

Appendix

[Previous research](#) indicates the importance of employment for lowering the risk of delinquency. Research shows that a 1 percentage point increase in the area unemployment rate is associated with a 0.036% to 0.063% increase in the monthly delinquency risk. Other research also shows that an [individual who experienced unemployment](#) is 5-13 percentage points more likely to default on their mortgage payment.

A sufficiently severe income loss due to prolonged unemployment virtually guarantees delinquency if the borrower also suffers from negative equity. Once an unemployed borrower in negative equity runs out of liquid financial resources, delinquency becomes inevitable and not even a quick sale can often pay off the outstanding balance.

Using aggregate data, a vector autoregressive (VAR) model and Granger causality tests reveal that housing appreciation falls while delinquency rates trend up immediately after an increase in the unemployment rate. An increase in the unemployment rate is associated with depressed housing appreciation and housing appreciation is a useful predictor of the mortgage delinquency rate. When home equity falls, mortgage delinquency increases.

Housing appreciation – growth in home equity, *ceteris paribus* – is also useful for predicting future economic activity – and thus unemployment. Perhaps this is because when homeowners feel wealthier, they also spend more. Conversely, a decrease in housing wealth leads to higher unemployment.

Labor and housing markets are interconnected. On one hand, higher unemployment leads to decreased housing appreciation and higher delinquency rates. At the same time, declining housing wealth leads to depressed activity and higher unemployment.

Due to the strong link between economic outcomes and mortgage default rates, our forecast suggests that the mortgage delinquency rate could go from a rate of 4.32% in the first quarter of 2020, to a peak of 8.96% before falling back to 6.4% with a 3.6% decrease in housing prices by this time next year if desperate sellers drastically lower prices, demand weakens and the unemployment rate remains near 20% – since the lockdown began the share of unemployed Illinoisans has increased to 24%. While the national unemployment rate [reportedly](#) fell to 13.3% in May (although when appropriately accounting for those “absent from work” the unemployment rate would have risen to more than 16%) as many other states began reopening, Illinois’ lockdown remained in place.

To provide some perspective, mortgage delinquency in Illinois during the Great Recession – a crisis that began with the housing market – peaked at 11%.

Our forecast implies almost 130,000 Illinois households could fall behind on their mortgage payments by the end of this year.

Given the unprecedented income loss and the complex interactions between housing values, mortgage delinquency and economic activity, preventing a housing crash and widespread mortgage delinquency should be a priority for Illinois policymakers in order to avoid worsening the economic conditions due to the COVID-19 shock.

Methodology

Following [Hamilton, Isaac, and Lesh \(2010\)](#), we use aggregate time series data to forecast the mortgage delinquency rate. We use vector autoregressive (VAR) modeling with Granger causality tests is a flexible way to elucidate underlying causal mechanisms in time series data.

The vector autoregressive (VAR) model is one of the most commonly employed multivariate regression time series analytic techniques. A VAR model is advantageous because it can explain past and causal relationships among multiple variables over time, as well as predict future observations.

We collected quarterly data from the first quarter 1980 to fourth quarter 2019. Data on mortgage delinquency rates and total mortgages serviced come from the Mortgage Bankers Association. Housing price appreciation is collected from FRED published by the Federal Reserve Bank of St Louis. The unemployment rate is collected from the Bureau of Economic Analysis (BLS).

We tested for stationarity using an augmented Dickey-Fuller test for unit root. The Akaike information criteria was used to determine the optimal number of lags to include in the VAR. the Akaike criterion indicated that 10 lags were best. Residual autocorrelation was assessed with the Lagrange Multiplier (LM) test. We also assessed the stability of the VAR system.

Formally,

$$D_t = \delta + \sum_{i=1}^{10} \beta_i D_{t-i} + \sum_{j=1}^{10} \varphi_j U_{t-j} + \sum_{m=1}^{10} \phi_m HPA_{t-m} + u_{1t}$$

$$HPA_t = \delta + \sum_{i=1}^{10} \beta_i D_{t-i} + \sum_{j=1}^{10} \varphi_j U_{t-j} + \sum_{m=1}^{10} \phi_m HPA_{t-m} + u_{2t}$$

$$U_t = \delta + \sum_{i=1}^{10} \beta_i D_{t-i} + \sum_{j=1}^{10} \varphi_j U_{t-j} + \sum_{m=1}^{10} \phi_m HPA_{t-m} + u_{3t}$$

The result is as expected. Housing appreciation decreases one period after an increase in the unemployment rate. Depressed housing appreciation is a reliable predictor of an increase in the mortgage delinquency rate.

[Granger causality](#) testing revealed that the unemployment rate is a useful predictor of housing appreciation and that in turn housing appreciation is useful to forecast mortgage delinquency rates. A decrease in housing appreciation also predicts a rise in the unemployment rate.

The [mutual Granger causality](#) relation between the unemployment rate and housing appreciation may be an effect that these two time series are indeed causal to each other. It may also be that the two time series are driven by one or more common cause processes.

Our results are consistent with the theory (e.g., Gerardi et al. (2007), Foote et al. (2008), and Foote et al. (2010)) and [new](#) empirical evidence. Our results suggest that declining housing equity and [income loss](#) lead to higher delinquency rates.

Previous [research](#) on this topic also showed that counties with the most severe declines in housing net worth experienced the largest declines in employment during the Great Recession.

On one hand, unemployment leads to decreased housing appreciation. Meanwhile declining housing appreciation leads to higher mortgage delinquency rates, depressed activity and higher unemployment.