Incentives of commercial banks to finance energy efficiency

Anne Schopp, German Institute for Economic Research (DIW Berlin)

This paper investigates the incentives of commercial banks for providing energy efficiency lending. Using Germany, Bulgaria, Poland and Ukraine as case studies, interviews were conducted with banks to model their decision making related to energy efficiency. These show that energy efficiency investments differ from other lending projects for three reasons: first, information asymmetries and principal agent problems prevent energy efficiency investments. To overcome these barriers, many public banks provide energy efficiency lending at preferential rates often through commercial banks. Commercial banks reported that this allows them to gain customers. Second, energy efficiency lending is a new field of investment with unconventional revenue streams deriving from cost savings. Energy savings increase the value of the object that serves as collateral and diversify the lending portfolio. However, most banks reported that they do not consider energy efficiency specifics. Third, assessing these energy savings requires additional technical expertise. Therefore, some banks initiated cooperation with energy service providers. The model illustrates the trade-off banks face between initial transaction cost and benefits from portfolio diversification. According to these findings, two aspects are important to upscale energy efficiency lending: first, the requirement for banks to monetise energy savings to account for the benefit of low risk in the lending portfolio and, second, the need for energy efficiency programmes to reach a certain scale so that energy efficiency lending pays off.

**Keywords:** Commercial banks, Energy efficiency lending, Portfolio diversification, Transaction cost
1. Introduction

An increasing number of banks offer energy efficiency loans. These loans differ from traditional loans in that they require technical expertise to determine the potential of a project to reduce energy usage, thus creating the “savings” that will be used to repay the loan. These energy efficiency loans are increasing in popularity in part because public banks promote energy efficiency lending through commercial banks. Although there is a large literature on bank lending decisions, no known literature investigates the determinants of how banks make decisions with respect to offering energy efficiency loans.

The purpose of this paper is to examine the incentives and requirements of commercial banks related to energy efficiency lending. Germany, Bulgaria, Poland and Ukraine are used as case studies because commercial banks are active in providing energy efficiency loans in these countries. Semi-structured interviews were conducted with experts in retail banking, commercial banking and controlling from 27 banks. Furthermore, this paper models some of the factors as identified in the interviews to illustrate bank decision making: the interest earned from energy efficiency lending compared to conventional loans, transaction cost for advertising and building technical expertise, credit risk and capital constraints.

Three main differences are identified between energy efficiency investments and traditional lending project types:

First, in absence of any policy interventions, cost-effective energy efficiency investments are not realised due to various market failures and other barriers (Jaffe et al., 1994; Carbon Trust, 2005). To overcome these barriers and to initiate the market, public banks provide energy efficiency lending at preferential provisions. They often do so through commercial banks so as to enhance subsequent commercial up take. In Germany, commercial banks reported that serving as an intermediary of the Kreditinstitut für Wiederaufbau (KfW), the national public bank, is attractive, because it provides the opportunity to enhance customer relationships by offering preferential energy efficiency loans in combination with their own products. In addition, some banks initiated their own energy efficiency loans. In Bulgaria, Poland and Ukraine, the European Bank for Reconstruction and Development (EBRD) provides energy efficiency loans via commercial banks. Although the loans are offered at commercial rates, they can be attractive to commercial banks since banks mainly refinance themselves through deposits and the EBRD provides longer term credit lines in addition to free technical assistance. Furthermore, banks can combine these loans with their own products.

Second, energy efficiency lending is a new field of investment with unconventional revenue streams deriving from (energy) cost savings. This requires banks to quantify risks associated with energy price developments and benefits resulting from energy savings (Palmer et al., 2012). These savings can increase the value of the building or the equipment and consequently also the value of the collateral that the bank uses to secure the loan in case of default; they can also allow for portfolio diversification and thereby reduce banks’ capital requirements. According to the interviews, however, most banks do not consider energy efficiency specifics in their creditworthiness or lending portfolio assessment.

Third, energy efficiency investments require technical expertise to assess energy savings and depend on energy service markets (IPCC, 2007). In the Eastern European countries, the EBRD employs a technical assistance team that trains bankers and supports them in organizing client visits, assessing energy savings and developing the project pipeline. In Germany, KfW allocates the energy savings
assessment to certified energy service providers in order to reduce transaction costs for banks. Furthermore, some regional banks reported that they initiated their own programmes with reduced interest rates for hiring local craftsmen – allowing them to gain new customers through marketing campaigns or recommendation by craftsmen.

Based on the interviews, an analytic model is developed to assess the trade-off banks face between additional fixed transaction cost for demand development and benefits from portfolio diversification and associated lower capital requirements. In the model, a representative bank maximises its lending profits. The choice of the lending portfolio is constrained by the requirement to cover the associated risk with equity. To calibrate the model, information is used from the interviews. The model assumes that introducing energy efficiency loans into the lending portfolio involves some additional fixed cost for the bank. Setting up a new loan programme requires information campaigns, staff training and demand development. Once loan products have been integrated into the standard processes of a bank, transaction costs decline for each additional loan. At the same time, the composition of the lending portfolio is constrained, as the risks need to be covered by equity. This offers opportunities to reduce the credit risk associated with the portfolio through diversification. If all effects are jointly considered, energy efficiency lending can pay off for the banks, once a certain scale is achieved.

The rest of the paper proceeds as follows: Section 2 reviews the relevant literature on decision making of banks and characteristics of energy efficiency investments. Section 3 discusses findings from interviews with commercial banks on their energy efficiency lending activities in Germany, Bulgaria, Poland and Ukraine. Section 4 presents the model on banks’ decision making about energy efficiency lending. Section 5 draws conclusions.

2. Literature

Why is energy efficiency lending specific compared to conventional bank lending? From an economic perspective, investments in energy efficiency are particular and the market might deliver an investment level below the social optimum. Previous studies identify several market failures and other barriers (IPCC, 2007):

Jaffe et al. (1994) list lack of information and split incentives between landlords and tenants as potential market failures inhibiting energy efficiency investment. Schleich et al. (2008) underpin this argument empirically. Their findings show that split incentives between landlords and tenants due to rented office space and the lack of information about energy consumption patterns are indeed significant barriers for German firms. In addition, high investment cost, lacking awareness of potential benefits or irrational behaviour by firms and households are additional examples of barriers inhibiting investment in low carbon technologies (Carbon Trust, 2005). As a consequence, the potential of cost-effective energy efficiency measures is not fully realized (Tuominen et al., 2012).

Barriers exist not only on the demand side, but also on the supply side. From banks’ perspective, energy efficiency lending is a new field of investment where revenue streams are derived from energy savings. To consider this in the credit assessment, banks need to quantify risks associated with energy price developments that impact revenue streams. Benefits resulting from decreased default probability or increased collateral value are also relevant (Hayes et al., 2011; Palmer et al., 2012). This requires expertise and a track record of successful energy efficiency projects for comparison (Hamilton, 2009).
Energy efficiency lending is also specific because technical expertise is needed to identify energy efficiency measures and assess associated energy savings (IPCC, 2007). This expertise is typically not available in banks and therefore may require efforts to train bankers or to initiate some form of cooperation with energy auditors. At the same time such cooperation can open up new business opportunities. In a survey with 500 US energy auditors, many reported that they act as gatekeeper for banks to energy efficiency financing (Palmer et al., 2011).

What determines bank energy efficiency lending decisions? In the industrial organisation literature on banking, specific energy efficiency aspects in banks’ lending decisions have not been considered yet. Previous studies identify several levers that banks use to optimise their lending activities: portfolio composition, product differentiation, and capital requirement considerations.

The lending portfolio composition is an important lever for banks to gain in market share. Berger et al. (2002) argue that smaller banks pursue more relationship lending, as they have lower hierarchies and therefore can more easily use soft information about the creditworthiness of smaller companies than large banks. Indeed, De Haas et al. (2010) find empirical evidence in Eastern European and other transition countries that size is an important determinant for a bank’s portfolio composition next to the ownership structure and the legal enforcement in the country.

Product differentiation can also enable banks to gain a comparative advantage and compete with other banks beyond prices. To differentiate themselves from their competitors, banks increase the number of branches, spend more on advertising or introduce new lending products. Dick (2007) shows, for instance, that with growing market size banks invest more in sunk cost on advertising, branching or geographic diversification to gain in market share.

Another factor impacting lending decisions is capital requirements. The regulator requires banks to hold more equity if they lend to more risky investments in order to prevent banks from taking too much risk and not being able to repay deposits (Dewatripont et al., 1994). Theoretical and empirical studies find that with capital requirements banks reduce lending and increase interest rates in the short term and increase capital ratios in the long term (VanHoose, 2007). Furthermore, banks can reduce their regulatory capital requirements by diversifying their lending portfolio (see Section 3.2). In a theoretical model, Winton (1999) demonstrates banks’ trade-off between lower risk from diversification and higher monitoring cost. The author argues that diversification across industries pays off, if the risk of large losses associated with the loans is small; whereas monitoring is more important in case of high risks of large losses. Behr et al. (2007) analyse the portfolio composition of German banks. Thus, regional banks increased their industrial and sectoral diversification during the 1993 to 2002 period. The level of diversification remained constant in bigger banks, as they already had higher level at the beginning of the investigated period. According to the authors the development towards more diversification may have been encouraged by the revised international capital framework (Basel II).

This paper aims to contribute to the relevant energy efficiency literature by examining how the factors that previous studies identified, namely transaction cost, capital requirements and diversification are important to banks in the context of energy efficiency lending. In order to illustrate banks’ decision making an analytic model, based on interviews with bankers, is used.
3. Interviews

To study commercial banks in greater detail, Germany, Bulgaria, Poland and Ukraine are used as case studies. In these countries public banks have been an important trigger for energy efficiency lending by commercial banks. In Germany, the German public bank, KfW, has been quite active in developing the financing and service market; in the Eastern European countries, the EBRD established dedicated energy efficiency credit lines with local banks starting in the early 1990s in order to develop financing capacities in this area. Following Gläser and Laudel (2009), semi-structured interviews were conducted with experts from 27 banks. These include mainly experts from retail banking, in particular, construction financing, but also experts in commercial banking and controlling. The interviews covered questions on the types of loans, banks’ motivation behind the lending portfolio, the financing conditions, the required collaterals and the capital requirements related to energy efficiency lending.

3.1 Lending portfolio

Germany

In Germany, KfW is the main financial institution implementing energy efficiency policies. KfW has run energy efficiency programmes since the mid-1990s. In 2012, KfW committed 9.8 billion Euro to households, 3.4 billion Euro to firms and 0.3 billion Euro to municipalities for energy-efficient construction, refurbishment and technology (KfW, 2013b). In November 2013, the interest rates for these concessional loans were at 1-1.4 % per year for households and firms. Depending on the borrower and the type of investment, this is more than two percentage points below market rates. For municipalities the interest rate is 0.1% per year. KfW provides these energy efficiency loans through local banks. These carry the credit risk and thus a borrower’s financial creditworthiness must be in line with the local bank’s requirements. However, the energy efficiency measures must be approved by a certified energy auditor and the final approval for these loans lies with KfW.

As a consequence, commercial banks across Germany provide KfW loans at preferential rates and combine them with their own financial products. For providing KfW loans, commercial banks receive a fixed margin of 0.75 percentage points from KfW over the loan duration (as in June 2013; KfW margin in the area of commercial banking is higher). In the interviews, banks reported that this margin is relatively low compared to the margins earned from standard financial products. At the same time the work intensity is relatively high, as banks have to monitor their customers’ receipts of the energy efficient measures. Therefore, some banks do not offer KfW loans for smaller measures. To address this barrier, KfW allocated the main tasks that require technical expertise to energy auditors.

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2 See KfW programmes 151, 152 and 153 for households, 242, 243 and 244 for companies, 201 and 218 for municipalities for further information.
Banks reported that they consider KfW loans as a service to their clients allowing them to stay competitive. Furthermore, KfW loans are limited to 50,000 Euro for new buildings and up to 75,000 Euro per housing unit for refurbishment of existing buildings and therefore they are typically combined with conventional loan products. Some banks reported that KfW accounts for about a third of a typical loan. Obviously, the share between KfW and the bank’s own financial products varies with the type of investment.

In retail banking, some banks also have their own energy efficiency programme. Dedicated energy efficiency programmes are mainly part of the portfolio in banks such as GLS or Umweltbank who identified energy efficiency as one of their core business activities. They offer an energy efficiency bonus on the standard housing loan in case a certain energy efficiency standard is achieved (KfW 70: 70% of annual primary energy consumption of comparable new building according to the energy saving regulation). Some regional banks initiated cooperation with local craftsmen with energy efficiency expertise. Households, for example, receive a lower interest rate when they use local craftsmen. Banks reported that these initiatives allow them to gain new customers through marketing campaigns or recommendation by craftsmen.

In addition to the conventional construction financing, many banks introduced modernisation loans in the last few years. This might be related to the fact that KfW phased out their modernisation loans at the end of 2011 (KfW, 2013a). According to the interviews, this financial product is offered to clients who are interested in a fast loan application process or those who do not fulfil the technical energy efficiency requirements for the KfW funding; e.g. they intend to install the window themselves rather than by a certified craftsman. The modernisation loans build on the creditworthiness of the borrower and therefore do not require a mortgage and the associated notaries’ cost. The smaller loans are therefore offered at higher interest rates than secured construction financing, but at lower rates than the classical consumer loan. Typically the target group are households that already have a mortgage on their building and are interested in an additional loan to modernise the house.

According to the interviews commercial banks in Germany provide several financial products that can be used to finance energy efficiency projects. In particular, this applies to constructing financing, since default rates are low and the building serves as collateral. This is not directly linked to energy efficiency considerations. However, energy efficiency investments increase the value of the building that serves as collateral.

**Bulgaria, Poland and Ukraine**

In several Eastern European countries, the EBRD has established a series of energy efficiency credit lines with local banks worth 1.9 billion EUR at the end of 2011 (EBRD, 2012). In each country the EBRD created one or more facilities for households or corporates and employed a technical assistance team. This assistance team supports local banks in developing a project pipeline.

The approach to integrate these credit lines into the existing loan portfolio differs across countries and banks. For example, the public bank UKR Exim in Ukraine established its own green department. In Ukraine, banks usually combine EBRD funding with their standard financial products, so that the final product is not labelled as a dedicated energy efficiency loan. This is different in Bulgaria or Poland, where the energy efficiency loans can be combined with EU funded grants and therefore local banks have an incentive to explicitly highlight the preferential rates of these loans. Also the size of the credit lines differs, depending on the country and the bank’s size. In Bulgaria banks started with a credit line
of 10 million Euro with the option of an increase by 10 million Euro. With bigger banks in Poland the EBRD established credit lines worth 50 million Euro or more.

The local banks receive EBRD loans at commercial rates for about five years. The EBRD loans are attractive to banks since they are longer-term than deposits, the main refinancing source. The accompanying technical assistance, which is free of charge, allows banks to offer additional service and thus gain market share. So far the technical assistance amounted to 3-3.5% of the facilities’ financial volumes. This was spent on training banks’ staff on technical energy efficiency aspects, organizing client events or visits to raise awareness, and energy audits to develop the project pipeline.

The level of leverage depends on many factors. In Ukraine leverage amounted to 200% because its high gas prices triggered demand for energy efficiency lending that exceeded EBRD financing. In some cases leverage may be due to a low maximum EBRD loan volume or due to investment in ancillary equipment that is not eligible for EBRD financing and therefore is supported by the bank’s own lending sources. Many of the facilities are in their second phase and facilities in Bulgaria and other Eastern European countries are about to finish receiving EBRD financing. It remains to be seen to what extent commercial banks will continue to offer energy efficiency lending without public bank involvement.

3.2 Capital requirements

Banks have to cover a minimum share of their risk-weighted assets with equity in order to ensure that in severe circumstances with several non-performing loans the bank will be able to serve its liability. These requirements have been strengthened under the international regulatory framework for banks (Basel III): Banks must gradually increase their total capital from 8% to 10.5% of their risk-weighted assets (BIS, 2010). To calculate their regulatory capital requirements, banks can either use predetermined risk weights and external credit ratings (standardised approach) or they can use their own models (internal rating based approach) (BIS, 2005b). The calculations ultimately require that banks can cover the losses of non-performing loans with 99.9% probability. This determines a minimum share of equity so as to ensure that debt raised or bonds issued by a bank can be securely serviced (BIS, 2005a).

Two factors are important to the calculation: the correlation of the loss event with other losses and the likelihood of the loss event. With regard to the correlation, the capital calculations under the internal rating based approach assume that banks own perfectly diversified portfolios (BIS, 2006). However, banks need to measure the concentration of their lending portfolio and increase their regulatory capital if it is highly concentrated (granularity adjustment). This provides an incentive for banks to diversify across sectors, products and borrowers. This adjustment is typically applied to commercial banking, while the private retail banking is considered well diversified (BIS, 2001). Thus, energy efficiency lending could add to the diversification of a bank’s lending portfolio, if it is not fully correlated with the remaining portfolio assets.

With regard to the likelihood of losses, loans for energy efficiency investments are often argued to be less likely to default compared to conventional loans. Blyth et al. (2011) find anecdotal evidence for this effect examining eight companies in a study commissioned by the EBRD. This is because the borrowers save energy and are therefore less exposed to energy price risk. If energy costs account for a
significant share of total cost such as in energy-intensive firms, the risk that the borrower defaults can be reduced. However, it was reported that in practice banks do not account for this effect.

In the interviews, it was also reported that projected energy savings are not considered as collateral because the value of future savings is not certain, but depends on e.g. energy price developments and therefore does not comply with financial regulation (BaFin, 2012). One interviewee also pointed out that banks cannot monetise energy savings in case of default. Energy efficiency, however, plays an indirect role in the capital requirement calculations. If loans are given to energy efficiency investments, the underlying building or machinery needs to serve as collateral. The resulting energy savings increase the value of the building or machinery. This in turn increases the value of the collateral and therefore reduces the risk exposure and ultimately the capital requirement for the bank providing the loan.

4. Quantification

This section outlines the model and then presents the model results illustrating banks’ incentives and requirements related to energy efficiency lending.

4.1 Model

In the model, a bank provides two types of loans: energy efficiency, $e$, and conventional, $c$. For each loan type $j$ the lending volumes for projects are of the same size $l_j$. The bank holds a portfolio of $n_e$ loans for energy efficiency and $n_c$ loans for conventional projects. To optimise this portfolio the bank chooses the number of projects for each loan type $n_j$ considering revenues from lending and the associated risk and cost. The choice of the portfolio depends on the interest that the bank can charge for each loan type $r_j$, the transaction cost for each loan type $t_j$ and the equity $E$ available to the bank to cover the portfolio risks.

Interest rate

Banks charge a price in the form of interest for their financial loan products. From banking theory, we know that the interest rate banks charge results from the risk free rate, namely the rate at which banks can refinance their loans at the capital market plus a premium. The premium in turn reflects four components: the cost associated with the expected credit risk, the transaction cost related to advertising or processing the loan, the cost related to covering part of the loan with equity and a profit margin (Bösch, 2011).

In this model, the risk premium reflects the expected default cost for each project. It is assumed that this project-specific idiosyncratic risk is the same across projects of the same loan type $r_{jd}$. The transaction and equity cost do not only impact the interest rate, but the composition of the portfolio and are therefore modelled separately. Thus, the interest rate for each loan type is the sum of the risk free rate and the risk premium $r_j = r_f + r_{jd}$.

The expected revenue from energy efficiency loans derives from the interest rate multiplied by the lending volume across projects $r_e l_e n_e$. Alternatively, the bank can invest in conventional loans $r_c l_c n_c$. The expected lending revenue is:
\[ R = r_e n_e l_e + r_c n_c l_c. \] (1)

Transaction cost

Lending for energy efficiency investments involves transaction cost. As reported in the interviews, the bank organizes, for example, information campaigns to raise awareness, trains its loan officers, initiates cooperation with energy auditors to assess energy savings or sets up processes to standardise loan applications. Some of these components also apply to conventional projects and may decrease with experience and scale.

For both types of loans the transaction costs include some fixed cost \( t_{fj} \) and some variable cost \( t_{vj} \) that can increase at a decreasing rate with the lending volume \( n_j l_j \) in order to reflect scale effects:

\[ T = t_{fe} + \sqrt{t_{ve} n_e l_e} + t_{fc} + \sqrt{t_{ve} n_c l_c}. \] (2)

Capital requirements

The portfolio decision also depends on capital requirements. According to BIS (2005a) the probability of credit losses \( L \) that are covered neither by equity \( E \) nor interest rate charges should not exceed 0.1%:

\[ B = P(L \geq E) \leq 0.1\% \] (3)

In order to compute the regulatory capital, the Basel rating based approach assumes perfect diversification. In this way the capital required for a loan depends on the credit risk of the loan and not on the composition of the existing portfolio (BIS, 2006). To provide incentives for portfolio diversification, the regulatory capital is adjusted \textit{ex post} through the granularity adjustment under Basel (see section 3.2). In this model, banks consider diversification benefits when choosing the lending portfolio, as they are assumed to anticipate this adjustment.

To estimate the probability that losses exceed the available equity \( B \), the credit loss \( L \) needs to be defined. It is assumed that credit loss occurs to the bank when the sum of the values of the projects that the bank is lending to is lower than the bank’s total lending volume, \( n_e V_e + n_c V_c < n_e l_e + n_c l_c \). Hence, \( B \) can be rewritten as:

\[ B = P(n_e(V_e - l_e) + n_c(V_c - l_c) \leq -E) \] (4)

Furthermore, the probability density function of the project values \( f(V_e, V_c) \) needs to be specified in order to compute \( B \). To do so, two types of risk are differentiated: concentrations in portfolios can relate to idiosyncratic risk (project-specific) and systematic risks (e.g. sectoral risks). The latter risk is the focus of this analysis and assumed to be fully correlated across all projects of the same type \( \sigma_j \). The variance associated with the value of the portfolio varies however with the correlation between energy efficiency loans and conventional loans \( \rho_{ec} \). Thus, the bank can reduce the risk of its portfolio by combining these two types of loans. It is assumed that the project values follow a bivariate normal
distribution  \[ f(V_e, V_c) = \frac{1}{2\pi\sigma_e\sigma_c \sqrt{1-\rho^2}} \exp \left[ -\frac{1}{2(1-\rho^2)} \left( \frac{(V_e-\mu_e)}{\sigma_e} \right)^2 - 2\rho \frac{V_e-\mu_e}{\sigma_e} \frac{V_c-\mu_c}{\sigma_c} + \left( \frac{V_c-\mu_c}{\sigma_c} \right)^2 \right] \].

Graphically, this means that \( B \) corresponds to the grey area below the straight line \( V_c = \frac{n_c l - E - n_c (V_e - l_e)}{n_c} \) in the contour plot of the probability density function of the project values that are positively, but not perfectly correlated (Figure 1).

![Figure 1: Illustration of probability density function of project values](image)

The grey area can be calculated by integrating the probability density function to the value where \( V_c = \frac{n_c l - E - n_c (V_e - l_e)}{n_c} \):

\[
B = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \frac{n_c}{n_c} \left( \frac{n_c l - E - n_c (V_e - l_e)}{n_c} \right) f(V_e, V_c) \, dV_e \, dV_c
\]

(5)

**Decision problem**

The bank chooses the number of projects for each loan \( n_j \) type in order to maximise profits from its lending portfolio considering the equity constraints. The decision problem of the bank is as follows:

\[
\max_{n_j} p = \max_{n_j} \, r_e n_e \, l_e + r_c n_c \, l_c - t_{fe} - \sqrt{t_{ve} n_e} l_e - t_{fc} - \sqrt{t_{vc} n_c} l_c
\]

s.t.

\[
0.1\% \geq \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} \frac{n_c}{n_c} \left( \frac{n_c l - E - n_c (V_e - l_e)}{n_c} \right) f(V_e, V_c) \, dV_e \, dV_c
\]

This constrained maximisation problem cannot be solved analytically since the normal cumulative distribution function does not have a closed form. The area under the integrals, however, can be approximated by rectangles. For this purpose the decision problem is coded in Matlab.
4.2 Parameterisation

To parameterise the model, some information is used from the interviews. The energy efficiency projects that a bank provides loans for can differ substantially. In the interviews, it was reported that the financing volume and the type of borrower are different, for example, in the case of a family investing in a private residential home compared to the case of a real estate developer investing in multiple family dwellings or an energy intensive firm improving its machinery. Therefore, the reference project is stylized reflecting some common givens.

Table 1 summarises the parameters. In the base case portfolio, energy efficiency loans and the conventional loans have the same characteristics. The lending volume per project $l_j$ is 1 million Euro and the number of projects for each loan type $n_j$ is set at 100, so the overall lending volume is 200 million Euro in the base case.

The EBRD reported that it costs about 3% of the lending volume to set up a dedicated energy efficiency programme. This figure is used to calibrate the initial fixed cost $T_{ij} = 4$ million Euro and the variable transaction cost parameter $t_{ij} = 0.001$ million Euro, so that the transaction cost $T$ amounts to 6 million Euro in the base case. The assumed interest rate above the risk free rate (=0%) is 5%. In the current market situation, this market rate is rather on the high side for secured low risk loans in Germany, but the level of the interest rate $r_j$ impacts merely the magnitude of the profitability and not the direction of results.

The expected value of the project $\mu_j$ is assumed to be 1 million Euro and accordingly the expected value of lending is zero. With Basel III, banks are required to hold capital of at least 10.5% of their risk-weighted assets by 2019. Assuming a 100% weighting, the bank’s overall equity $E$ is set at 20 million Euro, i.e. 10% of the overall lending volume.

The variances $\sigma_j$ and the correlation $\rho_{ec}$ are calibrated so that the base case portfolio with $n_e = n_c = 100$ just meets the capital requirement. The two project types are assumed to be positively, but not perfectly correlated.
<table>
<thead>
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<th>Parameter</th>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>$l_j$</td>
<td>Lending volume of reference project (million €)</td>
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</tr>
<tr>
<td>$t_{ij}$</td>
<td>Fixed transaction cost of project $e$ and $c$ (million €)</td>
<td>4</td>
</tr>
<tr>
<td>$t_{vj}$</td>
<td>Variable transaction cost parameter of project $e$ and $c$ (million €)</td>
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</tr>
<tr>
<td>$r_j$</td>
<td>Interest rate (above risk free rate) of reference project $e$ and $c$ (%)</td>
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</tr>
<tr>
<td>$\mu_j$</td>
<td>Expectation of project value $e$ and $c$ (million €)</td>
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</tr>
<tr>
<td>$E$</td>
<td>Equity (million €)</td>
<td>20</td>
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<tr>
<td>$\sigma_j$</td>
<td>Variance of project value $e$ and $c$ (million €)</td>
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<tr>
<td>$\rho_{ec}$</td>
<td>Correlation of project $e$ and $c$</td>
<td>0.496</td>
</tr>
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</table>

These parameters are held constant in order to compare various portfolios. Therefore, the bank adjusts the number of projects for each loan type to obtain optimal portfolios with the same equity cost.

4.3 Results

In the model, the bank faces a trade-off between additional (fixed) transaction cost and diversification benefits when introducing an additional loan type into its lending portfolio. This applies to any new field of investment, but is especially relevant in the case of energy efficiency. Setting up a new loan programme requires information campaigns, staff training and demand development. Once loan products have been integrated into the standard processes of a bank, the transaction cost increase less and less for additional projects. Hence, banks require a certain lending scale to overcome initial transaction cost. At the same time, the composition of the lending portfolio is constrained as part of the risks need to be covered by equity. This offers opportunities to reduce the credit risk associated with the portfolio through diversification.

Figure 2 depicts the net profitability for portfolios that equally meet the capital requirements (area between revenue and transaction cost lines). If a bank starts with a small share of energy efficiency lending in its portfolio, the revenue hardly compensates for the transaction cost associated with energy efficiency lending. With an increasing share of energy efficiency lending, the revenue and accordingly the net profitability increase. The optimal portfolio consists of 50% energy efficiency lending. This is not surprising, because the model assumes that the energy efficiency loans and the conventional loans have the same characteristics, while the default risk of both project types is not perfectly correlated.
Figure 2: Transaction cost and revenue of lending portfolios with equal equity cost

Figure 3 shows the probability density function of the project values building the portfolio. The straight lines represent three portfolios from Figure 2 where the share of energy efficiency lending is 31%, 50% and 66% respectively. For all three portfolios, the probability of large losses of the lending portfolio that are not covered by equity (area below straight line) corresponds to 0.1%. With an increase in energy efficiency lending to 100 projects, the net profitability increases, because diversification benefits allow the bank to reduce the risk associated with the portfolio and therefore to increase the total lending volume. A further increase in energy efficiency lending yields a lower net profitability. This is because diversification benefits are exploited and the overall lending volume would have to be decreased to meet the capital requirements.

Figure 3: Risk diversification of lending portfolios with equal equity cost

The opportunity costs between energy efficiency lending and conventional lending, however, depend on the calibration of the variance and the correlation (Figure 4). If the variance of each project type is higher and the correlation between conventional projects and energy efficiency projects is smaller than
in the base case (so that capital requirements are just met), the curve of potential portfolios is more curved. In this case an increase in the share of energy efficiency lending from, for example, 20 to 30 projects, requires a lower decrease in conventional lending projects than the base case, but allows for a lower overall number of projects given the capital constraints. The direction of results, however, remains the same.

![Figure 4: Lending portfolios with equal equity cost for various variances and correlations](image)

So far, the model assumes the same characteristics for energy efficiency loans and conventional loans. If banks were to rate energy efficiency loans with a smaller variance (e.g. because energy savings reduce energy price risk exposure), it would be profitable to increase the share of energy efficiency lending above 50% of the overall lending volume. Banks might do so, when the resulting energy savings increase the value of the building or machinery that serves as collateral and therefore decrease the loan to value ratio (see section 3.2). In the interviews, however, it was reported that banks neither account for a lower default risk associated to energy efficiency projects nor do they recognise energy savings as standalone collateral.

### 4.4 Conclusion

Using Germany, Bulgaria, Poland and Ukraine as case studies, this paper sheds light on commercial banks’ incentives related to energy efficiency lending. For this purpose semi-structured interviews were conducted with bankers. Some of the factors as identified in the interviews were modelled to illustrate banks’ decision making in this context.

Energy efficiency investments as project type differ from other lending projects in various aspects: information asymmetries and principal agent problems prevent cost-effective energy efficiency investments; energy efficiency lending is a new field of investment where revenue streams derive from energy savings; and assessing these energy savings requires technical expertise.
In Germany, commercial and semi-public banks provide KfW preferential energy efficiency loans and combine these with their classic lending products. This involves some transaction cost, but at the same time allows the banks to gain and bind customers. In addition, some banks initiated their own energy efficiency loans or programmes with reduced interest rates for energy efficiency investments that involve local craftsman. In Bulgaria, Poland and Ukraine, on-lending of EBRD energy efficiency financing differs as commercial banks provide lending at preferential rates only if these are combined with EU grants. Since banks refinance themselves mainly through deposits, longer loan terms and free technical assistance make these loans attractive for commercial banks. They also combine these with their own lending products.

However, so far most banks do not consider energy efficiency specifics in their assessment of creditworthiness or riskiness of the overall lending portfolio. To understand this choice banks’ decision-making is modelled. This involves the trade-off between transaction cost for information campaigns or building technical expertise and benefits from diversification and reduced capital requirements. The results demonstrate that energy efficiency lending can actually have benefits for the bank, once initial transaction costs are overcome.

According to these findings, two aspects are important in order to encourage banks to upscale energy efficiency lending: first, the requirement for banks to monetise energy savings in order to account for the benefit of low risk in the lending portfolio and, second, the need for energy efficiency programmes to reach a certain scale so that energy efficiency lending pays off. This in turn may require policy support in order to catalyse market development and to reach the necessary scale. It remains open for further research to explore existing policies, e.g. the Green Deal energy saving loans in the UK where the energy savings pay for the costs of finance.
References


