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Sovereign Wealth Funds in Theory and Practice

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Abstract

Are natural resources a curse or a blessing? The answer may depend on how natural wealth is managed. By transforming a temporary windfall into a permanent stock in the form of a sovereign wealth fund, resource-rich economies can avoid volatility and Dutch disease effects, save for future generations, and invest locally. We review the theory behind these resource funds and explore the empirical evidence for their success. Our review is complemented by case studies that highlight some of the more nuanced features, behavior, and effects of resource funds. While the theoretical research highlights the situational success of funds, empirical examinations are minimal. We discuss possible reasons for this gap in the literature and, in doing so, highlight some of the challenges associated with empirical research in this area and discuss possible paths forward.

1. INTRODUCTION

Over the last half-century, sovereign wealth funds (SWFs) have become a major policy instrument for countries rich in natural resources to capture and invest these resource rents for the public good of their citizens. As a natural resource such as oil or coal is extracted and sold, the government captures some of the rents and grows the fund by either taxing a private seller or diverting some fraction of the public sale into the fund.[1] A natural resource–based SWF (NR-SWF) serves three main purposes: (*a*) as savings funds to address intergenerational equity from the depletion of nonrenewable resources; (*b*) as stabilization funds for current generations; and (*c*) as reserve investment and strategic development funds to spend on human, natural, social, and physical capital. Examples abound. Norway has created a US$1.2 trillion SWF from the sale of its oil reserves. Kuwait, Abu Dhabi, Qatar, Saudi Arabia, and other oil-rich countries have established their own multibillion-dollar SWFs. In the USA, Alaska has established an $81 billion SWF from oil sales; Wyoming has a $25 billion SWF from coal, oil, and natural gas sales; and New Mexico has a $34 billion fund mostly from oil.

In the case of these resource-rich countries, provinces, or states, SWFs have emerged as a tool to help address the long-standing question of whether natural resources promote or hinder economic growth and development. Recall the classic debate: Initially, many perceptive observers argued that natural resources should promote economic growth because resources can be used as a factor of production or sold off and the proceeds invested locally in various forms of physical and human capital. Intuitively, this argument makes logical sense—more resources, more growth. But, counter to this intuitive argument, empirical research (Sachs & Warner 1995, 2001) found the opposite—more resources, less growth (e.g., a resource "curse"). The countries most dependent on natural resources seem to grow the slowest, and this result has motivated a large literature that more generally explores the economic and political effects of natural resource wealth.

While the academic literature continues to debate the pros and cons of resource wealth,[2] SWFs have emerged as a promising policy tool to avoid some of the pitfalls associated with natural resource dependence. In this article, we examine the role of NR-SWFs in a modern economy. The basic question that motivates this review is whether SWFs should be more commonplace in natural resource policy. People have asked whether a country or state should create an SWF for every resource it possesses, not only the nonrenewable resources but the renewable resources as well (e.g., fisheries, forests, wildlife). We also wonder whether a country should create one large SWF (both resource-funded and non-resource-funded) to create a system that could support the idea of a universal basic income (e.g., Bolton et al. 2012, *NOĒMA* 2020). In Section 2, we discuss the theoretical underpinnings of why an SWF is attractive to real-world policy makers in research-rich economies. We then consider the empirical evidence for how well NR-SWFs have performed at achieving policy objectives. Section 3 highlights some of the inherent empirical challenges facing researchers working in this area. In Section 4, we present a set of three comparative studies of

[1] Not all SWFs are created from natural resource exports. In addition to receipts from resource exports, sources used to establish SWFs include balance of payment surpluses, foreign currency operation, any proceeds from privatization of public assets, governmental transfer payments, and any fiscal surpluses.

[2] Theoretical evidence supports the idea of a Dutch disease (Corden & Neary 1982) resulting from a booming natural resource sector, yet empirical evidence is weak (Allcott & Keniston 2018). Other researchers have argued that natural resources cause civil conflict (Collier & Hoeffler 2005b), yet, beyond case studies, this result is sensitive to modeling assumptions and specification (Nillesen & Bulte 2014). The interpretation of the negative relationship between resource dependence and growth has even been called into question (Brunnschweiler & Bulte 2008, Davis 2011, James 2015a). A more robust positive relationship exists between income levels and the timing of resource discoveries and extraction (Mideksa 2013, Smith 2015, James 2016).

how these NR-SWFs have been formed or not, how they have been corrupted or not, and how the revenues from the funds have been distributed.

2. THEORY

A theoretical literature has emerged on when, and why, governments in resource-exporting countries should establish an SWF. The literature has focused on natural resources, rather than other sectors, because of the large economic rents they generate.[3] The first question that resource-exporting governments face is how to capture rents through taxation, which has been studied in an extensive literature that is beyond the scope of this review (Daniel et al. 2010). Once the government has captured the rents, the next question is how to use them for the greatest benefit of the nation and its citizens.

In this section, we outline how recent academic literature has found that SWFs are crucial for harnessing the benefits of natural resource rents, if they are tailored to the country's level of development. In doing so, we draw on related reviews of the literature (van der Ploeg & Venables 2011, 2017; van den Bremer & van der Ploeg 2013; Venables & Wills 2016; Wills 2018). In the appendix, we present the basic theoretical structure used in this literature (based on Wills 2018). Generally, the literature has found that developed countries should set up a future generations fund to transform a temporary windfall into a permanent one. In contrast, developing countries should focus on repaying debt and investing domestically, while making use of a temporary parking fund to avoid issues that arise from investing too quickly. This recommendation recognizes that governments face a hierarchy of needs and thus must repay debt and invest domestically before saving abroad. All countries should save extra in the interest of precautionary savings. Stabilization funds can be a useful tool for temporarily smoothing changes in government spending, especially when monetary policy is constrained,[4] but they should not replace necessary fiscal tightening when resource prices fall.

2.1. Developed Countries Should Save in Future Generations Funds

Once a government has received a windfall, the first issue facing policy makers is whether it should be spent or saved. The simplest setting involves the government receiving a temporary, exogenous stream of resource rents and then choosing whether to consume them or save them in perfect global capital markets (Venables & Wills 2016, Wills 2018). The term perfect markets means that both foreign and domestic assets earn the same, constant, global rate of interest. In this setting, we quickly recover Friedman's (1957) "permanent income hypothesis": that resource revenues should be saved to convert a temporary windfall into a permanent stock of financial assets in the form of an offshore SWF.[5] The government should then consume a constant amount from the windfall in perpetuity, equal to the interest on the windfall's present value, as part of recurrent spending in its usual budget process.

Even this simple setting yields some useful rules of thumb for how much of the resource revenues should be saved in any particular year (Venables & Wills 2016). If the resource is extracted quickly and intensely, then a greater share of the revenues will need to be saved. If it is left in the

[3] Natural resource rents arise because demand is inelastic and supply is oligopolistic and dictated by geography.
[4] For example, by use of exchange rate pegs, which are used by three-quarters of natural resource exporters (Wills 2019).
[5] This argument is similar to that of Hartwick (1977), who first argued that revenues from exhaustible resources should be invested in aboveground assets. However, he ignored access to foreign assets, so the only asset available to him was domestic capital.

ground and extracted slowly, then more can be spent. In both cases, the share of revenues that is saved should increase with time, as the government can instead spend the interest from the SWF.

The spending rule can also be expressed in terms of the size of the SWF. Under the permanent income hypothesis, spending should be a constant fraction of total wealth. Total wealth includes both aboveground SWF assets and belowground resource assets. In the early years of the windfall, total wealth is dominated by assets beneath the ground, so spending should be a relatively high proportion of the (small) SWF. As resources are extracted and the fund grows, spending should fall relative to the size of the fund. In recent years, Norway's Government Pension Fund–Global (GPFG), which has been described as a model for other funds (Chambers et al. 2012, 2021), has done exactly this by lowering its *handlingsregelen* (budgetary rule) from 4% to 3% in 2017 (see also van den Bremer et al. 2016).

This simple framework also provides insight into why SWFs in developed countries such as Norway should invest offshore rather than domestically. It is because the framework assumes easy access to global capital, so that projects that are profitable at the world rate of interest will already be financed. If the resource windfall is large relative to the size of the country and is all invested domestically, then this glut of savings would push the domestic return on investment below that which can be achieved abroad. If capital moves freely, then foreign investors would flee the country for higher returns elsewhere. If it does not, then the domestic economy will see overinvestment in unnecessary projects and dismal rates of return. Investing the SWF in large, liquid, global capital markets avoids this outcome (as well as diversifying risk, which we consider below).

2.2. Developing Countries Should Repay Debt and Invest Domestically

This assumption of perfect capital markets does not make sense for many countries. In particular, Venables & Wills (2016) point out that developing economies tend to have only asymmetric access to global capital markets: saving more easily than they can borrow. Therefore, developing countries are characterized by a lower capital stock, and a higher return on capital, than their developed counterparts. A massive resource discovery can alleviate some of these constraints, allowing these countries to repay foreign debt and invest domestically with higher returns than they can achieve abroad.

We can analyze developing countries using a framework by van der Ploeg & Venables (2011), who assume that a country's domestic interest rate increases with its level of foreign debt.[6] Countries without debt (or with net foreign assets, like an SWF) can borrow at the constant global rate, like the developed economies described in Section 2.1. Those with debt, however, face financial frictions and an increasing cost of borrowing—like a developing economy.

In this setting, developing countries can use a resource windfall to relax some of the financial frictions they face. Unlike in developed countries, policy makers in developing countries should not simply choose between spending the windfall immediately or saving it abroad at a constant global rate. Instead, they must also consider whether to repay expensive foreign debt or invest in domestic projects with a higher return than can be achieved globally.[7]

The answer, as van der Ploeg & Venables (2011) show, is for policy makers to use the windfall to gradually repay foreign debt and invest domestically at the same time. In theory, the marginal benefit from spending a dollar on repaying debt should be kept the same as investing in

[6]The assumption is based on empirical evidence and could be due to, for instance, risk aversion by creditors.
[7]These domestic projects will not have been financed already, because of the financial frictions faced by domestic borrowers.

local projects. In practice, it means starting with projects that have the highest social rate of return while repaying the most onerous debts, and continuing until all the debt is repaid and local projects can be funded by private global capital markets. Only then, when domestic interest rates are similar to those in the rest of the world, does it make sense to start saving revenues for future generations in an offshore SWF (Chang & Lebdioui 2020).

While debt is being repaid and domestic projects are being built, government spending on recurrent expenses like health care, justice, and education should also be rising. This is because the resource windfall is effectively bringing forward the path of development (van der Ploeg & Venables 2011). The difference should be largest in the short term, because the current generation is poorer than future generations. But there needs to be balance—too much consumption initially will rob future generations of development; too little will rob the current generation.

Government spending can also come in the form of direct transfers to citizens, through lump sums or tax breaks (Devarajan 2019). If executed properly, the direct transfers can improve accountability (as the government must still rely on normal taxation), broaden access to capital, and relax absorption constraints as individuals identify the best projects (Collier et al. 2010).

2.3. Developing Countries Should Also Use Parking Funds

Absorption constraints describe the difficulties that an economy can face in finding productive uses for a large influx of investment that arrives all at once, particularly in developing countries. A parking fund allows governments to hold some of the wealth offshore until it the economy is ready to put it to use.

These constraints can be microeconomic: for example, a lack of domestic talent for selecting and designing projects, a basic need for projects to be sequenced, and the time it takes for projects to be vetted to avoid corruption. Roads must connect to roads, and it takes a teacher to produce teachers. Collier et al. (2010) describe lifting these microeconomic constraints on investment as "investing in investing."

Absorption constraints can also be macroeconomic. Rapid expenditure by the government will bid up the price of nontraded services, relative to traded goods, causing the real exchange rate to appreciate and nonresource export sectors to contract (known as Dutch disease; Corden & Neary 1982). This may cause irreversible loss of some industries if there are learning-by-doing effects (van Wijnbergen 1984, Krugman 1987, Gylfason et al. 1999, Sachs & Warner 2001, Torvik 2002, Matsen & Torvik 2005), though the effects will be mitigated if there are large domestic inputs into resource production and the windfall is due to higher resource volumes rather than prices (as in Norway; Bjørnland et al. 2019). The real appreciation may occur either through the nominal exchange rate or through nominal wage and price inflation. The latter poses a challenge for monetary policy, especially in the 75% of resource-dependent countries that have some form of exchange rate targeting regime (Wills 2019). Because there is typically a delay between discovery of the resource and the beginning of spending (Arezki et al. 2017), forward-looking prices, or the exchange rate, may appreciate in anticipation, causing a recession (Eastwood & Venables 1982, Wills 2019). If the central bank is following a simple Taylor rule, then it would tighten policy against inflation, exacerbating the recession (Wills 2019).

These challenges can be mitigated if the government commits to saving resource revenues in an offshore parking fund while it scales up the country's absorptive capacity (van der Ploeg 2012, van der Ploeg & Venables 2013, Venables & Wills 2016, Chang & Lebdioui 2020). Spreading the expenditure over time allows the government to develop the capacity needed to make the spending most effective. Committing to do so in advance prevents inflation and the exchange rate spiking, as individuals will anticipate that spending will happen only when the economy is ready.

Spending that is focused on expanding absorptive capacity, especially in the tradeable sector, can diversify the economy and reduce the cost of misjudging the duration of a resource windfall (Chang & Lebdioui 2020).

2.4. Dealing with Risks Through Hedging and Stabilization Funds

The theory discussed so far has treated resource revenues, and investments, as certain. In practice, of course, they are nothing of the sort. Not only is the exact size of resource deposits unknown, but also the price they can be sold for is highly volatile, and the return on the SWF is risky. To manage this risk, governments should first try to reduce the aggregate uncertainty of the income they receive. The remaining uncertainty can be managed through additional precautionary savings, which are treated the same as the savings discussed in Sections 2.1 and 2.2, or as a last resort a stabilization fund, if monetary policy cannot offset shocks to government demand.

The aggregate uncertainty in government revenues can be reduced through hedging. Small windfalls can be hedged directly by use of swaps and futures, as in Mexico (Duclaud & Garcia 2012). Larger windfalls can be hedged using the asset allocation in future generations funds (Gintschel & Scherer 2008; Scherer 2009, 2010; Balding & Yao 2011; van den Bremer et al. 2016). Beyond the diversification recommended by classic portfolio theory (Markowitz 1952, 1959; Tobin 1958; Sharpe 1964), van den Bremer et al. (2016) show that an SWF should be weighted toward assets that are negatively correlated with the resource price, while the resource remains in the ground. If transaction costs and uncertain correlations make hedging too difficult at the level of individual stocks, then they recommend doing so through the equity/bond mix. The overall share of equities (which the authors assume are positively correlated with the resource price) should initially be low while much of the resource remains beneath the ground. The equity share should then rise over time, as the resource is extracted and the proceeds invested in the SWF. In recent years, Norway's SWF has both reduced its allocation to the equities that are most exposed to oil prices and increased its equity/bond mix.

Even after hedging, government revenues are likely to be volatile. The first response to this volatility should be precautionary savings, which arise whenever one faces a risky income stream (Kimball 1990, Carroll & Kimball 2006, van der Ploeg 2010, Bems & de Carvalho Filho 2011, Berg et al. 2013, Cherif & Hasanov 2013, van den Bremer & van der Ploeg 2013, Agénor 2016). This amounts to saving more today in order to generate more interest income for generations in the future as compensation for the extra risks they have to face. The additional savings is due to prudence (a positive third derivative of the utility function) rather than risk aversion (a negative second derivative). Governments should direct this extra savings in the ways described above, either to a future generations fund in developed countries or to debt repayment and domestic investment in developing ones. In both cases, the savings should not be used to smooth fluctuations in oil price (Wills 2018).

In practice, governments can achieve precautionary savings by heavily discounting the value of future resource revenues. As discussed in Section 2.1, the government should aim to spend a constant fraction of total wealth, which is the sum of below- and aboveground assets (or debt). In the extreme, the bird-in-hand rule involves discounting belowground assets to zero (an infinite discount rate), so that spending is a fixed share of the SWF and rises as it grows (van den Bremer et al. 2016). Less extreme discounting is likely to be appropriate, particularly in developing countries where current generations are poorer than future generations (Wills 2018).

Self-insurance differs from precautionary savings and amounts to saving into a stabilization fund when resource prices are high and drawing down on it when prices are low. If resource prices

fluctuated only temporarily around a stationary long-term mean, then this would be easy.[8] In practice, though, resource price shocks tend to be permanent and prices follow a random walk (Hamilton 2009, Bems & de Carvalho Filho 2011, van den Bremer & van der Ploeg 2013).[9] If prices follow a random walk, then it does not make sense to add to a stabilization fund after prices rise, or draw down on it when prices fall, because the best forecast of the price in the future is the price today (Wills 2018). So, if prices are low today, then it is best to get used to it.

The best reason to establish a stabilization fund is to smooth the government's adjustment to lower commodity prices. There are likely to be real costs associated with a sharp reduction in government spending. It will take time for prices of domestic goods to adjust, through deflation or exchange rate depreciation, and time for public sector workers to be absorbed into the private labor force (Collier et al. 2010, van der Ploeg & Venables 2013). Monetary policy can offset such a demand shock (Wills 2019), but if it is constrained by something like an exchange rate peg, then drawing down a stabilization fund can help mitigate the short-term frictions of lower government spending.

3. EMPIRICAL EVIDENCE

The theoretical literature provides prescriptions for the settings where funds are likely to maximize welfare, but how successful have NR-SWFs been in practice? This section evaluates the empirical literature on NR-SWFs to synthesize findings.[10] We focus our attention on three broad areas: (*a*) the effect of funds on intergenerational wealth transfers, (*b*) political institutions and economic development, (*c*) and economic volatility. These areas roughly align with the theoretical objectives of NR-SWFs described in Section 2. However, in practice, funds may be established for multiple purposes or their objectives may shift over time, so aligning all empirical research on wealth funds cleanly into the objectives outlined in Section 2 proves challenging. We begin in the following subsection by briefly discussing a related literature that examines the determinants and structure of SWFs more generally.

3.1. Determinants of Wealth Funds

As discussed by Eldredge (2019), establishing an SWF requires two conditions to be met. The first is capability. Establishing a fund that generates significant benefits—via saving, smoothing, or investment—requires significant capital that many states lack. Establishing a fund also requires necessity to save for future generations, smooth the effects of outsized economic shocks, or invest locally. On the basis of these criteria, Eldredge (2019) argues that "middle powers" (medium-sized countries that may be relatively vulnerable to international market fluctuations, but also small enough to benefit from an SWF) are more likely than other countries to establish a fund. Empirical evidence supports this theory; the probability of establishing a fund is maximized for a GDP of US$700 billion. Countries with GDP above or below this threshold are, on average, less likely to establish an SWF. Beyond middle powers, governments of resource-rich economies are uniquely positioned to both fund and benefit from an SWF, which can be used to avoid some

[8]If the government also had ready access to international capital, then it could simply save when prices are above average and borrow when prices are below, so that the expected value of the stabilization fund would be zero (Venables & Wills 2016).

[9]There is some evidence that it is possible to beat a random walk forecast for oil prices out to 6 months, but beyond that it is better to assume a random walk (Alquist et al. 2013).

[10]Carpantier & Vermeulen (2021) similarly evaluate some of empirical literature on the successes and failures of SWFs more generally and note that "this is a severely understudied area."

of the economic and political problems associated with sudden natural resource windfalls (Dixon & Monk 2011).[11] Eldredge (2019) shows that both fuel exports and natural resource income per capita are strong indicators of establishing an SWF (while oil reserves are not). He also finds negligible effects of political regime, government spending, or trade surplus, which is somewhat at odds with other, related studies.

Carpantier & Vermeulen (2018) analyze a panel of international data from 1998 to 2008, during which 16 countries in their sample established an SWF. They find that both resource rents and GDP per capita are significant predictors for the establishment of an SWF. They also find that government spending on education and infrastructure reduces the probability of establishing a fund. A broader set of government characteristics also matter; autocratic regimes are more likely to establish SWFs than are democratic ones. Interestingly, Carpantier & Vermeulen (2018) also show that, while natural resource rents increase the probability of establishing a fund, this effect exists only in democratic countries. A speculative interpretation of this observation is that, because natural resource funds can be embezzled by autocratic regimes, they are managed more responsibly in democracies. Relatedly, the authors show that countries dependent on more volatile natural resources are more likely to establish SWFs, consistent with the idea that precautionary saving helps smooth the effects of stochastic commodity price shocks.

Amar et al. (2018) demonstrate that the determinants of SWFs differ according to how a fund is financed (e.g., commodity versus noncommodity) and the stated objectives of the fund (e.g., savings, stabilization, domestic investment). Similar to Carpantier & Vermeulen (2018), they find that commodity price volatility contributes to the likelihood of establishing a fund. Many of these findings are echoed by Aizenman & Glick (2009), who examine both the establishment of SWFs and their respective size. Contrary to the findings of Carpantier & Vermeulen (2018), they find that GDP per capita is statistically uncorrelated with the establishment of SWFs. They also study the role of governance using the Worldwide Governance Indicators constructed by Kaufmann et al. (2009) and find that countries with better governance measured in terms of government effectiveness, regulatory quality, and control of corruption are more likely to have SWFs than other countries with weaker political institutions.

The key point is that establishing an SWF requires both capability and necessity. This literature argues that, in addition to being a middle-power economy, natural resource wealth, dependence on volatile commodities, strong political institutions, and lack of domestic investment opportunities all increase the probability of establishing a fund.

3.2. Intergenerational Wealth Transfer

As described in Section 2.1, a straightforward objective of some resource funds is rent transfer from resources exploited today to future generations. We did not identify any publications concerned exclusively with evaluating the performance of funds in this regard. While some literature does characterize the size and longevity of funds as positive features, and these have direct implications for intergenerational savings goals, it is difficult to evaluate this goal in isolation from other targets. The success of funds for the purpose of wealth transfer will be determined largely by the quality of governance; therefore, the empirical research reviewed in Section 3.3 is certainly relevant.

Rather than evaluating the success of intergenerational funds simply on the basis of whether they have increased in size, we might ask whether such funds are desirable in the first place. As outlined in Section 2, which describes ample returns from investing in the domestic economy

[11] There is theoretical and empirical evidence that natural resource wealth causes political corruption both nationally (Arezki & Brückner 2011) and subnationally (James & Rivera 2021).

(as in developing countries) to accelerate the growth path, the justification for investing in global markets is weaker. In theory, this principle is sound, but whether institutions are able to identify domestic investment opportunities with returns that exceed those achievable in global markets is an empirical question, one for which we did not identify significant literature.

3.3. Political Institutions and Local Development

Some of the most resource-rich—and certainly the most resource-dependent—countries in the world are also some of the poorest.[12] There is good empirical evidence that natural resources (especially so-called point resources, such as fossil fuels and minerals) cause corruption and degrade the quality of political institutions (Ades & Di Tella 1999, Leite & Weidmann 1999, Treisman 2000, Bhattacharyya & Hodler 2010, Vicente 2010, Arezki & Brückner 2011, Tsui 2011, Brollo et al. 2013, Caselli & Michaels 2013, Caselli & Tesei 2016, James & Rivera 2021), for two main reasons. The first is that natural resource–extracting firms tend to earn large rents. Public officials then seek out these rents by accepting bribes in exchange for relevant tax cuts, deregulation, or protection from foreign or domestic competition. The second, less obvious mechanism is that resource-dependent governments tend not to tax their constituents (Bornhorst et al. 2009, James 2015b) and taxation may be necessary for robust democratic representation (Moore & Rakner 2002, Ross 2004, Collier & Hoeffler 2005a, Herb 2005).[13] An NR-SWF provides a possible solution to these political and economic problems. To the extent that the funds are managed in prudent and transparent ways, they can help keep resource rents out of the hands of corruptible politicians and state officials. The question of whether such funds are successful in bringing about desired political and economic change is an important one, but also one that has received especially little attention in the empirical literature.

Examining a sample of 27 fossil fuel–rich countries from 1996 to 2007, Tsani (2013) estimates the effect of resource funds (and differentiates between types of funds) on three Worldwide Governance Indicators (see also Tsani 2015). Countries that have established resource funds have greater government effectiveness, rule of law, and control of corruption. Tsani suggests that resource funds might therefore be a useful tool for combating political resource curse effects of fossil fuel production. Frynas (2017) argues that the fund type, rather than the mere existence of a fund, is more important in determining societal governance indicators and provides some supporting evidence for this assertion. In particular, Frynas shows that the quality of government (measured as regulatory quality, corruption perceptions, and political stability) is higher in countries with SWFs that have high Truman scoreboard ratings.[14]

Beyond political institutions, a small empirical literature also considers regional development effects of SWFs. For example, Ouoba (2020) analyzes a sample of 23 countries and finds that countries without resource funds grew more quickly from 2000 to 2014 than did those with

[12] Resource dependence is a measure of the relative importance of natural resources to an economy. It could be measured as the share of natural resource production in GDP, share of exports, or share of natural resource labor in the labor force, for example.

[13] The idea is that, without taxation, constituents are less interested in keeping a watchful eye on how public revenue is spent. After all, money is not fungible. People tend to be less prudent with windfall gains as opposed to hard-earned cash (Thaler 1990, Cherry et al. 2002, Danková & Servátka 2015).

[14] The Truman scoreboard is an index measuring factors like the structure, governance, accountability, transparency, and behavior of SWFs. It is designed to be a measure of the institutional quality of fund structures. According to Truman (2007), New Zealand's Superannuation Fund had the highest score (24) and the United Arab Emirates' Abu Dhabi Investment Authority and Corporation had the lowest (0.50), reflecting scores of zero for transparency and accountability, behavior, and governance.

savings or stabilization funds. However, countries with stabilization and savings funds nonetheless experienced greater physical and human capital accumulation, respectively, over that time period, which might indirectly increase economic growth. While not focused on the role of resource funds, Mohaddes & Raissi (2017) similarly find that terms-of-trade volatility decreases growth by lowering the accumulation of physical and human capital and that this effect is reduced in countries with SWFs. Relatedly, the Alaska Permanent Fund (APF) finances annual dividend checks paid out to every state resident (typically ranging between $1,000 and $2,000).

Our review uncovered only three papers focused on the effect of SWFs on institutional quality. All three (Tsani 2013, 2015; Frynas 2017) document a positive relationship between the establishment of SWFs and various measures of institutional quality.

3.4. Volatility and Stabilization

One of the greatest challenges facing resource-rich economies is commodity price volatility, and the various economic ills associated with it. Negative commodity price shocks are associated with reduced government revenue and expenditures on important public goods like health care and education, and they are generally associated with economic recession. But economic booms can also have deleterious effects on non-resource-traded sectors à la Dutch disease (Corden & Neary 1982). But economic volatility more generally implies added risk and uncertainty to financial markets as well. In fact, economic volatility and uncertainty reduce economic growth (Ramey & Ramey 1995, Aizenman & Marion 1993), educational attainment (Flug et al. 1998), and firm-level investment (Aizenman & Marion 1993). One study linked resource-induced economic volatility specifically to slow economic growth (van der Ploeg & Poelhekke 2009), leading the authors to conclude that "volatility is a quintessential feature of the resource curse." Tazhibayeva et al. (2008) provide evidence that procyclical fiscal policies are responsible for most of the volatility that resource-rich economies face. This finding implies that governments can mitigate volatility. It is for these reasons that some resource-rich economies have established stabilization funds, in order to avoid the economic hardships associated with boom-and-bust commodity price cycles. But have such funds been successful in stabilizing macroeconomic outcomes like employment, income, and government finances?

Using a time-series approach to identify structural breaks, Davis et al. (2001) found little evidence that funds have any influence on government expenditures. There is heterogeneity in this result, however, which Davis et al. (2001) associate with changes to management rules of the funds. Crain & Devlin (2003) employ a pooled cross-sectional approach and find that resource funds exacerbate volatility in government expenditures, as they provide more resources for otherwise imprudent governments. Using similar methods and conditioning on institutional quality variables, Bagattini (2011) finds a positive impact of funds on a series of fiscal performance measures, including nonrenewable resource balance, debt, and nonresource exports. Analyzing an international panel of data, Sugawara (2014) also finds that volatility in government spending is 13% lower in countries with stabilization funds compared with countries without such funds. Koh (2017) obtains a similar result in an analysis of 42 oil-exporting countries, although, in this case oil funds are fairly effective at reducing fiscal procyclicality, especially in countries with sufficiently strong institutions.

Ossowski et al. (2008) employ a fixed-effects approach to identify the potential stabilizing effect of funds on fiscal policy outcomes. A primary concern regarding the empirical identification of the effect of wealth funds on fiscal policy outcomes is that more prudent and responsible governments might be more likely to establish wealth funds as a vehicle for fiscal discipline. This fixed-effects approach corrects the problem of unobservable characteristics (fiscal prudence), but

only if these characteristics do not change over time. Ossowski et al. (2008) address this concern by conditioning the estimates on institutional quality. They find that wealth funds have no statistically significant impact on fiscal policy outcomes.

Shabsigh & Ilahi (2007) investigate a different set of macroeconomic outcomes (exchange rates, inflation, and money in circulation) and how volatility of these outcomes is affected by the presence of funds. Their study uses a fixed-effects approach along the lines of Ossowski et al. (2008), estimated for a sample of 15 oil-producing countries with and without wealth funds from the period 1973–2003. They find a decrease in volatility of these macroeconomic outcomes in the countries that established wealth funds. While this set of outcomes differs from that of Ossowski et al. (2008), the results do contrast to a degree.

Asik (2017) finds that NR-SWFs have the intended smoothing effect on government spending and notes that the timing of NR-SWF establishment can follow soon after the discovery and extraction of a natural resource. To address endogeneity concerns, Asik employs an instrumental variables approach and finds qualitatively similar results to the naïve model specifications.

Case studies are another way in which the literature has addressed the question of wealth fund success. These studies employ various empirical approaches. Ayadi & Adegbite (2018) employ time-series econometric approaches and find that Nigeria's wealth fund had no effect on government spending, while Kudrin (2007) uses a more qualitative approach to assess the impact of Russia's wealth fund.

In summary, cross-sectional, panel, and time-series studies tend to find either negative or statistically insignificant effects of wealth funds on economic volatility. A study by Crain & Devlin (2003) is the only one identified to document evidence that funds contribute to volatility in government expenditures. We also find that institutional quality is an important predictor of wealth fund success in this regard (Davis et al. 2001, Bagattini 2011).

4. CASE STUDIES

To complement the lessons from existing theoretical and empirical investigations, in this section we present three original case studies. The first comparison (Norway and the United Kingdom) highlights some more-nuanced aspects of the decision to establish a fund. Next, we explore the difference in wealth fund success between Chile and Venezuela under differing levels of stewardship. Finally, we compare two highly rated wealth funds in the USA (Alaska and New Mexico) that share similar intergenerational goals but have distinct methods of wealth redistribution that may lead to differences in public perception.[15]

As described in Sections 2 and 3, wealth funds live and die by their institutional design and quality, providing a natural basis to begin comparisons. A common measure of SWF institutional quality is the Truman scoreboard. The scoreboard contains 33 elements that broadly measure fund structure, governance, accountability, transparency, and use of leverage and derivatives (Truman 2009). More broadly, the scoreboard is intended to provide a kind of benchmark of best practices. **Table 1** presents ratings from Truman's SWF scoreboard taken in 2009 and 2019 (Truman 2009, Maire et al. 2021) for the case study jurisdictions. Norway scores highly and is often held up as a

[15] Even with standardized wealth fund scoring systems, it is tricky to make sense of why certain countries or states have large, successful wealth funds and others do not. A true apples-to-apples comparison is not feasible for any two wealth funds; nations have vast heterogeneity across natural resource endowment and institutional quality. The following comparisons showcase differences in wealth fund outcomes for countries or states which share what we believe to be relevant characteristics.

Table 1 Truman SWF scoreboard for case study funds[a]

Country	Wealth fund	2009 score	2019 score
Norway	GPFG	92	100
USA: Alaska	APF	94	88
USA: New Mexico	NMSIC	86	87
Chile	ESSF	70	92
Venezuela	FEM	23	No data

[a]Score values are derived from an index of 33 questions divided across four categories: structure, governance, accountability/transparency, and investment behavior (Truman 2009). Truman notes significant correlations between this index and those developed by others (Maire et al. 2021). The maximum possible score is 100.
Abbreviations: APF, Alaska Permanent Fund; ESSF, Economic and Social Stabilization Fund; FEM, Fondo para la Estabilización Macroeconómica (Macroeconomic Stabilization Fund); GPFG, Government Pension Fund–Global; NMSIC, New Mexico State Investment Council; SWF, sovereign wealth fund.

model for resource-rich economies to follow. Within the USA, both the APF and the New Mexico State Investment Council (NMSIC) receive good scores, despite their significant differences in fund structure and management. Note that, even within the USA and Norway (where institutions are strong and somewhat homogeneous), there are differences in scores both across space and time. In fact, the difference in scores between New Mexico's fund in 2009 and Norway's fund in 2019 (14 points) is roughly equal to the difference in scores for Chile's and New Mexico's funds in 2009 (16).

4.1. Norway and the United Kingdom: Choosing to Invest

Norway's GPFG is the largest NR-SWF in the world. Founded in 1990, the GPFG was intended to smooth fluctuations in oil revenue and provide benefits to future generations from resource windfalls (see **https://www.nbim.no/en/the-fund/about-the-fund**). The latest annual report places the GPFG's holdings at almost NOK 11 trillion, or more than US$1.2 trillion, which works out to more than $240,000 per Norwegian resident. This fund is the only one to achieve a perfect score in Truman's SWF scoreboard (Maire et al. 2021).

Few countries have been as heavily endowed with hydrocarbons as Norway. One interesting (and somewhat surprising) exception is the United Kingdom, which also sits adjacent to the oil- and gas-rich North Sea. The British and Norwegian resource basins have produced roughly similar quantities of hydrocarbons (Ross & Mahdavi 2015). So why doesn't the United Kingdom have a US$1.2 trillion wealth fund? One reason is that hydrocarbon revenue in the United Kingdom was transferred directly to UK residents in the form of lower nonresource tax rates [a common use of resource revenue both across (Bornhorst et al. 2009) and within (James 2015b) countries]. As the author of a 2014 *Guardian* op-ed laments, massive increases in UK oil revenue in the 1970s and 1980s were used to fund "Thatcher's tax-cuts for the rich" (Chakrabortty 2014). This is not to say that, had the United Kingdom instead saved the resource revenue in an SWF, a Norwegian-sized fund would exist there. First, much of the United Kingdom's oil production occurred earlier than Norway's, at a time when prices were lower (Ross & Mahdavi 2015). Additionally, Norway was blessed with larger field sizes, leading to lower extraction costs (Manley & Myers 2015). Still, this comparison helps to shed some light on "what could have been" for the United Kingdom (**Figure 1**).

The British National Oil Company was privatized in the 1980s, whereas Norwegian state-owned oil companies retained majority stakes in most of the oil fields (Manley & Myers 2015). Thanks to this equity, the Norwegian government earned close to US$10 per barrel in revenue

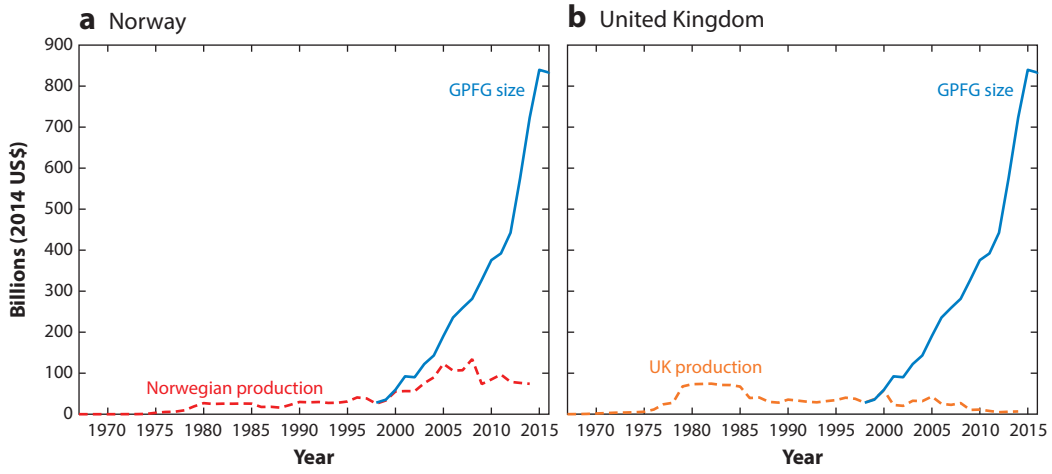

Figure 1

Resource funds and production for (*a*) Norway and (*b*) the United Kingdom. Each solid blue line represents the real value of Norway's Government Pension Fund–Global (GPFG) (constructed from Norges Bank Investment Management 1998–2020 annual reports; see **www.nbim.no/en/publications/**). The dashed red and orange lines represent the value of production of petroleum and natural gas in Norway and the United Kingdom, respectively (collected from Ross & Mahdavi 2015). As of 2015, the value of Norway's GPFG was $840 billion, or around 45% of total lifetime aggregate oil production. If the United Kingdom also had a wealth fund valued at the same percentage of lifetime oil production value, the fund (in 2015) would have been worth around $624 billion.

alone (Manley & Myers 2015). But it was not until 1990 that the GPFG was founded, and high levels of state equity come with fiscal risks. Norway's oil revenue in the 1980s was mostly spent as soon as it was earned. Much of the money went to social spending on health care and education, as well as to improve physical infrastructure (Bernstein et al. 2013). But there was also windfall money used to prop up dying or noncompetitive sectors that would later perish (Bernstein et al. 2013). The final years of the 1980s brought a severe drop in government spending with the collapse of oil prices, which led to an increase in bank failures and citizen bankruptcies (Bernstein et al. 2013).

Political will to turn nonrenewable resources into wealth for future generations paved the road for Norway's fund to become what it is today. There is no question that the GPFG is a wealth fund world leader, but the fund was created decades after North Sea oil was first discovered. The United Kingdom missed an opportunity to start a wealth fund in the 1980s and 1990s. If it had mimicked the type and structure of the Norwegian fund, how large would the UK fund be today? The aggregate value of all Norwegian oil production is approximately $1.9 trillion. For the United Kingdom, the amount is around $1.4 trillion, in 2014 dollars (Ross & Mahdavi 2015). By taking their ratio and multiplying by the current GPFG size, we find that a similar UK fund would have a value around $624 billion today. There is still an opportunity for the United Kingdom to establish a resource fund; as of 2020, the Oil and Gas Authority estimates recoverable reserves between 10 billion and 20 billion barrels of oil equivalent under the British seas (see **http://www.ogauthority.co.uk/data-centre/data-downloads-and-publications/reserves-and-resources**).

4.2. Chile and Venezuela: Governance Matters

Chile holds the world's largest reserves of copper and is the largest copper exporter (see **https://www.usgs.gov/centers/nmic/copper-statistics-and-information**). In 1985, the Copper Stabilization Fund was established to smooth public spending in the face of volatile copper prices and

subsequent revenues. The Economic and Social Stabilization Fund (ESSF) was created in 2007, replacing Chile's existing fund and absorbing its capital stock (see **https://tinyurl.com/essf2021**).

In a similar vein, Venezuela holds the largest proven oil reserves in the world (OPEC 2020). The Macroeconomic Stabilization Fund [Fondo para la Estabilización Macroeconómica (FEM)] was founded in 1998 to soften economic blows resulting from oil price volatility, as much of the state's funding comes from oil revenues.

Both Latin American countries are world leaders in valuable natural resource stocks, but their stabilization-oriented funds have followed two distinct paths. Chile's ESSF is worth more than US$8 billion, as of the first quarter of 2021 (see **https://tinyurl.com/essf2021**). Venezuela's FEM reached a peak value of more than US$7 billion in 2001 only a few years after it was formed. However, by 2004, the fund's assets had dropped below $1 billion and today hover around $3 million (see **http://www.bcv.org.ve/estadisticas/reservas-internacionales-totales-bcvfiemfem**). Why was the Chilean fund so successful while the Venezuelan fund failed? We can glean some insights from Truman's SWF scoreboard. In 2009, the Venezuelan fund received a score of 23 (out of 100), reflecting its poor governance structure, lack of accountability, and investing behaviors (Truman 2009). The fund's rules were changed with each iteration of budgeting laws, making the FEM a more discretionary spending account and thus undermining its stated objectives (Manzano & Scrofina 2013). As of 2019, the FEM no longer receives a rating (**Figure 2**).

In contrast, Chile's ESSF score, using the same benchmark, was 70 in 2009 and increased to 90 in 2019, placing it squarely in the top five rated funds worldwide (Maire et al. 2021). The Chilean Ministry of Finance maintains easily accessible, publicly available information about the ESSF from asset management values to risk benchmarks. Despite its rise in rating, Chile's wealth fund has fallen in value from its peak of just under US$20 billion. The government has made no contributions to the fund since 2013 (see **https://tinyurl.com/essf2021**). Note, however, that the lack of contributions is in line with laws setting contribution and withdrawal rules that were passed when Chile's wealth funds were established. Specifically, fiscal surpluses must be transferred to the

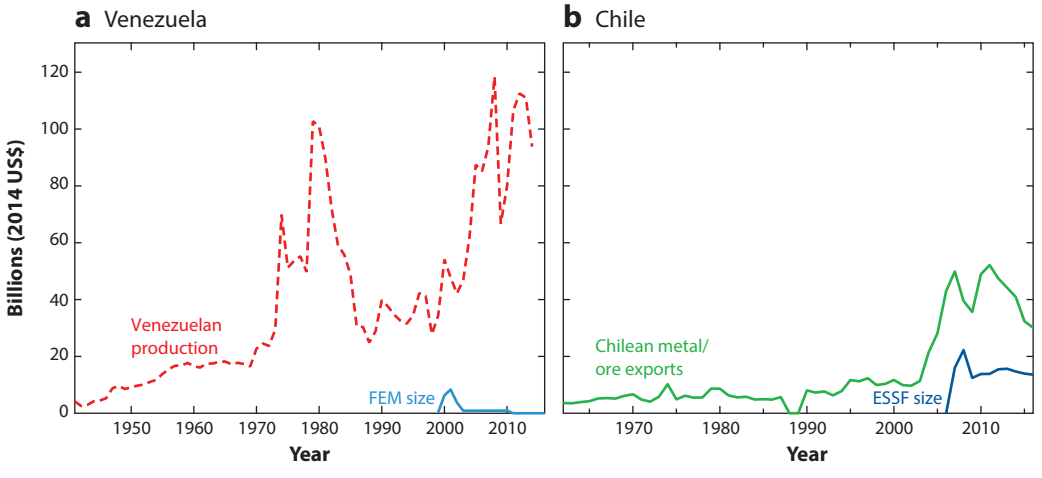

Figure 2

Resource funds and production for (*a*) Venezuela and (*b*) Chile. The blue lines represent the sizes of the Venezuelan and Chilean funds in panels *a* and *b*, respectively (see **https://tinyurl.com/essf2021**, **http://www.bcv.org.ve/estadisticas/reservas-internacionales-totales-bcvfiemfem**). The dashed red line represents the value of Venezuelan production of petroleum and natural gas (World Bank 2021a,b). The green line indicates the real value of Chilean ore and metal exports (Ross & Mahdavi 2015). Abbreviations: ESSF, Economic and Social Stabilization Fund; FEM, Fondo para la Estabilización Macroeconómica (Macroeconomic Stabilization Fund).

ESSF the following year. The ESSF works in tandem with a separate fund used for pension and welfare payments (see **https://tinyurl.com/essf2021**).

Venezuela's wealth fund, on one hand, was drawn down by what appear to be opportunistic changes to its structure over time. Chile's wealth fund, on the other hand, has been playing by the same rules for 15 years. Maintenance of strong checks and balances between the state and the fund's assets guide withdrawals in line with the fund's objectives, rather than pet projects or personal gain.

4.3. Alaska and New Mexico: Similar Goals, Different Methods

When choosing how to utilize investment returns, funds have several options. A common approach is to reinvest income for inflation proofing, and additional income reinvestment to grow the real value of the fund might be rules based or ad hoc. Alaska and New Mexico provide interesting, contrasting cases in how income beyond reinvestment might be earmarked.

In the late 1960s, the largest oil field in the USA was discovered in Prudhoe Bay, Alaska. In 1976, the APF was created in the wake of competition for drilling rights on the state's land. The recently completed oil infrastructure, including the Trans-Alaska Pipeline, prompted the state to save a portion of the annual oil revenues to benefit all generations of Alaskans though the APF (see **www.apfc.org/what-we-do/**) (**Figure 3**).

In New Mexico, the NMSIC manages the state's seven permanent funds, the two largest of which are the Land Grant Permanent Fund (LGPF) and the Severance Tax Permanent Fund (STPF). The founding of the LGPF predates the statehood of New Mexico. The LGPF's funding comes from resource royalties and land leases, and its primary goal is to provide financial support for public schools and universities (see **https://www.sic.state.nm.us/investments/permanent-funds/land-grant-permanent-fund**). The STPF receives its funding from resource taxes, and its objective is to provide bond maintenance, with the state's general fund receiving revenue

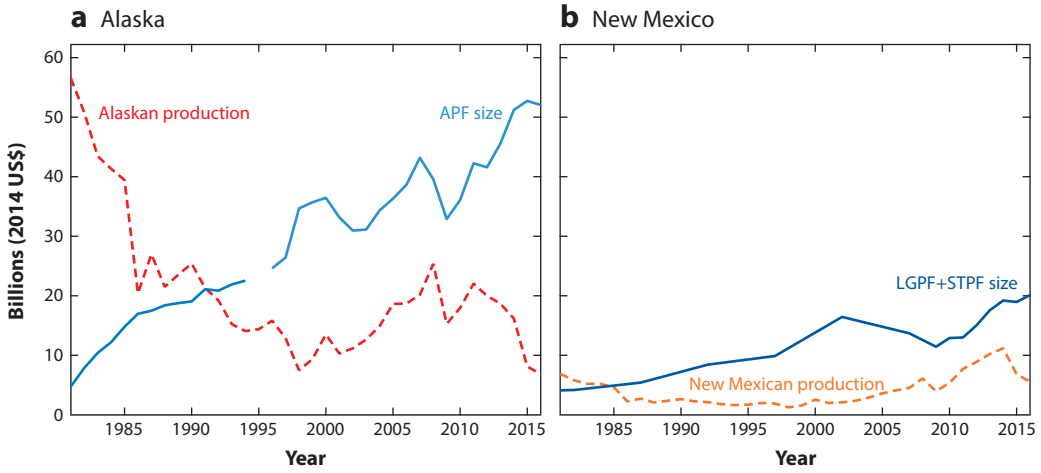

Figure 3

Resource funds and production for (*a*) Alaska and (*b*) New Mexico. The blue lines represent the fund size for each state (data for the APF are from **https://apfc.org/report-archive/14-12-annual-reports**, and New Mexico fund sizes are from **www.sic.state.nm.us/publications-reports/investment-holdings-reports**, with earlier data approximated from NMSIC 2020). The dashed red and orange lines represent the value of oil production per year for each state (see **https://www.eia.gov/petroleum**). Abbreviations: APF, Alaska Permanent Fund; LGPF, Land Grant Permanent Fund; STPF, Severance Tax Permanent Fund.

beyond the bond requirements (see **https://www.sic.state.nm.us/investments/permanent-funds/severance-tax-permanent-fund**).

Both the NMSIC and the APF score highly on each of the wealth fund benchmarks, earning scores no lower than 86 since 2009, and both score similarly within each category (Truman 2009, Maire et al. 2021). Alaska and New Mexico are 2 of only 10 states in the USA that have created an NR-SWF. Is it still possible for some of the other 40 states to start their own permanent funds? In the case of Minnesota, McIntosh et al. (2021) show that the answer is yes. Although much of Minnesota's iron ore mining industry is relatively small today compared with 60 years ago, under reasonable forward-looking assumptions, enough minerals could still be extracted to create a permanent fund ranging between $3 and $5 billion by 2050.

For much of its existence, Alaska's APF has reinvested 50% of its earnings into the fund and distributed the other 50% as cash payments directly to its citizens through its Permanent Fund dividend (PFD) program.[16] All residents receive the same amount, and in recent years PFD payments have accounted for up to 5% of per capita annual income for Alaskans, even up to 10% for the state's Indigenous populations (Berman 2018).

In New Mexico, 5% of the LGPF and STPF are withdrawn annually and earmarked for public education. These disbursements offset some funding that would otherwise come from state or local taxes. These transfers are estimated to lighten the average household's tax burden by around $1,000 annually (see **https://www.sic.state.nm.us/investments/permanent-funds/severance-tax-permanent-fund**).

Aside from the difference in size, the differences in distribution structure have two important implications. First, the highly publicized direct cash payments of the Alaska PFD program make it much more salient in the minds of citizens than the New Mexico LGPF. Second, these distribution structures have different socioeconomic effects, with important distributional implications.

Residents of Alaska must apply for the dividend each year, and the payment date is highly publicized. The popularity of the PFD program has created a political constituency for its preservation and, in turn, the APF itself. In New Mexico, distributing the wealth takes place in the background—no filing process is required for benefits. For New Mexicans, even with the reduction in tax burden from the STPF, the lack of explicit payout may affect attitudes toward the fund. Williams (2008) argues that residents fail to think of fund benefits as income, causing them to view the funds too conservatively. Such conservative views help funds grow faster over time by avoiding disbursements but can also create opposition to expanding beneficial social programs such as public schools (Williams 2008).

A small body of empirical research has investigated the socioeconomic impacts of the Alaska PFD. Research to date has found that the annual payment of the PFD leads to an increase in employment for men on the extensive margin but a decrease for employed women on the intensive margin, especially those with young children (Bibler et al. 2019); excess sensitivity in consumption from high-income households (Kueng 2018); temporary decreases in financially motivated crime but increases in substance abuse (Watson et al. 2020); and benefits to children's health (Watson et al. 2019).

Another facet of fund spending relates to distributional implications. In New Mexico, the absence of the LGPF would likely lead to some combination of lower school spending and/or

[16]This formula was used between 1983, the year following the establishment of the PFD, and 2016, when a partial veto by Alaska's governor reduced the dividend appropriation. Since 2018, disbursement from the APF has been based on a percent of market value rule, and dividend amounts have been determined by legislative appropriation.

higher state income and local property taxes. New Mexico's K-12 public schools rank lowest in the nation (see **https://www.usnews.com/news/best-states/rankings/education/prek-12**) and rank toward the bottom in spending per student, consistent with the idea that the fund has been used to finance income and property tax reductions instead. The Alaska PFD's flat payout structure is more progressive than income tax offsets, but recent declining oil revenue to state government has placed the Alaska dividend in direct competition with government spending on education, rural energy rebates, and other programs, some of which are targeted to lower-income households.

The continuously high benchmark scores achieved by the NMSIC and the APF reflect a degree of institutional quality sufficient for fund growth and longevity. Both states turned their stocks of nonrenewable resources into robust long-term vehicles for investment in future generations. Though there are differences in how the two funds benefit their residents, both have arguably been successful in achieving intergenerational wealth transfer (both funds have grown in real terms beyond their principals) and increasing contemporary private consumption.

5. DISCUSSION

Natural resource funds offer various theoretical benefits, including macroeconomic stabilization, intergenerational wealth transfer, and domestic investment. While the existing theoretical research makes a convincing case, empirical tests of the viability of SWFs are scarce. Some of this scarcity might reflect that the widespread use of NR-SWFs is a relatively recent phenomenon. But identifying the effects of SWFs is not a simple exercise. In this section, we review some of these econometric challenges and offer possible remedies and suggestions for future research.

There are two broad sources of endogeneity. As discussed by Eldredge (2019), establishing a meaningful SWF requires significant capital; some natural resource endowments are large enough to establish a fund, and others are not. This is problematic if outcomes of interest are endogenous to the size of the natural resource endowment. For example, suppose that large natural resource endowments cause political corruption (as the existing literature indicates) and that large endowments are also required to establish funds. Here, even when restricting a sample to units endowed with natural resources, one might find that resource funds are associated with political corruption. But in this context, it would be wrong to conclude that funds cause the corruption. Rather, in this case large resource endowments cause both fund establishment and corruption.

Simply conditioning the effect of resource funds on resource production or resource dependence is not appropriate, for two reasons. First, both resource production and dependence are endogenous variables [resource production is endogenous to institutional quality (Cust & Harding 2020), and resource dependence is also endogenous to the size of GDP (Brunnschweiler & Bulte 2008, James 2019)].[17] Second, the relationship between resource wealth and outcomes of interest might be nonlinear. As such, controlling for resource wealth in an ordinary least squares regression on the establishment of a resource fund would not be appropriate.

Ideally, the effects of resource funds can be estimated among a group of units (with and without funds) that have similar resource endowments. But here, small sample size becomes an issue. This point is highlighted in **Table 2**, which depicts the 20 largest producers of oil and gas per capita from 1932 to 2014. Note that the most oil- and gas-rich countries (per capita) have an SWF. In

[17] In fact, what differentiates countries like Saudi Arabia, Russia, and the USA is not oil production but rather nonoil production. Whereas all three countries produce roughly similar quantities of oil (the USA currently produces slightly more oil than both other countries), the USA produces roughly US$19 trillion in nonoil products. To the extent that weak institutional quality causes deteriorates nonresource sectors like

Table 2 Oil and gas production and the establishment of SWFs[a]

Country	(Oil and gas)/population	Year	SWF
Qatar	1.345	2005	Qatar Investment Authority
Kuwait	1.165	1953	Kuwait Investment Authority
United Arab Emirates	0.843	1976	Abu Dhabi Investment Authority
Brunei	0.792	1983	Brunei Investment Agency
Saudi Arabia	0.406	1952	Saudi Arabian Monetary Agency
Norway	0.298	1990	Government Pension Fund–Global
Libya	0.277	1981	Libyan Investment Authority
Oman	0.242	1980	State General Reserve Fund
Trinidad and Tobago	0.183	2007	Heritage and Stabilization Fund
Bahrain	0.172	2006	Mumtalakat Holding Company
Equatorial Guinea	0.161	2006	Fund for Future
Gabon	0.157	1998	Fund for Future Generations
Venezuela	—	—	—
Canada	—	—	—
Iraq	—	—	—
Russia	0.073	2004	Reserve and National Welfare Funds
Turkmenistan	0.065	2008	Stabilization Fund
Iran	0.056	2010	National Development Fund
Algeria	0.054	2000	Revenue Regulation Fund
USA	—	—	—

[a]The values of oil and gas production per capita are from Ross & Mahdavi (2015). Value of production is expressed in millions of US dollars (year 2000) per capita and is summed for each country from 1932 to 2014. Countries are ranked from highest producers to lowest. Dashes indicate the the country has no SWF.
Abbreviation: SWF, sovereign wealth fund.

fact, only four of the countries listed do not currently have a fund: Venezuela, Canada, Iraq, and the USA (both the USA and Canada have sizable state- and provincial-level resource funds). Restricting an analysis to this set of countries helps to limit unobserved heterogeneity (all countries are major fossil fuel producers, though significant variation in production still exists) but comes at the cost of a small sample (**Figure 4**). Using this restricted sample, one could compare contemporary outcomes in countries with SWFs with outcomes in those without, but Iraq and Venezuela are arguably not valid controls for, say, Norway. One might try to exploit temporal heterogeneity in the establishment of NR-SWFs. However, as shown in **Table 2**, countries with more significant oil and gas production tend to have established their funds relatively early.[18] This problem of small sample size is exacerbated by the fact that not all funds have similar goals.

Additional endogeneity is introduced by the fact that establishing an NR-SWF is a choice variable. A corrupt government might be less likely to establish an SWF as it could make rent seeking less profitable for public officials. It is also possible that governments establish stabilization funds in response to, say, extraordinary macroeconomic volatility. As such, one might find that the establishment of SWFs is associated with reduced corruption and enhanced economic volatility!

manufacturing and services, variation in institutions causes variation in resource dependence, rather than the other way around.

[18]For example, the Kuwait Investment Authority was created in 1953, the Saudi Arabian Monetary Agency in 1952, and the Abu Dhabi Investment Authority in 1976.

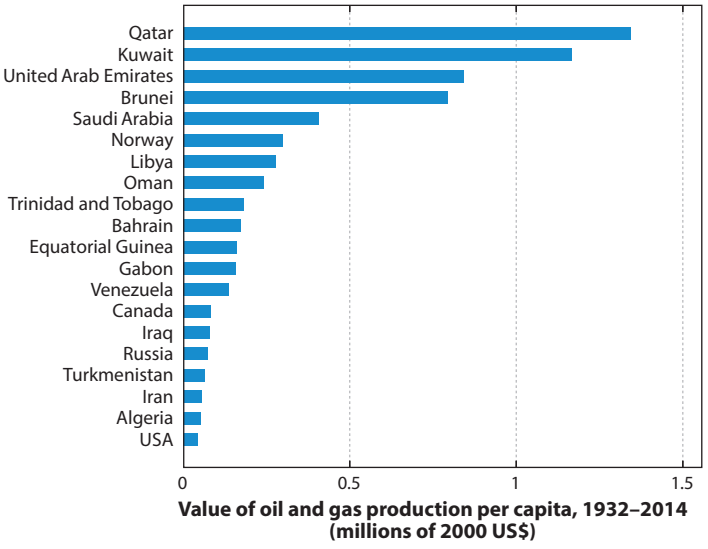

Figure 4

Oil and gas dependence. The value of oil and gas production per capita is from Ross & Mahdavi (2015). Value of production is expressed in millions of US dollars (year 2000) per capita and is summed for each country from 1932 to 2014.

As discussed in Section 3.4, some empirical research has attempted to address these identification issues. One approach is to condition estimates on observables or proxies for unobservables. Doing so involves adding controls for institutional quality and measures of resource income and wealth. Conditioning has the advantage of allowing these confounders to be time varying (especially relevant for changes to resource income and the value of resource endowments). However, many confounding factors are unobserved. Many controls are also endogenous (to, say, natural resource wealth) and may require extrapolation outside the sample data.

Utilizing fixed effects (e.g., Shabsigh & Ilahi 2007, Ossowski et al. 2008) can address the issue of time-invariant unobservable characteristics, which could credibly address some aspects of institutional quality (e.g., intrinsic culture characteristics) and a jurisdiction's geologic resource base. Using an instrumental variables approach (as in Asik 2017) would mitigate issues around time-varying unobservables, but performance depends on instrument quality, which is difficult to assess in practice. Synthetic control (e.g., Mideksa 2013, James 2016) and matching approaches might present a fruitful course of future empirical national-level investigations. Much like the resource economic development literature has recently migrated toward subnational analysis, there are likely unexploited opportunities to understand the fiscal outcomes in subnational jurisdictions.

6. CONCLUSION

Our review has explored how economists have approached the role of NR-SWFs. We have identified several key points. For nonrenewable resources, we know that, in theory, establishing an SWF can be useful in many contexts over the long run, and with the best empirical estimates we find that these funds have proven to be helpful. We also find that management quality and institutions truly matter for SWF success. Funds are more successful when matched with good governance and strong political institutions. But we also know that SWFs are not for every country or state government—some countries with either (*a*) strong domestic investment

opportunities or (*b*) significant debt are better off doing something else with their resource rents, at least in the short run. In these cases, capital-scarce markets receive high rents on capital investments and lower debt. For empirical estimations of the power of SWFs, we find that future research will be presented with continued and serious identification challenges—until a broader set of countries (or units) implement wealth funds that allow for proper identification. If half the cities in the USA established funds, for example, identifying the effects of having a city fund would be much more straightforward.

We conclude by noting that we have not answered one of our main motivating questions—should we set up an SWF for renewable resources like fisheries and forestry? Long-term permanent funds have been established to help support conservation into the future, namely for wildlife, water, land, and environmental quality. A few permanent renewable resource funds do exist that generate a flow of income for conservation of land and habitat, such as the Wyoming Wildlife Fund, the Berkshire Environmental Endowment Fund, and the Massachusetts Environmental Trust (e.g., Foster & Foster 2014). Other renewable resource funds are revolving funds—"money in, money out"—such as the Conservation Fund's Working Forest Fund and the International Monetary Fund's Managing Natural Resource Wealth Topical Trust Fund (Int. Monet. Fund 2020). While we believe that wildlife, water, and environmental funds still make sense, the justification comes from internalizing externalities.[19] We save this discussion for another day.

APPENDIX

The theory in Section 2 is based on an optimization problem in which a social planner (the government) receives a temporary oil windfall of price $P(t)$ and quantity $O(t)$ and must decide whether to use the proceeds for consumption $C(t)$, investment $I(t)$ in domestic capital $K(t)$, or saving in foreign assets $F(t)$ [or repaying foreign debt if $F(t) < 0$]. Following Wills (2018), the planner must maximize the continuous time value function $J(\cdot)$ (for a similar version in discrete time, see Venables & Wills 2016):

$$J(F,K,P,t) = \max_{C(t)} \left[\int_t^{\infty} U[C(\tau)] e^{-\rho(\tau - t)} \mathrm{d}\tau \right],$$

such that

$$S(t) = F(t) + K(t) - S^*,$$

$$\mathrm{d}F(t) = \{[r(F(t)]\, F(t) + P(t)O(t) + Y\,[K(t) - C(t) - I(t)]\}\mathrm{d}t,$$

$$\mathrm{d}K(t) = [I(t) - \delta K(t)]\mathrm{d}t,$$

$$\mathrm{d}P(t) = \alpha P(t)\mathrm{d}t + \sigma P(t)\mathrm{d}Z(t),$$

where $U(\cdot)$ is the utility function; $S(t)$ is the deviation of total assets from their steady state S^*; ρ is the rate of time preference; $r[F(t)]$ is the interest rate faced by the planner, which may depend

[19] From a theoretical perspective, two of the three main reasons for having an SWF for a nonrenewable resource do not necessarily apply to renewable resources (Venables & Wills 2016, Wills 2018). First, for permanent income, there is no need to smooth a temporary windfall into permanent income—the resource already generates a permanent income. Second, for the case of parking funds, there is not much need for this type of fund in developing countries—renewable resources do not generate short-sharp windfalls like an oil discovery. Third, for volatility, a case can be made for an SWF based on precautionary savings from a volatile renewable commodity. A stabilization fund that is built up when prices are high, and drawn down when prices are low, would make sense if the commodity price is mean reverting.

on the level of assets/debt; $Y[K(t)]$ is the level of output, which depends on domestic capital; δ is the depreciation rate on domestic capital; and oil prices $P(t)$ follow a geometric Brownian motion with drift α, volatility σ, and Wiener process $Z(t)$.

Solving this model, assuming constant absolute risk aversion, yields the two first-order conditions for consumption and total assets (for details, see Wills 2018):

$$\frac{1}{\mathrm{d}t}E[\mathrm{d}C(t)] = \{r - \rho - p[F(t)]\} + \frac{1}{2}aP(t)^2C_P(t)^2\sigma^2, \quad 1.$$

$$\frac{1}{\mathrm{d}t}\mathrm{d}S(t) = rS(t) + P(t)O(t) - C(t) + C^*, \quad 2.$$

where r is the global riskless rate of interest, $p[F(t)]$ is the risk premium on interest rates ($p'_F > 0$), $a > 0$ is the coefficient of absolute risk aversion (and prudence), $C_P(t) \equiv \partial C(t)/\partial P(t)$ is the marginal propensity to consume from a change in the oil price, and C^* is the prewindfall steady-state level of consumption.

Parameterizing these two first-order conditions yields many of the results presented in Section 2. Section 2.1 describes how governments in developed countries should save their oil windfall in an SWF so that consumption is stabilized at the permanent income level. This can be seen when the world rate of interest equals the discount rate, $r = \rho$; there is no risk premium on borrowing, $p[F(t)] = 0$; and oil prices are deterministic, $\sigma = 0$, so that $\mathrm{d}C(t)/\mathrm{d}t = 0$.

Section 2.2 outlines how developing countries, which face capital scarcity due to a risk premium on borrowing, should direct some of the windfall to accumulating domestic capital and repaying debt, so that consumption gradually rises to its steady state. This can be seen when $r = \rho$ and $\sigma = 0$ but foreign assets $F(t) < 0$, so that there is a risk premium on borrowing, $p[F(t)] < 0$, and $\mathrm{d}C(t)/\mathrm{d}t > 0$.

Section 2.4 states that all countries should save more in the interests of precautionary savings. This can be seen by allowing oil prices to be volatile, $\sigma > 0$, which causes the optimal path of consumption to rise, $\mathrm{d}C(t)/\mathrm{d}t > 0$. Consumption is therefore lower today, allowing assets to be accumulated to fund higher consumption in the future.

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