A Path towards Incorporating Energy and Transportation Costs into Mortgage Underwriting: Shifting to Fact-Based Analysis

Lane Burt, David B. Goldstein, and Susan Leeds, Natural Resources Defense Council

ABSTRACT

The lack of consideration given to the cost of energy and transportation in underwriting residential mortgages has been identified as a significant barrier to energy and location efficiency and as a potential risk factor for lenders. This risk has been discussed qualitatively as a result of the rampant foreclosures in areas located far from centers of commerce and amenities and because of the practical reality that operational costs vary significantly from home to home, but not quantitatively in a format that is usable to lenders. Data and analysis are needed to demonstrate to lending institutions that the energy performance and location of the buildings that they are financing are important factors that influence the performance of a mortgage, and that incorporating these factors in the underwriting process may be an effective risk management tool. This paper discusses the format, scale, and scope of the data needed to convince lenders, in their own language, of the quantifiable benefits of location and energy efficient homes. The paper also discusses the process for developing the data and the policies that may be used to incorporate the energy and transportation impact in the underwriting process for every mortgage. The paper concludes that because of the cost of necessary data collection of sufficient sample size, a federal agency in coordination with other related agencies is the ideal candidate to conduct the study and suggests how the process may begin.

Introduction

The United States is emerging from a recession triggered by the collapse of the real estate sector. We know that various market mechanisms encouraged risky lending to borrowers who were not qualified resulting in inappropriate overextension of mortgage credit to borrowers who proved unable to meet their payment obligations in unprecedented numbers. We also know that the current system of checks and balances designed to protect both individuals and our economy at large from these mistakes failed. Foreclosure rates have risen rapidly, causing home prices to fall, all exacerbated by the slumping of the greater economy.

There is now a push from lenders to go "back to basics" in determining mortgage qualification. This involves less loans being issued with tighter terms, as is historically consistent in credit markets – cyclical tightening and loosening as markets go up and down. However, returning "back to basics" may not be the best solution if the contribution that "the basics" may have made to the crisis is overlooked.

Traditional underwriting may have contributed to the crisis by failing to consider the additional default risk represented by homes that are location and/or energy inefficient and require large operational and transportation expenditures on the part of the homeowner relative to a more energy efficient home or a home located in an area with more transit options. The traditional factors that determine a borrower's ability to qualify for a mortgage include the ratio of loan amount to appraised value of the home (LTV), the borrower's debt to income ratio (DTI), the borrower's credit score (FICO), the borrower's verifiable assets, and other financial and

process/documentation factors, none of which incorporate the variability of energy and transportation costs associated with ownership of a different homes. This means there is an implicit and false assumption that the relative efficiencies of these properties are equal—or that the difference in relative efficiency is not consequential financially. The effects of this assumption are that each home is considered equally location and energy efficient.

Homes that are energy efficient will require less monthly utility expenditures, and this additional unused income may help the homeowner to avoid default during tough economic times. Similarly, homes that are location efficient, meaning located in areas with access to many forms of transportation that allow the owner to own and maintain fewer or no automobiles, may provide even greater financial resources. Both of these impacts are magnified when energy prices are high. Price volatility continues to be an issue for residential electricity and natural gas (Logan and Weller 2009). Location and energy efficiency can insulate homeowners from economic stress during peaks through lower relative expenditures.

A priori, one would expect that the effects of location and energy efficiency should be large. Over the 30-year life of a mortgage, the present value of transportation costs for getting to and from a house in an inefficient location is $300,000. This exceeds the value of the median house, which is now about $175,000 and was no higher than about $225,000 even at the peak of the housing bubble. The 30-year mean cost of energy is about $75,000—over 40% of the cost of the house (Goldstein 2010). It is logical to expect that the magnitude of these costs as well as the savings possible through efficiency should make an observable difference. These cost estimates are based on conventional projections of energy cost but with dwindling fuel supply and global population growth, energy prices signal an even greater increase in the long term, justifying greater study on impact of these factors to which the mortgage industry has traditionally paid little attention.

The suggestion that underwriters may be overestimating default risk for mortgages applied to energy and location efficient homes and also possibly underestimating default risk for inefficient homes has profound implications. The current inefficient state of most buildings in the US is a detriment to the US economy as a whole, as funds that would otherwise be spent productively are wasted on household energy that provides no service, leaking out poorly insulated walls, windows, and ducts. Tremendous expenditures are made on automobiles, fuel, and car maintenance to drive long distances on a daily basis. These lost financial opportunities are significant. If the mortgage industry were implicitly encouraging the construction of location and energy inefficient homes, then the construction, real estate, and financing industries would be implicitly encouraging this economic inefficiency. As the uncertainty around fossil fuel energy sources and the need to move towards clean energy grows, it becomes vital to realign consumer and industry interests. This alignment is all the more important because of the congruence of these direct economic interests with national impacts, such as the national security and environmental implications of our use of fossil fuels and their global warming impact (CAN Corporation 2007). The possibility that changes in lending practice could improve all of these conditions warrants further analysis.

Recently, a study on the relationship between mortgage defaults and location efficiency was conducted by Rauterkus, Thrall & Hangen (2010), finding that location efficiency, as measured by the rate of vehicle ownership in the borrower's neighborhood normalized for income, does appear to affect default risk, while calling for further study. This study determined that the lower risk associated with location efficient homes could be used to justify greater LTV

or DTI ratios or lower credit scores while maintaining or decreasing the level of default risk and that this impact should be further assessed and incorporated into automated underwriting models.

Based on the initial confirmation of the significance of location efficiency and the call for more study, we suggest the application of similar methods to detect and quantify the impact of energy efficiency on default risk for consideration in automated underwriting models. We further suggest the scale and scope of the data, propose an entity to conduct such a study, and discuss the policy implications of a confirmation of a real effect on default risk resulting from residential energy efficiency.

Literature Review

There has been little to no formal research attempting to quantify the impact of both location efficiency and energy efficiency on default risk. What research has occurred has focused on either location or energy efficiency.

Energy

The impact of energy efficiency on default risk was discussed by Stein and Meier (2000) in a paper that assessed the accuracy of home energy ratings, primarily the Home Energy Rating System (HERS). Stein and Meier dismiss the impact of energy efficiency on default risk based largely on correspondence with officials at Fannie Mae and an assessment by an official at the National Renewable Energy Laboratory, stating that,

> *"Loan-to income ratios have not been revised much in the last 40 years and are based on the monthly energy costs of inefficient houses from that era. However, homes are generally more efficient now, so homeowners usually can meet the mortgage even if expected energy savings do not materialize. Furthermore, even if savings do not materialize and homeowners are squeezed for cash, they are more likely to accept a lower level of comfort than to default on a mortgage. Thus there is very little risk to the lender from HERS accuracy."*

This statement assumes negligible default risk for all home loans. Homes where "the energy savings do not materialize", are not likely to be energy efficient in actuality and would not be expected to show any improvement in mortgage performance. We also disagree with the assessment that static loan to value ratios based on decades old energy costs will result in an overestimation of monthly energy burden, and therefore risk. While new homes are certainly more efficient than 40 years ago, they are also much larger (43.5 percent larger for homes built 2000-2005 than in the 60s according to the Energy Information Administration (EIA) 2005) and the proliferation of newly developed energy consuming technologies and other "plug loads" have expanded the end uses of energy. EIA shows through the Residential Energy Consumption Survey increasing average household electricity consumption, from 9,114 kilowatt hours per year in homes constructed before 1940 to 10,703 kilowatt hours for those constructed in the 60s, to 13,969 for those constructed 2000 to 2005. Average residential electricity prices have also increased by 37 percent and natural gas prices by 76 percent between 2000 and 2008 (EIA 2010), magnifying the effect that Stein and Meier discounted. To ignore energy costs, one would need evidence that the level of energy costs is below some threshold of insignificance. With real data,

rather than hypothetical arguments about comfort and bill payment behavior, the impact of the energy efficiency-risk relationship could be analyzed and then consistently revisited as energy prices and the relative energy efficiency of homes change, and a methodology should be developed for this analysis.

More importantly, changes in the amount of energy costs imposed by a house would not affect the validity of the choice to consider relative energy efficiency in underwriting. Even if energy costs had decreased over 40 years, the 30-year burden of making these payments still represents 40 percent of the cost of the house; therefore it is plausible that lower energy costs would still lead to lower default risks. Perhaps if energy costs had declined for a generation, this change would justify relaxed minimum DTI ratios.

We also disagree that the mortgage payment will be prioritized over the monthly energy bill. This is a hypothesis that needs to be demonstrated with evidence, not just logic, especially when there is a strong argument that the logic cuts in the opposite direction: when financially stressed a borrower will certainly cut back on purchases that do not represent absolute necessity. Energy and transportation costs can be reduced by conservative behavior; however, there is some level of spending required by the location and efficiency of the home, for example to commute to a job or to stay warm in the winter, or even to keep the pipes from freezing. In such cases, mortgage payments are likely to happen after utility and transportation costs are covered as the homeowner weighs the longer term consequences of possible foreclosure and eviction at some future date with the loss of power for heating or a source of income in the near term.

Stein and Meier also based their conclusion on a study by Horowitz (1996), which speculates that because energy savings are not certain to be applied to mortgage payments, no impact on default risk will be present. Horowitz criticizes the Energy Efficient Mortgage (EEM) product that allows an increase in the allowable debt to income ratio. He also notes the difference between predicted and actual energy savings that result from computer simulations that have been overly simplified and unpredictable occupant behavior as evidence that relative efficiency will not affect default rates. Horowitz also notes that because of the lack of success of the EEM (in terms of market share), “there has been no interest in creating an EEM database or studying the determinants of EEM choice or EEM default rates”.

We agree with Horowitz’s assessment of the difficulty of predicting *energy savings*—that is, the difference in energy use before and after an efficiency upgrade– and suggest in this paper a study to determine the existence and quantification of an efficiency-risk relationship by using *indicators of relative efficiency* rather than energy savings.

The stated lack of *consumer* interest in the EEM is hard to demonstrate empirically. When it comes to mortgages, the marketing is often driven by the needs of the “back-end” and not by the desires of consumers. The EEM is not supported at Fannie Mae and weakly supported by FHA and thus it is hard for the consumer to find out about EEMs. Arguably the lenders have never seriously attempted to develop the EEM as a product. The lack of market share for EEMs cannot be attributed to a lack of consumer interest rather than a lack of marketing by producers. The fundamental processes developed around promoting origination pipelines should be evaluated and research designed to determine what consumer interest would be in a widely available and strongly supported EEM. The dearth of research on the origination and impact of this program motivates the recommendations of this paper.

Location

In the case of location efficiency, the aforementioned research by Rauterkus, Thrall & Hangen found that the probability of default increases with the number of vehicles owned by an average resident of the neighborhood after controlling for income and suggests that underwriting flexibility can be used to encourage the purchase of location efficient homes while decreasing the probability of mortgage default. The study utilized DTI, FICO, and LTV, as well as other commonly used data, as control variables to test the mortgage performance of location efficient homes compared to non-location efficient homes and finds superior performance. The methods used in this study should provide the blueprint for a similar study including energy efficiency.

Suggested Approach

Rauterkus, Thrall & Hangen provide an initial study of limited scope on the effect of location efficiency on default risk and will hopefully generate further research that may be conducted by the private sector, as lenders look to lower defaults and the associated costs. The consequences of mortgage defaults may also encourage a federal role in conducting this research, perhaps by Fannie Mae, Freddie Mac, The Department of Energy (DOE), or the Department of Housing and Urban Development (HUD), justified by the negative societal impact of foreclosures. In the case of the location-risk relationship, an initial study has been conducted utilizing a significant but limited dataset and rigorous methods to observe statistical correlations in the data. A larger scale study should be conducted to incorporate energy efficiency into the scope.

This larger study must consider both energy and location efficiency in an attempt to develop or suggest an approach for incorporation into common underwriting practice. The hypothesis that energy and location efficient homes will show superior mortgage performance as compared to inefficient homes when traditional underwriting factors are held constant has logical plausibility and should be tested.

Unfortunately, energy efficiency has unique challenges that will require some departures from the methods utilized by Rauterkus, Thrall & Hangen. A metric for assessing relative energy efficiency is not easily assessed “from the top down” based on housing characteristics as was done for location efficiency through vehicle ownership. Assumptions about energy consumption per square foot based on construction type (wood frame, brick, etc) and construction date could be made, but the estimates would not be useful as renovation, addition, and deterioration would result in variability compounded by unpredictable occupant behavior. While macro-level indicators should be considered in case a correlation is found, this paper suggests approaches that require more physical data collection.

A possible exception would be the use of utility bill data if a utility maintains a database of consumption data, and this dataset could be matched with information on housing characteristics such as house size. If this type of database exists, then perhaps regional aggregation could be possible for macro level comparison to similarly aggregated mortgage data. If some correlation were found within this region, it would certainly justify additional research to increase the geographic scope. It may be difficult to find a large enough and random enough sample size for analysis even if the data exist, and therefore this paper focuses on other methods.

Suggested Implementers

The lack of sufficient data to create a "top down" analysis indicates that a more involved study must be conducted by an entity with the scope and resources to collect data from a large sample of homes. This would suggest a federal agency, whose participation is more than justified by the potential benefit to the greater economy; however, private sector implementers like mortgage insurers may also be able to conduct the study. The most likely implementation plan involves a federal agency, directed by Congress, studying the relationship under conditions laid out by statute and guidance.

The conclusion that a government agency is necessary to successful implementation of this study brings forward important process considerations. Should the agencies lack motivation and legal authority to move forward, then Congress would need to direct the agency in question to act, likely with the relevant committees authorizing and appropriating the needed funding. This changes the discussion from merits to politics. The authors and other efficiency advocates have experience working with Congress on energy efficiency policy and energy efficiency finance mechanisms but the energy committees in the House and Senate lack the jurisdiction over some potential agency implementers, meaning that efficiency advocates must work with financial industry advocates to generate political interest. An important result of this paper could be a dialogue between energy efficiency, building, and finance advocates so as to present the appropriate committees with a single request for legislation.

It may be possible for certain agencies to move forward with this study without new authority or explicit direction from Congress. Recently, Van Ness Feldman, funded by the US Green Building Council, the Natural Resources Defense Council, and other organizations, released "Using Executive Authority to Achieve Greener Buildings" (2010), which outlines authorities in existence at many agencies to increase the energy efficiency of commercial and multifamily buildings. This report also contains several cross-cutting recommendations that would impact other sectors, including residential efficiency. One such recommendation is that the Federal Housing Finance Agency, the overseer of Fannie Mae and Freddie Mac, direct these entities to reform underwriting standards to appropriately value energy efficiency. HUD also possesses broad data collection authority that could be used to determine the relative efficiency of all Federal Housing Administration backed mortgages and could be used to inform revisions to underwriting guidelines. Section 502 of the Housing and Urban Development Act of 1970 provides robust authority to collect data as the statute reads that the Secretary may "request and receive such information or data as he deems appropriate from private individuals and organizations, and from public agencies". HUD also supports a version of the EEM, suggesting a familiarity with the issues.

Assuming an agency is motivated to attempt to quantify the efficiency risk relationship, by existing authority or Congress,, then the agency must have access to significant mortgage information. This would indicate that the ideal conductor of such a study would be Fannie Mae or Freddie Mac. Fannie and Freddie are government sponsored enterprises (GSEs) that act in the secondary market to encourage home ownership by providing debt securities in capital markets. Fannie and Freddie have tremendous databases containing the relevant mortgage characteristics for their portfolios and have sophisticated in-house expertise on tracking mortgage performance.

The Department of Energy may be chosen as a result of the significant building level data that must be utilized. DOE, through the Builder's Challenge E Scale (based on the HERS Index) has a familiarity with the existing building energy efficiency metrics and is currently creating the

National Building Rating Program as announced in the plan the enhance the Energy Star program (2010), which would create a building energy rating designed to be useful to the financial industry.

This paper is agnostic on the lead agency tasked with the research, but suspects that agency motivations must result from direction from Congress. In this case, the determination of which agency will be made based on political reality, where interested members of Congress will use the relevant committees to direct the agency where the committee has jurisdiction to conduct the research "in consultation with" the other relevant agencies. Regardless, representation of the expertise of each agency in the process is very important through Fannie and Freddie for underwriting, HUD for experience with the EEM, and DOE for technical building expertise.

In practical terms, it is important that not only are the relevant agencies' views reflected in the analysis, but also those of the private sector. We recommend that a project advisory committee be used for this study and be composed of representatives from each agency previously mentioned, and multiple members from academia and the private sector. The private sector advisors should include both building efficiency experts and mortgage industry experts (representing mortgage lenders, the mortgage insurance industry, investors in mortgage-backed securities, credit analysts who follow the mortgage markets and possibly rating agencies). The research team should be similarly mixed between public and private representation and include housing economists from within the agency and from outside.

Data Needs

This study will require a large amount of data on both building efficiency and mortgage performance. The following suggestions are meant to inform the scope of the data collection.

Mortgage

Detecting an efficiency-risk relationship will require a large database containing specific information on mortgage characteristics. The database used by Rauterkus, Thrall & Hangen may be sufficient and is owned by LPS Applied Analytics. Alternatively, the mortgage portfolio databases maintained by Fannie Mae or Freddie Mac would likely be sufficient for this study and available to a federal agency conducting the research.

The study could consider mortgages in default and varying degrees of delinquency. The analysis could be simplified by using a binary, default or not, approach or utilize bins for thirty, sixty, and ninety day delinquencies. Given the economic significance of the results, we recommend the most comprehensive approach of utilizing all of the available variables, subject to the opinion of industry experts and Fannie and Freddie, who already track mortgage performance.

Building

The relative energy efficiency of the studied properties must be determined. The efficiency metric(s) used will inform the collection of the data in the home and this decision is extremely important. The metric must be useful to the financial industry and correlated to the level of energy expenditures in the home. This is far from a simple question, as home energy consumption varies with building characteristics, occupant characteristics, and weather.

All household energy data must be normalized for weather, but there are two potential approaches to assessing relative energy efficiency: asset based ratings, where the building is simulated using standardized assumptions for occupant behavior, and operation based ratings, where actual consumption data would be utilized in some way. Both approaches have strengths and weaknesses, but we suspect the asset rating is likely to be more predictive of defaults (a hypothesis that could be explicitly tested in this research). If possible, the study should consider both approaches to determine which is most predictive and invite further study.

An asset approach would entail collecting data in each home, creating an energy model using standardized assumptions about the building's operation, and using this model to predict performance. The HERS Index produced by Home Energy Raters using software certified through the Residential Energy Services Network (RESNET) provides potential asset metrics. The Index is the basis of all existing Energy Efficient Mortgages, and is accepted by the lending industry, as well as by the Energy Star new homes program and the Internal Revenue Service for the purposes of compliance with the efficiency criteria of the builder tax credit for efficient new homes. This metric was evaluated by Stein and Meier (2000) who concluded that the system can, on average, predict annual energy costs accurately, but that some differences may occur on an individual home basis. These differences are to be expected, given large behavioral variation between households. The HERS Index is improved on a recurrent basis as a result of such criticism and should be a strong candidate for testing as a measure of relative energy efficiency.

The benefits of an asset based metric include the standardization of weather, building size, construction type, and other technical considerations. The elimination of variance in operations (personal comfort differences, failure to provide basic maintenance, failure to turn off/on equipment, amenity preference) and occupation (unusual number of occupants, frequency of equipment operation) occurs and may affect the projected costs in ways that should be analyzed. Potential privacy issues with obtaining and using homeowner consumption data are also avoided. The downside to this approach is cost (each model must be produced and verified). RESNET survey data from 2009 indicate an average cost for this building data collection of $492 per home evaluated.

We suggest that the most explanatory metric in the context of loan performance would be projected energy use by fuel multiplied by the cost of that fuel for the property in question as utilized in determining the HERS Index. Certainly correlation with the overall HERS Index, or other components of an asset rating should be explored as well.

With an asset approach, homes would be identified for the study and then given an energy audit to determine relative efficiency using the HERS Index or other metric. This would include the entire sample, including those in default and delinquent. Obtaining this data will be time consuming and subject to scheduling and completion of audits with homeowners. We suspect the delinquent homeowners may not want to allow an auditor in even at no cost. There may also be an issue with damage to foreclosed homes that will affect the rated performance. Assuming these sampling difficulties could be overcome, the mortgage performance of the rated homes could be compared.

The operational approach would utilize electricity and gas consumption data collected by utilities for homes selected from the mortgage characteristic database. Bill data collection would require consumer consent consistent with state and federal privacy laws. This approach would quantify the actual economic impact of home operation, as felt by the mortgage holder in a cheaper fashion than the asset approach, as less building characteristic data must be collected (only easily identifiable characteristics like size, construction type, etc).

The operational rating approach may be of limited usefulness to the financial sector as a predictor of risk of default. Interpreted bill data is certainly the most accurate assessment of the past financial impact of the energy consumption on the homeowner, but it is only an accurate predictor of the future energy consumption of the same building and occupant combination. With most mortgages, there are new occupants so this information is not available for consideration in underwriting.

Refinances offer different opportunities to use this data and perhaps consideration of bill data for refinances may be the subject of another study if useful to the lending industry. This paper recommends pursuing the efficiency risk relationship in the context that is usable in the most transactions including home purchase and suggests the consideration of asset ratings to provide some level of standardization of occupant behavior and provide a basis for comparison where there is a change of occupants.

A hybridized rating approach is possible, where an asset rating is "calibrated" to actual user bill data. This will result in more accurate predictions for individual homes where occupancy differs from the standard assumptions and should be given consideration by the study implementers. The lack of data available on new occupants in a home purchase remains a significant drawback for this approach. Another drawback is that a low energy use due to behavioral choices by the occupant may result in different default performance than the same low energy use due to efficiency. While both have the same financial effect on the borrower during normal times, the latter allows more flexibility to reduce bills in a time of financial distress.

Collection Process

Assuming the mortgage and building level data can be collected then the ideal approach would be to:

- Conduct a random sample of mortgages of desired vintages (origination date range) and area.
- Note the status of the mortgage, whether pre-paid, delinquent, in default, or in foreclosure.
- Measure relative efficiency with the appropriate metric, i.e. annual average utility bills as calculated from the HERS Index or utility bill data. It is an open question, and one that this methodology could answer, as to whether the HERS index itself (which measures relative efficiency for a given house size) or the predicted level of utility costs generated by the index is a better predictor of defaults.
- Remove homes where the relative efficiency has changed over the lifetime of the mortgage, either as a result of efficiency retrofit or through damage to equipment (easily detectable by the rater or through homeowner disclosure).
- Analysis to predict probability of default for homes that are energy efficient.

Alternatively, the opposite approach could be taken using fixed samples, where:

- Homes are selected for their mortgage performance status (pre-paid, delinquent, in default, or in foreclosure) and possibly existence of relative efficiency rating through the EEM program of Energy Star for new homes.

- Measure relative efficiency of these selected homes with the appropriate metric.
- Remove homes where the relative efficiency has been changed as above.
- Analysis to predict probability of being energy efficient for homes that are in default.

Analysis Method

Industry experts familiar with the statistical methodologies currently in use should be selected to analyze the correlations that underpin the assumptions in current loss models, and consider how new factors like energy and location efficiency need to be incorporated. As such, this paper recommends only potential analysis methodologies that should be considered subject to the discretion of a full research team.

The suggested analysis method builds on the methodology of Rauterkus, Thrall & Hangen. This study used a probit regression analysis to model the probability of default. The model uses $default = a_0 + b_1 LEFF + b_2 CONTROL + \varepsilon$, where default is a binary variable set to one if the mortgage is in default and zero otherwise, LEFF is a variable measuring location efficiency and CONTROL is a vector of control variables that are widely seen as driving foreclosure risk. Examples of control variables should at a minimum include the most commonly used default predictors: back-end debt-to-income ratio (DTI), loan-to-value ratio (LTV) and FICO score.

We suggest modifying this model through the addition of a variable to represent the relative energy efficiency of the property, measured in terms of dollars per year. In this case, the model would use, $default = a_0 + b_1 LEFF + b_2 EEFF + b_3 CONTROL + \varepsilon$, where EEFF represents relative energy efficiency. As in Rauterkus, Thrall & Hangen, multiple configurations of this model can be analyzed to determine impact of varying factors on probability of default.

Including both location efficiency and energy efficiency is extremely important in any attempt to detect an efficiency-risk relationship. Many energy efficient homes are recently constructed and located in neighborhoods that are not location efficient. The impact of this practical reality must be controlled in a robust study, since the *a priori* influence of energy efficiency is about a factor of three or four lower than that of location efficiency. Drawing conclusions on energy efficiency and risk without considering the impact of location efficiency could result in discounting the potential contribution of energy efficiency to default risk.

Of course, there are also large differences in the process of qualification and not every loan is underwritten under the same process. Consideration of the traditional factors, the standard of documentation (from full documentation to no documentation), the automated underwriting process itself (versus manual), as well as how originators are compensated are all points for consideration and may be included in the analysis.

Implications

The implications of a quantified relationship between default risk and energy efficiency combined with location efficiency are profound. The finding would immediately justify further research and strongly suggest that exploration of how to best incorporate these relationships into mortgage underwriting. This should be a natural reaction from both Fannie Mae and Freddie Mac, the entities that take the risk with most residential mortgages.

Greater study should be given to the impact of the relationship on socioeconomic factors. Differentiation of underwriting standards may be beneficial environmental and energy policy

standpoint, as well as a risk mitigation standpoint, but not from a social equity standpoint. There may be low income homeowners who live in old, inefficient housing in areas poorly served by public transport that may be affected by these risk relationships. These impacts should not be disregarded.

Consideration must also be given to the potential impact of negative discoveries, meaning if the findings call for more stringent lending qualifications for most homeowners rather than less, as has been the focus in the past. There are certainly other policy tools available to address this potential, such as incorporating the costs of efficiency improvements into the mortgage amount and providing alternative financing structures for improvements through tax and utility bill assessments (although not possible for location efficiency). During a refinance where no choice of property is being made the potential for negative discoveries must be fully considered.

Should the efficiency-risk relationship be detected and quantified, then location efficiency and energy efficiency should be considered for inclusion in automatic underwriting software. There are several potential strategies for utilizing the property level energy and location efficiency information in automated underwriting software, including assuming inefficiency (i.e. high rate of vehicle ownership, high HERS Index) unless shown otherwise. Then the borrower would have the incentive to obtain both metrics and provide this information to improve mortgage terms, while the lender would be insulated from additional risk.

Incorporating these factors into the lending process will have beneficial side effects regardless of how they are included. If efficiency became a factor every time a property was financed, then we would illuminate countless opportunities for cost effective efficiency improvements and increase uptake. A homeowner may invest in a comprehensive efficiency retrofit with confidence that the benefits would be assessed (and hopefully valued appropriately) at the time of resale.

Consumer awareness of home efficiency would increase exponentially, as homeowners strive to purchase more efficient homes as superior investments. Homeowners understand much more about mortgages and finance once they have been through the process than they do about home efficiency. This situation would change if efficiency were factored into the finance process. A robust and understandable building energy label would be supported by and dependent on greater consumer understanding of home energy and location principles, as would the developing home retrofit industry.

These benefits may extend to the construction of new homes, where increased energy code compliance and support for more advanced building energy codes may follow, as builders see a tangible benefit to building more efficient homes in smart locations.

Conclusions

The initial confirmation of the significance of location efficiency as a determinant of default risk justifies further study into energy and location efficiency as a determinant of default risk. The treatment of the topic in the literature, which is minimal to begin with, is largely out of date and supports further study as a result of increased energy costs.

Because of the necessary data at both the building and mortgage level, we suggest that a federal agency be tasked by Congress to conduct the study, in consultation with all the relevant agencies (DOE, HUD, Fannie Mae, Freddie Mac) and with private sector presence (mortgage lenders, the mortgage insurance industry, investors in mortgage-backed securities, credit analysts who follow the mortgage markets, and possibly rating agencies) on advisory and research team

levels. The federal role is justified by the significant national consequences of supporting energy efficiency, location efficiency, and responsible mortgage underwriting.

We recommend an asset based determination of relative efficiency be used, possibly based on the HERS index, but suggest bill data and other potential metrics be considered. The analysis methods should build on those utilized by Rauterkus, Thrall & Hangen and incorporate both energy efficiency and location efficiency. We suggest that socioeconomic factors be fully considered. Finally, we recommend a great deal of thought be given to the implications of the study once completed, including the potential national benefits, implementation strategies for automated underwriting, and potential negative impacts on borrowers.

References

CAN Corporation. 2007. "**National Security and the Threat of Climate Change**." <http://securityandclimate.cna.org >

Department of Energy and Environmental Protection Agency. 2009. "**Enhanced Program Plan for Energy Star Products**." <http://www.energystar.gov>

[EIA] Energy Information Administration. 2005. "**Average Consumption of Fuels Used, 2005**." <http://www.eia.doe.gov>

[EIA] Energy Information Administration. 2010. "**Average Retail Price of Electricity to Ultimate Customers by End-Use Sector**." <http://www.eia.doe.gov>

[EIA] Energy Information Administration. 2005. "**Housing Unit Characteristics by Unit Floorspace, 2005**." <http://www.eia.doe.gov>

[EIA] Energy Information Administration. 2010. "**U.S. Price of Natural Gas Delivered to Residential Consumers**." <http://www.eia.doe.gov>

Goldstein, D. 2010. **Invisible Energy: Strategies to Rescue the Economy and Save the Planet**. Point Richmond, Calif: Bay Tree Publishing.

Horowitz, M. 1996. "**Innovative Financing of Home Efficiency Improvements**." *Proceedings of the 1996 ACEEE Summer Study on Energy Efficiency in Buildings 2*; 97-105

Housing and Urban Development Act of 1970, 12 U.S.C. § 1701z–2 (1970).

Rauterkus, S, Thrall, G and Hangen, E. 2009. "**Location Efficiency and Mortgage Default**." Paper accepted for publication by the Journal for Sustainable Real Estate.

Residential Energy Services Network. 2009. "**National Average Cost of Home Energy Ratings**." <http://www.natresnet.org>

Stein, J and Meier, A. 2000. "**Accuracy of Home Energy Rating Systems**." *Energy.* 25:339-354.