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Regional Economic Stability and Mortgage Default Risk in the Netherlands

Piet M.A. Eichholtz*

This paper investigates the relationship between regional economic diversification and stability, and residential mortgage default risk in the Netherlands. To describe and measure regional economic diversity and stability, methods from both the regional economics and the industrial economics literature are used. All measures are based on regional employment characteristics. Mortgage default rates were obtained from a database of the population of insured mortgage defaults in the Netherlands from 1983 through 1990. To test the relationship between the measures and mortgage default risk, cross sectional Seemingly Unrelated Regression was used. The paper concludes that the employed measures explain regional mortgage default rates to a significant extent, and that stability measures outperform diversity measures.

Like many countries, the Netherlands has a program of incentives for private home-ownership. It consists mainly of tax advantages and subsidies, but a public mortgage insurance system is also included in the program. This mortgage insurance system is called *Gemeentegarantie* (Municipal Guarantee). The system is run partly by the central government and partly by the municipalities. Applications for mortgage insurance are judged by a central body, which advises the municipalities whether to grant the insurance or not. This advice is followed by the municipalities in 97% of all cases, with the basic criteria being the same for all the municipalities.

A distinguishing feature of the Municipal Guarantee system is that mortgagors pay no insurance premiums for the guarantee. The system is fully subsidized by the government. Losses on a defaulted mortgage are shared equally by the central government and the municipality that granted the mortgage. Between 1983 and 1991, the average losses of the system were 50 million guilders per year, which amounted to about 20 million United States dollars using the average guilder/dollar exchange rate. The losses reached a peak of about 90 million Dutch guilders in 1985, which was then

*University of Limburg, 6200 MD Maastricht, The Netherlands

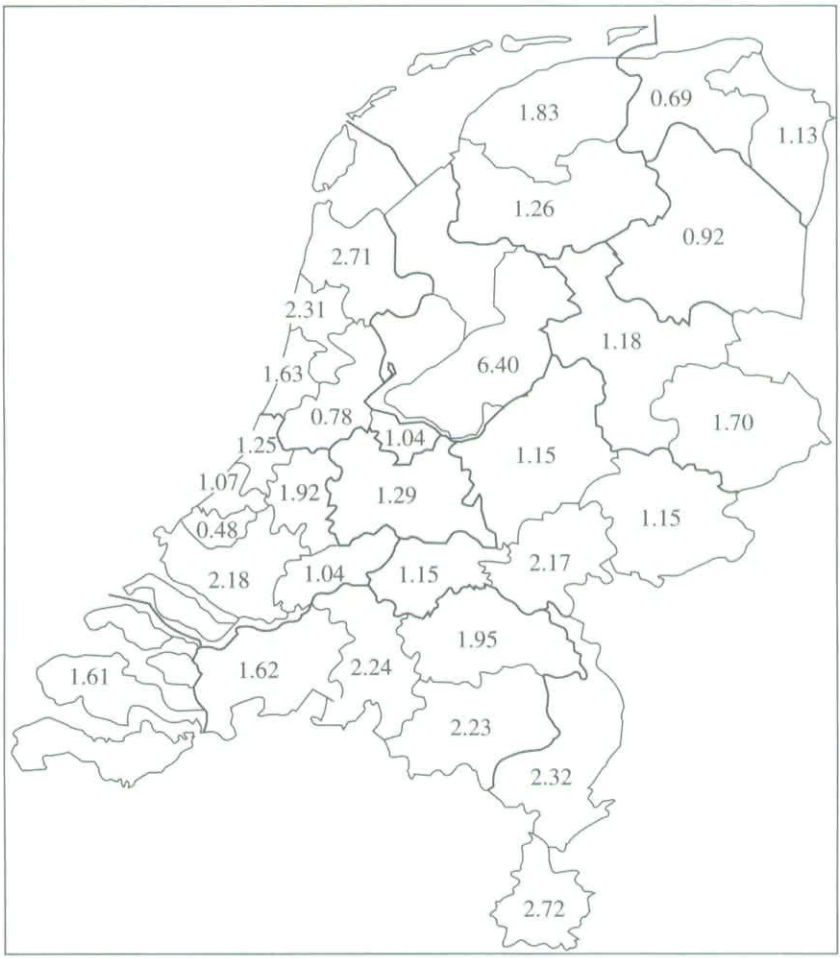
equivalent to about 30 million U.S. dollars. Since then, losses have dimenished and a discussion whether to introduce insurance premiums has continued.

Two characteristics of the system deserve further comment. The first is that municipalities and central government equally share the risk of the mortgage guarantees. An advantage of this system is that the body which grants the insurance also bears part of the risk. This prevents agency problems and gives the municipality an incentive to assess the risk of the applications properly. On the other hand, the municipality runs more risk than the central government, for the same zero premium income. This is easily seen from a portfolio point of view. The central government has diversified part of the risk of the mortgage portfolio, since it has the whole population of insured mortgages in the portfolio. In other words, it holds the market portfolio, and consequently only runs market risk. The municipality, on the other hand, only has a small geographic subset of the market in a portfolio. Thus, it runs the market risk plus the unique risk the government has diversified away. For this extra risk, the municipality is not rewarded, since it can be diversified away in principle. Clearly, this is not economically efficient. The problem could be solved by an insurance system in which all the risk is borne by the central government, or by another central body that insures the whole market.

The second feature of the Dutch system that deserves further comment is that, since all premiums are zero, no premium differentiation exists with respect to municipalities. If mortgage portfolios in some municipalities are more risky than those in others, then it would be economically efficient to take these differences into account in the premiums. A key question is thus whether regional differences in the riskiness of mortgage portfolios exist. Figure 1 is a map of the Netherlands showing an overview of insured mortgage defaults per 1000 mortgages per region from 1983 to 1991. It is clear that substantial regional differences in mortgage default risk exist. The number of defaults per 1000 mortgages varies from 0.48 to 6.40. In this paper, these differences can be explained by the degree of economic diversification in the regions and by the degree of economic stability. This implies that the degree of regional economic stability and diversification should be taken into account when introducing premiums in the system.

The next section contains a relevant literature review and a discussion of the model used. Thereafter, the indicators of regional economic diversity and stability are presented. Then, the data is outlined, followed by a presentation of the results concerning the relationship between economic diversification and mortgage portfolio risk and the conclusion.

Figure 1 ■ Cumulative Insured Mortgage Defaults per 1000 Mortgages per Region, 1983–1990.



Literature

In the recent mortgage literature, defaults on mortgages are mostly seen as exercises of put options by mortgagors. Early contributions based on this idea are by Cunningham and Hendershott (1984), Foster and Van Order (1984, 1985), and Epperson *et al.* (1985). Allowing for possible transactions costs, mortgagors are hypothesized to exercise this put option when their equity position in the home becomes negative. Thus, the equity position of the home-owner is the key decision variable. In empirical research regarding

mortgage default risk, the explanatory power of various equity measures have been investigated and have usually been found significant. Von Furstenberg (1969) uses the equity-to-value ratio at the time of origination, and Campbell and Dietrich (1983) use the initial loan-to-value ratio. These measures are only crude indicators of the contemporaneous equity position of the home-owner. More recent contributions therefore employ current equity measures. Giliberto and Houston (1989) employ the book value of the equity and Springer and Waller (1993) a variety of equity measures. Apart from equity measures, these studies also employ national variables like the unemployment rate and the difference between the current mortgage rate and the mortgage rate at origination to explain mortgage default risk. Furthermore, mortgage-specific variables, like the age of the mortgage and whether the home is new or not, have been found significant.

The portfolio consequences of mortgage default risk have had less attention in the literature. Vandell (1993) argues that default is a consequence of systematic conditions like interest rates and inflation, and nonsystematic conditions like regional economic fluctuations. He suggests the appropriateness of research that would include the determination of optimal diversification strategies for mortgage investors and insurers and the empirical separation of the nonsystematic from the systematic default risk components.

Some literature exists regarding the regional diversification of mortgage and real estate portfolios. Campbell and Dietrich (1983), for example, evaluate the relationship between contemporaneous regional economic characteristics and mortgage default risk. They find that defaults are significantly influenced by changes in regional rates of unemployment, and conclude that a continuing need exists for geographic diversification of mortgage portfolios. Shulman and Hopkins (1987) informally link local economic diversity to real estate risk. They use employment characteristics of regions in the U.S. to construct measures of local economic diversity and then link these measures to commercial property performance. Hartzell, Eichholtz and Selender (1993) use a similar approach for Europe. In that paper, the authors actually develop a formal measure of local economic diversification.

Corgel and Gay (1987) argue that geographic portfolio diversification can decrease mortgage default and prepayment risk. Without formally testing this, they use regional economic diversification and stability to explain mortgage portfolio risk, as proxied by the variance of changes in employment. Clauretie (1988) formally tests the effects of local economic diversity and stability on mortgage default risk. To determine the degree of economic diversity in a region, he uses measures based on regional employment characteristics. He investigates whether the degree of regional diversity can help

to explain mortgage default rates, and compares different measures in that regard. He finds that stability measures give a better explanation for mortgage default risk than diversity measures. In this paper, we follow Clauretie and analyze the relationship between indicators of local economic diversity and stability, and mortgage default risk.

More specifically, we test two separate hypotheses. The first is that mortgage default risk is relatively low in economically diverse regions. Individual borrowers are hypothesized to default on their mortgage when the value of their house falls below the remaining value of the loan, or when sudden declines in income or other changes in borrower status prevent the mortgagor from making the required payment on schedule. The total income of all mortgagors in an economically diverse region depends on a group of industries. Thus, their ability to support the mortgage is also dependent on a diverse set of economic activities. In other words, the regional economy is an important source of mortgage default risk, and this risk has a systematic and a nonsystematic component. In regions characterized by a significant mix of economic activity, the latter component may be diversified away.

If we use measures of economic diversity to explain mortgage default rates, we test a joint hypothesis. Specifically, we jointly test the hypotheses that concentrated economies are unstable, and that mortgage portfolios in unstable economies are relatively risky. On the other hand, if we use stability measures, we directly measure economic stability. In that case, we no longer test a double hypothesis, but a single one: unstable regional economies lead to high levels of mortgage default risk. Theoretically, therefore, using stability measures is more sound than using diversity measures. Clauretie (1988) tests both stability and diversity measures and finds that the latter are outperformed in explaining mortgage default rates. We similarly test not only the hypothesis that mortgage default risk is relatively lower in economically diverse regions, but also that mortgage default risk is relatively lower in economically stable regions.

We test these hypotheses separately by first cross-sectionally regressing the annual regional mortgage default rate on measures of regional economic diversification and regional economic stability. Like Campbell and Dietrich (1983) we take logarithms of the annual mortgage default rates.[1] Our general model is of the form

$$D_{r,t} = \alpha_t + \beta M_{r,t} + \epsilon_{r,t} \qquad (1)$$

[1] This reduces heteroskedasticity in the dependent variable.

where α_t is a constant and β reflects the relationship between $D_{r,t}$, the logarithm of the default rate in region r in year t, and $M_{r,t}$, which is either some measure of economic diversification or of economic stability in region r in year t. Of course, one can estimate equation (1) in annual Ordinary Least Squares (OLS) regressions. However, we expect the relationship between the stability measures and the mortgage default rate to be fundamentally stable over time. Therefore, we want to pool the individual OLS regressions. For this, the method we use here is Seemingly Unrelated Regression (SUR) with restricted βs, since it requires no additional assumptions regarding the error structure of the annual regression equations (See Judge *et al.*, 1982; Zellner, 1962). In this setup, β is fixed over time, while α is allowed to vary.[2] We estimate the model from 1983 to 1990.

Since the model is cross sectional, we assume that no institutional differences in the mortgage guarantee system exist between regions. In the introduction, we noted that the criteria on which the judgement of mortgage applications is based do not differ among municipalities. However, we did not describe foreclosure procedures. Clauretie (1987, 1988) shows that these can have a significant influence on mortgage default rates. Formally, all municipalities' foreclosure procedures are based on equal rules in the Netherlands. In practice, differences exist. In our model, we should therefore include independent variables which take the differences in these procedures into account. However, these differences are all informal and quantitative information about the procedures is therefore impossible to obtain. This could in principle impact our results, but we believe this problem to be of limited importance. Municipal foreclosure procedures vary around some unknown *average* national foreclosure procedure. When we aggregate our 887 municipalities in 30 regions, we approach the *average* foreclosure procedure. When we aggregate the 30 regions in 12 provinces, we approach it even more. This implies that an analysis at two separate levels of regional disaggregation may provide information about the magnitude of the problem of differences in foreclosure procedure. If the results of the analyses differ substantially, then foreclosure procedures may have some effect on default outcomes. If they do not, then foreclosure procedures may not be very important. We find somewhat better results at the provincial level of disaggre-

[2] The advantage of this method is that it is very efficient in estimating the β coefficients. The disadvantage is that it estimates the average of β over time. More information concerning the level of the β coefficients in each year can be obtained from the OLS results. These were presented in a previous version of the paper, which is available from the author.

gation, and therefore conclude that foreclosure procedures are of little consequence to the research results.

Measures of Economic Diversity and Stability

In our model, the independent variables are comprised of measures of regional economic diversity and stability. To develop such measures, we explore two branches of literature. The first is the regional economics literature, in which many measures have been developed to describe regional diversity and stability. In some cases, these measures were linked to real estate performance. The second branch of literature is the industrial economics literature. Here, measures have been developed to describe diversity and stability of markets. These issues are very much like regional economic stability, and the measures developed in this field can be used to construct better measures for regional economic stability.

In the regional economics literature, the first relevant work for this study was by Florence (1948). He proposed a diversity measure in which the sector proportions of employment in a region are compared to the national average sector proportions. Thus, this National Average measure defines a diversified region as one in which the proportion of employment in each sector is equal to the national economy. In such a case, the measure equals zero. Our hypothesis is that lower mortgage default rates are observed in more diversified regions, ceteris paribus. We therefore expect a positive relationship between the National Average measure and the mortgage default rate. For region r in year t, the measure is

$$NA_{r,t} = \sum_{i=1}^{n} \frac{(S_{ir,t} - S_{ie,t})^2}{S_{ie,t}} \tag{2}$$

where $S_{ir,t}$ is the employment share of sector i in region r in year t, and $S_{ie,t}$ is the national employment share of sector i in year t.

As we noted before, we can find problems very similar to regional economic stability and diversity in the industrial economics literature. Many measures have been developed to describe the diversity and stability of markets. These measures are all based on market shares of companies operating in a particular market. It is but a small step to go from market shares to employment shares and from diversity and stability of markets to diversity and stability of local economies. Therefore, it can be very illuminating to compare the measures from the regional science literature to some measures which have

been proposed to describe stability of markets. Buijink and Maijoor (1993) give an overview of these measures and also compare their information outcomes when it comes to describing markets.

We test both diversity and stability measures as explanatory variables to mortgage default rates. We use two diversity and two stability measures. The first diversity measure is the National Average measure in equation (2). The other diversity measure is the Herfindahl index, which is the sum of the squared sector employment shares in a regional economy. It implicitly defines an optimally diversified economy as one in which there are many sectors, which all have an equal share of total employment in the economy. It has the problem that its absolute level is very dependent on the way the national bureau of statistics defines economic sectors. However, since we compare regions in which economic sectors have all been defined in the same way, this problem is not relevant here. The Herfindahl index is

$$H_{r,t} = \sum_{i=1}^{vn} (S_{ir,t})^2 \tag{3}$$

This measure can vary between zero and one. If it is zero, the economy is fully diversified; if it is one, the economy is perfectly specialized. Thus, we expect a positive relationship between the Herfindahl index and the mortgage default rate.

The first stability measure is due to Cable (s.d.). It is the sum of the squared sector share changes, and defines a stable economy as one in which shifts in sector shares do not occur. It is

$$C_{r,t} = \sum_{i=1}^{n} (S_{ir,t} - S_{ir,t-1})^2 \tag{4}$$

This measure provides a metric in which the amount or severity of change in a local economy can be evaluated. It varies from zero to one, where zero means stability and one means instability. We expect a positive relationship between the Cable measure and mortgage default rates.

The second and last stability measure is a correlation measure. For each region, it calculates the correlations of the vector of sector shares in a year with the vector of sector shares in the previous year. This measure defines a stable economy as an economy in which the sector shares do not change. In that case, the Correlation measure equals one. Therefore, we expect a negative relationship between the Correlation measure and the mortgage default rate. The measure is:

$$CO_{r,t} = cor(S_{r,t}, S_{r,t-1}) \tag{5}$$

where $S_{r,t}$ is the vector of sector employment shares in region r in year t.

Employment and Mortgage Default Data

All four proposed measures are based on regional employment characteristics. We obtained the necessary employment data from the *Statistiek Werkzame Personen* (*Statistics of Employed People*) of the Central Bureau of Statistics (1973–1990).[3] The results are published on three levels of sectoral disaggregation, and on two levels of regional disaggregation. We use the second level of sectoral disaggregation, which distinguishes 8 sectors: Agriculture, Mining/Manufacturing, Utility, Construction, Trades/Tourism, Transport/Communication, Finance/Insurance/Real Estate and Other Services.[4]

With regards to the regional disaggregation, the Central Bureau of Statistics uses the provincial level, where twelve provinces are distinguished, and the Coordination Committee Regional Research Program (COROP) level, where 43 so-called Coordination Committee Regional Research Program (COROP) regions are distinguished. However, for the less densely populated COROP regions, due to the small sample effect, the data is not very reliable.[5] There-

[3] The *Statistiek Werkzame Personen* provides employment information, which is obtained through an annual survey of all companies and organizations in the Netherlands with people in employment. Of the organizations employing 10 persons or more, all are surveyed. This involves about 45,000 organizations. Of the smaller organizations, a random sample of 10% of the population is drawn, which amounts to about 25,000 organizations. The number of employees is therefore very accurate for larger firms. For smaller firms, sampling error could influence the data. Measurement error in the *Statistiek Werkzame Personen* is probably limited, since the employment information obtained from organizations is quite accurate. It is derived from the wages administrations, which are strictly regulated by the government. Error due to non-response is probably also limited. Cooperation is obligatory, and 91% of the organizations respond. The Central Bureau of Statistics does not have information as to possible biases in the non-response (Central Bureau of Statistics, 1991).

[4] More detailed information about the sectoral decomposition of the Dutch economy is available from the author upon request.

[5] For the 95% confidence interval, the margin of error of the employment figures in the Statistiek Werkzame Personen is in the order of 10%. This holds for both levels of regional disaggregation, but for very small and for less densely populated regions, the margin goes up to over 15%. Further information concerning the regional disaggregation of the Netherlands and the reliability of the employment statistics at different levels of regional disaggregation can be found in the *Statistiek Werkzame Personen* of the Central Bureau of Statistics, 1973–1990.

fore, to increase the reliability, we put some of the small regions together, going from 43 to 30 regions in the process. We also perform our analysis using the first, provincial level. We do this to limit the small sample effect further, and to test the robustness of our results with respect to the small sample effect and to possible differences in foreclosure procedures. Based on this employment data, we calculate our four measures. For all measures we do this for 1983 through 1990. In Table 1b, we have included cross sectional means and standard deviations for all measures. From this table, we can conclude that temporal differences of the stability and diversity measures are not sizable, the only exception being the Cable measure.

As noted before, the indicators of regional economic diversity and stability are used to explain mortgage default rates in the Netherlands. The mortgage-default data used is from a database of defaulted publicly insured mortgages in the Netherlands. This dataset provides the possibility of research on mortgage default risk in the Netherlands, which has previously been impossible due to lack of data. The dataset contains the entire population of defaulted guaranteed mortgages from 1983 through 1990. In these eight years, a total of 8558 insured mortgages defaulted. The fact that we only look at insured mortgages could influence our results. For example, insured mortgages could default more frequently than uninsured mortgages. However, we do not look at the absolute riskiness of the mortgages. We only look at mortgage default risk in some individual region relative to other regions.

Of course, the number of mortgage defaults in a region is by itself useless. We have to look at it as a percentage of total insured mortgages outstanding in that region. Unfortunately, the total number of insured mortgages is not available on a regional basis. Therefore, we take the number of total mortgages outstanding per region as a stand-in. We obtained the information about total mortgages outstanding per region from the Central Bureau of Statistics (1983–1990). Table 1a gives cross sectional means and standard deviations of the default rate, here defined as the ratio between the number of mortgage defaults and the total number of mortgages. The table shows that intertemporal variability of default rates is limited. However, a problem with using all mortgages outstanding as a stand-in is that the absolute level of our mortgage default rate is not directly interpretable. To interpret that rate, we need to know the ratio between insured mortgages outstanding and total mortgages outstanding. On a regional level, data limitations preclude us from determining that ratio. However, at the national level, the ratio is about 0.45. It is fairly stable. That is why we believe the importance of another possible problem, the fact that the regional proportion of loans in the government guarantee program is not exactly constant, to be limited. Nevertheless, differences between regions and the country as a whole may

Table 1 ■ Cross Sectional Means and Standard Deviations of Mortgage Default Rates and Stability Measures, 30 Regions.

	1983	1984	1985	1986	1987	1988	1989	1990
Panel A: Default Rates								
Natural Logarithm of Annual Mortgage Default Rate								
Mean	−5.57	−4.11	−3.52	−3.70	−3.81	−4.37	−4.08	−4.49
Std. Dev.	0.64	0.73	0.53	0.70	0.46	0.53	0.62	0.85
Panel B: Stability Measures								
National Average Measure								
Mean	9.43	8.29	8.14	8.11	8.16	8.34	8.50	8.43
Std. Dev.	12.54	11.33	9.70	9.25	10.55	12.13	12.39	11.80
Herfindahl Index								
Mean	0.22	0.22	0.22	0.23	0.22	0.22	0.22	0.22
Std. Dev.	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Cable Measure								
Mean	2.99	15.76	5.52	6.61	5.98	2.70	1.57	1.28
Std. Dev.	2.79	10.80	5.20	6.34	9.50	1.81	1.25	1.25
Correlation Measure								
Mean	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00
Std. Dev.	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00

The National Average measure compares the sector proportions of employment in a region to the national average sector proportions, and defines a diversified region as one in which the proportion of employment in each sector exactly matches the sector proportion of the national economy. The higher the measure, the more specialized is the region. The measure is zero for a fully diversified region. The Herfindahl Index is the sum of the squared sector employment shares in a regional economy, and defines a diversified region as one in which there are many sectors, which all have an equal share of total employment. It varies between zero and one, where zero means a fully diversified region and one a perfectly specialized region. The Cable Measure is an economic stability measure, and is based on the changes of the sector employment shares in a region. It defines a stable economy as one in which these changes do not occur. It varies from zero to one, where zero means stability and one means instability. The Correlation Measure determines the correlations between the vector of sector employment shares in a year and the vector of sector shares of the previous year. It defines a stable economy as one in which sector shares do not change. The correlation measure varies between one and minus one, where the former means stability and the latter instability.

exist. This is due to the fact that mortgage insurance is only obtainable for homes priced under 250,000 guilders. Since average house prices are relatively high in the western regions of the country, this could imply that the percentage of home-owners qualifying for mortgage insurance is relatively low. This could mean that the ratio between insured and total mortgages is relatively low in those regions. Furthermore, strong economic growth in certain regions can lead to increasing house prices. This could also imply a decrease of the ratio between insured and total mortgages relative to regions where economic growth is slow. This means that we probably underestimate mortgage default risk in regions where house prices are relatively high, or growing relatively fast. However, it is not clear how that relates to economic diversity and stability, and it is therefore difficult to assess the influence on our results.

Do Economic Stability and Diversity Influence Mortgage Default Risk?

We test our bivariate regression model annually from 1983 to 1990 using the diversity and stability measures we developed in the previous section.[6] For both levels of regional disaggregation, we use SUR to test the model.

First the model is tested on the second level of regional disaggregation: the 30 regions. Table 2 shows the results. The use of the SUR method makes the R^2s of the regressions uninterpretable, so we only report the standard error of the equations. Since we expect the relationship between the stability measures and the mortgage default rate to be fundamentally stable over time, we estimate the model, while forcing the βs to be equal in all 8 regression equations. We find the stability measures to have considerably more explanatory power than the diversity measures. The regression coefficient of neither of the diversity measures has the expected sign: both show a negative relationship with mortgage default risk, although that relationship is not statistically significant for the National Average Measure. Of the stability measures, the Cable measure and the Correlation measure's regression coefficients are both significant, and have the expected sign. For the Cable measure, the β coefficient is 0.006, which indicates that the regional stability effect as captured by the Cable measure has relatively little influence on the regional mortgage default rate. However, the economic meaning of the regional stability effect seems to be larger when gauged by the Correlation measure. This measures' β coefficient is -16.253. For all measures em-

[6] We also investigated the explanatory power of the stability measures simultaneously in a multiple regression framework. The results indicated dependence of the explan-

Table 2 ■ Seemingly Unrelated Regressions, 30 Regions.

	1983	1984	1985	1986	1987	1988	1989	1990
Panel A: National Average Measure								
α	−5.52	−4.07	−3.48	−3.66	−3.76	−4.33	−4.03	−4.44
	(−43.57)	−(31.31)	(−31.29)	(−28.67)	(−39.20)	(−37.67)	(−33.21)	(−28.86)
β	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01	−0.01
	(−0.91)	(−0.91)	(−0.91)	(−0.91)	(−0.91)	(−0.91)	(−0.91)	(−0.91)
SEE	0.65	0.73	0.55	0.71	0.47	0.56	0.63	0.86
Panel B: Herfindahl Index								
α	−4.24	−2.80	−2.22	−2.34	−2.48	−3.06	−2.77	−3.19
	(−6.48)	(−4.30)	(−3.47)	(−3.51)	(−3.81)	(−4.78)	(−4.33)	(−4.92)
β	−5.94	−5.94	−5.94	−5.94	−5.94	−5.94	−5.94	−5.94
	(−2.07)	(−2.07)	(−2.07)	(−2.07)	(−2.07)	(−2.07)	(−2.07)	(−2.07)
SEE	0.66	0.76	0.52	0.72	0.48	0.52	0.62	0.88
Panel C: Cable Measure								
α	−5.58	−4.20	−3.55	−3.74	−3.84	−4.39	−4.09	−4.50
	(−47.17)	(−28.35)	(−37.42)	(−29.48)	(−49.86)	(−44.99)	(−36.02)	(−29.20)
β	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	(1.44)	(1.44)	(1.44)	(1.44)	(1.44)	(1.44)	(1.44)	(1.44)
SEE	0.66	0.75	0.54	0.72	0.45	0.55	0.64	0.88

Table 2 ■ (continued)

	1983	1984	1985	1986	1987	1988	1989	1990
Panel D: Correlation Measure								
α	10.66	12.01	12.69	12.51	12.40	11.86	12.16	11.75
	(1.44)	(1.63)	(1.73)	(1.69)	(1.68)	(1.60)	(1.64)	(1.59)
β	−16.25	−16.25	−16.25	−16.25	−16.25	−16.25	−16.25	−16.25
	(−2.19)	(−2.19)	(−2.19)	(−2.19)	(−2.19)	(−2.19)	(−2.19)	(−2.19)
SEE	0.66	0.75	0.52	0.71	0.43	0.55	0.64	0.88

The mortgage default rates are regressed on the stability measures. This is done cross-sectionally over 30 regions, using seemingly unrelated regression. The regression coefficient was forced to be fixed over time. The stability measures are defined as follows. The National Average measure compares the sector proportions of employment in a region to the national average sector proportions, and defines a diversified region as one in which the proportion of employment in each sector exactly matches the sector proportion of the national economy. The higher the measure, the more specialized is the region. The measure is zero for a fully diversified region. The Herfindahl Index is the sum of the squared sector employment shares in a regional economy, and defines a diversified region as one in which there are many sectors, which all have an equal share of total employment. It varies between zero and one, where zero means a fully diversified region and one a perfectly specialized region. The Cable Measure is an economic stability measure, and is based on the changes of the sector employment shares in a region. It defines a stable economy as one in which these changes do not occur. It varies from zero to one, where zero means stability and one means instability. The Correlation Measure determines the correlations between the vector of sector employment shares in a year and the vector of sector shares of the previous year. It defines a stable economy as one in which sector shares do not change. The correlation measure varies between one and minus one, where the former means stability and the latter instability. *t*-Statistics are denoted in parentheses.

ployed, the constant term, which is effectively a time period dummy, is highly significant, both statistically and economically.

The level and significance of the constant term imply that effects not captured by the regional diversity and stability measures are very important sources of mortgage default risk in the Netherlands. In the literature review, we mentioned the relevance of national effects like the unemployment rate and the relationship between the current mortgage rate and the mortgage rate at origination, as well as borrower-specific effects like the borrowers' equity position, the age of the mortgage, and whether the home is new or not. Data limitations prevent the inclusion of those variables in our model. However, we can give some intuition regarding their expected influence on the results. The average age of the mortgage may vary per region, and could therefore bias the results. One can argue that in unstable regions, people are forced to move more often, which would imply that many mortgages are of relatively recent vintage in those regions. Campbell and Dietrich (1983) find a positive relationship between age and mortgage default risk. Therefore, this effect will probably have a systematic and positive effect on our results. Another effect, the question whether homes are new or not, may also vary regionally. However, the relation to economic diversity and stability is not clear, and therefore, it is difficult to determine whether this effect could be the source of any bias. This also holds for the national effects.

The following step in our analysis is to test our regression model using the first, provincial level of regional disaggregation. The results are in Table 3. Except for the Herfindahl index, all measures perform well in explaining mortgage default risk. The significance level of the National Average and the Cable measure is 99.5% in our model. For these measures, the β coefficients are 0.064 and 0.034, respectively. The Correlation measure' β is -59.456 and significant at the 95% level. Again, the constant term is highly significant. These findings confirm the results of the analysis at the 30 region level.

To conclude the results, our notion that stability measures have a more direct link with mortgage defaults than diversity ones is confirmed. Stability measures generally outperform diversity measures in explaining mortgage default rates. Also, our results on the regional level of geographic disaggregation are confirmed by those on the provincial level. The relationships we find tend to be somewhat stronger on the provincial level. This confirms our expectations. We expected the small sample effect to be less disturbing on the provincial level, and the effect of municipal differences in the foreclosure procedures to diminish.

Table 3 ■ Seemingly Unrelated Regressions, 12 Provinces.

	1983	1984	1985	1986	1987	1988	1989	1990
Panel A: National Average Measure								
α	−5.80	−4.26	−3.83	−3.91	−4.08	−4.64	−4.21	−4.59
	(−43.11)	−(34.67)	(−31.91)	(−35.25)	(−43.01)	(−40.02)	(−27.15)	(−28.45)
β	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	(6.14)	(6.14)	(6.14)	(6.14)	(6.14)	(6.14)	(6.14)	(6.14)
SEE	0.47	0.46	0.38	0.32	0.32	0.43	0.58	0.61
Panel B: Herfindahl Index								
α	−2.58	−1.09	−0.60	−0.57	−0.82	−1.46	−1.03	−1.41
	(−2.93)	(−1.24)	(0.69)	(−0.63)	(−0.93)	(−1.66)	(−1.17)	(−1.60)
β	−13.43	−13.43	−13.43	−13.43	−13.43	−13.43	−13.43	−13.43
	(−3.38)	(−3.38)	(−3.38)	(−3.38)	(−3.38)	(−3.38)	(−3.38)	(−3.39)
SEE	0.54	0.59	0.58	0.42	0.48	0.50	0.64	0.70
Panel C: Cable Measure								
α	−5.60	−4.43	−3.63	−3.85	−4.02	−4.45	−3.99	−4.35
	(−40.99)	(−29.27)	(−25.82)	(−34.50)	(−45.31)	(−28.36)	(−21.64)	(−23.33)
β	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
	(14.45)	(14.45)	(14.45)	(14.45)	(14.45)	(14.45)	(14.45)	(14.45)
SEE	0.52	0.57	0.54	0.41	0.31	0.59	0.70	0.71

Table 3 ■ (continued)

	1983	1984	1985	1986	1987	1988	1989	1990
Panel D: Correlation Measure								
α	53.87	55.08	55.82	55.68	55.45	55.02	55.48	55.10
	(11.74)	(12.06)	(12.18)	(12.16)	(12.11)	(11.98)	(12.07)	(11.99)
β	−59.46	−59.46	−59.46	−59.46	−59.46	−59.46	−59.46	−59.46
	(−12.94)	(−12.94)	(−12.94)	(−12.94)	(−12.94)	(−12.94)	(−12.94)	(−12.94)
SEE	0.50	0.54	0.51	0.38	0.34	0.60	0.69	0.71

The mortgage default rates are regressed on the stability measures. This is done cross-sectionally over the 12 Dutch provinces, using seemingly unrelated regression. The regression coefficient was forced to be fixed over time. The stability measures are defined as follows. The National Average measure compares the sector proportions of employment in a region to the national average sector proportions, and defines a diversified region as one in which the proportion of employment in each sector exactly matches the sector proportion of the national economy. The higher the measure, the more specialized is the region. The measure is zero for a fully diversified region. The Herfindahl Index is the sum of the squared sector employment shares in a regional economy, and defines a diversified region as one in which there are many sectors, which all have an equal share of total employment. It varies between zero and one, where zero means a fully diversified region and one a perfectly specialized region. The Cable Measure is an economic stability measure, and is based on the changes of the sector employment shares in a region. It defines a stable economy as one in which these changes do not occur. It varies from zero to one, where zero means stability and one means instability. The Correlation Measure determines the correlations between the vector of sector employment shares in a year and the vector of sector shares of the previous year. It defines a stable economy as one in which sector shares do not change. The correlation measure varies between one and minus one, where the former means stability and the latter instability. *t*-Statistics are denoted in parentheses.

Conclusion

Regional economic diversity and stability can explain regional mortgage default risk. In general, measures of stability have more explanatory power on mortgage default risk than do diversity measures. This has two important implications.

First, the relationship between mortgage performance and regional economic diversity and stability indeed exists. Since our measures of regional economic diversity and stability are based on employment, this implies that employment, and especially changes in employment, can serve as a good indicator of real estate and mortgage portfolio risk. This suggests that real estate and mortgage portfolio performance can be improved by taking regional employment composition and dynamics into account.

The other implication of our results concerns the Dutch mortgage guarantee system. The current system in the Netherlands has zero insurance premiums. However, there is ongoing discussion on whether to introduce such premiums into the system. Our results suggest that regional economic diversity and stability should be taken into account when determining the premium of the mortgage guarantee. However, due to lack of data, we are not able to price default risk in each of the regions directly. Determining optimal guarantee premiums for the Dutch mortgage insurance system therefore requires improved data resources. We call upon the Dutch government to help develop that information.

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