more reserves. More generally, optimal extraction in face of stochastic price variation around a growth path implies that the ability to withhold production indefinitely and never incur the cost of production – the 'option' value of reserves – gives rise to an incentive to delay the rate of production of natural resources; having convex (concave) costs of resource extraction speeds up (slows down) extraction (Pindyck, 1981).

These models analyse the aggregate supply of a resource and the consequent path of the world price. What should guide the depletion policy of small open economy? Even though the Hotelling rule is not confirmed empirically (with prices of oil and many other minerals following a random walk Hamilton, 2009) it anchors price expectations.[15] If prices are expected to follow the Hotelling rule, then a country is indifferent about the time profile of depletion unless there are either features of its geology that make for a particular depletion path, or features of the economic environment that cause it to want to shift resource revenues forwards are back in time.

For developing countries a number of economic reasons suggest relatively fast depletion. The first is a high discount rate. As discussed earlier, developing countries are likely to be capital scarce, facing relatively high interest rates and returns to capital, in which case optimal depletion should be relatively rapid. Second, stochastic volatility of natural resource prices makes resource extraction more aggressive when exploring for new reserves, or when the government has prudent preferences (Pindyck, 1980, van der Ploeg, 2010). Third, for highly resource dependent economies the diversification motive is strong, once again suggesting fast depletion. But, cutting in the opposite direction is the ability of the country to make good use of the revenue. In countries with fragile states or inability to constrain wasteful spending (as discussed in section 3.1) the best option may be to keep oil and natural resources in the ground until the political system improves.

6. Conclusions

The 'resource curse' arises as countries fail to transform subsoil assets into surface assets that create a sustainable future income stream. The economics of this transformation is difficult, involving large changes, high degrees of volatility and uncertainty, and inter-temporal choices. The model sketched in section 2 of this paper outlines the economics of the main choices and some of the factors on which they depend. The politics of making and implementing the choices is even more difficult, and has meant that countries have systematically failed to make the best use of resource wealth.

[15] If faster price increases are expected then a resource importer should save to provide for these future increases, and a resource exporter should borrow and postpone extraction (Vincent et. al. 1997). A similar argument holds if a resource exporter expects future improvements in extraction technology.

The survey has reviewed the issues and the literature, and also offers a number of policy conclusions. The first is that a high proportion of rents from a non-renewable resource should be saved. However, in developing countries, the simple recommendations of the permanent income hypothesis (smoothing across generations) need to be modified to take into account the fact that the current generation is particularly poor. There is a case for current transfers both to reduce poverty and to put resource wealth into the hands of citizens rather than the political elite. This is particularly so if transfers take the form of conditional cash transfers (e.g. linked to health and education), although not if they take the form of distortionary transfers such as fuel subsidies. Achieving high saving requires that society can resist the current spending demands – legitimate and illegitimate – of competing constituencies and groups. This requires transparent and disciplined fiscal and public expenditure systems. Fiscal constitutions have assisted in some countries (notably Chile). Volatility is a particular problem, and needs to be addressed by operation of an off-shore stabilisation fund in conjunction with fiscal rules. However, this is not a cure-all: a fund that just transfers revenues from current well-intentioned politicians to future politicians who are less well-intentioned is worse than useless.

High saving is important, and so too is the way in which the savings are invested. In a capital abundant country the prescription is for putting funds in a long-run inter-generational sovereign wealth fund. This is not appropriate for a developing economy which has low levels of public, human, and private capital; the objective then should be primarily to invest in building these assets in the domestic economy. However, this often faces problems in the country's institutional, political, and economic capacity to identify and implement efficient investments. These absorption problems can be addressed, in part, by being open (thereby facilitating the real transfer of resource revenue into imported capital equipment), and by anticipating spending bottlenecks that are likely to arise. However, since there is no reason to believe that the time profile of revenue flows and of an efficient investment path are the same, revenues may need to be 'parked' off-shore until they can be effectively invested domestically. Public investments should be selected to be complementary to the private investment that is ultimately needed to drive long-run growth and diversification away from resource dependence.

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