Regional Economic Diversification and Residential Mortgage Default Risk

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Abstract. **Geographic diversification allows those involved in real estate markets to manage risk. In this paper we discuss the role of local economic diversification in risk management. We show that residential foreclosure rates are negatively related to local economic diversification. We conclude that geographical diversification with reference to local economic diversification is more efficient than naive geographic diversification alone.**

Mortgage investors and insurers are concerned with loses which occur through delinquency, default, and foreclosure on properties in which they have an interest. The risk of loss through default and the pricing of insurance has been modeled for isolated loans by Swan [24], Epperson et al. [13], Cunningham and Hendershott [12] and Foster and Van Order [15]. Important parameters in such models include the distribution of property price and interest rate movements.[1] For a portfolio of loans, geographic diversification (as related to local unemployment) rates has been discussed by Corgel and Gay [11]. They claim that, if it can be shown that local unemployment rates (or property prices) are to any extent less than perfectly positively correlated, diversification efforts will prove useful in mortgage risk management. By extending loans (insurance) beyond a single local area, lenders (insurers) may reduce the risk that results from adverse economic conditions unique to that area. Corgel and Gay find less than perfect correlation between area employment and thus settle on a mean–variance model of employment growth rates as a superior diversification strategy.

Diversification and Mortgage Lending

In order to focus more clearly on the diversification process two issues must be resolved. First, it is necessary to distinguish between two types of diversification efforts involving the extension of loans or insurance to distinct geographical areas. Second, it has to be demonstrated, empirically, that mortgage risk (default) is related to local economic conditions.

On the first point, one type of (naive) diversification simply involves lending (insuring) funds in different geographic regions without regard to the nature of the local economies; it assumes each area is independent of the other. A second type involves lending (insuring) funds within a given selected local area which is itself economically diversified. Indeed, a

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portfolio of loans from a single economically diversified area may be equally, or more, diversified than one constructed from loans over several different localities. Consider the variance in returns (as affected by default) of a portfolio of loans as represented by

$$\sigma_p = \sum_i \sum_j w_i w_j \sigma_{ij} \quad (1)$$

where w_i denote the proportion of the portfolio allocated to region i and j and σ_{ij} denotes the covariance of returns. Equation (1) can be disaggregated into

$$\sigma_p = \sum_j w_j^2 \sigma_j^2 + \sum_{i \neq j} \sum_{i \neq j} w_i w_j \sigma_{ij} \quad (2)$$

In this form the variance in portfolio return is composed of variance contributed by each geographical area (a function of its own economic diversification) and the covariance between the geographical areas. Geographical diversification across many areas is undertaken with the expectation that the second part of the right-hand side of equation (2) is small. However, minimization of risk can also be accomplished by avoiding geographical areas for which the first part is large. This may be the case for areas that are themselves *not* economically diversified, but instead are economically specialized.[2]

Now, given the distinction between the two types of diversification the second point becomes important; that it be determined empirically that risk is related to a local economy's diversification. The central purpose of this study is to determine if regional residential default rates have a non-systematic component related to local economic diversification (specialization). Secondarily, we report on the type of measure of regional diversification (there are several) which best explains default rates.

For these purposes we employ several measures of economic diversification and default rates from major SMSAs throughout the U.S. Data on default rates for FHLBB institutions in the second half of 1982 and the first half of 1983 are obtained for 109 SMSAs.[3] Several alternative measures of economic diversification are obtained for a series of subsets of these same SMSAs. The cross-sectional data are used to determine how and which measures of local economic diversification are functionally related to mortgage default rates.[4]

In the next section we discuss measures of regional economic diversification. The following section presents the empirical results and the remaining section is a conclusion and summary.

Measuring Regional Economic Diversification

Several efforts to quantify regional economic diversification have been published. Most have been developed as an explanatory variable of regional economic instability (REI) and are based for the most part on industry employment relatives. There are five classes of diversification measures that can be identified. Somewhat in order of increasing sophistication they are as follow.[5]

The first class implicitly defines a diversified local economy as one in which the proportion of employment in each industry is equal to that in the U.S. economy. Florence [14] and Steigenga [23] are examples of early works that measured departure from diversification as deviations of actual employment in local industrial categories from their respective U.S. proportions.

A second, and similar class, considers ideal regional diversification as one with equal percentages of employment in each industrial group. McLaughlin [20] and Tress [25] are also early examples of this "ogive" type measure. Most recent examples are those of Garrison and Paulson [16], Rodgers [21], and Kort [18].

A third class measures diversification with reference to employment in durable goods production. Siegel [22] suggests that durable goods production involves products with greater income elasticity of demand. Local economies with a large segment involved in such production are expected to experience relatively large fluctuations in employment in response to changes in national income.

"Minimum requirements" measures (MR) are the fourth type; they were first suggested by Ullman and Dacey [26]. In this type the "normal" level of employment for a given industrial category is that level that is the minimum necessary to satisfy the needs of the local economy. Such levels are usually determined by cross-section regressions of employment levels in regions of different size classes. A diversity index can then be computed with reference to deviation of actual employment from these "minimum requirements."[6]

Portfolio measures of diversification represent the fifth and final class. Conroy [9] uses a Markowitz approach, while Brown and Phaesant (6) employ a Sharpe method and Brewer [3] a mean-variance analysis. We will discuss the Conroy and Brewer measures in detail as they will be employed in the empirical section.[7] Conroy computes a portfolio measure of diversification by utilizing the interindustry covariance of employment (over 120 months) for 118 three-digit, SIC manufacturing industries at the national level. From this covariance matrix and local employment structures (weights) for the same industries, he computes a portfolio variance for each of 52 SMSAs.

$$\sigma_p = \sum_i \sum_j w_i w_j \sigma_{ij} \tag{3}$$

where w_i and w_j are the local industry employment weights and σ_{ij} is the national covariance matrix.

The advantage of this type of measure of economic diversification lies, of course, in its consideration of each industry's contribution to regional economic stability in terms of its stabilizing or destabilizing effects.

Brewer's measure of diversification is also portfolio based but is constructed somewhat differently. He analyzed monthly employment figures (also over 120 months) for twenty manufacturing categories. However he did not utilize industry covariance. Instead, for each industry Brewer divided each of the 120 months' employment figures (1972 through 1981) by the 1977 average level of employment. He then utilized the mean and standard deviation of the resulting 120 monthly relatives to construct mean-variance efficient portfolios.[8]

Data and Empirical Results

Geographical diversification is fruitful only to the extent that residential default rates between different regions are not identical. Furthermore, if the default (foreclosure) experience of a local area can be identified as a function of its own economic diversification then more efficient portfolio construction and risk pricing can occur by mortgage lenders and insurers. The purpose of this section is to test the hypothesis that residential defaults and foreclosures are related to local economic diversification. We test a model of the form:

$$F_j = \alpha + \beta_l D_j + \sum_{i=2}^{n} \beta_i X_{i,j} + \epsilon_j \tag{4}$$

where

F = log of the foreclosure rate in area j,[9]

D_j = an index of economic diversification in area j

$x_{i,j}$ = a set of n variables reasonably expected to influence foreclosure rates in area j, and

ϵ_j = an area team

Data

We initially use the foreclosure rate for underwritten and conventional loans of member institutions of the Federal Home Loan Bank Board (FHLBB) in 109 SMSAs in the last half of 1982.[10] To measure economic diversification we employ, alternatively, four indices: a simple ogive measure reported by Kort [1981], a minimum requirements measure reported by Bahl [1971], and two portfolio measures reported by Conroy [1975] and Brewer [1984]

Additional explanatory variables include those that reflect the local legal structures of the default–foreclosure process. Clauretie [7] has shown that regional foreclosure rates are very responsive to such legal considerations as they affect the costs and benefits of default and foreclosure. He has shown that, in jurisdictions where the legal costs of foreclosure are high (low) in terms of: (a) the type of foreclosure, (judicial vs. non–judicial) and instrument (mortgage or deed of trust); (b) the average required length of time to foreclose; (c) the existence (and length) of a statutory right of redemption; and (d) the existence of deficiency judgment, lenders choose a foreclosure remedy less (more) frequently. Dummy variables are used for the type of foreclosure process (0 = non–judicial, 1 = judicial), the existence of a statutory right of redemption (1 = presence), and the existence of a deficiency judgment (again, 1 = presence). We enter the number of months for the average time for foreclosures and the length of a statutory right of redemption.[11]

Finally, we include the population size of the SMSA as an explanatory variable. Rodgers [21], Clemente and Sturgis [8] and Marshall [19] all demonstrated a significant relationship between city size and economic diversification. If larger cities are more diversified they may experience, ceteris paribus, a smaller residential mortgage default rate.[12]

While we include legal variables and SMSA size in the equations for the purpose of overall explanatory power, our goal is to focus on the role of economic diversification.

Results

Equation (4) was tested employing four alternative measures of economic diversification: those of Kort [18], Bahl [2], Conroy [9], and Brewer [4]. Exhibit 1 shows the results of the OLS estimates for each equation.[13]

Of the indices employed, the Conroy measure is the most successful in explaining foreclosure rates. It is also the most sophisticated, being a portfolio measure. If any measure of economic diversification (specialization) is related to residential foreclosures, one would expect that it is the one that incorporates unemployment covariances.

The Kort measure explains foreclosure rates on government underwritten loans but not on

Exhibit 1
Results of OLS Estimation
Dependent Variable = Log of Foreclosure Rate, 1982 II

	KORT		CONROY		BREWER		BAHL	
	FHA/VA	Conv.	FHA/VA	Conv.	FHA/VA	Conv.	FHA/VA	Conv.
Constant	5.356	−.716	−5.988	−2.664	−2.689	−3.506	−1.649	−2.476
Diversification	−2.31	−.522	97.351	29.581	−.148	−2.575	.0030	.0038
Index	(2.04)**	(.63)	(5.20)***	(2.61)**	(.62)	(.02)	(.66)	(1.20)
Type of	−1.861	−1.092	−.420	−.709	−.498	−.397	−1.052	−.722
Foreclosure	(2.80)***	(2.70)**	(.97)	(2.70)**	(.49)	(.85)	(1.93)**	(2.16)**
Statutory		.746			1.114	.024		
Rt. of Red.		(2.68)***			(1.63)	(.08)		
Length of			.079	.085				0.52
Stat. Rt.			(1.98)*	(3.30)***				(2.11)**
of Red.								
Deficiency	.053			.303	.657	4.14		
Judgment	(.13)			(1.28)	(1.17)	(1.36)		
Time to			.229		.136			.0537
Foreclose			(2.42)**		(1.24)			(1.95)*
$(POP)^{1/2}$	.033	.007	.014	.0008	−.047	3.85	−.003	.0009
	(2.53)**	(.92)	(1.78)*	(.18)	(.51)	(1.07)	(.42)	(.16)
R^2	.216	.310	.606	.5276	.09	.00	.037	.159
D-W	2.0061	1.975	2.055	2.155	2.17	2.332	2.22	2.20
F-V	2.93**	5.27***	7.46***	6.58***	1.38	.89	1.79	4.06***
n	48	48	31	31	40	40	102	102

Values in parenthesis are t–values. One, two and three asterisks represent significance at the .1, .05, and .01 level respectively.

conventional loans. None of the remaining measures are related to foreclosures on either type of loan.

Second, the legal variables are generally important in explaining foreclosure rates on both types of loans. Generally, where legal (foreclosurer) costs are high, the foreclosure rate is low, ceteris paribus.

Clearly the most important finding is that of a functional relationship between regional economic diversification and foreclosure rates. The significance of this relationship can be explored by considering the predicted default rate between the most and least diversified cities in the Conroy series: Topeka, Kansas and Stockton, California. The foreclosure rates on FHA/VA loans for these two SMSAs were .06% and 4.22% respectively in the second half of 1982. Assuming that the loss ratio (dollar loss per dollar of exposure) is identical, loans in the latter SMSA were seventy times more risky than in the former. Such a result would appear to justify pricing of insurance in terms of the risk resulting from relative economic diversification.

Finally, the equations in Exhibit 1 were tested employing data from the first half of 1983. Here, the coefficient on the Conroy Index was significant (t–value = 6.02) for government underwritten loans but only marginally significant for conventional loans (t–value = 1.39). Those on the Kort Index were not significant.

Summary and Conclusions

The results of this study indicate that regional economic diversification is important in explaining foreclosure rates on residential loans. Furthermore, a portfolio measure of diversification taking into account the covariance of unemployment between industries is the best predictive measure. The implication is that insurers should price their guaranty with reference to regional economic diversification. That is, simple naive diversification with a uniform fee structure will not lead to minimization of risk or maximization of return. Pricing and portfolio diversification with respect to the economic diversification of the region is required. Ideally, the model should be tested over different stages of the cycle. However, the initial results with the available data suggest that regional economic diversification matters. Furthermore, those interested in underwriting single real estate investments should consider, as do the rating agencies, local economic diversification. Certainly, an area of research previously reserved for issues of regional economic instability can and should be applied to macro and micro real estate investment issues.

Notes

[1]This literature has been based on option pricing theory. See [17] for a summary.

[2]The situation is analogous to the market model for corporate equities. Complete diversification is achieved when the portfolio reflects the market composition of equities. Further risk reduction can be achieved by eliminating high beta equities and including low beta equities in the portfolio. High beta equities are retained only to the extent justified by higher expected returns; thus the capital asset–pricing model.

Complete geographic diversification of mortgage lending (insurance) will provide the investor with a "market" portfolio of loans. Further risk reduction can be accomplished by including more loans from local areas that are economically diversified and excluding loans from areas that are economically specialized, unless justified by relative returns. If the risk of default is reduced (increased) in areas of economic diversification (specialization) lenders and insurers may want to price the risk accordingly.

[3]Unfortunately data on foreclosure rates by SMSA was collected by the FHLBB on an experimental basis for these time periods only. No other known data are available on foreclosure rates by SMSA. Consequently, we test the cross-section model only twice (with similar results). Ideally, the model should be tested at different stages of the cycle.

[4]Even though we are primarily interested in the issue of regional economic diversification in a portfolio context it also has applications to unit real estate investments (although not pursued here). The expected return and variance in return on a real estate investment located in a given locality is a function of, among other variables, the expected level of economic activity (regional income) and the variance in the level of economic activity. For this reason the rating agencies consider the economic diversification of the region in which a commercial property is located for the purpose of grading CMOs backed by the property. Moody's, for example, includes the percent employment in base (vs. non-base) industries of the regions as one of several factors in its grading formula. As will be shown below, such a measure of economic diversification is of a less sophisticated type. The rating agencies may well profit by employing more sophisticated measures of diversification.

[5]Formulae representing the various measures are included in Appendix A.

[6]Bahl [2] demonstrated that the MR index suggested by Ullman and Dacey (and included in Appendix A) is biased by the size of the regional economy for which the index is computed. He suggested an alternative measure such that larger regional areas will show somewhat greater diversity than under the original formulation.

[7]Brown and Phaesant's methodology involves the use of data unavailable for national SMSAs (they used county employment data from Indiana) and, as such, is not included in our tests.

[8]Since 1977 was near the average level of employment for the ten-year period covered, the means of the relatives were close to unity for each industry: ranging from .98 to 1.036 (except for one) with ten of them between .99 and 1.009. Had he chosen, say, 1976 as the base year to compute the relatives different industries would have experienced somewhat different mean (and variance) relatives. Thus, his choice of mean-variance efficient portfolios and the measures of regional diversification constructed from them are crucially dependent on his choice of the base year to compute the relatives and not on interindustry covariances.

[9]The natural log of the foreclosure rate is employed since the rate, bounded by zero on the downside, is positively skewed and is approximately log-normal. See [7].

[10]To be included an SMSA had to be represented by a minimum of four FHLBB institutions and have had one or more indices of diversification reported in the literature on regional diversification. We also test equation 4 with data from 1983 I to confirm the basic results from the initial test.

[11]Because the existence and the length of a statutory right of redemption are likely to be highly correlated we include only the most explanatory of those two variables in any single equation. Likewise, because many states with a non-judicial foreclosure employ a deed of trust as an instrument we include only that with the superior explanation.

[12]We check for multicollinearity between population and the index of diversification and find none.

[13]Conroy's measure of diversification is positively related to specialization (inversely to diversification) where the reverse is true for Kort's measure. The positive sign on the former and the negative on the latter are in the expected direction. The reader will note that for a specialized area such as Gary, Indiana Conroy's measure is relatively large while Kort's is small.

APPENDIX A
Formulae of Regional Economic Diversification

A. National Average: $D = \sum_{i=1}^{n} \frac{(x_i - x_i^{*})^{\alpha}}{x_i^{*}}$

B. Ogive or Entropy: $D = \sum_{i=1}^{n} \frac{(x_i - x_i^{**})}{x_i^{**}}$

C. Minimum Requirements: $D = \sum_{i=1}^{n} \frac{\dfrac{(x_i - M_i)^2}{M_i}}{\dfrac{(\sum_{i=1}^{n} x_i - \sum_{i=1}^{n} M_i)^2}{\sum_{i=1}^{n} M_i}}$

D. Portfolio: $D = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \sigma_{ij}$

$\sum_{i=1}^{n} x_i$ = total employment in the region
x_i = proportion of total employment in industry i
x_i^{*} = national average proportion of employment in industry i
x_i^{**} = proportion of employment equal to $1/n$
M_i = minimum requirements proportion of employment in industry i
n = number of industry classes
σ_{ij} = covariance of employment between industry i and industry j

APPENDIX B
Indices of Economic Diversification

City	Kort	Conroy	Brewer	Bahl
1 Akron, OH			6.178	29.59
2 Allentown, PA	3.51677	.02059	4.646	27.91
3 Altoona, PA	3.61446			23.66
4 Atlanta, GA	3.66415	.02059		9.44
5 Atlantic City, NJ	3.43746			7.02
6 Austin, TX			3.517	4.71
7 Baltimore, MD	3.67600	.01824		16.22
8 Baton Rouge, LA	3.40417	.01354	5.179	8.70
9 Beaumont, TX				18.32
10 Birmingham, ALA		.02628	3.341	23.17
11 Boston, MA	3.73121			2.62
12 Canton, OH				25.09
13 Charlotte, NC			4.724	7.18
14 Chicago, IL	3.70461	.02206		0.95
15 Cincinnati, OH				10.12
16 Cleveland, OH				116.56
17 Columbus, OH			3.298	12.42
18 Dallas, TX		.01916		6.98
19 Davenport, IA	3.19816			18.37
20 Dayton, OH			5.990	60.12
21 Denver, CO		.01811		3.15
22 Des Moines, IA				5.51
23 Detroit, MI		.02799		76.42
24 Duluth, MN				21.82
25 El Paso, TX				6.49
26 Evansville, IND	3.61912			7.71
27 Fargo, ND				12.55
28 Fort Wayne, IND	3.44303	.02868		29.35
29 Galveston, TX				11.28
30 Gary, IND	2.99170	.03833	4.605	92.11
31 Greenville, SC			3.496	39.83
32 Hamilton, OH				16.74
33 Harrisburg, PA			3.420	7.47
34 Hartford, CT			6.091	34.48
35 Honolulu, HA			3.181	4.21
36 Houston, TX				6.11
37 Huntington, WV				13.35
38 Jackson, MS				5.20
39 Jacksonville, FL			3.649	4.46
40 Jersey City, NJ	3.53057		3.411	18.65
41 Kansas City, KS	3.72380			5.63
42 Johnson City, TX	3.41997			
43 Knoxville, TN	3.47987	.02270	3.511	12.53
44 Lexington, KY	3.60274			8.21
45 Lima, OH				12.03
46 Long Branch, NJ	3.55949		4.810	
47 Los Angeles, CA		.02216		4.40
48 Louisville, KY	3.70579			30.60
49 Madison, WI				5.37
50 Memphis, TN	3.63227		4.064	4.88
51 Miami, FL		.02388		3.65
52 Milwaukee, WI	3.58962			7.94
53 Minneapolis, MN		.01811		4.14
54 Nashville, TN	3.74659		3.975	4.23
55 Newark, NJ	3.72843			7.21
56 New Brunswick, NJ	3.62742		4.379	

57 New Orleans, LA	3.66673		3.873	4.63
58 New York, NY	3.75935	.01822		1.67
59 Norfolk, VA			3.871	13.31
60 Northeast, PA	3.65872		3.694	
61 Oklahoma City, OK			4.958	4.31
62 Omaha, NE	3.60028	.02220	4.305	5.69
63 Orlando, FL			4.758	6.30
64 Paterson, NJ	3.63347		4.043	29.21
65 Peoria, IL	3.18153			25.99
66 Philadelphia, PA	3.78597	.01869		4.66
67 Pittsburgh, PA	3.57672	.03249		158.30
68 Portland, OR		.02228		3.34
69 Raleigh, NC			4.781	5.78
70 Richmond, VA			3.634	6.88
71 Rochester, NY	3.37739	.02637	8.157	16.67
72 Rockford, IL	3.28448			22.10
73 Sacramento, CA			4.128	4.67
74 St. Louis, MO	3.71692			7.87
75 Salt Lake City, UT		.02172	5.105	6.72
76 San Antonio, TX			3.521	4.04
77 Riverside, CA				6.40
78 San Diego, CA		.02610		28.76
79 San Francisco, CA		.02066		2.03
80 Seattle, WA		.02252		136.25
81 Shreveport, LA	3.68376			6.16
82 South Bend, IND	3.54301			22.40
83 Springfield, OH				12.27
84 Stockton, CA		.05710		7.73
85 Tampa, FL		.02463		0.06
86 Texarkana, TX				20.37
87 Toledo, OH			4.691	10.63
88 Trenton, NJ	3.65721	.01987		6.58
89 Tulsa, OK			5.376	9.12
90 Tyler, TX				12.36
91 Vineland, NJ	3.14234			
92 Washington, D.C.	2.98892			3.08
93 Wichita, KS	3.50014		5.813	57.71
94 Wilmington, DE	3.48785		3.740	23.00
95 Chattanooga, TN	3.52247	.02143	3.298	13.07
96 Columbia, SC				6.19
97 Grand Rapids, MI			4.943	9.16
98 Lafayette, LA	3.29312			
99 Lancaster, PA	3.67224			9.96
100 Little Rock, AR				5.24
101 New London, CT				23.52
102 Phoenix, AZ	3.65850	.02496		7.12
103 Springfield, IL	3.39774			7.24
104 Topeka, KS	3.49382	.00883		8.83
105 Waterbury, CT				18.76
106 West Palm Beach, FL			4.048	9.66
107 Wheeling, WV				14.74
108 Wichita Falls, TX				14.33
109 Wilmington, NC				23.00

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