# The Impact of On-Bill Programs on Loan Performance: Evidence from the Green Jobs, Green New York Program

*Jeff Deason, Goldman School of Public Policy at UC Berkeley, Berkeley, CA*

## ABSTRACT

I investigate the credit enhancement value of NYSERDA's on-bill energy efficiency financing program relative to its similar conventional unsecured loan program. The two programs have run concurrently for several years and are similar in many respects, allowing me to interpret the unsecured loans as a counterfactual for the on-bill loans. In the raw data, while both loan pools perform well relative to credit card lending, the on-bill loans default more often than the unsecured loans. Using loan-level data to eliminate known problematic loans and control for other differences in the loans that might affect loan performance, I show that this result persists: on-bill loans default more often, and this finding is not sensitive to model specification. I also show that NYSERDA's alternate underwriting mechanism based on mortgage and utility bill repayment history performs well, and that projected dollar savings from the installed projects do not significantly influence loan performance.

Loan payments to NYSERDA's on-bill program are subordinated to utility bill charges: by law bill payments are first directed toward utility bill charges and only applied to the loan when bill charges are fully paid. Subordination may be responsible for my surprising results, as most observers expect on-bill programs generally to have some credit enhancement value. As such, while my finding is cautionary for the credit enhancement value of on-bill arrangements, other on-bill programs that do not fully subordinate loan payments may well offer positive loan performance value.

## Introduction

Loan programs that finance energy efficiency projects in buildings via payments on utility bills have grown substantially in number in recent years. This growth is part of a broad expansion of interest in alternate financing arrangements for energy efficiency (and to some extent for distributed renewable energy generation technologies). As such projects involve upfront capital expenditures that can in many cases be "self-financed" through the energy cost savings they generate, many view financing as an appealing way of aligning consumer needs with the characteristics of energy efficiency projects. If the financial performance of energy efficiency lending proves strong, low-cost private capital might flow into the space, reducing public expenditures on rebates and expanding the pool of capital available.

Specific programmatic designs can offer benefits that are potentially well-matched to energy efficiency markets (Bell, Nadel, and Hayes 2011; Henderson 2013; SEE Action 2014b). In the case of on-bill programs, I separate those benefits into two classes. First are features that may drive demand for energy efficiency through channels other than improving the financial performance of loan, including:

- On-bill programs can leverage standing relationships utilities have with their customers, and may be able to increase uptake through those relationships.
- Borrowers may prefer to consolidate their energy obligations in a single "energy account," or may like that their bills will tend to go down without external loan payment obligations.
- In some program designs, loan payments are tied to the energy meter rather than the borrower and can be transferred to a new owner upon property sale, overcoming a common split incentive problem between current and future owners for long-lived energy investments.

The second set of potential benefits bear directly on loan performance and could thereby lower the cost of capital for energy efficiency measures (thereby ultimately driving demand as well):

- Utility bills are repaid relatively reliably, and attaching loan payment to this channel may leverage this strong performance.
- On-bill structures provide some measure of security that may encourage borrowers to repay at higher rates than otherwise, for fear of having their utility service switched off. Program designs vary on whether they allow shutoff for non-payment of on-bill loans, but even for programs that don't, the customer may perceive the threat of shutoff and behave accordingly.
- Loans that are attached to a meter could survive a foreclosure or bankruptcy process to be assumed by the eventual new owner, providing additional security to the lender. In practice, this issue is largely untested (SEE Action 2014b).

This paper provides preliminary evidence on loan performance impacts in the case of one particular on-bill program using detailed loan-level data. While many on-bill programs have enjoyed low default rates (SEE Action 2014b), it is unclear whether these rates are due specifically to the on-bill structure itself. So far as I am aware, no work has attempted specifically to evaluate on-bill loan performance relative to a conventional unsecured energy efficiency lending baseline.

## The Programs

### Smart Energy Loan and On-Bill Recovery Loan Programs, Compared

The New York State Energy Research and Development Authority (NYSERDA), a public benefit corporation that promotes energy efficiency and renewable energy in New York State, began a low-interest residential energy-efficiency loan program in December 2010. Known as the Smart Energy Loan (SEL), it is a traditional unsecured energy efficiency loan product. Loan underwriting and issuance are done by an outside loan servicer. The capital comes from a state revolving loan fund that was initially seeded using auction proceeds from the Regional Greenhouse Gas Initiative (RGGI), a carbon cap-and trade system covering New York and several other Northeastern states. Loan recipients pay annual interest rates of 3.49% if they elect automatic bank payments, or 3.99% if paying by check. (About 80% of borrowers elect automatic payments.) Loan minimums are $1,500 and maximums are $25,000; terms can be 5, 10, or 15 years, with 15-year terms predominating.

In March 2012, NYSERDA introduced the On-Bill Recovery Loan (OBRL) as a second financing option. On-Bill Recovery Loans are made from the same revolving loan fund as the SEL. At program inception, the annual interest rate was 2.99%; in March 2014 NYSERDA raised the rate to 3.49%. OBRL amount restrictions and terms are identical to the SEL. Payments go to participating utilities through a dedicated charge on the borrower's utility bill. All seven of the major New York State utilities participate in the on-bill program. Both SEL and OBRL programs are housed within NYSERDA's Green Jobs, Green New York (GJGNY) program.

Both programs finance energy efficiency measures in residential buildings.[1] The list of eligible measures for financing is identical for the two programs, and the programs share a similar loan approval process. Cost-effectiveness screens employed by the two programs do differ as discussed below.

---

[1] The programs were recently expanded to finance solar PV installations; however, very few PV loans have yet been issued, and I drop those loans from this analysis.

Contractors who offer the loans are instructed to describe both products to their customers.[2] A potential borrower fills out a single loan application, and is automatically evaluated for approval under both programs. The underwriting process includes screens for both applicant credit quality and project economics. When applying, the borrower expresses a preference for which loan program she prefers.

Evaluation of applicant credit quality is identical under the two programs. Both use two different tests. Tier 1 is a typical approach based on credit scores and debt-to-income ratios (DTI); Tier 2 is an alternative screen based on mortgage and utility bill repayment history. An applicant is first evaluated under Tier 1 criteria, and then under Tier 2 if she fails the Tier 1 test. The Tier 2 alternative approach has increased approvals by about ten percent (SEE Action 2014b). The exact screens used have evolved over the course of the program, but have at all times been the same for both loan programs. As long as the prospective borrower passes either Tier screen, they are eligible for either loan product.

In both programs, the project's cash flows are subject to a cost-effectiveness screen: projects that do not come close to paying for themselves through future energy savings are not financed. Such screens are common, though somewhat controversial, in energy efficiency financing programs. They ensure that public dollars are not spent for financing costs of projects whose economics are not strong and, consequently, that financed projects do not diminish a borrower's ability to repay. However, the screens may dissuade borrowers from undertaking more ambitious energy-saving projects that would fail them.

The cost-effectiveness screen for OBRL is more difficult to meet than that for SEL. The SEL test requires either that prescreened energy efficiency measures (which are presumably individually cost-effective on average) constitute at least 85% of the financed amount, or that anticipated energy cost savings *over the life of the installed measures* equal at least 80% of the upfront investment. OBRL, by contrast, requires *average annual* cost savings to equal at least 100% of annual payments. Clearly the 100% requirement is more stringent than the 85% or 80% requirements. More subtly, since future savings amounts build in an energy cost escalator, the SEL test is also easier to meet because it compares future (cost-escalated but undiscounted) savings to current investment, while OBRL compares time-averaged payments to each other.

The net result of this cost-effectiveness test disparity is that some potential borrowers who state a preference for OBRL are denied an OBR loan but instead offered a SE loan. Below I take steps to account for this distinction.

## OBRL Design Features that Bear On Credit Enhancement Value

Legally, the obligation to repay an OBR loan lies with the individual, not with the energy meter (electric or gas). But the legislation authorizing the OBRL mechanism provide that "unless fully satisfied prior to sale or transfer, the on-bill recovery charges… shall survive changes in ownership, tenancy, or meter account responsibility, and arrears in on-bill recovery charges at the time of account closure or meter transfer shall remain the responsibility of the incurring customer, unless expressly assumed by a subsequent purchaser of the property." [3] As such, OBR loans can transfer to a new owner upon property sale. NYSERDA believes the legislation provides that the charge could survive a foreclosure process, but a bankruptcy process may result in the discharge of the debtor's obligation by a

[2] NYSERDA staff indicated that on balance the contractors might exhibit a slight preference for SEL loans, as OBRL qualification is more difficult and more time-consuming. On the other hand, some community-based organizations that promote the programs prefer OBRL for their constituents, believing it is more forgiving and flexible from a consumer protection perspective - an interesting position given the results I find. On balance, staff does not believe contractors or other promoters try overly hard to push one product over the other.

[3] New York State Public Service Law Section 66-m(2)(d).

bankruptcy court. As of December 2014, seventeen OBR loans[4] have been transferred to a new owner, but none under adverse circumstances, while a handful of properties are in bankruptcy proceedings.

A critical feature of NYSERDA's OBRL program is that, statutorily, the on-bill loan is subordinate to utility bill charges. Borrower payments are first applied to utility bill charges, and only begin paying down the loan if all those charges are current. An alternative approach used by many other programs is to make payments pass *pari passu* to the two accounts – in other words, in proportion to the outstanding charges on each. At least one program - the Hawaii Energy Bill $aver program - has even made on-bill loan payments senior to utility bill charges.

This program design feature has proved consequential in unexpected ways. Most specifically, some OBRL customers are under deferred payment arrangements (DPAs) to resolve past utility bill payments. Until such a customers exits the DPA, the loan will likely go entirely unpaid thanks to its subordinate position. These loans, by standard practice, almost automatically become delinquent, go into default, and are charged off,[5] whether or not the customer is abiding by the terms of the DPA (SEE Action 2014b). NYSERDA did not anticipate this issue during program design but noted it over time as a surprising number of OBR loans were being charged off. NYSERDA subsequently changed its charge-off policy and now does not charge off any loans to accounts under DPAs under the assumption that it will start to receive funds once the DPA clears. NYSERDA also now screens for existing DPAs as part of the loan application and disqualifies customers who are on them (Pitkin 2015).

The OBRL program does permit utilities to shut off their customers in the event that they fail to pay their OBR loan, which should encourage repayment and create security. Utilities may be loath to do so – particularly for the residential customers served by this program. The utilities participating in OBRL have not yet shut off any customer for non-payment of a loan, despite the fact that there are loans in the data that are hundreds of days delinquent (Pitkin 2015).

In the final stages of OBRL legislative authorization development, concerns were expressed about making the OBRL installment charge *pari passu* to the utility service charges, while also maintaining requirements for shutoff for non-payment. NYSERDA was given a choice between having shutoff power or *pari passu* payments. NYSERDA's financial advisors recommended shutoff power, under the theory that even subordinated payments would still result in shutoff and that this would provide a form of valuable security to the loans and support secondary markets financing. However, in late 2012, NYSERDA pursued a rating on an initial portfolio of GJGNY loans, including OBR loans, and received feedback from the rating agency that the subordination feature would not support an effective rating (Pitkin 2015). With the benefit of hindsight and a lot of data, my results support the notion that shutoff over *pari passu* may have been the wrong choice.

## Data and Data Preparation

### Description of Data

Thanks to extraordinary cooperation from NYSERDA, I observe every loan made under either residential program from the inception of OBRL in March 2012 through December 2014. Contract data include the underwriting tier (1 or 2) used to approve the loan; the original loan amount; the contract

[4] The fact that some loans have transferred is a positive for the model's potential to overcome split incentives, though the number of transfers is small. An unknown share of prepaid loans (discussed further below) may have been paid off to ease property transactions, so it may well be that despite transferability, the majority of loans are paid off upon sale.
[5] When a creditor (NYSERDA in this case) charges off a loan, it is declaring the loan is unlikely to be collected. Charging off a loan entitles the creditor to a tax deduction. Chargeoff does not relieve the borrower of the obligation to pay.

date; the original loan term; and the interest rate of the loan. Borrower information includes the credit score[6] and debt-to-income ratio (DTI) at the time of loan issue, city, county, and zip code. I observe the utility service provider for OBR loans but not for SE loans.

Data provided by NYSERDA show, among other things, the monthly loan balance and the number of days the loan is delinquent, which is how the loan servicer tracks loan status. For current loans, "days delinquent" are negative, indicating that payment was made within the last month or even earlier. This field will be missing if the borrower has paid off the loan entirely (loan balance is zero). If, on the other hand, the borrower has missed a payment, this field will carry a larger positive value. I also observe the predicted first-year dollar savings for each project.

I drop from the analysis 24 loans missing credit score data (all of which were approved using Tier 2 underwriting criteria) and one loan missing project data, leaving a total of 5471 loans. 2080 of these are OBRL loans and 3391 are SEL loans.

Several subgroups of loans merit special consideration. As discussed above, OBR loans that are on deferred payment plans essentially enter default automatically. Once NYSERDA diagnosed this issue, they began to screen for customers on DPAs and to disqualify them from the loan program. As these loans are their own special case, I drop them from most of the estimations. This eliminates 30 OBR loans, all of which went into 120-day default.[7]

Another issue threatening OBR loan performance is the timing of bill payments (SEE Action 2014b). 192 OBRL borrowers are on bimonthly billing cycles, meaning that a single missed payment could send them into default. Also, utility billing cycles sometimes change without warning, potentially creating a delinquency without a missed payment. Accordingly, I use a relatively long-run measure of default, as 30- or 60-day default definitions would be more likely to be confounded by these issues without revealing truly risky loan payment patterns. For some specifications I drop the bimonthly loans entirely, though as it turns out this makes no qualitative difference in the results.

Finally, as discussed earlier, some SEL borrowers expressed interest in OBRL but failed to meet the cost-effectiveness criteria and opted for SEL instead. As we are considering SEL borrowers to be a counterfactual for OBRL borrowers, one could argue that these borrowers – who we know could not choose OBRL – should be excluded. Therefore, for some specifications, I perform a simple calculation that mimics the OBRL cost-effectiveness test and exclude all loans that fail to meet it. This restriction is quite consequential – about 60% of SE loans fail to meet the test. For whatever reason, so do 9% of OBR loans;[8] for consistency's sake, I exclude these as well.

Table 1 presents the number of loans remaining in the sample as I drop these groups of loans, along with the number of those loans that enter 120-day default at any time in the sample. Notably, in all cases the percentage of OBR loans in default is higher than the percentage of SE loans in default, even after removing the more suspect groups of loans. Since on-bill repayment is generally expected to provide a credit enhancement, this is somewhat surprising. Also surprisingly, SEL loans that do not meet the OBR cost-effectiveness test default less often than those that do.

---

[6] In the many cases where there are two co-borrowers, I use the higher of the two credit scores, which is the approach taken in underwriting determinations.

[7] This 100% default is due to the specifics of the data-generating process. At program start, NYSERDA was unaware of the DPA issue. Subsequently it began checking every loan for a DPA once it reached 120-day delinquency, and later began screening out applicants on DPAs. Prior to 120-day delinquency, however, NYSERDA does not know whether loans are on DPAs. Therefore, the only loans flagged as DPA in NYSERDA's data are those that are 120 days delinquent or more.

[8] Most of the OBR loans that fail the test do so narrowly, suggesting that I am failing to replicate some details of the cost-effectiveness screen; however, NYSERDA program staff was not able to immediately identify any deficiency in my calculation. Some loans fail by a wider margin, likely due to some combination of data errors, underwriting errors, and specific exceptions made for whatever reason.

**Table 1.** Loans and defaults in sample after various potential exclusions

| | OBR loans | SE loans | OBRL 120-day defaults | SEL 120-day defaults |
|---|---|---|---|---|
| Full sample | 2080 | 3391 | 76 (3.65%) | 41 (1.21%) |
| **Excluding OBR DPA loans** | **2050** | **3391** | **46 (2.24%)** | **41 (1.21%)** |
| Excluding OBR DPA and bimonthly loans | 1894 | 3391 | 41 (2.17%) | 41 (1.21%) |
| **Excluding OBR DPA and all loans that fail OBR cost-effectiveness test** | **1858** | **1349** | **40 (2.15%)** | **21 (1.56%)** |

**Loan Performance in the Raw Data**

Before proceeding to estimation, we should consider what the raw data tell us about the performance of these loan programs compared to other consumer debt. To do this, I compare the dataset with market data from Standard & Poor (S&P) and Experian (S&P 2015).

I generate comparable values to those used by S&P from my data and compare these values to the S&P/Experian indices over the same time period (specifics not discussed due to space constraints) SE loans perform well for unsecured debt. Their 12-month default rate is comparable to auto loans and first mortgages, both of which are secured debt (by the auto and the home, respectively). The default rate is much lower than unsecured credit card debt. OBR loans likewise outperform credit cards easily; however, their 12-month default rates are considerably higher than auto loan or first mortgage default.

While it is a good sign that the GJGNY loans outperform credit card lending, it is unclear why. As Table 2 shows, most borrowers have strong credit ratings. If this is the explanation, there is nothing about the projects themselves that drives this result. Perhaps energy efficiency lending is most attractive or interesting to borrowers who watch their expenses carefully, thereby selecting for strong-performing borrowers. Or, perhaps the below-market interest rate offered through both programs is important for improving loan performance. As discussed below, my results suggest that the dollar savings generated by the installed projects may not be an important driver of loan performance.

**Summary Statistics**

Table 2 presents summary statistics for the bolded sets of loans in Table 1, which I adopt as my preferred loan populations. Looking at the first two columns of results, the table shows that the average OBR loan is larger than the average SE loan. While 180-month loan terms predominate in both, they are nearly ubiquitous for OBRL, while a greater fraction of SE loans carry shorter terms. The average OBR loan was made 20 days later than the average SE loan, but the median OBR loan was made 20 days *earlier* than the median SE loan. OBRL borrowers' credit scores and DTIs are very slightly stronger than SEL borrowers', with the exception that median DTI is slightly higher for SEL borrowers. Projected dollar savings are higher for OBR loans in both gross and net terms;[9] while the average and median OBR loans have positive net savings, the average and median SE loans do not. With the exceptions of loan date, monthly payment, and DTI, all mean differences between the two groups are statistically significant with 95% or greater confidence.

[9] Gross expected first-year savings are given in the data. I calculated net savings by subtracting the monthly loan payment times 12 from the gross expected first-year savings.

**Table 2.** Summary statistics for OBRL and SEL loans, OBRL DPA loans dropped

| | OBRL | SEL | Cost-effective OBRL | Cost-effective SEL |
|---|---|---|---|---|
| Mean (median) loan amount | $10,980 ($9748) | $9524 ($8386) | $10,930 ($9637) | $10,010 ($8363) |
| Mean (median) loan date | 9/12/13 (8/23/13) | 8/23/13 (9/12/13) | 9/12/13 (8/23/13) | 8/3/13 (8/23/13) |
| Mean (median) term, months | 174.5 (180) | 158.8 (180) | 174.5 (180) | 170 (180) |
| Mean (median) monthly payment | $80.41 ($70.48) | $79.33 ($70.99) | $79.87 ($69.98) | $76.21 ($64.65) |
| Mean (median) credit score | 751.4 (764) | 745.5 (757) | 751.2 (764) | 744.3 (754) |
| Mean (median) DTI | .328 (.324) | .341 (.322) | .329 (.324) | .373 (.336) |
| Share of Tier 2 underwriting | 9.6% | 11.9% | 9.8% | 14.5% |
| Share of Assisted Rate borrowers | 25.1% | 31.4% | 25.7% | 42.4% |
| Mean (median) predicted gross first-year dollar savings | $1425 ($1177) | $937 ($641) | $1489 ($1236) | $1503 ($1221) |
| Mean (median) predicted net first-year dollar savings | $461 ($223) | -$15.44 (-$132.9) | $530 ($273) | $589 ($312) |

The two rightmost columns compare the set of loans that pass the OBRL cost-effectiveness screen for each program. The data on OBR loans change little. These SE loans look more like the OBR loans in several respects related to the cost-effectiveness calculation, including loan amount, term, and gross and net dollar savings. However, all of these except gross savings are still significantly different at 95%; mean loan date and monthly payment are also now significantly different.

The raw data presented in Table 1 reveal that OBR loans have defaulted more often than SE loans, even with actually (DPA loans) and potentially (bimonthly-billed loans) problematic cases removed. However, Table 2 suggests that SE loans are not a perfect counterfactual for OBR loans, as the two groups of loans are different in many respects – not only whether they are paid back on a utility bill. I therefore now turn to methods for controlling out the influence of potentially confounding factors.

## Estimation Method

I seek to estimate the credit enhancement value of on-bill lending by assessing whether OBR loans performed differently than otherwise-equivalent SE loans. I consider both default and prepayment lending risks. In the case of default, a lender may not be able to recover all or much of the loan balance; in the case of prepayment, a lender will not receive the full set of potential interest payments.[10]

[10] NYSERDA's view on prepayment is equivocal (Pitkin 2015). Prepayment reduces future interest payments, which are pledged to repay a revenue bond issued by NYSERDA to finance the program. On the other hand, prepayment eliminates the risk of future default, which would threaten bond repayment revenues more. The default results are of primary importance for my purposes here.

The features of the GJGNY loan program discussed above make it a particularly attractive data environment for addressing this issue. Specifically, the SEL program exists alongside the OBRL program, and is generally very similar in its terms and requirements. As such, its performance provides a good counterfactual for the OBR loans if we can adequately control for other differences between loans.

I model the performance of the GJGNY portfolio using a competing risks survival model of a type commonly used in loan performance analyses (see, e.g., Agarwal, Ambrose, and Chomsisengphet. 2008 in a parallel application for auto loan performance determinants). Survival analysis was originally developed to estimate the effects of treatments on patient survival. In this context, we consider whether a loan can "survive" the twin risks of default and prepayment.

I employ a multi-state transition-specific Cox proportional hazard model (Cox 1972). The model fits the observed pattern of loan termination through either prepayment or default while controlling for differences in borrower and loan characteristics. It estimates the probability of an event (default or prepayment) conditional on a set of covariates. The model takes the form

$$h_q(t) = h_{q0}(t)\exp(\beta_q Z_q)$$

where $t$ is time since loan inception, $q$ indexes a "hazard" (default or prepayment in this case), and $Z$ is a vector of covariates indexed for each type of hazard. The model estimates the $\beta$s – the covariate coefficients – from the data. The indexing allows each covariate to take on a different coefficient for each hazard: we estimate the effect of each covariate on default and prepayment, respectively. $h_q(t)$ is the risk that a loan described by covariates $Z_q$ will enter default or be prepaid, respectively, at a given time given that it has not already done so. $h_{q0}$ is known as the baseline hazard function, analogous to an intercept in ordinary least squares regression; no functional form need be specified for $h_{q0}$.

Prepayment is readily defined: when the loan is paid in full and has a balance of zero. I define default as 120 days delinquent in my base specifications, though I explore sensitivity to this definition in the next section. I choose 120 days so as to avoid any possible confounding of the results due to unidentified DPA arrangements, since DPAs are identified only when loans reach 120-day delinquency. I consider prepayment and default to be "absorbing" states: Once a loan enters prepayment or default, it remains there and cannot transition back to another state.

I discuss alternate model specifications in the next section. However, I do not control for differences in loan interest rates in my preferred models. As discussed in the Programs section, interest rates in each program are completely determined by other factors. For SEL, the rate depends on whether or not the borrower elects automatic payments. For OBRL, the rate depends on the contract date of the loan. Thus, testing for the impact of interest rate is inevitably confounded by these other factors. In particular, interest rate is significantly correlated with the loan type, which is our main variable of interest, and including it in the model therefore potentially obscures those results. The data do show clearly that 3.49% automatic payment SE loans perform much better than 3.99% conventional payment loans, which is very likely due to autopayment itself and not a 0.5% decrease in the interest rate. As for the OBRL interest rate change, I may investigate its impact in future work; for now it is captured loosely by the contract date variable in the model. Recall that interest rates across the entire sample range only from 2.99% to 3.99%, so it is unlikely that such small differences would drive large changes in loan outcomes. In any event, adding the interest rate to the model has little impact on the results.

## Estimation Results and Discussion

Table 3 presents results of estimating the model with the same covariates displayed in Table 2 above: loan amount, date, and term; borrower credit score and DTI; underwriting tier used; projected first year dollar savings; and customer energy rate. I also control for borrower location using a set of county dummy variables as fixed effects; I do not report coefficients of those variables below. SEL, Tier 1, and market rate energy prices are the base case. "OBRL" shows the impact of that program relative to SEL controlling for the other covariates, Tier 2 shows the impact of the alternative underwriting criteria, and Assisted Rate shows the impact of being on the assisted pricing plan.

As the raw coefficients in the Cox model are difficult to interpret, I report the hazard ratio for each covariate instead, as well as p-values for the coefficients. The hazard rate is the exponentiated coefficient for each covariate. Referring to the equation in the Empirical Method above, the hazard ratio is the relative effect of a unit change in the coefficient of interest on the chance of default or prepayment in any given month, assuming a loan has stayed current ("survived") until that point.

**Table 3.** Results of base model estimation, OBRL DPA loans dropped

| | **Impact on default** | | **Impact on prepayment** | |
|---|---|---|---|---|
| | **Hazard ratio** | **P-value** | **Hazard ratio** | **P-value** |
| OBRL | 2.054 | 0.009 | 1.314 | 0.128 |
| Loan amount | 1.000 | 0.450 | 0.999 | 0.000 |
| Loan date (days) | 0.997 | 0.000 | 0.997 | 0.000 |
| Loan term (months) | 1.006 | 0.196 | 0.995 | 0.002 |
| Credit score | 0.987 | 0.000 | 1.006 | 0.002 |
| DTI | 0.995 | 0.967 | 0.288 | 0.013 |
| Tier 2 | 0.594 | 0.118 | 1.380 | 0.287 |
| Gross predicted first year dollar savings | 0.999 | 0.617 | 1.000 | 0.283 |
| Assisted Rate | 3.024 | 0.000 | 0.821 | 0.256 |

The covariates all behave reasonably. Loan amount and term have no particular relationship with default, at least this early in the portfolio, but larger loans and those with longer terms are less likely to be prepaid in any given period. More recent loans are less likely to default and less likely to be prepaid in any given period. Higher credit scores are associated with lower default and higher prepayment. Borrowers with higher DTI are less likely to prepay; surprisingly, perhaps, DTI has no impact on default in this model. Assisted rate borrowers are more likely to default.

Notably, loans underwritten using the alternative procedure (Tier 2) perform comparably to Tier 1 loans, all else equal. This suggests that the alternative underwriting criteria are performing well – all else held equal, borrowers screened using Tier 2 pay back their loans as reliably as those who pass the Tier 1 screen.[11] Underwriting criteria have no effect on prepayment.

Perhaps surprisingly to some, projected gross dollar savings have no impact on default (or prepayment). This is at odds with one of the arguments often made in support of the risks attendant to energy efficiency lending – namely, that such loans are low risk because they generate a positive cash

[11] Recall that borrowers are only screened using Tier 2 if they fail the Tier 1 screen. Therefore, my result is in no way a test of whether Tier 2 is superior or inferior to Tier 1 as an underwriting approach – it merely indicates that Tier 2 is not a negative indicator of loan performance in the cases where it is applied.

flow, helping the recipient to pay back the loan by improving her cash position (see, e.g, Henderson 2013). However, the average gross dollar savings amount to only a thousand dollars or so per year, and net savings are considerably smaller still. Compared to economic shocks that typically accompany default, such as job loss, these savings may not be economically important. Moreover, projected dollar savings are somewhat notoriously inaccurate and tend to be overestimated (Bardhan et al. 2014; Parker, Mills, and Rainer 2012). Even if there were a relationship between actual savings and default, using predicted savings could inject enough noise to obscure that relationship. For this particular set of loans, projected dollar savings were not near statistical significance in any model specification I tried.

As for the relative performance of OBRL and SEL, we see that controlling for these variables does not alter the fact that OBR loans are more likely to default than SE loans. This effect is highly statistically significant, and is also economically meaningful. As the OBR variable is binary, its hazard ratio suggests that an OBR loan that is current on payments is about twice as likely to default as an otherwise equivalent SE loan at any given time, holding all other covariates equal. OBR loans may also be more likely to be prepaid, though less dramatically so – the risk is only about 1.3 times as great as for an equivalent SEL and does not quite attain conventional levels of statistical significance.

Table 4 displays the results when I run the same model on only the loans that meet my approximation of the OBRL cost-effectiveness screen, in an effort to restrict SEL comparables to loans that could have been OBR loans.

**Table 4.** Results of model estimation on loans that meet simple OBRL cost-effectiveness screen, OBRL DPA loans dropped

| | **Impact on default** | | **Impact on prepayment** | |
|---|---|---|---|---|
| | **Hazard ratio** | **P-value** | **Hazard ratio** | **P-value** |
| OBRL | 1.797 | 0.075 | 1.503 | 0.071 |
| Loan amount | 1.000 | 0.410 | 0.999 | 0.000 |
| Loan date (days) | 0.997 | 0.000 | 0.997 | 0.000 |
| Loan term (months) | 1.010 | 0.175 | 0.999 | 0.856 |
| Credit score | 0.982 | 0.000 | 1.002 | 0.326 |
| DTI | 0.884 | 0.840 | 0.717 | 0.571 |
| Tier 2 | 0.664 | 0.318 | 0.946 | 0.883 |
| Gross predicted first year dollar savings | 1.000 | 0.343 | 1.000 | 0.243 |
| Assisted Rate | 2.467 | 0.003 | 0.921 | 0.702 |

The total loan pool is cut by more than 40% as a result of this restriction (see Table 1). As a result, the coefficients are estimated less precisely and most p-values go up. My main result is comparable in magnitude – OBR loans are 1.8 times as likely as SE loans to default in any given period – but is not statistically significant at a 95% confidence level, though it still attains significance with greater than 90% confidence. Nothing else of note changes for default. For prepayment, the effect of OBR is now slightly more significant statistically, and of comparable magnitude. The impacts of alternate underwriting and projected dollar savings are still not close to statistical significance.

I ran a number of alternate specifications with the full (not cost-effectiveness screened) loan pool. In a model with loan type as the only covariate, the hazard ratio for OBRL is slightly lower, but still highly statistically significant; the effect on prepayment is positive but small and not statistically significant. I also consider a model that only controls for borrower characteristics and not loan characteristics. It is possible that loan characteristics are not entirely defined prior to interacting with the program – borrowers may shape their projects during their interaction with the progams, so the programs could actually be causing some of the deviations in observed loan characteristics. In this model the hazard ratio is statistically significant and similar in magnitude for OBRL's impact on default, while the prepayment effect is small and not statistically significant.

I ran alternate models that include squared terms for credit score and DTI; in these models the other variables are largely unaffected and the OBRL results are qualitatively unchanged. Models that omit the county dummy variables yield results that are not qualitatively different from those in Table 3. Dropping the bimonthly OBR loans likewise has no qualitative impact. Replacing gross savings with net savings in either loan pool made almost no difference.[12] When I redefine default to 90 days rather than 120 days, the impact of OBRL on default is even greater, though this could be explained at least in part if there are DPAs in the data that contributed to 90-day delinquency but cleared before 120 days and therefore were never flagged as such.

In every specification I tried, OBRL's positive hazard ratio was economically meaningful, and was always at least marginally statistically significant at conventional levels. So, we are left with a result that is, at first glance, both surprising and unfortunate for the credit enhancement value of this particular on-bill program. How can we make sense of this result?

My best guess is that the subordination of the loan plays a critical role. Subordination not only lessens the theoretical credit enhancement provided; it may actually put the loan at greater risk than an off-bill loan. In a sense, the loan faces the risk of failed utility bill payments as well as the risk of its own non-payment. If an OBRL borrower for whatever reason fails to pay a utility bill or makes partial utility bill payments, the loan is exposed first, and will go into default unless the customer becomes fully current in the 90-day window (or whatever window is used to define default). The traditional argument for on-bill programs as credit enhancement relies in part on the belief that utility bills are reliably repaid. My results here suggest, however, that any positive effect of tying loan payments to utility bills is overwhelmed by the negative effect of subordinating payments to utility charges.

If the loan were not subordinate to the utility bill, some of these issues would be ameliorated. While partial payment from a *pari passu* arrangement would fund the loan to some extent, it would not do so fully. Still, it would be easier to "catch up" from one or two missed payments before going into default. If the loan were senior to the bill payments, the credit enhancement value could be substantial.

Competing explanations seem less compelling. Given that I remove DPA loans and define default such that no unidentified DPAs can be present in the data, DPAs cannot explain the results. It is possible that some of the OBRL delinquency in the data is due to the idiosyncrasies of utility billing cycles mentioned in the Data section above. If that is the case, this is a real risk for any on-bill program to the extent that the participating utilities are typical in terms of such foibles. Program design can address these risks by including debt service reserve funds to address any temporary cash flow issues (SEE Action 2014a). However, I don't really observe these types of issues in the data, and I don't believe these idiosyncrasies are playing a major role.

## Conclusions

I find that the NYSERDA OBRL program has experienced higher default rates than the SEL program, which is in most respects its "off-bill" equivalent. This finding is both statistically and economically significant, and persists when controlling for differences in the two loan pools that might be expected to affect repayment outcomes.

---

[12] Indeed, this is expected since net savings is determined by gross savings and by variables already in the model – loan amount, loan term, and interest rate, which is itself a function of the loan program and date.

This is not a positive finding for the credit enhancement value of on-bill programs, and should inject some skepticism for those who assert that value is likely to be substantial. Nonetheless, we should not overgeneralize from it. The fact that the loan is subordinate to utility bill payments may well be pivotal to the results. Similarly, if participating utilities were more aggressive with shutoff for customers who do not pay their OBR loans, the loans might perform better – though utilities everywhere are understandably reluctant to shut off customers, especially residential customers. Perceived or actual threat of shutoff may matter more for recovery – the process of collecting debt once a loan has been charged off – than for default, and I did not have data to test the impact on recovery. Empirical investigation of the credit enhancement value of other on-bill arrangements is necessary before drawing broad conclusions. That value may vary significantly depending on program design specifics.

On-bill arrangements may also provide benefits other than credit enhancement, as others have argued. Customers may prefer on-bill loans to consolidate their payment obligations, or be attracted to the notion that their energy-related expenses are in the same account. Utilities may be better able to leverage their existing relationships with customers through on-bill programs. The transferability of loan payments to future owners may prove to be empirically important. In short, on-bill arrangements could drive demand through means other than financial efficiency. More work on this point is needed.

SE loans perform quite strongly – their first-year performance is similar to home mortgages and auto loans. Mortgage-level performance would seem to be the hope for property-secured energy efficiency financing arrangements, such as property assessed clean energy (PACE). If unsecured loans can perform this strongly, perhaps the conversation should shift towards determining the lowest-cost way to achieve strong performance rather than the pursuit of security *per se*. If PACE, OBR designs, or any other arrangement can deliver SEL-level performance at lower cost, they may have an advantage. Or perhaps security will become more consequential as the loan portfolio becomes more seasoned over time, or if energy efficiency loans increase take-up among borrowers with weaker credit characteristics. Again, there is much work to be done to improve our understanding of these issues.

Along the way, we also derive several other lessons for energy efficiency lending:

- The issue of deferred payment arrangements is likely to arise in other on-bill schemes as well. To be sure, they were more problematic for NYSERDA due to the loan subordination than they might be elsewhere. Even so, any program should consider whether it ought to provide special charge-off treatment for these customers, or whether it should disqualify them altogether as NYSERDA eventually did.
- My results suggest that NYSERDA's "Tier 2" alternative underwriting criteria that focus on mortgage and utility bill payment history are performing well for both programs: loans made using those criteria are performing as well as the Tier 1 loans all else held equal, and as such Tier 2 is accessing additional customers with no deleterious credit issues. Such alternative underwriting methods exist in many other programs as well, but should be strongly considered where they do not.
- In this set of loans projected dollar savings from lower energy consumption were not associated in any way with loan performance. While this finding should be tested in other settings, I don't believe these loans are unusual in any particular respect that would drive this result. I have no way of testing whether this finding is due to the noisiness of energy savings projections, or whether actual savings would also not matter. Many assert that dollar savings from energy efficiency projects lower the financial risk of those projects, but nowhere is this assertion proven, and it should be viewed with skepticism at least for residential energy efficiency loans. This result also suggests that cost-effectiveness screens may not be important for strengthening loan performance, though that question would ideally be tested in a setting that allowed us to specifically observe the inclusion or removal of such a screen.

## References

Agarwal, S., B.W. Ambrose, and S. Chomsisengphet. 2008. "Determinants of Automobile Loan Default and Prepayment." *Economic Perspectives*, Federal Reserve Bank of Chicago, 3Q/2008.

Bardhan, A.. et al. 2014. "Energy Efficiency Retrofits for U.S. Housing: Removing the Bottlenecks." *Regional Science and Urban Economics*, 47: 45-60.

Bell, C.J., S. Nadel, and S. Hayes. On-Bill Financing for Energy Efficiency Improvements: A Review of Current Program Challenges, Opportunities, and Best Practices. American Council for an Energy-Efficient Economy Report Number E118.

Cox, D.R. 1972. "Regression Models and Life-Tables." *Journal of the Royal Statistical Society, Series B* **34** (2): 187–220.

Henderson, P. 2013. On-Bill Financing: Overview and Key Considerations for Program Design. Natural Resources Defense Council Issue Brief 12-08-A.

Parker, D., E Mills, and L Rainer. 2012. "Accuracy of the Home Energy Saver Energy Calculation Methodology." *ACEEE Summer Study on Energy Efficiency in Buildings*: 206–222.

Pitkin, J., and Johnson, J. (NYSERDA). 2015. Personal communication to author. Various dates in 2015.

State and Local Energy Efficiency Action Network (SEE Action). 2014. Credit Enhancement Overview Guide. Prepared by M. Zimring, Lawrence Berkeley National Laboratory.

State and Local Energy Efficiency Action Network (SEE Action). 2014. Financing Energy Improvements on Utility Bills: Market Updates and Key Program Design Considerations for Policymakers and Administrators. Prepared by: Mark Zimring, Greg Leventis, Merrian Borgeson, Peter Thompson, Ian Hoffman and Charles Goldman of Lawrence Berkeley National Laboratory.

Zimring, M., et al. 2013. Getting the Biggest Bang for the Buck: Exploring the Rationales and Design Options for Energy Efficiency Financing Programs. Lawrence Berkeley National Laboratory.