

Power to the Fiscal?

An Exploration of the Use of Credit Ratings to Estimate
the Expected Cost of a Guarantee of a Power-Purchase Agreement

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Abstract

Ministries of finance are often asked to guarantee a state-owned electricity utility's payments to an independent power producer under a power-purchase agreement. To decide whether to grant the guarantee, the ministry should have at least a rough estimate of the guarantee's expected cost. Making use of an analogy between a power-purchase agreement and a debt contract, this paper shows how the ministry can get such an estimate by applying a method developed to estimate the expected cost of debt guarantees. An estimate of the probability of the utility's not being able

to meet its obligations under the power-purchase agreement can be derived from the utility's actual or estimated credit rating in the absence of government support. The government's expected payments under the guarantee can then be estimated by multiplying the utility's payments under the power-purchase agreement by this probability. The estimates produced by the method will be imprecise, but the method may be easier to apply than alternative methods, and an imprecise estimate may be better for policy makers than no estimate.

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Contents

I. Introduction.....	3
II. Payment Obligations in Common Power-Purchase Agreements	5
PPA with only energy payments	5
PPA with capacity and energy payments.....	6
III. Power-Purchase Agreements and Debt Contracts.....	7
IV. Using Credit Ratings to Estimate the Expected Cost of a Debt Guarantee	8
V. Using Credit Ratings to Estimate the Expected Cost of a Guarantee of a Power-Purchase Agreement.....	11
PPA with only energy payments	11
PPA with capacity payments and energy payments	13
VI. Concluding Comments	15

I. Introduction¹

Ministries of finance in developing countries are often asked to guarantee a state-owned electricity utility's payments to an independent power producer (IPP) under a power-purchase agreement (PPA). From a policy-making point of view, there are usually plausible arguments for giving the guarantee to attract much-needed new investment and plausible arguments for not giving the guarantee on grounds of fiscal prudence.

In the typical case, the ministry of finance is understandably cautious about the risks of guarantees. The state-owned electricity utility's finances may be precarious, so any guarantee may well be called. The ministry may have previously granted guarantees that were in fact called, perhaps during an economic crisis when cash was scarce, and it may fear that credit-rating agencies, bond investors, international organizations, and others will look upon the government's guarantees as a significant source of fiscal risk.

Yet, in this typical case, the risks of not giving the guarantee are also clear. The country typically needs new power-generation plants to meet a growing demand for electricity. The proposed investment may be in renewable energy and reduce the use of coal-fired or other carbon-generating plants, giving it the added benefit of mitigating climate change. As in other public-private partnerships, the investors will probably assume construction and operating risks over most of the life of the plant, probably leading to better management than in projects owned and operated by the state-owned utility. Finally, the government's budget is almost certainly tight, so it probably does not want to finance the investment itself, while the state-owned utility's finances are often too weak for it to finance the investment. Private investment is thus attractive.

But private investors, too, are likely to be wary of risks. In the typical case, the state-owned utility is the only customer to which they are permitted to sell their output, and their investment will be largely irreversible (sunk): unless they operate a power-plant from a barge, they cannot take their investment elsewhere if it proves unprofitable. They can prudently invest only if they have a long-term contract with the utility—a PPA—that promises them a reasonable return. But if

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the utility's finances are precarious, such a contract may not be enough, because the equity investors and their lenders may reasonably fear that the utility will fail to meet its obligations, especially if the government keeps regulated electricity prices low. To mitigate this risk, the investors and lenders may ask the government to guarantee the utility's payments under the PPA.

The decision whether to grant the guarantee is unlikely to be straightforward. The costs and benefits of the decision depend on several factors that cannot be known with any precision, including the benefits of the investment and the decisions of investors and lenders in the absence of a guarantee. Thus, the decision will almost certainly require the exercise of judgement, not just a mechanical comparison of numerically estimated costs and benefits. But the ministry, and specifically the debt-management office or other group managing fiscal risks, is in a better position to make the judgment if it has some estimate of the expected cost of the guarantee.

Many papers have analyzed how government loan guarantees can be valued, and some work has considered how these ideas can be applied to guarantees of PPAs. Merton (1977) showed that loan guarantees are like put options and can thus be valued using the option-pricing ideas developed by Black and Scholes (1973) and Merton (1973) (see also Sosin, 1980). Baldwin, Lessard, and Mason (1983) and Mody and Patro (1996) pursue these ideas. Lewis and Mody (1997) and Irwin (2007, pp. 166–171) briefly discuss how option-pricing ideas and stochastic simulations can be used to value such guarantees. Bachmair (2016) and Bachmair, Aslan, and Maseko (2019) discuss a different approach, which is to assess loan guarantees by reference to credit ratings, which can be linked to probabilities of default. They also touch briefly on the use of the method to assess guarantees of PPAs.²

This paper explains in more detail how credit ratings can be used to generate a rough estimate of the expected cost of guarantees of PPAs and discusses some of the advantages and disadvantages of the approach. Section II describes the payment obligations that state-owned utilities commonly assume in two kinds of PPAs. Section III discusses the similarities (and dissimilarities) between these payment obligations and payment obligations in debt contracts. Section IV then

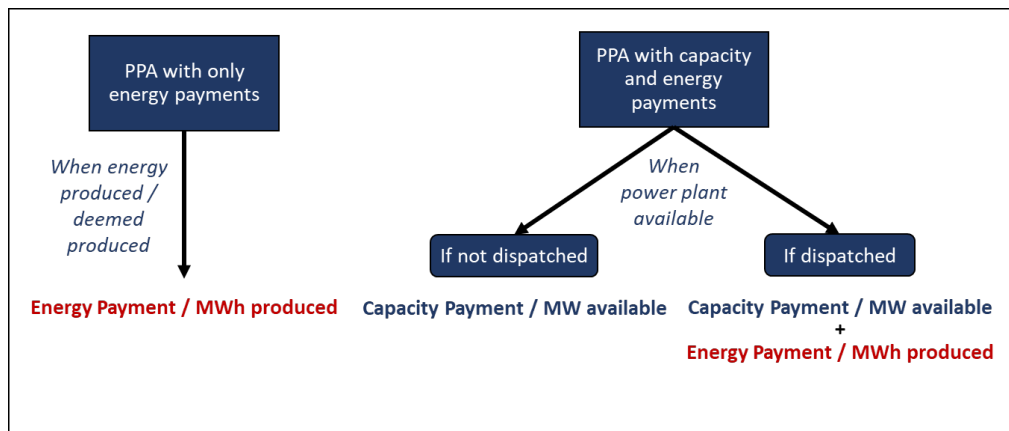
² There is also work that describes and evaluates IPPs and PPAs. See, for example, Albouy and Bousba (1998), Gray and Schuster (1998), Kerf and others (1998, including Annex 2), Eberhard and others (2016), and PPLRC (2019). Maurer and Barroso (2011) and Rudnick and Velasquez (2018) also describe alternatives to IPPs and PPAs.

summarizes a method for estimating the expected cost of a debt guarantee. Section V then shows how this method can be used to estimate the expected cost of a guarantee of a utility’s payments in the two kinds of PPAs. Section VI concludes by mentioning some possible extensions of the approach and some of its limitations.

II. Payment Obligations in Common Power-Purchase Agreements

Although PPAs cover many issues, the crucial clauses for our purposes are those that determine the payments that the state-owned utility (the “offtaker”) must make to the IPP that has invested in the power plant. There is no limit in principle to the variety of payment structures that a utility and an IPP can agree on in a PPA, and we do not attempt to survey the range of payment structures that have been used. Nor do we attempt to describe all the details of the most common structures. To estimate the expected cost of a particular guarantee, a ministry of finance must understand the details of the particular case. But to illustrate the approach set out here, it will be enough to describe the main elements of two common payment structures (see Figure 1).

Figure 1. Two common PPA payment structures



Source: Authors

PPA with only energy payments

The first and simpler of the two structures involves payments only for energy produced or deemed to be produced by the IPP.³ This structure is commonly

³ If the state-owned utility cannot physically take the energy that is produced, it may still have to pay for the energy that could have been produced. For the purpose of calculating the payment, the energy is deemed to have been produced.

used for solar plants, wind farms, and run-of-the-river hydro plants, which all generate energy at a low variable cost. Because the variable cost is low, the plants should normally generate electricity whenever they can.

In these PPAs, the price of energy paid by the utility to the IPP is typically fixed, subject possibly to indexation for inflation. It is thus expressed in real or nominal currency units per unit of energy produced. It may be denominated in local currency or foreign currency, with foreign currency being especially likely if the IPP relies on foreign financing. The payments depend, however, on how much energy is generated, which in turn depends on the availability of the plants and the ultimate source of energy.

The energy payments do not guarantee that the investors will receive an acceptable return on their investment, because the investors' return depends on the costs they incur in constructing and operating the plant and on the availability of the plant and the ultimate source of energy. The investors may thus lose money if there are cost overruns or the plant generates less energy than planned. But, if investors are to be persuaded to invest, the expected payments must be sufficient to cover all their expected costs, including the cost of capital.

PPA with capacity and energy payments

A second structure provides for payments for available capacity as well as payments for energy generated. It is commonly used for power plants that convert coal, gas, or diesel to electricity. It can also be used for hydroelectric power plants that generate electricity by allowing scarce water to flow from a reservoir (as opposed to a run-of-the-river hydro plant). A common characteristic of these plants is that their variable costs (the costs that depend on energy generated) are typically important, so they should be dispatched only when no other plants are available to generate energy at a lower variable cost. This is something that the utility is in the best position to know, so it makes sense for the utility, not the IPPs, to decide when the plants run. We assume that the utility can dispatch the power plants in the most cost-efficient way to meet the demand for electricity.

The energy payments in this kind of PPA are made if and only if the plant is dispatched. They typically cover the cost of fuel and other variable operating costs. If the payments are exactly equal to these costs, the IPP is indifferent to dispatch.

By contrast, the capacity payments must be made whether or not the plant is dispatched, so long as it is available to be dispatched. These payments are denominated in currency units per unit of average available electrical capacity.

The capacity payments do not guarantee that the investors will receive an acceptable return on their investment. They are conditional on the plant's being available and thus depend on the plant's being properly built and maintained. And they allow the investors to recoup only reasonable construction costs and operating costs, so the investors may lose money if there are cost overruns.

But if the investors do their part—building and maintaining the plant well and at reasonable cost—the capacity payments ensure that they receive an acceptable return even if the plant is never dispatched—something that is justifiable because it is up to the utility not the IPP to decide whether the plant is dispatched.

III. Power-Purchase Agreements and Debt Contracts

One approach to estimating the expected cost of guaranteeing payments under a PPA is to apply a method that has been used to estimate the expected cost of guaranteeing debt-service payments. The approach could be used for any kind of payments, whether debt-like or not, but its use is most plausible for payments that have similarities to debt payments.

PPAs create obligations that differ from the obligations in conventional debt contracts in several ways. The energy payments in energy-payment-only PPAs vary with energy generated, while the energy payments in capacity-payment PPAs are made only if the utility chooses to dispatch the plant. The consequences of not making the payments may also differ from the consequences of not making a debt payment.

But capacity payments and the payments in energy-payment-only PPAs have similarities to debt-service payments. Most notably, the utility has no control over whether the payments must be made, given the commitments it makes in the PPA. In a capacity-payment PPA, the utility must make the capacity payments if the plant is available to be dispatched. In an energy-payment-only PPA, it must make the payments if energy is generated or deemed to be generated, which is something over which it has no control.

The kind of debt that a PPA obligation most closely resembles depends on the PPA. For example, an obligation in a 20-year PPA to make capacity payments denominated in U.S. dollars resembles 20-year amortizing U.S. dollar debt. By contrast, an obligation in a 15-year PPA to make capacity payments denominated

in local currency and indexed to local inflation resembles 15-year amortizing inflation-adjusted local-currency debt. The obligation to make energy payments in an energy-payment-only PPA has no close relatives, but resembles a hypothetical kind of indexed debt, in which payments are linked (not to GDP, inflation, or a commodity price) but to energy production.

Because of the similarities between debt and some of the utility's obligations in PPAs, financial analysts sometimes treat PPAs and similar contracts as creating debt (and a corresponding asset) on the balance sheet of the utility. Standard & Poor's (2013, p. 14), for example, writes: "We view long-term purchased power agreements (PPA) as creating fixed, debt-like financial obligations . . ." (See also Standard & Poor's, 2007, and White, Sondhi, and Fried, 1998, p. 548.)

Deciding whether all the utility's payment obligations should be included in an estimate of the expected cost of a guarantee of a PPA raises a difficult issue. It seems clear that capacity payments in a capacity-payment PPA and energy payments in an energy-payment-only PPA should be included, since the utility is obliged to make these payments irrespective of its choices. It is less clear whether the energy payments in a capacity-payment PPA should be included, since the utility decides whether to make these payments when it decides whether to dispatch the plant. From the point of view of the utility, these payments are discretionary; they are not like debt. Moreover, if the utility's default or distress is likely to coincide with low demand for the electricity it sells (for example, because of a recession or a change in technology), the amount of the energy payments could be low in the circumstances in which the guarantee is called. These considerations create a case for not counting in the expected cost of the guarantee the energy payments in a capacity-payment PPA. By contrast, the ministry of finance may not have much control over whether these payments are made, and not including them may underestimate the expected cost of the guarantee.

IV. Using Credit Ratings to Estimate the Expected Cost of a Debt Guarantee

While other methods for valuing debt-guarantees could also be applied, and are mentioned below, in Section VI, we consider here a method that relies on credit ratings. The essential idea is that the credit rating can be used to estimate the probability that the government will have to make good on its guarantee; see Bachmair (2016) and Bachmair, Aslan, and Maseko (2019) for details. We consider as an example of this method a case in which a government guarantees conventional debt issued by a state-owned utility.

The first step in applying this method is to calculate or estimate the future debt-service payments that are being guaranteed, or the exposure, year by year. In the case of standard fixed-rate debt, this is straightforward, but in other cases it may require some estimates. In the case of variable-rate debt, for example, it requires a forecast of future interest rates.

The second step is to assign the utility a credit score. This score will depend on the utility's finances and various aspects of its environment, including the government's policies toward the utility, such as the regulation of the electricity tariffs. The score could be the credit rating of an agency such as Fitch, Moody's, or Standard & Poor's. To estimate the expected cost of the government's guarantee, however, it should be a rating that abstracts from possible government support. The overall (headline) ratings assigned by these agencies incorporates the possibility that the government will help the utility meet its obligations, but the agencies sometimes also report a "standalone" or "baseline" rating that excludes this possibility. If the utility does not have a credit rating, it is necessary to estimate the rating it would get if it had one. Bachmair (2016) and Bachmair, Aslan, and Maseko (2019) discuss how this can be done. See also the documents published by rating agencies that explain how they arrive at credit ratings for utility companies, such as Fitch (2015), Moody's (2018), and Standard & Poor's (2013).

The third step is to relate credit ratings to the probability that the government will have to honor its guarantee, or, more plausibly, that the government will choose to subsidize the utility so that the utility does not default and the guarantee is not officially called. We can call this the probability of distress. Credit-rating agencies such as Moody's and Standard & Poor's have published tables that show the historical relationship between credit ratings and default (e.g., Moody's, 2017). These tables show cumulative probabilities of default by year for 15 or 20 years for (in the case of Moody's) each of the following credit ratings: Aaa, Aa, A, Baa, Ba, B, and Caa-C.

To go from cumulative default rates to estimates of the probabilities of distress, we need to answer two questions. First, should we assume that historic default rates can be used as probabilities of default and that probabilities of distress are the same as probabilities of default? In what follows, we assume, for want of any better assumption, that they are. Second, should we assume that distress continues for the term of the debt? In principle, the utility might be in distress for a few years, but then recover, not simply because the government provided it with cash but because its circumstances changed. To take account of this possibility, we could make an estimate of the probability of the utility's remaining in distress given that it was in distress in the previous year. Then a

probability of the utility's being in distress in a given year could be estimated iteratively from the tables of cumulative probabilities.⁴ In what follows, we make the simple, and conservative, assumption that once a utility becomes distressed its distress lasts for the term of the contract.

The fourth step is to estimate the government's loss given distress. The loss given distress depends on whether the guarantor must provide the whole of the payment or only some of it and whether the government subsequently recovers any money from the entity whose borrowing is guaranteed. For simplicity, we make the assumption—again conservative—that the loss given distress is 100 percent of the exposure.

Given this information and these assumptions, it is possible to estimate the net amount that the government can expect to pay each year as a result of its guarantee. In particular, once we have estimated for each year t the government's exposure (E_t) and the probability of distress (PD_t) and made an assumption about the loss given distress (LGD), the government's expected payment, G_t , is given by

$$G_t = E_t \times PD_t \times LGD.$$

And once expected payments have been estimated for all the years of the debt contract, an estimate of the present value of the guarantee can be found by discounting the payments at the risk-free rate of interest.

The estimate is an estimate of the expected cost of the (explicit) guarantee relative to a base case in which there is no guarantee at all, including no implicit guarantee. In other words, it is an estimate of the cost of the guarantee relative to a base case in which the government lets the utility default. To estimate the incremental cost of an explicit guarantee over an implicit guarantee, it would be possible to apply a similar approach that, however, focused on the difference between the utility's overall (headline) rating and the government's own sovereign rating, and the implied differences in probabilities of distress.

⁴ More precisely, let c_t , f_t , and p_t denote, respectively, the utility's cumulative probability of distress in year t , the probability of the utility's being in distress for the first time in year t , and the probability of utility's being in distress in year t , and let r denote the probability of the utility's remaining in distress from one year to the next. Then $f_1 = p_1 = c_1$ and, for $t > 1$, $f_t = c_t - c_{t-1}$, and $p_t = p_{t-1}r + f_t$.

V. Using Credit Ratings to Estimate the Expected Cost of a Guarantee of a Power-Purchase Agreement

If we substitute for debt-service payments the payments that the utility must make to an IPP under a PPA, we can apply the same approach to a PPA guarantee.

We assume for the purpose of the illustration that the possible guarantee covers the entire term of the PPA and applies only to routine (energy or capacity) payments. In particular, we do not consider any guarantee of a termination payment. If the guarantee of routine payments is for a term significantly shorter than the entire PPA, a guarantee of a termination payment may have a large additional cost. But this is not the case if the guarantee covers routine payments for the entire term of the PPA: the effect of termination may be mainly to require an immediate payment roughly equal to the present value of the routine payments that would have been made if the contract had not been terminated. In that case, summing the cost of the guarantee of the routine payments and the guarantee of the termination payment would be double counting.

PPA with only energy payments

Consider first an energy-payment-only PPA. It might be a PPA for a wind farm or a solar plant or run-of-the-river hydro plant.

We suppose first that, by reading the PPA and seeking the advice of lawyers and other experts familiar with the project, we get the following information:

- The PPA has a term of 15 years.
- The PPA provides that the utility will purchase all the energy produced or deemed produced by the IPP at a year-zero price of 100 pesos per megawatt-hour increased by the actual rate of local consumer price inflation.

For simplicity, we assume all payments are made at the end of year, that the first payment will occur in exactly one year's time (and will be adjusted for actual inflation), and the guarantee is issued today.

We assume next that advice provided by macroeconomists and electricity engineers familiar with the project suggests the following two assumptions:

- Peso inflation is forecast to be 5 percent a year over the term of the PPA.
- The annual electricity production of the plant is forecast to be 300,000 MWh. (This forecast might be derived from data on the maximum

capacity of the plant; estimates of the percentage of the time the plant will be available, given maintenance requirements and the possibility of breakdowns; and information on normal hours of sunshine, windspeeds, or river flow as the case may be.)

Finally, we assume that financial analysis and the advice of financial experts suggests that:

- The actual or estimated credit rating for the utility in the absence of government support by, say, Moody's is Baa.
- The best estimate of the relationship between Moody's credit ratings and cumulative probabilities of default is that given in Moody's (2017, Exhibit 33).
- The forecast loss given default is 100 percent.
- The risk-free local-currency rate of interest is 7 percent a year. This rate can be estimated based on yields of the long-term government bonds denominated in local currency.

We can then use these assumptions to arrive to an estimate of the expected cost of the guarantee (see Table 1).

- Given the real price (100 pesos/MWh), forecast inflation of 5 percent a year, and forecast electricity generation of 300,000 MWh a year, the utility's forecast payment in year 1 is 31.5 million pesos. In each following year, the forecast payment increases with inflation by 5 percent.
- In the first year, the assumed probability of default is 0.177 percent, so the estimate of the government's expected payment is approximately 0.06 million pesos. Because the loss given default is assumed to be 100 percent, this is also the expected net payment. The estimated expected net payment increases each year because of inflation and increases in the cumulative probability of default.
- Discounted at a rate of 7 percent a year, the estimated expected net payment in the first year has a present value of approximately 0.05 million pesos. In the following years, discounting increasingly reduces the present value of the estimated expected payments.
- The estimated cost of the guarantee is the sum of the present values of the payments, which works out to be approximately 11.7 million pesos.

Table 1. Illustrative estimation of expected cost of guarantee of an energy-payment-only PPA (million pesos unless noted)

Year	Forecast energy payment	Assumed probability of distress (%)	Assumed loss given default (%)	Forecast net guarantee payment	Present value of net guarantee payment
1	31.5	0.177	100	0.06	0.05
2	33.1	0.461	100	0.15	0.13
3	34.7	0.804	100	0.28	0.23
4	36.5	1.216	100	0.44	0.34
5	38.3	1.628	100	0.62	0.44
6	40.2	2.058	100	0.83	0.55
7	42.2	2.472	100	1.04	0.65
8	44.3	2.908	100	1.29	0.75
9	46.5	3.393	100	1.58	0.86
10	48.9	3.925	100	1.92	0.98
11	51.3	4.500	100	2.31	1.10
12	53.9	5.121	100	2.76	1.23
13	56.6	5.760	100	3.26	1.35
14	59.4	6.384	100	3.79	1.47
15	62.4	7.006	100	4.37	1.58
Total					11.71

PPA with capacity payments and energy payments

Now consider a capacity-payment PPA. In the example, we include in the estimate of the expected cost of the guarantee only the capacity payments.

We assume that, by reading the PPA and seeking the advice of experts, we get the following information:

- The PPA has, as in the previous case, a term of 15 years.
- The PPA provides that the utility will pay for capacity at a year-zero price of 60,000 U.S. dollars per available megawatt every year, increased each year by U.S. consumer price inflation.

As above, we assume for simplicity that all payments are made at the end of year, that the first payment will occur in exactly one year's time, and the guarantee is issued today.

We assume next that advice provided by macroeconomists and electricity engineers familiar with the project suggests the following:

- U.S. dollar inflation is forecast to be 2 percent a year over the term of the PPA.
- The forecast average capacity of the plant is 200 MW. (This forecast might be derived from data on the maximum capacity of the plant and an estimate of the percentage of the time it will be available, given maintenance requirements and the possibility of breakdowns.)

Finally, we assume that the advice of financial experts suggests that

- The actual or estimated credit rating for this utility (in the absence of government support) by, say, Moody's is B. (We assume, that is, the utility in this example has poorer credit than the utility in the previous example.)
- As above, the best estimate of the relationship between Moody's credit rating and cumulative probabilities of default is that given in Moody's (2017, Exhibit 33).
- As above, the forecast loss given default is 100 percent.
- The risk-free rate of interest in U.S. dollars is 2 percent a year. This rate can be driven from the U.S. long-term government bond yields.

We can then use these assumptions to arrive at an estimate of the expected cost of the guarantee (see Table 2).

- Given the real price of capacity (\$60,000/MW every year), forecast U.S. inflation of 2 percent a year, and forecast average available capacity of 200MW, the utility's forecast payment in year 1 is \$12.2 million. In each following year, the forecast payment increases with U.S. inflation by 2 percent.
- In the first year, the assumed probability of distress is 3.573 percent, so the estimate of the government's expected payment is approximately \$0.4 million. Because the loss given default is assumed to be 100 percent, this is also the net payment. The estimated expected net payment increases each year partly because of inflation but mainly because of increases in the cumulative probability of default.
- Discounted at a rate of 2 percent of year, the estimated expected net payment in the first year has a present value of approximately \$0.4 million. In the following years, discounting slowly reduces the present value of the estimated expected payments.

- The estimated expected cost of the guarantee is the sum of the present values of the payments, which works out to be approximately \$51.0 million.

Table 2. Illustrative estimation of the expected cost of guarantee of capacity payments (million dollars unless noted)

Year	Forecast energy payment	Assumed probability of distress (%)	Assumed loss given default (%)	Forecast net guarantee payment	Present value of net guarantee payment
1	12.2	3.573	100	0.4	0.43
2	12.5	8.436	100	1.1	1.01
3	12.7	13.377	100	1.7	1.61
4	13.0	17.828	100	2.3	2.14
5	13.2	21.908	100	2.9	2.63
6	13.5	25.556	100	3.5	3.07
7	13.8	28.857	100	4.0	3.46
8	14.1	31.644	100	4.4	3.80
9	14.3	34.121	100	4.9	4.09
10	14.6	36.177	100	5.3	4.34
11	14.9	37.857	100	5.6	4.54
12	15.2	39.302	100	6.0	4.72
13	15.5	40.704	100	6.3	4.88
14	15.8	42.213	100	6.7	5.07
15	16.2	43.658	100	7.1	5.24
Total					51.03

VI. Concluding Comments

The paper has set out a method for getting an approximate valuation of a government guarantee of a state-owned electricity utility's payment obligations to an IPP under a PPA. To conclude, we briefly discuss some possible extensions of the approach and some of its limitations.

The paper has considered a single guarantee of obligations under a simple PPA at the time at which the ministry of finance is being asked to grant it. Various extensions could be considered. First, the method can easily be used to re-estimate the cost of the guarantee periodically. The inputs to the calculation just need to be updated. Second, the ministry may also want to estimate the expected cost of a portfolio of guarantees. Estimating the *risks* created by a portfolio of guarantees is not straightforward since measures of risk generally do not sum: the risk of a portfolio of guarantees is not the sum of the risks of the individual

guarantees. But the expected cost of the portfolio is just the sum of the expected cost of the individual guarantees. So, the method could be used to estimate the expected cost of a portfolio of guarantees. Third, the method might also be used to estimate the expected costs of guarantees of payment obligations under contracts other than a PPA, such as a bulk-water-supply contract between a water utility and independent water-supply company.

Several limitations of the method should also be noted. First, as just noted, the estimate is an estimate of the *expected cost* of a guarantee, but not its risk. It does not, for example, provide any estimate of cash-flow-at-risk (e.g., the 95th percentile of the distribution of the government's payments in the next year).

Second, and as discussed earlier, the method is most clearly applicable to debt-like payments in PPAs; that is, those that are nondiscretionary. It is not so clearly applicable to discretionary payments such as the energy payments in a capacity-payment PPA.

Third, even in cases in which it is clearly applicable, the estimate of the expected cost will not be precise. Many of the inputs to the calculation are estimates, some of them probably quite rough. For example, if the utility does not have its own credit rating, the ministry of finance will have to estimate the rating, and its estimate may not be accurate. The future relationship between credit ratings and probabilities of default may differ from the past relationship. The probability of defaulting on a payment obligation in a PPA may be different from the probability of defaulting on (conventional) debt. Forecasts of the available capacity of the power plant and the energy it produces may prove to be wide of the mark. And so on.

Fourth, the estimation of the cost of government guarantees of the obligations of state-owned enterprises (whether related to PPAs or conventional debt) raises some specific issues. Governments seldom wait until such a guarantee is officially called before intervening; instead, they prevent the call of the guarantee. The expected cost to the government may not be very different, but it may not (as assumed here) be identical. Related to this, the calling of the guarantee does not necessarily mean (as assumed here) that the government will have to meet all the PPA obligations for the entire remaining term of the agreement.

Fifth, there are two costs of granting guarantees that the method ignores. The first is simply the administrative cost of granting guarantees. The second is subtler: it is the cost of bearing risk. The estimate is of the government's expected payments, discounted at the risk-free rate of interest. It thus does not vary according to whether the payments will probably be made in good times, when

the government's revenue is growing strongly and its access to finance is good, or whether the payments will probably be made in bad times, when the government's revenue is shrinking and its access to finance is limited. The cost of bearing risk is hard to estimate, but it may be significant.

Some of these problems may partly offset each other. The assumption that in the event of distress the government pays all the remaining costs of the PPA means that the estimate errs on the side of overestimating the cost of the guarantee. By contrast, counting only the cost of the capacity payments in an energy-and-capacity-payment PPA (as we did in the illustration) and ignoring the cost of bearing risk means that that estimate errs on the side of underestimating the cost of the guarantee. There is no reason, however, to think these factors will exactly offset each other. Overall, the method can be expected to give only a very rough estimate of the cost.

One way of responding to these problems is to test how the estimate of the expected cost of the guarantee varies with changes in assumptions. For example, it is possible to estimate the effects on the estimate of varying the forecast inflation rate, the discount rate, the capacity of the plant, annual energy production, the utility's estimated credit rating, the link between cumulative default probabilities and probabilities of distress, and the loss given default. In addition, by changing several assumptions at once, a variety of scenarios could be produced, including a base case, an adverse scenario, and an upside scenario.

Another way of responding to these problems is to test the approach against the results of other methods of estimating the cost of the guarantee, including the stochastic simulations mentioned in the introduction. If they give markedly different answers, more work needs to be done.

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