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WELLS FARGO SECURITIES

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Special Commentary

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The Labor Market and Credit Risk

Executive Summary

For a financial firm, one question that continually resurfaces is the reliability of the unemployment rate as an indicator of overall credit conditions and, particularly, the delinquency and charge-off rates for commercial and residential loans. Public policymakers place a high level of emphasis on using the unemployment rate to assess and predict the state of the credit market. However, we have observed structural changes in the labor market that bring into question the reliability of the unemployment rate as a predictor of credit quality in the modern economy.[1]

In our first report on this topic, we focused on the development of the Labor Market Index, which we believe is a more comprehensive measure of the labor market than the unemployment rate.[2] The Labor Market Index uses six key labor market variables that draw on a more expansive set of information about the household and business sector than the unemployment rate. In our second report, we focused on the link between the unemployment rate and the broader economy as measured by real GDP.[3] We found that a carefully constructed index of labor market indicators provided a better forecasting result for real GDP and displayed a clearer causality link to real GDP. In this third report, we are interested in identifying a possible statistical relationship between the Labor Market Index and credit market indicators including the delinquency rate and charge-offs over the past 20 years. In addition, we compare the performance of the Labor Market Index versus the unemployment rate in assessing credit quality. The relationship between credit quality and the unemployment rate has traditionally been a rough guide for public policymakers but we find it is less useful in the private sector, even though the unemployment rate is used as a benchmark for stress testing by policy makers. Thus, how can we characterize the relationship of the Labor Market Index to credit quality?

How reliable is the unemployment rate as a predictor of credit quality in the modern economy?

Some say, due to the Great Recession, credit market indicators have shown a break from their traditional long-run trend, which has made it more difficult to predict delinquency rates compared to the pre-Great Recession era. Our statistical analysis, based on the Granger causality test, suggests that the Labor Market Index has a stronger relationship with delinquency rates compared to the unemployment rate. Moreover, the Labor Market Index can be used to predict future values of the delinquency rates for both the pre- and post-Great Recession periods, as seen in Figure 1. Our research shows that the unemployment rate should not be used solely to predict delinquency rates, as seen in Figure 2. The contrasting data from 1996-2001 and at present show the lack of correlation between the two variables.[4]

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[1] Silvia, John E., Domestic Implications of a Global Labor Market, *Business* Economics, V. 1, No.3, July 2006. This paper received the Adolph G. Abramson award for the best written paper in *Business Economics*, 2006.
[2] Silvia, John E., Azhar Iqbal and Blaire Zachary, *Measuring the State of the U.S. Labor Market: A New Index*. Special Commentary, October 28, 2013.
[3] John E. Silvia, Azhar Iqbal and Blaire Zachary, *Is the Unemployment Rate a Reliable Barometer?* Special Commentary, November 7, 2013.
[4] The use of the unemployment rate reflects the pattern of the anchoring bias where decision makers anchor their benchmarks for decision making in the past although the economy, in this case, the labor market, has changed structure and does not operate as in the past. See John E. Silvia, *Dynamic Economic Decision Making*, Wiley, 2011, pp. 71-73.

This report is available on wellsfargo.com/economics and on Bloomberg WFRE.

Figure 1

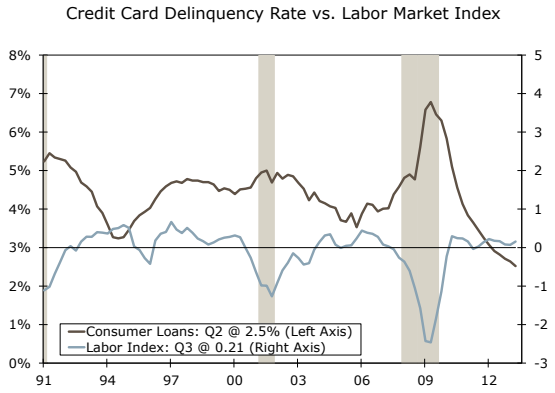
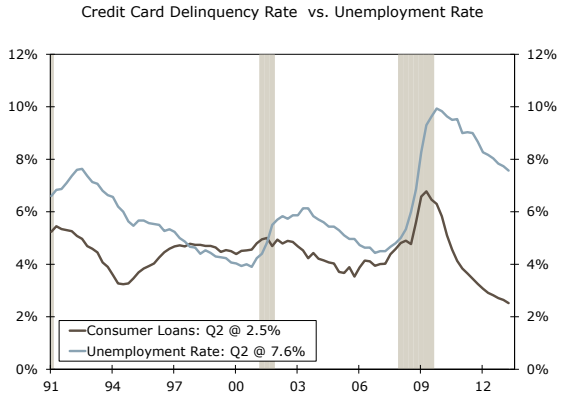


Figure 2



Source: U.S. Dept. of Commerce, U.S. Dept. of Labor and Wells Fargo Securities, LLC

Statistical Tools to Determine a Relationship Between Variables

An economic relationship between two or more variables can be explored by conducting an econometric analysis to evaluate the strength of that relationship and its reliability as a predictor of overall economic activity. Several econometric techniques can characterize the statistical relationship between two or more variables.[5] We begin with a simple regression analysis using seven different delinquency and charge-off rates as dependent variables and the unemployment rate as an independent variable. We then compare those models' results with delinquency and charge-off rates (as dependent variables) and the Labor Market Index (as an independent variable) models. A regression analysis provides a certain precision when estimating a statistical relationship. The regression analysis provides useful statistics to evaluate our models. For example, the R^2 quantifies how much variation in the dependent variable is explained by the independent variable. To compare models, we use the root mean square error (RMSE), which provides an average deviation of the estimated delinquency rates from the actual delinquency values. The t-value indicates whether an independent variable is useful to include in the model.

Once a statistical relationship is identified between variables, the direction of the relationship can be tested.[6] Two questions can be asked: What are the leading and lagging variables? What is the cause and effect? The Granger causality test helps identify the direction of the relationship. For instance, in the case of stress tests, an analyst may want to test the relationship between delinquency rates and the unemployment rate.[7] The causality idea is important and useful for business leaders and policy makers. In the present case, we want to know whether the Labor Market Index or the unemployment rate can improve the predictability of delinquency rates.[8]

The Labor Market Index and the unemployment rate have statistically significant relationships with delinquency rates.

Testing for an Existing Relationship: Delinquency Rates and Unemployment Rates

Next, we determine if the Labor Market Index and the unemployment rate are statistically significant with delinquency and charge-off rates. We find that, on both counts, the Labor Market Index and the unemployment rate have statistically significant relationship s with the delinquency rates. Tables I and II provide the statistical detail supporting these conclusions. In Table I,

[5] Our approach here follows our treatment in *Economic and Business Forecasting*, John E. Silvia, Azhar Iqbal et. al., Wiley, forthcoming 2014.
[6] C.W.J. Granger (1969), "Investigating Causal Relationships by Econometric Models and Cross-Spectral Methods," *Econometrica* 37, no. 3. 424-438.
[7] The Granger causality test identifies whether two or more variables have a statistically significant causality relationship and thereby, making it appropriate to say "Granger-causes" instead of "causes." The term "Granger-causes" implies quantifying statistical causality between the variables of interest. See Granger (1969) for more detail.
[8] The statistical techniques here are covered in more detail in *Economic and Business Forecasting*.

estimated over the period Q1 1991—Q2 2013, the unemployment rate is our independent variable against each of the seven delinquency and charge-off rates. With the exception of the consumer loan delinquency rate, the unemployment rate has a statistically significant relationship with each of these rates. For example, in the case of delinquency rates of commercial and industrial (C&I) as a dependent variable, the unemployment rate explains 17 percent variation (R^2=0.17) in the delinquency rates of C&I loans.[9] The RMSE for that regression is 1.18 percent and that indicates average deviation of the estimated delinquency rates (C&I loans) from the actual series is 1.18 percent.

Table I

The Regression Analysis Results
Independent Variable : Unemployment Rate

Dependent Variable	Coefficient	t-value	R^2	RMSE
Delinquency rates-C&I loans	0.32	4.26*	0.17	1.18
Delinquency rates-consumer loans	0.053	1.01	0.01	0.82
Delinquency rates-residential loans	1.66	15.44*	0.73	1.68
Delinquency rates- commercial loans	1.45	10.52*	0.56	2.15
Charge-off, all real estate loans	0.38	19.42*	0.81	0.3
Charge-off, C&I loans	0.2	5.94*	0.29	0.54
Charge-off, consumer loans	0.55	6.06*	0.29	1.41

*Statistically Significant at 1%

Source: Wells Fargo Securities, LLC

One benefit of using the Labor Market Index is the significant association with all seven delinquency rates.

Testing for an Existing Relationship: Delinquency Rates and the Labor Market Index

When we use the Labor Market Index, we obtain statistically significant results for all seven delinquency and charge-off rates. In Table II, estimated over the period Q2 1991—Q3 2013, the Labor Market Index explains 20 percent (R^2=0.20) variation in the C&I delinquency rates. The RMSE of the regression is 1.16. As a result, the Labor Market Index shows a stronger statistical association with the C&I loans delinquency rates compared to the unemployment rate model.

In sum, one benefit of utilizing the Labor Market Index as an independent variable is that it has a statistically significant association with all the seven delinquency rates compared to the unemployment rate which has the same relationship with only six delinquency rates. On the other hand, statistical association, based on the RMSE, shows that the unemployment rate has a closer association with the four of the seven delinquency rates and the Labor Market Index has the closer association with the remaining three delinquency rates.

[9] To save space we explain only the delinquency rates for C&I loans and unemployment rate model. The interpretation for the rest of the models is identical.

Table II

The Regression Analysis Results
Independent Variable : Labor Market Index

Dependent Variable	Coefficient	t-value	R^2	RMSE
Delinquency rates-C&I loans	-0.93	-4.66*	0.2	1.16
Delinquency rates-consumer loans	-0.89	-8.37*	0.44	0.62
Delinquency rates-residential loans	-1.15	-2.11*	0.05	3.16
Delinquency rates- commercial loans	-1.3	-2.43*	0.06	3.12
Charge-off, all real estate loans	-0.49	-4.57*	0.18	0.62
Charge-off, C&I loans	-0.73	-9.65*	0.51	0.44
Charge-off, consumer loans	-1.39	-5.63*	0.26	1.44

*Statistically Significant at 1%

Source: Wells Fargo Securities, LLC

Testing the Direction of the Relationship: Cause and Effect

The Labor Market Index can distinguish both leading and lagging variables, which can be useful to business leaders and policy makers.

A regression analysis cannot be interpreted to establish a cause-and-effect relationship; it can only indicate how, or to what extent, variables are associated with each other. The regression coefficient indicates that the independent variable is statistically related with the dependent variable. Any conclusions about a cause-and-effect relationship must be based on judgment. For business leaders and policy makers, however, it is imperative to distinguish leading and lagging variables.

The Granger causality test provides a means to identify a causal relationship between two or more variables. According to Granger causality, if a variable X_t "Granger-causes" a variable Y_t, then past values of X_t should contain information that helps predict Y_t beyond the information contained in past values of Y_t alone.

This Granger causality test also indicates the direction of the causality, that is, whether it is one-way or two-way causality. For instance, if X_t "Granger-causes" Y_t but Y_t does not "Granger-cause" X_t then the relationship would be called one-way causality. If X_t "Granger-causes" Y_t and Y_t also "Granger-causes" X_t, then the test indicates two-way causality.

Tables III and IV provide the Granger causality results on the relationships between delinquency rates, the unemployment rate and the Labor Market Index over the 1991:Q1—2013:Q2 sample period. Our test criteria is the values reported under the label P_r > ChiSq, the third and last columns of these tables. In the present case, if the probabilities are less than or equal to 0.05, we can reject the null hypothesis of no Granger-causality.

Table III, over the period 1991:Q2-2013:Q2, shows the P_r > ChiSq values between the unemployment rate and delinquency rates are below the 0.05 benchmark for the four of the seven delinquency rates. This implies that the unemployment rate is not a good predictor for the other three delinquency rates in the estimated sample period. The three series are delinquency rates-residential, delinquency rates-commercial and charge-off for consumer loans.

It is important to note that our objective in this report is to determine whether the unemployment rate and Labor Market Index are good predictors of delinquency rates. That also means, we are more interested in one-way causality which runs from the unemployment rate (or Labor Market Index) to delinquency rates.

Table III

The Granger Causality Test Results: Unemployment Rate

Dependent Variable	Causality from Unemployment Rate to Delinquency Rates		Causality from Delinquency Rates to Unemployment Rate	
	Chi-Square	P-value	Chi-Square	P > ChiSq
Delinquency rates-C&I loans	8.63	0.00*	3.76	0.05**
Delinquency rates-consumer loans	23.02	0.00*	32.6	0.00*
Delinquency rates-residential loans	1.39	0.24	1.99	0.16
Delinquency rates- commercial loans	0.24	0.63	2.09	0.15
Charge-off, all real estate loans	6.46	0.01*	41.42	0.00*
Charge-off, C&I loans	6.02	0.01*	26.53	0.00*
Charge-off, consumer loans	1.02	0.31	6.76	0.01*

*Statistically Significant at 1%
**Statistically Significant at 5%

Source: Wells Fargo Securities, LLC

Table IV provides the results of the test on the relationship between delinquency rates and the Labor Market Index over the same period. In this case, the P_r > ChiSq probabilities are less than 0.05 for all seven delinquency rates, and, therefore, we can reject the null hypothesis of no Granger-causality. This implies that causality runs from the Labor Market Index to delinquency rates. This indicates that if we want to pick one predictor, whether the Labor Market Index or unemployment rate, then the Labor Market Index is a better predictor of future delinquency rates trends.

The Labor Market Index is a better predictor of future delinquency rates trends than the unemployment rate.

Table IV

The Granger Causality Test Results: Labor Market Index

Dependent Variable	Causality from Labor Market Index to Delinquency Rates		Causality from Delinquency Rates to Labor Market Index	
	Chi-Square	P-value	Chi-Square	P > ChiSq
Delinquency rates-C&I loans	105.44	0.00*	11.2	0.00*
Delinquency rates-consumer loans	7.28	0.01*	1.84	0.17
Delinquency rates-residential loans	43.28	0.00*	1.25	0.26
Delinquency rates- commercial loans	80.32	0.00*	5.61	0.02**
Charge-off, all real estate loans	27.79	0.00*	3.76	0.05**
Charge-off, C&I loans	54.02	0.00*	12.041	0.00*
Charge-off, consumer loans	48.23	0.00*	10.26	0.00*

*Statistically Significant at 1%
**Statistically Significant at 5%

Source: Wells Fargo Securities, LLC

Does the Great Recession Alter the Relationship Between Delinquency Rates and the Labor Market Conditions?

Economies evolve over time, and the framework for effective decision making at the private and public sector levels needs to be reevaluated. This has been reflected in our analysis of the labor market since our report in 2006. Simply stated, the labor market of the 21st century is quite different than in the past and, unfortunately, different from the mental images that frame many decision-makers' view of the labor market today.[10]

In recent years, a noticeable event in the economics and credit worlds was the Great Recession. For example, during the Great Recession, all seven delinquency rates, along with the unemployment rates, were trending upward and the Labor Market Index dropped below the zero line. Some say the Great Recession caused a structural change in the labor as well as credit markets and that may have altered the relationship between the two markets. One way to test the Great Recession effect on the relationship is to repeat the above-mentioned statistical analysis but excluding the post-2007:Q4 era (as 2007:Q4 is the starting quarter of the Great Recession) during the estimation process. The benefit of this exercise is that we can compare results from these two sample periods to examine if there is a change in the relationship between delinquency rates and unemployment rate/Labor Market Index. Since the difference between these two estimated results (and sample-periods) are the Great Recession (and post Great Recession era) and thereby the change in the results is due to the Great Recession and can be noted as a structural break.

[10] For a view on the evolution of economic frameworks and the biases, such as the anchoring bias, that prevents effective decision making see John E. Silvia, *Dynamic Economic Decision Making*, Wiley, 2011.

The results based on the 1991:Q1-2007:Q3 period are reported in the Appendix of this report. There are several noticeable observations. Table V, the unemployment rate is statically associated with five delinquency rates instead of six (delinquency rates-consumer loans and charge-off consumer loans are statistically insignificant with the unemployment rate). The RMSEs for all delinquency rates are smaller compared to those based on the complete sample period. Table VI, the Labor Market Index is statistically significant with six (not with delinquency rates-commercial) compared to all seven in the case of the complete sample period. For all except delinquency rates-commercial, the RMSEs are smaller compared to the ones based on the complete sample. Based on the RMSE criterion, the Great Recession did reduce the statistical association between the delinquency rates and unemployment rate/Labor Market Index. However, our Labor Market Index is still statistically associated with more (six of the seven) delinquency rates than the unemployment rate.

The Granger causality tests are reported in Tables VII and VIII. The unemployment rate and the Labor Market Index Granger-cause five of the seven delinquency rates.

Therefore, in sum, the Labor Market Index has a stronger statistical association with the delinquency rates compared to the unemployment rate. This conclusion holds for the complete sample period as well as for the pre-Great Recession era.

Conclusion

This report tests the predictive power of the Labor Market Index and compares it with the unemployment rate. The delinquency rates are used as a benchmark for this forecasting power. The statistical analysis suggests that the Labor Market Index is a better predictor for the delinquency rates. Therefore, private decision makers might be better off to utilize the Labor Market Index as a measure of the current state of the labor market, rather than the unemployment rate, as well as a potential predictor of credit risk.

Appendix

Estimates are based on the 1991:Q1-2007:Q3 sample period.

Table V

The Regression Analysis Results
Independent Variable : Unemployment Rate

Dependent Variable	Coefficient	t-value	R^2	RMSE
Delinquency rates-C&I loans	1.03	9.65*	0.59	0.87
Delinquency rates-consumer loans	0.09	1.32	0.03	0.52
Delinquency rates-residential loans	0.29	5.97*	0.35	0.39
Delinquency rates- commercial loans	2.68	11.26*	0.66	1.94
Charge-off, all real estate loans	0.28	11.57*	0.67	0.2
Charge-off, C&I loans	0.25	3.97*	0.2	0.51
Charge-off, consumer loans	-0.04	-0.38	0.002	0.94

*Statistically Significant at 1%

Table VI

The Regression Analysis Results
Independent Variable : Labor Market Index

Dependent Variable	Coefficient	t-value	R^2	RMSE
Delinquency rates-C&I loans	-1.69	5.59*	0.32	1.12
Delinquency rates-consumer loans	-0.62	-5.05*	0.28	0.45
Delinquency rates-residential loans	-0.31	-2.45*	0.08	0.46
Delinquency rates- commercial loans	-1.28	-1.44	0.03	3.27
Charge-off, all real estate loans	-0.18	2.0**	0.06	0.33
Charge-off, C&I loans	-0.94	-9.34*	0.57	0.37
Charge-off, consumer loans	-0.98	-4.35*	0.23	0.83

*Statistically Significant at 1%

**Statistically Significant at 5%

Source: Wells Fargo Securities, LLC

Table VII

The Granger Causality Test Results: Unemployment Rate

Dependent Variable	Causality from Unemployment Rate to Delinquency Rates		Causality from Delinquency Rates to Unemployment Rate	
	Chi-Square	P-value	Chi-Square	P > ChiSq
Delinquency rates-C&I loans	97.11	0.00*	41.12	0.00*
Delinquency rates-consumer loans	8.15	0.00*	19.99	0.00*
Delinquency rates-residential loans	8.19	0.00*	11.99	0.00*
Delinquency rates- commercial loans	12.31	0.00*	5.05	0.02**
Charge-off, all real estate loans	0.53	0.47	9.64	0.00*
Charge-off, C&I loans	6.03	0.01*	38.13	0.00*
Charge-off, consumer loans	1.0	0.32	3.11	0.08

*Statistically Significant at 1%

**Statistically Significant at 5%

Table VIII

The Granger Causality Test Results: Labor Market Index

Dependent Variable	Causality from Labor Market Index to Delinquency Rates		Causality from Delinquency Rates to Labor Market Index	
	Chi-Square	P-value	Chi-Square	P > ChiSq
Delinquency rates-C&I loans	47.8	0.00*	3.25	0.07
Delinquency rates-consumer loans	2.39	0.12	0.02	0.89
Delinquency rates-residential loans	0.32	0.57	1.19	0.28
Delinquency rates- commercial loans	13.22	0.00*	3.69	0.05**
Charge-off, all real estate loans	4.64	0.03**	3.89	0.05**
Charge-off, C&I loans	18.96	0.00*	1.53	0.22
Charge-off, consumer loans	10.9	0.00*	2.07	0.15

*Statistically Significant at 1%

**Statistically Significant at 5%

Source: Wells Fargo Securities, LLC

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