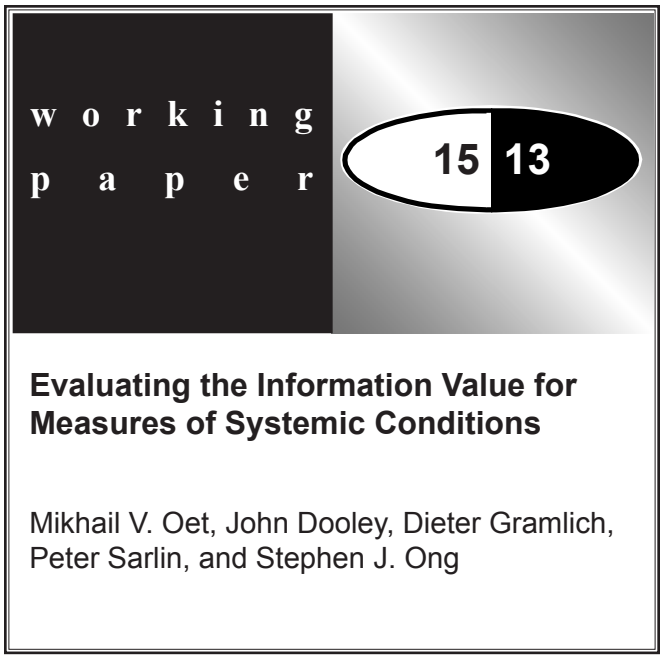
Advisory: This article is based in whole or in part on the CFSI (Cleveland Financial Stress Indicator), an indicator that was discontinued by the Federal Reserve Bank of Cleveland in 2016 due to the discovery of errors in the indicator's construction. These errors overestimated stress in the real estate and securitization markets. As a result, readers should be cautious and interpret any analysis based on CFSI data with those errors in mind.



Evaluating the Information Value for Measures of Systemic Conditions

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Timely identification of coincident systemic conditions and forward-looking capacity to anticipate adverse developments are critical for macroprudential policy. Despite clear recognition of these factors in literature, an evaluation methodology and empirical tests for the information value of coincident measures are lacking. This paper provides a twofold contribution to the literature: (i) a general-purpose evaluation framework for assessing information value for measures of systemic conditions, and (ii) an empirical assessment of the information value for several alternative measures of US systemic conditions. We find substantial differences among the measures, of which the Cleveland Financial Stress Index shows best-in-class identification performance. In terms of forecasting performance, Kamakura's Troubled Company Index, Cleveland Financial Stress Index, and Goldman Sachs Financial Conditions Index show moderately stable usefulness metrics over time.

JEL: G01; G18; G28; E32; E37.

Keywords: Information value; Systemic conditions; Coincident measures; Early warning; Macroprudential policy.

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1. Introduction

The complex and adaptive nature of financial systems imposes challenges to prudential supervision demanding a more holistic and flexible policy.[1] In addition to the regulation of individual institutions through microprudential supervision, a macroprudential focus on system-wide risks is essential. In the vein of Borio (2003), a macroprudential approach is concerned with the analysis of systemic risk along the cyclical and structural dimensions, where the former relates to the build-up of widespread imbalances and subsequent unraveling in times of crisis and the latter to the distribution of risks and shocks' transmission across the system. Adaptive supervision of systemic risk must be sensitive to potentially rapid transformations of the financial sector, as is indicated in Fig. 1. Suggestions for increased dynamic macroprudential policy have been made, for example, by the Bank of England (BoE, 2011) and the IMF (Lim et al., 2011). In line with more adjustable and granular regulation in Basel III, adaptive macroprudential policy contributes distinct conceptual and practical enhancements to the prudential toolbox. This paper supports adaptive policies by providing a structured approach to evaluate the information value for measures of systemic conditions.

Insert Fig. 1 about here

Fig. 1. Change in assets of financial intermediaries in the US, 1952–2013.

The fundamental objective of macroprudential policy is to limit the probability and severity of systemic failure, i.e. limit systemic risk. Its strategies are often oriented to the institution-specific limits and targets that depend on the risk profile of the system and the contribution to that profile of each institution. The limits mainly address institutional risk, return, and liquidity in the context of submarkets and the overall system (Aikman et al., 2013). For example, time-varying targets can include countercyclical buffers, time-varying provisioning, and time-varying reserve requirements (Frait and Komárková, 2011). Generally, in the vein of Minskian boom-bust cycles (Minsky, 1982), macroprudential policies of disclosure and targets in the cyclical dimension attempt to "create built-in mechanisms that attenuate the impact of procyclical behavior" (Cukierman, 2011). In the structural dimension, macroprudential policy controls the buildup of large systemic imbalances (common exposures) and increases the resilience of networks by attenuating risk propagation. Common exposures and connectivity among institutions arise particularly through contractual obligations (ECB, 2013; Flood et al., 2013). It is worth noting that macroprudential tools require forecasts of systemic stress to provide time for preparing and implementing policies (Kellermann and Mosch, 2013), as risks

[1] The concept of the economy as an adaptive, complex system was pioneered by Holland (1975, 1988) in his work on adaptive nonlinear networks. Brock and Hommes (1997, 1998) study financial markets as adaptive belief systems. Hommes (2001) extends this approach to markets as nonlinear adaptive evolutionary systems. See Arthur (1995) and Farmer and Lo (1999) for an analysis of heterogeneity in financial markets, Hollingsworth et al. (2005) for the socio-economic implications of a financial system's complexity, and Judge (2012) for the increasing complexity caused by the fragmentation of financial markets.

must be mitigated before they reach tipping points (ECB 2013). These considerations point to the variety of information needed to support macroprudential policy.

Beyond information requirements, the complexity and dynamics of modern financial systems further highlight challenges in accessing appropriate and timely measures of the system's structure and its transformation (Alampalli, 2013; Flood et al., 2013). To this end, Andersson et al. (2013) assert that "good supervision is analytical, holistic and forward-looking." Multiple measures have recently been developed to assess and analyze system-wide risks in the macro-financial environment. These include alternative measures of systemic conditions to identify the cyclical dimension continually, as well as institutional and macroeconomic early warning indicators of exuberance, excessive changes and misalignments.[2] Institutional early warning indicators are grounded in capacities to lead the recognition of institutional imbalances and result in a structural framework for monitoring the buildup of macroeconomic stresses (Oet et al., 2013). Macroeconomic early warning indicators are grounded in capacities to lead the recognition of systemic crises and germinate a common cyclical framework for evaluating policymaker's loss function (Alessi and Detken, 2011; Sarlin, 2013). Yet, little or no work has focused on the comparative information quality of the coincident measures of systemic conditions. To this end, we put forward and apply a methodology to assess the quality of information provided by these measures.

Determining the information value for the coincident measures of systemic conditions is critical for several reasons. First, the systemic risk literature has provided a wide array of alternative approaches to gauge systemic conditions. However, there is no agreement on one measurement approach above others. Second, the existence of an evaluation framework is essential for these measures as, in contrast to macroeconomic early warning indicators, they are not calibrated to rare crises. Finally, the framework to assess comparatively the measures' information value forms the basis for monitoring and forecasting financial instability at several horizons.

The first part of this paper provides a general-purpose evaluation framework for assessing the information value for measures of systemic conditions (Section 2). The framework relies on previous work in the early warning literature and extends it by provision of new performance measures. The following part applies the framework in an empirical assessment of the information value of several coincident measures for the US (Section 3 and 4). We explore the relative performance of a large palette of measures both in terms of coincident signaling quality and early warning performance. This analysis is completed at multiple frequencies to verify the robustness of signaling. Section 5 concludes with a brief discussion of the applications of this study.

[2] Overviews are given by Davis and Karim (2008), Gramlich et al. (2010), Kliesen et al. (2012), Babecký et al. (2013), and Holopainen and Sarlin (2015).

2. A framework for evaluating coincident measures of systemic conditions

This section presents the framework that is used to evaluate coincident systemic condition measures. The methodology includes performance tests for a standard two-class classification task as well as time-series methods for forecasting.

2.1. A contingency matrix and crisis signals

An immediate concern to policymakers is the issue of whether and when to implement macroprudential policy. Policymakers possess a set of instruments through which they can affect the financial system in case of crisis. However, these policies are costly to implement when there is no crisis. When a crisis occurs, policy is either implemented to the benefit of the system (true positive, TP) or not implemented with detrimental effect (false negative, FN). If a crisis does not occur, policymakers can implement an unnecessary and potentially burdensome policy (false positive, FP) or efficiently abstain from implementing policy (true negative, TN). As pointed out in Sarlin (2013), and following the notation of Elkan (2001), we map each of the alternatives to costs *c*, for which we assume that the costs c_{FN} and c_{FP} are non-negative while c_{TP} and c_{TN} are non-positive costs.[3] The cost of not implementing policy in times of crisis is $c_1 = c_{FN} - c_{TP}$, and the cost of implementing policy when there is no crisis is $c_2 = c_{FP} - c_{TN}$ which rolls all costs into two terms. Additionally, we denote by $P_1 = \frac{TP_i+FN_i}{TP_i+FP_i+FN_i+TN_i}$ the unconditional probability that there is a crisis and $P_2 = 1 - P_1$ the unconditional probability that no crisis will occur.[4]

Insert Table 1 about here

Table 1

Policymaker's cost matrix.

2.2. Evaluating identification properties for systemic condition measures

To evaluate the performance of systemic condition measures, we need to go beyond comparative classification quality obtained through the contingency matrix approach of Table 1 and consider the value of these measures to support policymakers' decisions continually. To this end we develop a general-purpose evaluation framework for assessing the coincident measures' information quality.

We begin by noting that the above contingency matrix requires two time series: an ideal indicator $B_{F,t}^{x}$ that accurately encodes the occurrence and absence of crisis events (or pre-crisis events) and a predictor $S_{F,i,t}^{x}$ that attempts to measure when a crisis (or pre-crisis) is occurring based upon which policymakers make their decisions. Therefore, evaluation metrics are essential for finding the optimal threshold $\tau_{F,i}^{x}$ for predictor i to generate $S_{F,i,t}^{x}$. Next, we recognize that

[3] Note that these costs are constant since we are considering the somewhat restrictive case where policymakers control the decision to implement policy but may not vary the magnitude of policy. This restriction allows us to deal with the two-class classification problem.

[4] The unconditional probabilities P_1 and P_2 are independent of the stress measure *i* used by policymakers to decide whether or not to implement policy.

information content of the coincident measures is relevant to policymakers' decisions from dual perspective x of the level of financial system conditions and of the change in these conditions since last observation. Thus, the evaluation framework is applied with two perspectives $x \in \{lev, diff\}$ using several analysis frequencies F and multiple stress measures i. The above observations result in a more granular view of the information quality of the coincident measures. To this end we quantify the measures' Noise to Signal Ratio (NTSR), Information Value (IV), absolute Usefulness (U_a), and relative Usefulness (U_R).

The noise to signal ratio is defined as $NTSR_i = \frac{T2_i}{(1-T1_i)}$. In our case, Type I error indicates the proportion of crisis observations which are falsely classified as non-crisis ($T1_i = \frac{FN_i}{(TP_i+FN_i)} = P(S_{F,i}^x = 0|B_F^x = 1)$), whereas Type II error refers to the proportion of non-crisis periods where a crisis was mistakenly signaled ($T2_i = \frac{FP_i}{FP_i+TN_i} = P(S_{F,i}^x = 1|B_F^x = 0)$). A noise to signal ratio lower than one indicates the measure is beneficial, and Kaminsky et al. (1998) select the thresholds for each indicator in their study ($\tau_{F,i}^{lev}$, and $\tau_{F,i}^{diff}$) to minimize NTSR. Unfortunately, since there are typically far more observations classified as "non-crisis" than "crisis" the NTSR can often be reduced to zero by setting the threshold for a stress measure conservatively high so that FP_i is zero while maintaining TP_i greater than zero.

The IV has been proposed when choosing between several regressors (see Siddiqi, 2006; Hababou et al., 2006; Lin, 2013). To calculate this measure we first determine whether the signal generated by our regressor was the same as that of the ideal indicator. Next we sort our data set by the regressor and group it into k bins delimited by the $k-1$ quantiles of series i, allowing us to define

$$IV_{x_i} = \sum_j (good_j - bad_j) \ln\left(\frac{good_j}{bad_j}\right) \quad (1),$$

where good_j (resp. bad_j) is the fraction of all good (bad) predictions located in bin j. Notice that if the regressor contains no relevant information we would expect to see the same proportion of good and bad predictions in each bin leading to an information value of zero. Due to the definition's use of the natural logarithm, the absolute value of IV_x may become very large if $good_j$ or bad_j become close to zero making it a somewhat unstable metric when working with a short dataset. We select the number of bins k in order to minimize the number of measures for which the IV becomes undefined. Siddiqi (2006) provides a heuristic guide whereby an IV of less than 0.1 is weak, IV from 0.1 to 0.3 is average, IV from 0.3 to 0.5 is strong, while IV greater than 0.5 may be suspiciously high.

Selecting the thresholds $\tau_{F,i}^{lev}$ and $\tau_{F,i}^{diff}$ based on the NTSR may lead to higher thresholds that tend to eliminate Type II error at the expense of Type I error. Unlike the NTSR, IV deviates from values near 0.5 (which we consider to be an optimal score); excessive Type I or Type II

errors are penalized leading to an optimal threshold which is potentially less biased.[5] Thus, the thresholds $\tau_{F,i}^{lev}$ and $\tau_{F,i}^{diff}$ are selected for each data series to minimize the deviation of IV from 0.5 allowing an unbiased comparison of measures which are individually signaling at their best. For $x \in \{lev, diff\}$ we find $\tau_{F,i}^{x}$ such that:

$$\min_{\tau_{F,i}^{x}} |IV_i - 0.5| \quad (2).$$

However, the IV and NTSR metrics do not consider the *cost* of Type I and Type II errors which clearly offers an opportunity to improve the evaluation framework. We attempt therefore to measure the monetary value of information provided by a stress measure which accounts for the costs of policy implementation and the unconditional probability of crisis. The policymaker is faced with the two-class problem from decision theory. Traditional metrics when handling this class of problems include the Expected Value Under Uncertainty (EVUU), the Expected Value of Perfect Prediction (EVPP), and the Expected Value of Perfect Information given by:

$$EVUU = -\min(P_1 c_{FN} + P_2 c_{TN}, P_1 c_{TP} + P_2 c_{FP}) \quad (3),$$

$$EVPP = -(P_1 c_{TP} + P_2 c_{TN}) \quad (4),$$

$$\begin{aligned} EVPI = EVPP - EVUU &= -(P_1 c_{TP} + P_2 c_{TN}) - (-\min(P_1 c_{FN} + P_2 c_{TN}, P_1 c_{TP} + P_2 c_{FP})) \\ &= \min\big(P_1(c_{FN} - c_{TP}), P_2(c_{FP} - c_{TN})\big) = \min(P_1 c_1, P_2 c_2) \\ &= (c_1 + c_2)\min\big(P_1 \mu, P_2(1-\mu)\big) \end{aligned} \quad (5),$$

where $\mu = \frac{c_1}{c_1 + c_2}$ represents the fraction of total costs incurred when the policymaker does not implement policy and a crisis occurs. If we wanted to calculate the Expected Value of Sample Information EVSI (also often called the value of imperfect information or VII) for a measure generating signals of crisis imperfectly, then we would first compute the Expected Value of the Sample Prediction (EVSP) as:

$$\begin{aligned} EVSP = &\frac{TP_i + FP_i}{TP_i + FP_i + FN_i + TN_i} * \left(-\frac{1}{TP_i + FP_i}\right) \min(TP_i c_{TP} + FN_i c_{FN}, TP_i c_{FN} + FN_i c_{TN}) \\ &+ \frac{TP_i + FP_i}{TP_i + FP_i + FN_i + TN_i} * \left(-\frac{1}{FN_i + TN_i}\right) \min(FN_i c_{TP} + TN_i c_{FP}, FN_i c_{FN} + TN_i c_{TN}) \end{aligned} \quad (6).$$

Then $EVSI$ is equal to $EVSP$ minus $EVUU$ which does not simplify conveniently. If we assume that the policies and their effectiveness are fixed and exogenous, then there are too many parameters to intuitively consider EVSI when evaluating crisis measures. However, if we were able to estimate c_{TP}, c_{FP}, c_{FN}, and c_{TN}, then the formula for EVSI would simplify dramatically leaving us only with the choice of thresholds. As a straightforward implementation of decision theory which accounts for the costs of FN compared to FP and their probabilities, EVSI can efficiently differentiate between alternative stress measures.

In the absence of specific information about the potential costs and benefits of implementing policy, Sarlin (2013) defines the absolute and relative Usefulness of predictor *i* according to:

[5] The relationship of the signaling threshold to the NTSR and IV metrics is somewhat erratic and while the tendencies outlined above hold true for the majority of this paper's empirical analysis, they are not guaranteed to hold for alternative datasets.

$$U_a(\mu) = min\big(P_1\mu, P_2(1-\mu)\big) - L(\mu) \quad (7),$$

$$U_R(\mu) = \frac{U_a(\mu)}{min\big(P_1\mu, P_2(1-\mu)\big)} \quad (8),$$

$$L(\mu) = \mu T_1 P_1 + (1-\mu) T_2 P_2 \quad (9),$$

where $L(\mu)$ represents the policymaker's loss function. Note that the first term in equation (7) is proportional to the expected value of perfect information. This construction then works on the idea that superior predictors allow policymakers to minimize $L(\mu)$ in which case $U_a(\mu)$ will approach $\frac{1}{(c_1+c_2)}EVPI$. Also note that by selecting the signaling thresholds $\tau_{F,i}^{lev}$ and $\tau_{F,i}^{diff}$ to optimize $U_a(\mu)$ for varying μ we do not determine which predictors are most valuable depending on policymakers risk preference μ. Instead we determine which predictors have value for differing relative cost of Type I error versus Type II error, while assuming that the policy maker is risk neutral.[6] As an alternative to the method described in equation (2) we therefore select the signaling thresholds $\tau_{F,i}^{lev}$ and $\tau_{F,i}^{diff}$ and the value of μ_i in order to maximize the absolute Usefulness (or equivalently the relative Usefulness):

$$\max_{\tau_{F,i}^{x}, \mu_i} U_R(\mu_i) \quad (10).$$

2.3. Evaluating early warning properties for coincident systemic measures

Several authors employ parts of the above methodology to determine whether individual measures consistently lead the benchmark as predictors of crisis, allowing time for policy to be implemented (see Kaminsky et al., 1998; Edison, 2003; Lo Duca and Peltonen, 2013). Most of these focus on the identification of periods in a predefined window prior to crisis events. By contrast, the measures under consideration in this study are designed to assess contemporaneous systemic conditions. While good coincident measures can provide useful information for the purpose of disclosure, limits, and targets of macroprudential policies, they may provide policymakers insufficient time to deploy slower policy instruments. Therefore, beyond testing the power of these measures to identify contemporaneous conditions, it is important to determine whether they possess a structure which is conducive to an early warning of adverse systemic developments. Namely, using only a collection of coincident measures, would a supervisor be capable of producing accurate near-term forecasts of systemic conditions? Naturally, any coincident measures that possess the relevant structure have enhanced quality to policymakers for the conduct of macroprudential policy. Therefore, the second aspect of the proposed

[6] It is interesting to note that when defining the policymaker's loss function, μ has been called the "relative preference of policymakers between FNs and FPs" (Lo Duca and Peltonen, 2013), the "policy maker's relative risk aversion between type I and type II errors" (Alessi and Detken, 2011), and "the decision-maker's degree of risk-aversion towards missing a crisis" (Fuertes and Kalotychou, 2007). Each of these terminologies seem to imply that this parameter captures the risk aversion of the policy maker's utility function. However, μ is only a measure of relative cost and relies on the assumption that the policy maker is inherently risk neutral. To account for the risk aversion of policymakers we could replace c_{TP}, c_{FP}, c_{FN}, and c_{TN} by $c_{TP}^U, c_{FP}^U, c_{FN}^U$, and c_{TN}^U where $c_x^U = U(c_x|\rho)$ for all $x \in \{TP, FP, FN, TN\}$ and $U(c|\rho)$ is a utility function appropriate for policymakers with risk aversion ρ.

evaluation framework considers the cyclical properties of coincident measures investigated by means of time series analysis.

We begin with an exploration of the autoregressive properties of individual stress measures using the Box-Jenkins (1970) methodology. For each stress measure we test several variations of the ARIMA(p,d,q) model, given by equation (11). We also test for the presence of heteroskedasticity, and where appropriate we implement the GARCH(p,q) methodology to account for this aspect of the data. The final model is selected based on properties of the residuals (stationarity, heteroskedasticity, autocorrelation, and partial autocorrelation), the Akaike information criterion (AIC), and the Schwarz criterion (SC). We define the difference operator Δ^d such that $\Delta^d x_t = x_{t-1}$ is the time series x_t differenced d times and consider a, b_i, and c_i constants:

$$\Delta^d y_{i,t} = a + \sum_{i=1}^{p} b_i \, \Delta^d y_{i,t-1} + \epsilon_{i,t} + \sum_{j=1}^{q} c_j \, \epsilon_{i,t-1} \quad (11).$$

We are also interested in the question of whether the stress measures collectively provide beneficial insight into the development of stress. We apply the Johansen (1995) method to test the properties of our data and select a VAR or VEC model following equations (12) or (13) respectively. We attempt to discern whether the assorted perspectives of financial system conditions provided by individual measures allow insight into a mechanism for the development of critical systemic episodes. [7]

$$Y_t = c + \sum_{i=1}^{k} A_i Y_{t-i} \; + \epsilon_t \quad (12),$$

$$\Delta \, Y_t = A(BY_{t-1} + c) + \sum_{i=1}^{k} B_i \, \Delta \, Y_{t-i} \; + \epsilon_t \quad (13).$$

Applying this methodology to a collection of coincident measures $y_{i,t}$, where $i = 1, \dots, n$, we define Y_t as the $n \times 1$ vector of coincident measures, c is an $n \times 1$ constant vector, and A, A_i, B, and B_i are $n \times n$ matrices where k is the number of lags considered for each stress measure. The number of lagged terms to incorporate is determined through consideration of the AIC, and the SC.

3. Data for empirical assessment

In this section, we describe the dataset used in the empirical assessment of the information value for alternative measures of US systemic conditions. We describe two types of data: first, a constructed representation $B_{F,t}^{x}$ of the ideal indicator, and second, the set of coincident measures.

3.1. A benchmark index of financial stress

To evaluate coincident measures, we need to ground the comparison to *truth*. The contingency matrix shown in Table 1 requires not only a predictor $S_{F,i,t}^{x}$ that attempts to measure when a crisis occurs, but also an ideal indicator of *truth* $B_{F,t}^{x}$ that accurately encodes the occurrence and absence of crisis events. Unfortunately, one single, widely accepted "true" series for the occurrence of financial crises does not exist. When determining a crisis benchmark, the

[7] The results are available from the authors upon request.

literature has used two approaches to define events: information on direct distress in the system and government interventions, and thresholds on market-based stress indexes. An example of the former type of events is the database of currency, debt and banking crises by Laeven and Valencia (2013), whereas Kaminsky et al. (1998) and Lo Duca and Peltonen (2013) are two examples of market-based indexes. Kaminsky et al. (1998) define currency crises to occur when their market-pressure index exceeds its mean with more than three standard deviations. Lo Duca and Peltonen (2013) identify systemic events when their financial stress index is above the 90th country-specific percentile.

In contrast to these studies we proxy the ideal indicator by a composite benchmark to reflect the US diverse financial system and to capture a multi-dimensional crisis.[8] To this end, the benchmark design proxies the ideal indicator by sensitizing our construction to three behavioral characteristics of actual crises: severity of the system's state, persistence over time, and pervasiveness across components of the system. Accordingly, the benchmark is calculated using six volatility series to broadly capture critical disturbances in the US markets for equity (through the Chicago Board Options Exchange VIX), foreign exchange (through JPMorgan Chase JPMVXYGL), interbank (through Merrill Lynch's MOVE), credit (through MLCORVOL), securitization (through SECURX), and real estate (through REALX)[9] markets. We use the following systematic approach to assessing threshold exceedances. Under the $x \in \{lev\}$ perspective, the benchmark is defined to indicate crisis if the imbalance *level* of a volatility series is above threshold $\tau_{B,F}^{lev}$ in two consecutive periods or if the imbalance *levels* of two volatility series are above $\tau_{B,F}^{lev}$ simultaneously. The alternative $x \in \{diff\}$ perspective generates a signal if the *difference* in the imbalance of a volatility series is above a threshold $\tau_{B,F}^{diff}$ in two consecutive periods or if the *differences* in the imbalances of two volatility series are above $\tau_{B,F}^{diff}$ simultaneously. Formally, we define the imbalance and indicator functions as:

$$i(x_{it}) = \frac{x_{it} - \mu_i}{\sigma_i} \quad (14),$$

$$I_F^{lev}(v_{i,t}) = \begin{cases} 1 & if\ i(v_{i,t}) > \tau_{B,F}^{lev} \\ 0 & else \end{cases} \quad (15),$$

$$I_F^{diff}(v_{i,t}) = \begin{cases} 1 & if\ \left(i(v_{i,t}) - i(v_{i,t-1})\right) > \tau_{B,F}^{diff} \\ 0 & else \end{cases} \quad (16);$$

then,
$$B_{F,t}^{lev} = \begin{cases} 1 & if\ \sum_{i=0}^{k-1} I_F^{lev}(v_{i,t-i}) = k\ or \sum_i I_F^{lev}(v_{i,t}) \geq l \\ 0 & else \end{cases} \quad (17),$$

[8] The frequently cited banking crisis episode list proposed by Laeven and Valencia (2013) finds only one US episode from 1992 to 2013 (the financial crisis starting in 2007). Their definition focusses on *systemic banking crises* and may therefore miss critical disturbances manifesting in the broader financial system and distinct markets.

[9] The MLCORVOL (credit) volatility is generated by calculating 30 day rolling standard deviation of the Merrill Lynch MLCORPM yield to redemption data series from Datastream. The SECURX (securitization) volatility and REALX (real estate) volatility measures are generated by calculating the rolling 90 day rolling standard deviation of the Barclays Asset Backed Securities Index (Datastream LHASSBK) and DOW JONES US Real Estate Index (GFD-DJU11) respectively.

and, $$B_{F,t}^{diff} = \begin{cases} 1 & if \ \sum_{i=0}^{k-1} I_F^{diff}(v_{i,t-i}) = k \ or \ \sum_i I_F^{diff}(v_{i,t}) \geq l \\ 0 & else \end{cases} \quad (18).$$

By monitoring the imbalance in volatility, the *level* perspective will produce signals throughout the crisis if a single market indicator demonstrates persistently high levels (two or more consecutive alerts) or if multiple markets are above the threshold simultaneously. In addition, monitoring the *differences* in volatility imbalances will focus on potential developing crises with alerts stemming from notable persistent growth in imbalances for at least one market or the simultaneous growth of imbalances in at least two markets. However, by design the difference methodology will produce signals only at the onset of a crisis and will not allow us to determine crisis termination. In summary, construction of the benchmark series $B_{F,t}^{x}$ proxies the ideal indicator of *truth* by capturing a multi-dimensional set of crisis characteristics: severity (through $\tau_{B,F}^{diff}$ and $\tau_{B,F}^{diff}$), persistence ($k = 2$ periods), and pervasiveness ($l = 2$ markets).

The benchmark thresholds $\tau_{B,F}^{lev}$ and $\tau_{B,F}^{diff}$ used in equations (14)-(18) are selected such that approximately 20% of observations indicate crisis.[10] Alternatives using multivariate logistic regression could also be used under similar considerations. Clearly, the benchmark design described above will not perfectly indicate the presence and absence of system-wide crisis; however, the degree to which several distinct characteristics align proxies the ideal indicator both experientially (by describing relevant critical systemic episodes) and metrically (by supporting the benchmark's convergent validity). The benchmark is compared to several published coincident measures in Fig. 2 under both $x \in \{lev, diff\}$ perspectives.

Insert Fig. 2 about here

Fig. 2. Benchmark compared to several stress series.

3.2. Systemic financial stress measures

Our dataset includes 23 published measures of contemporaneous US financial conditions, stress, risk, and system structure (not all measures are available for comparison at every frequency). To make use of the contingency matrix for evaluating coincident measures, we must also determine when each measure indicates that policy should be implemented, that is when they signal a crisis. Therefore, we propose a scheme parallel to that developed for the benchmark. Each measure is converted to an imbalance by subtracting the mean and dividing by the standard deviation.[11] Crisis signals are then generated for each series where crisis is indicated

[10] The benchmark threshold was set low in order to allow markets to signal due to modest pressure. However, the requirement that a single market experience stress in consecutive periods, or at least two markets experience stress simultaneously, mitigates the impact of a low threshold and increases the likelihood of the benchmark revealing systemic events.

[11] Several series are designed to reflect the conditions of the financial system or economy so that a negative imbalance may be interpreted as positive stress, requiring inversion of the series about its mean to ensure consistent comparison of crisis signals.

if the imbalance (or the differenced imbalance) is greater than the threshold $\tau_{F,i}^{lev}$ (respectively $\tau_{F,i}^{diff}$), specifically:

$$S_{F,i,t}^{lev} = \begin{cases} 1 & if\ i(x_{i,t}) > \tau_{F,i}^{lev} \\ 0 & else \end{cases} \quad (19),$$

$$S_{F,i,t}^{diff} = \begin{cases} 1 & if\ i(x_{i,t}) - i(x_{i,t-1}) > \tau_{F,i}^{diff} \\ 0 & else \end{cases} \quad (20).$$

Descriptive statistics are provided in Table 2. The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO MSA) was also calculated to determine whether these series would be conducive to factor analysis following equation (21) where r_{jk}^2 the correlations and p_{jk}^2 are the partial correlations between *j* and *k*. According to Kaiser (1970) a MSA above 0.8 is very good, between 0.6 and 0.8 is middling, and below 0.6 is poor. The KMO MSA for the specified variables (excluding the components of CFSI to eliminate multicollinearity) was computed as 0.842 indicating very good cohesion of the concepts captured by these measures (significant at 1%):

$$MSA_j = \frac{\sum_{k \neq j} r_{jk}^2}{\sum_{k \neq j} r_{jk}^2 + \sum_{k \neq j} p_{jk}^2} \quad (21).$$

Insert Table 2 about here

Table 2

Descriptive statistics.

The coincident measures considered in this paper focus on several aspects of financial system health. The first group of measures focuses on the concept of systemic stress which can be defined as relative pressure in the financial system. These indexes—Bloomberg Financial Conditions Index (FCI), Goldman Sachs FCI, Cleveland Fed Financial Stress Index (CFSI), Kansas City Fed Financial Stress Index (KCFSI), St. Louis Fed Financial Stress Index (STLFSI) and Chicago Fed National Financial Conditions Index (NFCI)—typically incorporate variables describing core markets and functions of the financial system which are then aggregated using a variety of weighting methodologies. For instance, the CFSI measures systemic stress as the credit weighted aggregate of stress in six markets (see Fig. 2). Systemic conditions in these markets are assessed on the basis of spreads, normalized using the relative rank, and are aggregated using credit weights as a dynamic weighting method (stress adjusts to variations in importance of each measure and market to the financial system). Alternately, the Bloomberg FCI looks at normalized spreads, equity prices, and equity volatility (VIX) using constant weights to determine a measure of the access to credit. Because systemic stress often evolves from individual sub-sectors and their correlated behavior, information about the state of stress in the systems' components and their comovement is particularly useful.

A second group of measures examines the state of gross economic activity—Chicago Fed National Activity Index (CFNAI) and Philadelphia's Leading Index—using transformations of a large set of variables. CFNAI looks at several aspects of the economy including personal

consumption and housing, employment/unemployment and hours, production and income, sales/orders and inventories. The third category of coincident measures included in this study—SRISK and Kamakura's Troubled Company Index—reflects the concepts of current expectations of systemic risk which are forward-looking by design. For instance, SRISK calculates the expected decrease in bank capital under a given set of adverse conditions at the institution level. The resulting knowledge about the factors of stress permits much more detail in macroprudential communication and also assists when guiding institutions' risk management functions.

We analyze the dataset in two samples. The first (main) sample maximizes the available breadth of the sample, while the second (robustness) sample seeks to maximize its length. Accordingly the main sample (June 2000 – December 2013) consists of 23 quarterly, 23 monthly, 14 weekly, and 10 daily series. The robustness sample (May 1992 – December 2013) consists of 21 quarterly, 21 monthly, 12 weekly, and 9 daily series and encompasses at least two full economic cycles (following the NBER delineation of recession periods),[12] including several well-recognized critical episodes. It has to be agreed that a longer time series provides more insight into the cyclical properties of the observed measures. However, the longer sample also limits the cross-sectional analysis, as not all indicators are available for a longer period. Our sampling strategy balances the trade-off between the number of indicators and the number of observations, emphasizing cross-sectional comparisons in the main sample and cyclical comparisons in the robustness sample. Importantly, at quarterly and monthly frequencies, the composition of both samples includes all three groups of coincident measures.

4. Results

This section presents evaluation results from the empirical assessment of alternative US coincident measures in the main sample. The section consists of two parts: the first part tests the coincident efficacy for measures of systemic conditions and the second part tests the early warning effectiveness of the measures. The results of testing the robustness sample are presented in Tables A.1–A.4 in the Appendix. As shown, the robustness sample results are generally consistent with main findings.

4.1. Efficacy of systemic condition measures

Tables 3 and 4 report the comparative signaling results for the tested coincident measures where thresholds $\tau_{F,i}^{lev}$ and $\tau_{F,i}^{diff}$ are selected to optimize the information value metric IV following equation (2). As these tables should display measures with comparable IV metrics by design, we will evaluate the comparative advantage of these measures in terms of the Type I (T1) error rate, Type II (T2) error rate, NTSR, and Usefulness metrics.

Table 3 displays comparative metrics when signals of crisis are based upon the level of imbalances in the volatility and stress time series. Almost every measure of stress produces a NTSR below unity at every frequency indicating varying degrees of benefit from their use.

[12] See http://www.nber.org/cycles/cyclesmain.html.

Additionally, the usefulness of most series (captured by $U_R(\mu)$) is maximized when the relative cost of Type I versus Type II error to risk neutral policymakers is given by $\mu = 0.7$, that is, Type I error is more costly than Type II error. This is advantageous since it indicates that the measures included in this study are in large part conducive to policymaker's needs. Typically it is assumed that the cost of not implementing policy in the case of crisis outstrips the cost of implementing policy in the case of no crisis. This is also in line with previous findings on relative costs between errors (Sarlin, 2013; Betz et al., 2014). These results indicate that the 6 sector CFSI, the Goldman Sachs FCI, and STLFSI consistently produce the highest Usefulness metrics and very low NTSRs. The CFSI produces a lower Type I error rate than the Goldman Sachs FCI at the cost of a slight increase in the Type II error rate. SRISK and Philadelphia's Leading Index also demonstrate fairly steady and attractive metrics. Although the Usefulness and NTSR for KCFSI, NFCI, and CFNAI 3-month moving average are attractive (particularly at monthly frequency), they exhibit excessively high (or low) IV. Additionally, it is interesting to note that CFSI and CFNAI, for which the components are also available, modestly outperform their components. This is a welcome observation, as it provides additional support for their composite methodologies and is consistent with the financial system's property of hierarchical composition and decomposability (Simon, 1962).

Insert Table 3 about here

Table 3

IV based results.

When we analyze the differenced imbalances in an effort to focus on the onset of crises instead of their duration, Table 4 indicates substantially different results in terms of the comparative advantage of each measure. STLFSI, NFCI, Bloomberg FCI, SRISK, and CFSI each demonstrate attractive NTSR and Usefulness metrics at assorted frequencies, however there is no clear leader.

Insert Table 4 about here

Table 4

IV based results.

If we determine $\tau_{F,i}^{lev}$ based upon maximization of the Usefulness following equation (10), we can note based upon Tables 5 and 6 that the NTSR is quite low, and more interestingly there appears to be a fairly clear divide between measures with strong IV metrics and those with weak IV metrics. The clear leaders using this methodology in Table 5 are CFSI and STLFSI, which consistently achieve high Usefulness metrics and low NTSR. At monthly and weekly frequency both produce strong IV, but at quarterly frequency STLFSI has a middling Usefulness and the IV is undefined. Philadelphia's Leading Index, NFCI, Goldman Sachs FCI, and Bloomberg FCI also

have attractive IV and NTSR. However, they produce somewhat lower Usefulness metrics due to their balance of Type I and Type II errors.

Insert Table 5 about here

Table 5

Usefulness based results.

Interestingly, determining $\tau_{F,i}^{diff}$ based upon equation (10) produces a collection of measures with little stability across frequencies, as is shown in Table 6. At quarterly frequency many measures (Bloomberg FCI, Goldman Sachs FCI, CFSI, and the CFNAI) possess attractive Usefulness measures and good NTSR, albeit accompanied by somewhat large variation in IVs. STLFSI, NFCI, and the CFNAI diffusion index do achieve a good balance of all three metrics. At other frequencies Goldman Sachs FCI, KCFSI, SRISK, and CFSI produce attractive Usefulness metrics with acceptable NTSR, but the IV results tend to diverge from the desired 0.4-0.6 range. Bloomberg FCI achieves good metrics at every frequency hindered only with high (low) IV at quarterly (weekly) frequencies.[13]

Insert Table 6 about here

Table 6

Usefulness based results.

4.2. Early warning effectiveness of coincident systemic measures

The set of experiments herein focus on early warning properties of the US coincident systemic measures. To apply the Box-Jenkins methodology, we begin by differencing the standardized coincident measures to achieve weak form stationarity. Once this is achieved we often find that based upon autocorrelation and partial autocorrelation evidence there is no support for an autoregressive or moving average structure in the data. These results appear to support the idea that systemic conditions, as viewed by these measures individually, display characteristics of random walk over the period 2002M01 to 2007M06, and thus we omit the estimation results.

We also pursue an atheoretical examination of the potential for a process through which financial conditions perceived by a collection of measures may develop into stress observed by another set of measures. The cointegrated VEC forecasts are presented visually in Figure 3 using an initial estimation sample from 1992M05 to 2004M01. The forecast is effected by estimating

[13] When generating the benchmark, each volatility series is converted into an imbalance which adjusts the location and scale parameters of its distribution but will not remedy skewness or kurtosis differences between volatility indices. As a result, if the distribution for the VIX time-series data exhibits fat tails compared to the other volatility benchmarks it may generate a disproportionate number of signals compared to the other volatility indices. This may explain why stress measures that include VIX demonstrate a modestly improved ability to locate observations of crisis.

the parameters using all observable data and calculating the forecast one period ahead repeatedly between 2004M02 and 2013M12.

Insert Figure 3 about here

Figure 3

VEC forecast results.

A comparison of the forecast accuracy from out-of-sample forecasts is available in Table 7, sorted by mean absolute percentage error (MAPE). Here NFCI provides the best absolute out-of-sample fit, while Bloomberg FCI exhibits the worst fit. From these forecasts we generate signals of crisis (using thresholds for each measure which maximize the in-sample Usefulness metric) to see if there is a significant difference between in-sample and out-of-sample Usefulness (Table 8). The estimation and forecasting samples were selected to provide sufficient data for lagged regression; so that the forecast timeframe would include observations where the benchmark generated signals of both crisis and no crisis (allowing forecasts to produce both Type I and Type II errors).

Insert Table 7 about here

Table 7

Forecast accuracy.

The Usefulness metric used to evaluate the forecasts is sensitive to the chosen in-sample and out-of-sample intervals, since without the opportunity to compare a forecast against both crisis and tranquil observations the Usefulness metric will have a maximum of zero. By definition, forecasts with a uniform prediction of crisis or no crisis have a maximum Usefulness of zero. We find the Usefulness, IV, and NTSR do no exhibit a great deal of persistence between in-sample and out-of-sample results. Interestingly, KCFSI and NFCI perform much better out-of-sample than in-sample, while Bloomberg FCI, CFNAI, and the Philadelphia's Leading Index all perform worse out-of-sample. Only three of the tested measures: Kamakura's Troubled Company Index, CFSI, and Goldman Sachs FCI demonstrate modestly stable Usefulness metrics over time.

Insert Table 8 about here

Table 8

Usefulness of in sample data compared to out of sample forecasts.

5. Conclusion

To be conducive to macroprudential policy in adaptive financial markets, coincident measures must support the identification, analysis and early warning of systemic risk conditions. They must reveal in timely manner information concerning the aggregation of exposures from individual firms or markets to the system level. Thus, the ability of decomposable coincident

measures to reflect the hierarchical composition of the system (Simon, 1962) is inherently useful for understanding the system and its critical modes. Decomposable coincident measures tend to have enhanced information value by reflecting conditions in a variety of aspects of the financial system. Further, coincident measures must be constructed with the ability to remain informative across time despite changes in the financial system, so that they can be used to analyze past trends, monitor the financial system, and serve as dependent variables in studies of financial instability.

This paper analyzes several metrics used to compare coincident measures of systemic conditions to a benchmark representing the presence of crisis, alongside the methodology used to generate signals. Concerning the choice between signaling the presence or absence of a crisis on the basis of the level of imbalances as opposed to the growth in imbalances, we note that defining thresholds in terms of imbalance levels advantageously produces much more stable information value, NTSR, and Usefulness metrics across frequencies. Analyzing the level of systemic conditions also allows a direct study of the beginning and end of each episode, an objective not attained by the difference perspective. With respect to the particular metrics used to compare coincident measures and determine thresholds we find that the Usefulness metric possesses several suitable properties. The Usefulness metric has a straightforward scale for which higher Usefulness is better (superior to the heuristic scale of IV), is stable across all selections of $\mu \in (0,1)$ (unlike the stability of IV which depends on the number of bins or NTSR which depends on the particular balance of Type I and Type II error rates), and it incorporates the necessary and intuitive aspect of policy cost versus benefit represented by the preference parameter μ. Usefulness should not be considered by itself, but it remains a convenient and accessible metric to use for introductory comparison. The balance between Type I and Type II error rates captured by the NTSR, the dispersion of good versus bad predictions in each quantile, and the raw Type I and Type II error rates each display distinct and beneficial insight into the quality of information provided by coincident measures. Empirical evaluation utilizing the imbalance level perspective and selecting thresholds that maximize the Usefulness metric (presented in Table 5) reveals that several measures exhibit consistently attractive properties, with CFSI leading across all analysis frequencies.

Policymakers rely on the ability to project systemic conditions to enable implementation of policies which take time to affect the financial system. Our analysis of US coincident measures using the Box-Jenkins ARIMA methodology indicates that they do not (after necessary transformation) possess sufficient structure individually. As an alternative, the VEC methodology is used with mixed results on a longer sample to determine whether there is a process through which observations of systemic conditions allow insight into a mechanism for the development of critical systemic episodes. On one hand, the results show significant cointegration which indicates that there are long run relationships between several of the coincident measures. In addition, some of the forecasts exhibit moderately stable positive Usefulness out-of-sample, which is attractive to policymakers. On the other hand, the one period

forecasts radically limit the application for policy implementation. This is a topic that requires further study using methods capable of producing robust, dynamic, and actionable forecasts.

A basic problem in identifying and analyzing systemic risk is that it may arise from patterns "for which we have no precedent" (Judge 2012). This is particularly relevant for adaptive markets. Alternatively, assessing systemic risk on the basis of a policymaker's own considerations and scenarios may lead to unrealistic assumptions. A particular challenge in applying early warning projections for macroprudential policy is that the policy itself leads to feedbacks and adverse or unanticipated dynamics. This further amplification of the system's adaptive response to macroprudential policy must be considered a major challenge of the policy itself. A further question, therefore, is to what extent policy should restrict itself to ex-post responses to the transformation of markets or direct itself ex-ante to control the sensitivity of the system's adaptation.

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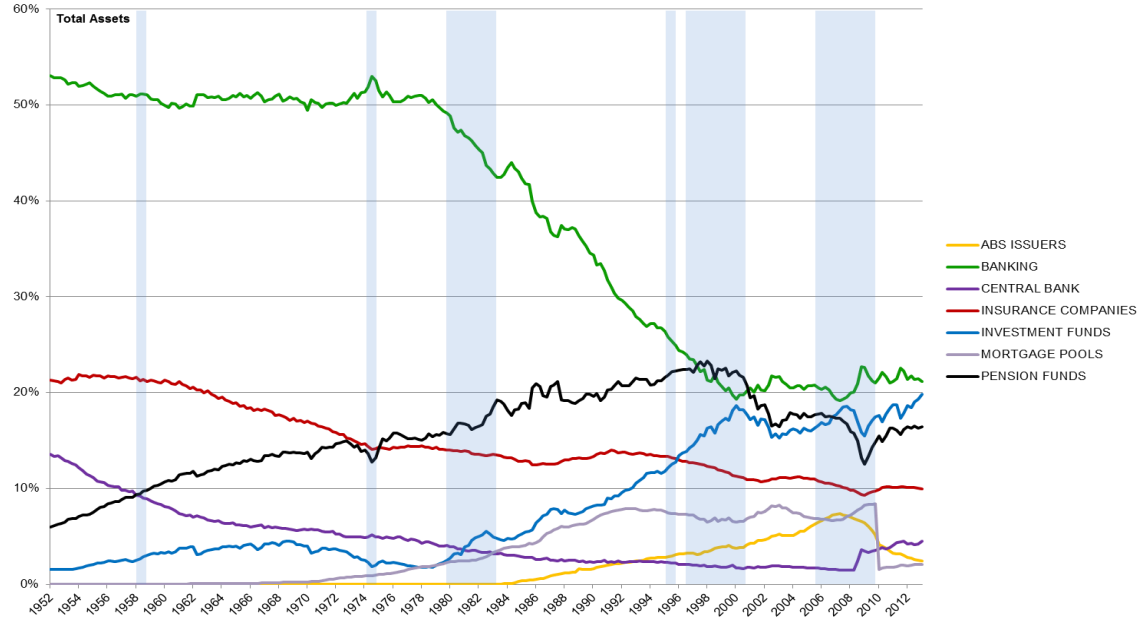
Figures and Tables

Fig. 1. Percentage of total financial assets held by each financial sector: 1952-2013.



Source: Board of Governors of the Federal Reserve System, 2014.

Fig. 2. Several coincident measures of systemic conditions (CFSI, SRISK, STLFSI, NFCI) at weekly frequency with the benchmark for crisis shaded ($\tau_{B,F}^{lev}$ on the left, $\tau_{B,F}^{diff}$ on the right).

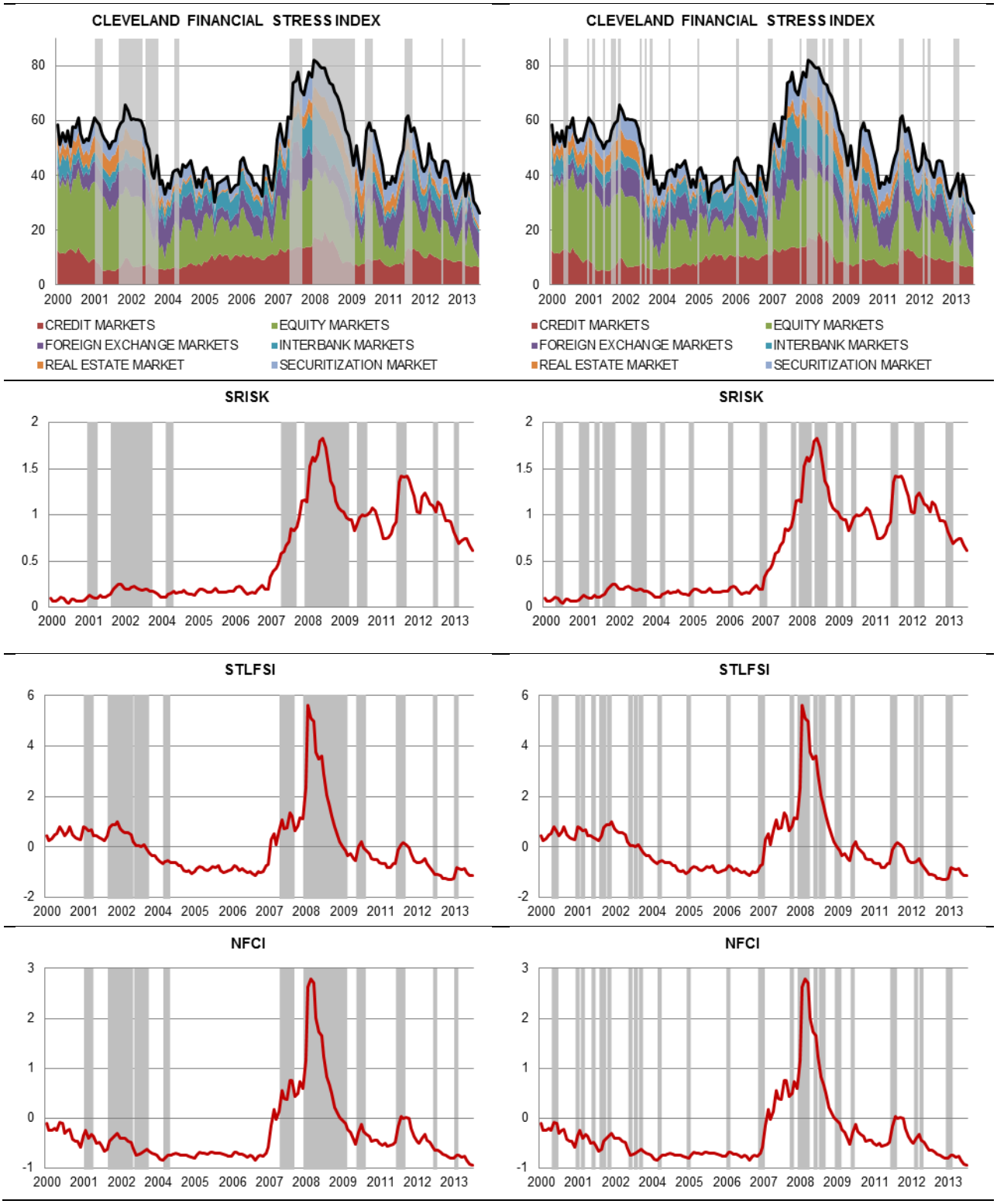
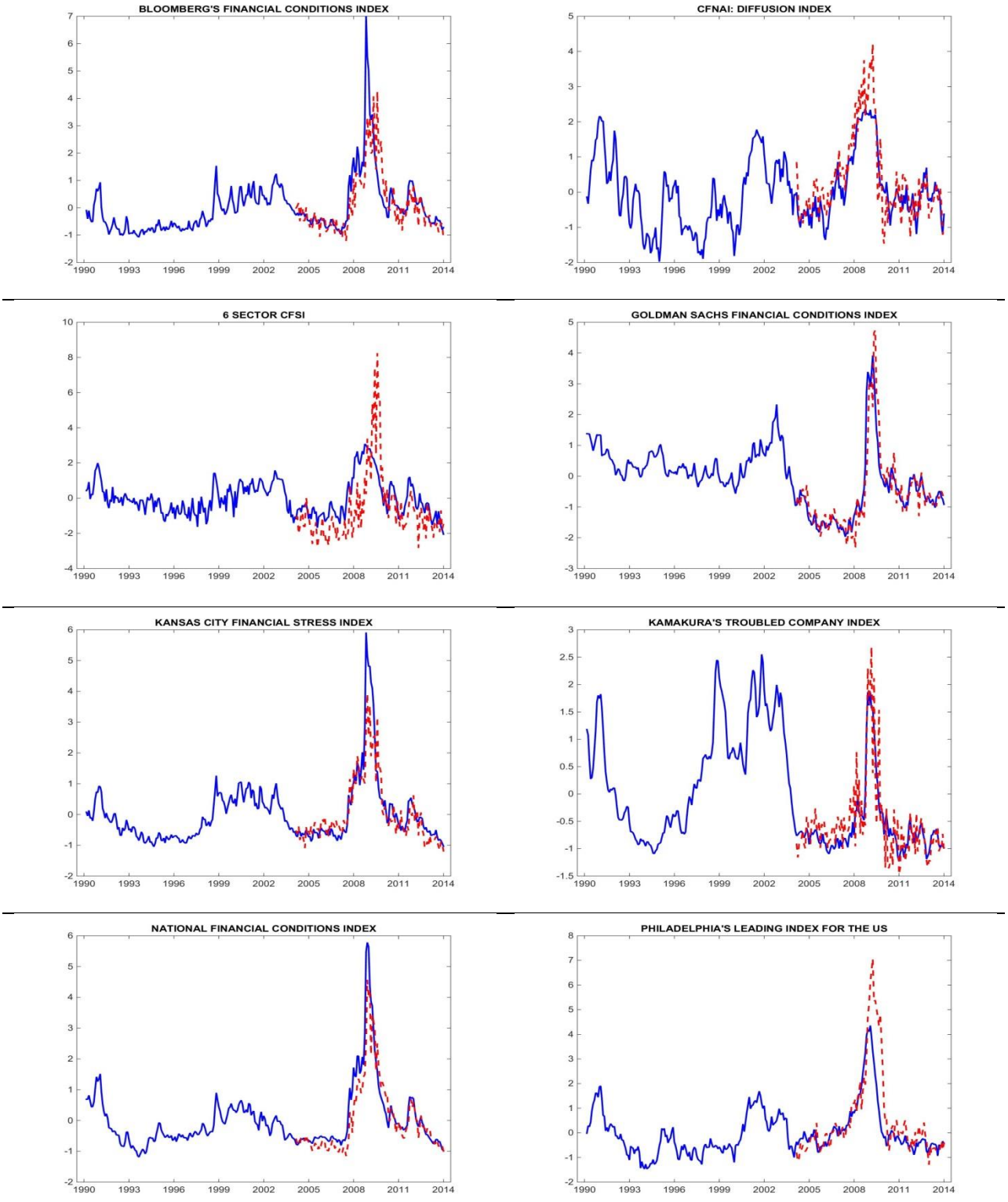


Fig. 3. VEC forecast results.



Note: Forecast—red dashed line; realized systemic conditions—solid blue line.

Table 1

Policymaker's cost matrix.

	Benchmark indicates crisis ($B_F = 1$)	Benchmark indicates no crisis ($B_F = 0$)
Signal is produced ($S_{F,i} = 1$)	True Positive (TP_i): cost c_{TP}	False Positive (FP_i): cost c_{FP}
No signal is produced ($S_{F,i} = 0$)	False Negative (FN_i): cost c_{FN}	True Positive (TN_i): cost c_{TN}

Table 2

Summary statistics for the stress series and benchmark volatility series calculated on quarterly data between 2002Q1 and 2013Q4.

Name	Code	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
Panel 1: Systemic Stress Series							
6 SECTOR CFSI	CFSI	32.46	82.24	49.26	13.20	0.93	-0.06
CREDIT MARKET FROM CFSI	CREDIT	2.04	14.51	5.64	2.87	1.50	2.09
RE MARKET FROM CFSI	REAL_ESTATE	4.15	27.08	15.28	6.37	0.25	-1.04
FUNDING MARKET FROM CFSI	INTERBANK	3.66	13.18	8.43	2.24	-0.09	0.02
EQUITY MARKET FROM CFSI	EQUITY	0.42	8.90	3.89	2.55	0.49	-1.06
FX MARKET FROM CFSI	FOREIGN_EXCHANGE	2.73	10.61	6.32	2.01	0.23	-0.55
SECURITIZATION MARKET FROM CFSI	SECURITIZATION	5.25	17.62	9.70	2.99	0.66	0.05
KANSAS CITY FINANCIAL STRESS INDEX	KCFSI	-0.91	5.33	0.18	1.24	2.62	7.82
ST LOUIS FINANCIAL STRESS INDEX	STLFSI	-1.26	5.24	-0.06	1.23	2.45	7.64
BLOOMBERG FINANCIAL CONDITIONS INDEX	BFCIUS	-8.63	1.09	-0.62	1.72	-2.65	9.61
Panel 2: Economic Activity Series							
GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	GSERFCI	98.88	102.36	99.89	0.82	1.36	1.71
NATIONAL FINANCIAL CONDITIONS INDEX - CHICAGO	NFCI	-0.90	2.70	-0.31	0.70	2.58	7.75
NFCI: NONFINANCIAL LEVERAGE SUBINDEX	NFCINONFINLEVERAGE	-1.05	3.49	0.04	0.86	2.08	5.11
NFCI: LEVERAGE SUBINDEX	NFCILEVERAGE	-1.36	2.70	0.27	1.37	0.54	-1.09
CFNAI: THREE MONTH MOVING AVERAGE	CFNAIMA3	-3.73	0.55	-0.31	0.85	-2.61	7.23
CFNAI: DIFFUSION INDEX	CFNAIDIFF	-0.84	0.43	-0.08	0.33	-1.07	0.54
CFNAI: PERSONAL CONSUMPTION AND HOUSING	CANDH	-0.37	0.13	-0.09	0.17	-0.13	-1.58
CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	EUANDH	-1.55	0.27	-0.14	0.36	-2.14	5.24
CFNAI: PRODUCTION AND INCOME	PANDI	-1.17	0.45	-0.03	0.31	-2.12	4.92
CFNAI: SALES, ORDERS, AND INVENTORIES	SOANDI	-0.57	0.15	-0.02	0.14	-2.26	5.61
PHILADELPHIA'S LEADING INDEX FOR THE US	USSLIND	-2.77	1.66	0.78	1.03	-2.21	4.93
Panel 3: Systemic Stress Series							
KAMAKURA'S TROUBLED COMPANY INDEX	TC_INDEX	5.13	22.70	10.01	5.32	1.47	0.68
SRISK FROM VLAB	SRISK	53892.81	881827.34	318249.82	244417.27	0.50	-1.00
Panel 4: Volatility Series							
SECURITIZATION VOLATILITY INDEX	SECURX	0.03	0.96	0.21	0.21	2.46	5.75
MERRILL LYNCH'S MOVE	MOVE	56.17	200.50	101.28	32.22	1.07	1.28
REAL ESTATE VOLATILITY INDEX	REALX	0.04	0.46	0.13	0.08	1.58	3.92
JP MORGAN GLOBAL FX VOLATILITY	JPMVXYGL	6.20	21.76	10.60	2.83	1.67	4.49
MERRILL LYNCH CORPORATE BOND INDEX VOLATILITY	MLCORVOL	0.03	0.51	0.12	0.09	2.63	9.56
CBOE'S VIX	VIX	11.40	43.79	20.62	8.45	1.29	1.05

Table 3

Comparison of coincident measures' ability to signal stress based on the imbalance level and optimal IV.

	Name	$\tau_{F,I}^{lev}$	TP	FP	TN	FN	T1	T2	IV	NTSR	μ	$U_A(\mu)$	$U_R(\mu)$
Panel 1: Quarterly ($\tau_{B,Q}^{lev} = 1$ and 3 bins were used for IV)													
1	BLOOMBERG FINANCIAL CONDITIONS INDEX	2	2	0	38	14	0.88	0		0	0.5	0.02	0.13
2	KANSAS CITY FINANCIAL STRESS INDEX	2	2	0	38	14	0.88	0		0	0.5	0.02	0.13
3	RE MARKET FROM 6 SECTOR CFSI	2	1	0	38	15	0.94	0		0	0.2	0	0.06
4	ST LOUIS FINANCIAL STRESS INDEX	2	2	0	38	14	0.88	0		0	0.5	0.02	0.13
5	NATIONAL FINANCIAL CONDITIONS INDEX	1.83	3	0	38	13	0.81	0	0.77	0	0.2	0.01	0.19
6	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	1.21	5	1	37	11	0.69	0.03	0.74	0.08	0.7	0.06	0.29
7	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.73	12	4	34	4	0.25	0.11	0.54	0.14	0.7	0.13	0.64
8	LEADING INDEX FOR THE US	0.62	6	5	33	10	0.63	0.13	0.52	0.35	0.7	0.05	0.24
9	CFNAI: THREE MONTH MOVING AVERAGE	1.5	3	1	37	13	0.81	0.03	0.51	0.14	0.7	0.03	0.16
10	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	1.48	3	1	37	13	0.81	0.03	0.51	0.14	0.7	0.03	0.16
11	KAMAKURA'S TROUBLED COMPANY INDEX	1.67	4	3	35	12	0.75	0.08	0.48	0.32	0.7	0.04	0.17
12	6 SECTOR CFSI	0.76	10	3	35	6	0.38	0.08	0.47	0.13	0.7	0.11	0.54
13	SRISK FROM VLAB	1.17	5	4	34	11	0.69	0.11	0.47	0.34	0.7	0.04	0.21
14	EQUITY MARKET FROM 6 SECTOR CFSI	0.85	10	6	32	6	0.38	0.16	0.46	0.25	0.7	0.1	0.46
15	CFNAI: DIFFUSION INDEX	1	5	5	33	11	0.69	0.13	0.46	0.42	0.7	0.04	0.18
16	CFNAI: PERSONAL CONSUMPTION AND HOUSING	2	0	0	38	16	1	0	0.46		0.4	0	0
17	FX MARKET FROM 6 SECTOR CFSI	0.91	2	7	31	14	0.88	0.18	0.44	1.47	0.7	-0.01	-0.06
18	FUNDING MARKET FROM 6 SECTOR CFSI	0.55	5	6	32	11	0.69	0.16	0.36	0.51	0.7	0.03	0.15
19	CREDIT MARKET FROM 6 SECTOR CFSI	1.2	6	1	37	10	0.63	0.03	0.34	0.07	0.7	0.07	0.35
20	CFNAI: PRODUCTION AND INCOME	0.5	5	6	32	11	0.69	0.16	0.31	0.51	0.7	0.03	0.15
21	NFCI: LEVERAGE SUBINDEX	2	0	0	38	16	1	0	0.31		0.4	0	0
22	CFNAI: SALES, ORDERS, AND INVENTORIES	0.71	4	5	33	12	0.75	0.13	0.18	0.53	0.7	0.02	0.12
23	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	1.58	2	3	35	14	0.88	0.08	0.17	0.63	0.7	0.01	0.04
Panel 2: Monthly ($\tau_{B,M}^{lev} = 1$ and 3 bins were used for IV)													
1	KAMAKURA'S TROUBLED COMPANY INDEX	1.73	10	5	110	38	0.79	0.04	1.58	0.21	0.7	0.03	0.16
2	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.76	17	4	111	31	0.65	0.03	0.83	0.1	0.7	0.07	0.32
3	KANSAS CITY FINANCIAL STRESS INDEX	0.71	15	3	112	33	0.69	0.03	0.74	0.08	0.7	0.06	0.29
4	ST LOUIS FINANCIAL STRESS INDEX	0.59	23	6	109	25	0.52	0.05	0.74	0.11	0.7	0.09	0.43
5	EQUITY MARKET FROM 6 SECTOR CFSI	0.74	28	24	91	20	0.42	0.21	0.72	0.36	0.7	0.08	0.37
6	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.76	31	10	105	17	0.35	0.09	0.69	0.13	0.7	0.11	0.56
7	RE MARKET FROM 6 SECTOR CFSI	1.06	26	4	111	22	0.46	0.03	0.67	0.06	0.7	0.1	0.51
8	CFNAI: DIFFUSION INDEX	1.32	14	11	104	34	0.71	0.1	0.52	0.33	0.7	0.04	0.19
9	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	1.62	12	0	115	36	0.75	0	0.51	0	0.6	0.04	0.25
10	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	1.95	8	0	115	40	0.83	0	0.5	0	0.3	0.01	0.17
11	CFNAI: THREE MONTH MOVING AVERAGE	1.58	10	1	114	38	0.79	0.01	0.5	0.04	0.7	0.04	0.2
12	6 SECTOR CFSI	0.5	34	17	98	14	0.29	0.15	0.49	0.21	0.7	0.11	0.56
13	LEADING INDEX FOR THE US	1.11	11	6	109	37	0.77	0.05	0.49	0.23	0.7	0.04	0.18
14	SRISK FROM VLAB	1.11	15	11	104	33	0.69	0.1	0.49	0.31	0.7	0.04	0.21
15	FX MARKET FROM 6 SECTOR CFSI	1.45	4	9	106	44	0.92	0.08	0.49	0.94	0.7	0	0
16	CFNAI: PERSONAL CONSUMPTION AND HOUSING	0.61	23	28	87	25	0.52	0.24	0.46	0.51	0.7	0.05	0.23
17	CFNAI: PRODUCTION AND INCOME	0.56	15	25	90	33	0.69	0.22	0.46	0.7	0.7	0.02	0.09
18	NATIONAL FINANCIAL CONDITIONS INDEX	2	8	0	115	40	0.83	0	0.44	0	0.3	0.01	0.17
19	CFNAI: SALES, ORDERS, AND INVENTORIES	0.71	14	19	96	34	0.71	0.17	0.43	0.57	0.7	0.03	0.12
20	NFCI: LEVERAGE SUBINDEX	0.5	11	33	82	37	0.77	0.29	0.39	1.25	0.7	-0.01	-0.07
21	FUNDING MARKET FROM 6 SECTOR CFSI	0.5	17	20	95	31	0.65	0.17	0.31	0.49	0.7	0.04	0.18
22	CREDIT MARKET FROM 6 SECTOR CFSI	0.5	18	28	87	30	0.63	0.24	0.25	0.65	0.7	0.03	0.12
23	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	1.67	8	4	111	40	0.83	0.03	0.11	0.21	0.7	0.03	0.13
Panel 3: Weekly ($\tau_{B,W}^{lev} = 1.2$ and 4 bins were used for IV)													
1	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.5	97	36	491	84	0.46	0.07	1.43	0.13	0.7	0.08	0.45
2	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.73	118	53	474	63	0.35	0.1	0.99	0.15	0.7	0.09	0.53
3	EQUITY MARKET FROM 6 SECTOR CFSI	2	0	0	527	181	1	0	0.87		0.4	0	0
4	RE MARKET FROM 6 SECTOR CFSI	1.14	93	30	497	88	0.49	0.06	0.82	0.11	0.7	0.08	0.44
5	ST LOUIS FINANCIAL STRESS INDEX	0.64	88	23	504	93	0.51	0.04	0.79	0.09	0.7	0.08	0.43
6	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	1.18	70	13	514	111	0.61	0.02	0.58	0.06	0.7	0.06	0.36
7	6 SECTOR CFSI	0.79	106	40	487	75	0.41	0.08	0.54	0.13	0.7	0.09	0.49
8	NATIONAL FINANCIAL CONDITIONS INDEX	1.24	58	11	516	123	0.68	0.02	0.5	0.07	0.7	0.05	0.29
9	CREDIT MARKET FROM 6 SECTOR CFSI	0.77	76	87	440	105	0.58	0.17	0.5	0.39	0.7	0.04	0.21
10	SRISK FROM VLAB	0.88	86	81	446	95	0.52	0.15	0.49	0.32	0.7	0.05	0.28
11	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	1.55	20	68	459	161	0.89	0.13	0.49	1.17	0.7	-0.01	-0.05
12	FX MARKET FROM 6 SECTOR CFSI	0.88	42	91	436	139	0.77	0.17	0.48	0.74	0.7	0	0.02
13	FUNDING MARKET FROM 6 SECTOR CFSI	0.5	75	74	453	106	0.59	0.14	0.33	0.34	0.7	0.04	0.24
14	NFCI: LEVERAGE SUBINDEX	1.71	33	14	513	148	0.82	0.03	0.27	0.15	0.7	0.03	0.15
Panel 4: Daily ($\tau_{B,D}^{lev} = 1.2$ and 4 bins were used for IV)													
1	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.5	698	212	3336	715	0.51	0.06	1.16	0.12	0.7	0.09	0.43
2	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.73	856	361	3187	557	0.39	0.1	0.89	0.17	0.7	0.1	0.5
3	RE MARKET FROM 6 SECTOR CFSI	1	716	253	3295	697	0.49	0.07	0.76	0.14	0.7	0.09	0.43
4	EQUITY MARKET FROM 6 SECTOR CFSI	2	1	0	3548	1412	1	0	0.74	0	0.6	0	0
5	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	1.27	471	23	3525	942	0.67	0.01	0.59	0.02	0.7	0.07	0.33
6	6 SECTOR CFSI	0.91	658	178	3370	755	0.53	0.05	0.51	0.11	0.7	0.08	0.41
7	CREDIT MARKET FROM 6 SECTOR CFSI	0.67	584	666	2882	829	0.59	0.19	0.51	0.45	0.7	0.04	0.21
8	FX MARKET FROM 6 SECTOR CFSI	0.85	341	647	2901	1072	0.76	0.18	0.5	0.76	0.7	0.01	0.05
9	SRISK FROM VLAB	0.5	745	999	2549	668	0.47	0.28	0.49	0.53	0.7	0.04	0.22
10	FUNDING MARKET FROM 6 SECTOR CFSI	0.5	540	511	3037	873	0.62	0.14	0.28	0.38	0.7	0.05	0.23

Table 4

Comparison of financial stress indices' ability to signal stress based on the differenced imbalance and optimal IV.

	Name	$\tau_{F,I}^{lev}$	TP	FP	TN	FN	T1	T2	IV	NTSR	μ	$U_A(\mu)$	$U_R(\mu)$
Panel 1: Quarterly ($\tau_{B,Q}^{lev} = 1$ and 3 bins were used for IV)													
1	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	2	1	0	41	11	0.92	0	0.75	0	0.6	0.01	0.08
2	CFNAI: THREE MONTH MOVING AVERAGE	1.13	2	0	41	10	0.83	0	0.62	0	0.2	0.01	0.17
3	SRISK FROM VLAB	0.02	8	16	25	4	0.33	0.39	0.59	0.59	0.8	0.03	0.22
4	BLOOMBERG FINANCIAL CONDITIONS INDEX	2	1	0	41	11	0.92	0	0.58	0	0.6	0.01	0.08
5	NATIONAL FINANCIAL CONDITIONS INDEX	2	1	0	41	11	0.92	0	0.58	0	0.6	0.01	0.08
6	FUNDING MARKET FROM 6 SECTOR CFSI	0.55	3	6	35	9	0.75	0.15	0.54	0.59	0.7	0.01	0.04
7	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.02	6	21	20	6	0.5	0.51	0.51	1.02	0.8	-0.02	-0.1
8	CFNAI: PRODUCTION AND INCOME	1.29	0	1	40	12	1	0.02	0.51		0.7	-0.01	-0.04
9	FX MARKET FROM 6 SECTOR CFSI	1.05	0	3	38	12	1	0.07	0.5		0.7	-0.02	-0.11
10	CFNAI: DIFFUSION INDEX	0.48	4	6	35	8	0.67	0.15	0.49	0.44	0.7	0.02	0.12
11	LEADING INDEX FOR THE US	0.2	3	10	31	9	0.75	0.24	0.49	0.98	0.7	-0.02	-0.11
12	RE MARKET FROM 6 SECTOR CFSI	0.55	3	0	41	9	0.75	0	0.48	0	0.3	0.02	0.25
13	EQUITY MARKET FROM 6 SECTOR CFSI	0.89	5	2	39	7	0.58	0.05	0.48	0.12	0.7	0.05	0.35
14	6 SECTOR CFSI	1.74	1	0	41	11	0.92	0	0.45	0	0.6	0.01	0.08
15	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	1.31	1	0	41	11	0.92	0	0.45	0	0.6	0.01	0.08
16	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.85	4	1	40	8	0.67	0.02	0.44	0.07	0.7	0.05	0.3
17	CFNAI: SALES, ORDERS, AND INVENTORIES	0.63	2	6	35	10	0.83	0.15	0.44	0.88	0.7	-0.01	-0.05
18	CREDIT MARKET FROM 6 SECTOR CFSI	0.34	7	7	34	5	0.42	0.17	0.43	0.29	0.8	0.05	0.34
19	ST LOUIS FINANCIAL STRESS INDEX	0.46	2	2	39	10	0.83	0.05	0.43	0.29	0.7	0.02	0.1
20	KAMAKURA'S TROUBLED COMPANY INDEX	2	0	0	41	12	1	0	0.43		0.7	0	0
21	KANSAS CITY FINANCIAL STRESS INDEX	0.28	3	5	36	9	0.75	0.12	0.4	0.49	0.7	0.01	0.07
22	CFNAI: PERSONAL CONSUMPTION AND HOUSING	0.18	3	7	34	9	0.75	0.17	0.39	0.68	0.7	0	0
23	NFCI: LEVERAGE SUBINDEX	2	0	0	41	12	1	0	0.28		0.7	0	0
Panel 2: Monthly ($\tau_{B,M}^{lev} = 0.6$ and 3 bins were used for IV)													
1	NATIONAL FINANCIAL CONDITIONS INDEX	0.24	8	5	124	25	0.76	0.04	0.71	0.16	0.8	0.03	0.19
2	KAMAKURA'S TROUBLED COMPANY INDEX	0.12	9	23	106	24	0.73	0.18	0.59	0.65	0.8	0.01	0.08
3	LEADING INDEX FOR THE US	0.18	7	28	101	26	0.79	0.22	0.58	1.02	0.8	0	-0.02
4	CFNAI: DIFFUSION INDEX	0.3	8	29	100	25	0.76	0.22	0.56	0.93	0.8	0	0
5	CFNAI: THREE MONTH MOVING AVERAGE	0.22	6	24	105	27	0.82	0.19	0.54	1.02	0.8	0	-0.02
6	CFNAI: PRODUCTION AND INCOME	0.69	7	30	99	26	0.79	0.23	0.54	1.1	0.8	-0.01	-0.04
7	CFNAI: PERSONAL CONSUMPTION AND HOUSING	0.46	7	19	110	26	0.79	0.15	0.53	0.69	0.8	0.01	0.05
8	ST LOUIS FINANCIAL STRESS INDEX	0.18	10	6	123	23	0.7	0.05	0.51	0.15	0.8	0.04	0.24
9	KANSAS CITY FINANCIAL STRESS INDEX	0.1	14	20	109	19	0.58	0.16	0.51	0.37	0.8	0.04	0.26
10	6 SECTOR CFSI	0.3	11	18	111	22	0.67	0.14	0.51	0.42	0.8	0.03	0.18
11	FUNDING MARKET FROM 6 SECTOR CFSI	0.22	7	12	117	26	0.79	0.09	0.5	0.44	0.8	0.02	0.1
12	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	2	0	0	129	33	1	0	0.5		0.4	0	0
13	SECURITIZATION MARKET FROM 6 SECTOR CFSI	2	0	0	129	33	1	0	0.5		0.4	0	0
14	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.18	12	17	112	21	0.64	0.13	0.49	0.36	0.8	0.03	0.22
15	CFNAI: SALES, ORDERS, AND INVENTORIES	1.56	6	15	114	27	0.82	0.12	0.49	0.64	0.8	0.01	0.05
16	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	0.36	11	26	103	22	0.67	0.2	0.47	0.6	0.8	0.02	0.12
17	EQUITY MARKET FROM 6 SECTOR CFSI	0.42	10	17	112	23	0.7	0.13	0.46	0.43	0.8	0.02	0.16
18	FX MARKET FROM 6 SECTOR CFSI	0.38	5	24	105	28	0.85	0.19	0.46	1.23	0.8	-0.01	-0.05
19	RE MARKET FROM 6 SECTOR CFSI	0.2	9	20	109	24	0.73	0.16	0.44	0.57	0.8	0.02	0.1
20	CREDIT MARKET FROM 6 SECTOR CFSI	0.28	8	20	109	25	0.76	0.16	0.44	0.64	0.8	0.01	0.07
21	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.2	9	11	118	24	0.73	0.09	0.42	0.31	0.8	0.03	0.17
22	SRISK FROM VLAB	0.1	8	11	118	25	0.76	0.09	0.42	0.35	0.8	0.02	0.14
23	NFCI: LEVERAGE SUBINDEX	2	0	0	129	33	1	0	0.35		0.4	0	0
Panel 3: Weekly ($\tau_{B,W}^{lev} = 0.3$ and 4 bins were used for IV)													
1	RE MARKET FROM 6 SECTOR CFSI	0.04	51	116	413	127	0.71	0.22	0.64	0.77	0.7	0	0.01
2	NATIONAL FINANCIAL CONDITIONS INDEX	0.02	71	93	436	107	0.6	0.18	0.58	0.44	0.7	0.03	0.17
3	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.02	87	159	370	91	0.51	0.3	0.58	0.61	0.7	0.02	0.11
4	FUNDING MARKET FROM 6 SECTOR CFSI	0.06	51	92	437	127	0.71	0.17	0.56	0.61	0.7	0.01	0.07
5	6 SECTOR CFSI	0.18	52	82	447	126	0.71	0.16	0.5	0.53	0.7	0.02	0.09
6	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.18	41	92	437	137	0.77	0.17	0.5	0.76	0.7	0	0.01
7	NFCI: LEVERAGE SUBINDEX	0.02	75	151	378	103	0.58	0.29	0.49	0.68	0.7	0.01	0.06
8	EQUITY MARKET FROM 6 SECTOR CFSI	0.26	41	89	440	137	0.77	0.17	0.49	0.73	0.7	0	0.02
9	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.02	96	150	379	82	0.46	0.28	0.47	0.53	0.7	0.03	0.18
10	CREDIT MARKET FROM 6 SECTOR CFSI	0.14	49	86	443	129	0.72	0.16	0.44	0.59	0.7	0.01	0.07
11	FX MARKET FROM 6 SECTOR CFSI	0.28	31	85	444	147	0.83	0.16	0.43	0.92	0.7	-0.01	-0.03
12	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	2	0	0	529	178	1	0	0.43		0.3	0	0
13	ST LOUIS FINANCIAL STRESS INDEX	0.04	64	91	438	114	0.64	0.17	0.42	0.48	0.7	0.02	0.14
14	SRISK FROM VLAB	0.04	43	65	464	135	0.76	0.12	0.3	0.51	0.7	0.01	0.09
Panel 4: Daily ($\tau_{B,D}^{lev} = 0.1$ and 4 bins were used for IV)													
1	FUNDING MARKET FROM 6 SECTOR CFSI	0.04	127	297	3896	640	0.83	0.07	0.54	0.43	0.8	0.01	0.07
2	CREDIT MARKET FROM 6 SECTOR CFSI	0.12	102	290	3903	665	0.87	0.07	0.53	0.52	0.8	0	0.04
3	FX MARKET FROM 6 SECTOR CFSI	0.28	94	317	3876	673	0.88	0.08	0.52	0.62	0.8	0	0.02
4	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.08	111	38	4155	656	0.86	0.01	0.51	0.06	0.8	0.02	0.13
5	6 SECTOR CFSI	0.14	141	246	3947	626	0.82	0.06	0.51	0.32	0.8	0.01	0.1
6	EQUITY MARKET FROM 6 SECTOR CFSI	0.18	147	290	3903	620	0.81	0.07	0.51	0.36	0.8	0.01	0.1
7	RE MARKET FROM 6 SECTOR CFSI	0.02	63	284	3909	704	0.92	0.07	0.51	0.82	0.8	0	-0.01
8	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.28	35	1	4192	732	0.95	0	0.5	0.01	0.8	0.01	0.05
9	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.12	110	275	3918	657	0.86	0.07	0.47	0.46	0.8	0.01	0.05
10	SRISK FROM VLAB	0.08	56	108	4085	711	0.93	0.03	0.45	0.35	0.8	0	0.04

Table 5

Comparison of financial stress indices' ability to signal stress based on the imbalance level and maximization of Usefulness.

	Name	$\tau_{F,I}^{lev}$	TP	FP	TN	FN	T1	T2	IV	NTSR	μ	$U_A(\mu)$	$U_R(\mu)$
Panel 1: Quarterly ($\tau_{B,Q}^{lev} = 1$ and 3 bins were used for IV)													
1	6 SECTOR CFSI	0.61	12	4	34	4	0.25	0.11	0.34	0.14	0.7	0.13	0.64
2	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.73	12	4	34	4	0.25	0.11	0.54	0.14	0.7	0.13	0.64
3	RE MARKET FROM 6 SECTOR CFSI	0.94	9	2	36	7	0.44	0.05		0.09	0.7	0.11	0.51
4	EQUITY MARKET FROM 6 SECTOR CFSI	0.65	11	7	31	5	0.31	0.18	0.46	0.27	0.7	0.1	0.5
5	CFNAI: PERSONAL CONSUMPTION AND HOUSING	1.06	9	4	34	7	0.44	0.11	0.04	0.19	0.7	0.09	0.46
6	CREDIT MARKET FROM 6 SECTOR CFSI	1.05	7	3	35	9	0.56	0.08	0.18	0.18	0.7	0.07	0.36
7	CFNAI: DIFFUSION INDEX	0.67	8	6	32	8	0.5	0.16	0.23	0.32	0.7	0.07	0.34
8	SRISK FROM VLAB	0.62	9	9	29	7	0.44	0.24	0.6	0.42	0.7	0.07	0.32
9	CFNAI: THREE MONTH MOVING AVERAGE	0.85	6	3	35	10	0.63	0.08	0.38	0.21	0.7	0.06	0.29
10	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	0.89	6	3	35	10	0.63	0.08	0.38	0.21	0.7	0.06	0.29
11	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	1.21	5	1	37	11	0.69	0.03	0.74	0.08	0.7	0.06	0.29
12	FUNDING MARKET FROM 6 SECTOR CFSI	1.23	5	1	37	11	0.69	0.03	0.13	0.08	0.7	0.06	0.29
13	ST LOUIS FINANCIAL STRESS INDEX	0.64	6	3	35	10	0.63	0.08		0.21	0.7	0.06	0.29
14	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.5	6	4	34	10	0.63	0.11		0.28	0.7	0.06	0.27
15	LEADING INDEX FOR THE US	0.74	6	4	34	10	0.63	0.11	0.41	0.28	0.7	0.06	0.27
16	NATIONAL FINANCIAL CONDITIONS INDEX	0.86	5	2	36	11	0.69	0.05	0.77	0.17	0.7	0.05	0.26
17	CFNAI: PRODUCTION AND INCOME	1.14	5	2	36	11	0.69	0.05	0.17	0.17	0.7	0.05	0.26
18	KAMAKURA'S TROUBLED COMPANY INDEX	0.83	7	7	31	9	0.56	0.18	0.59	0.42	0.7	0.05	0.25
19	KANSAS CITY FINANCIAL STRESS INDEX	0.61	5	3	35	11	0.69	0.08		0.25	0.7	0.05	0.23
20	CFNAI: SALES, ORDERS, AND INVENTORIES	1.48	4	1	37	12	0.75	0.03	0.03	0.11	0.7	0.05	0.22
21	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.8	5	4	34	11	0.69	0.11	0.04	0.34	0.7	0.04	0.21
22	FX MARKET FROM 6 SECTOR CFSI	0.55	6	10	28	10	0.63	0.26	0.32	0.7	0.7	0.02	0.11
23	NFCI: LEVERAGE SUBINDEX	2	0	0	38	16	1	0	0.31		0.1	0	0
Panel 2: Monthly ($\tau_{B,M}^{lev} = 1$ and 3 bins were used for IV)													
1	6 SECTOR CFSI	0.67	31	10	105	17	0.35	0.09	0.32	0.13	0.7	0.11	0.56
2	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.64	33	14	101	15	0.31	0.12	0.78	0.18	0.7	0.12	0.56
3	RE MARKET FROM 6 SECTOR CFSI	0.65	31	15	100	17	0.35	0.13	0.75	0.2	0.7	0.11	0.51
4	ST LOUIS FINANCIAL STRESS INDEX	0.5	26	11	104	22	0.46	0.1	0.78	0.18	0.7	0.09	0.44
5	EQUITY MARKET FROM 6 SECTOR CFSI	0.53	32	28	87	16	0.33	0.24	0.87	0.37	0.7	0.09	0.42
6	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	1.11	19	1	114	29	0.6	0.01	0.32	0.02	0.7	0.08	0.39
7	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	0.62	23	11	104	25	0.52	0.1	0.31	0.2	0.7	0.08	0.38
8	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.5	21	8	107	27	0.56	0.07	0.83	0.16	0.7	0.08	0.37
9	CFNAI: DIFFUSION INDEX	0.56	25	19	96	23	0.48	0.17	0.38	0.32	0.7	0.07	0.35
10	NATIONAL FINANCIAL CONDITIONS INDEX	0.5	19	6	109	29	0.6	0.05	0.25	0.13	0.7	0.07	0.34
11	KANSAS CITY FINANCIAL STRESS INDEX	0.52	20	11	104	28	0.58	0.1	0.87	0.23	0.7	0.07	0.32
12	SRISK FROM VLAB	0.79	23	20	95	25	0.52	0.17	0.51	0.36	0.7	0.06	0.3
13	CFNAI: PERSONAL CONSUMPTION AND HOUSING	1.12	19	12	103	29	0.6	0.1	0.06	0.26	0.7	0.06	0.29
14	KAMAKURA'S TROUBLED COMPANY INDEX	0.5	23	21	94	25	0.52	0.18	1.74	0.38	0.7	0.06	0.29
15	FUNDING MARKET FROM 6 SECTOR CFSI	0.83	16	7	108	32	0.67	0.06	0.07	0.18	0.7	0.06	0.27
16	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.71	17	9	106	31	0.65	0.08	0.03	0.22	0.7	0.06	0.27
17	LEADING INDEX FOR THE US	0.53	20	16	99	28	0.58	0.14	0.54	0.33	0.7	0.06	0.27
18	CFNAI: THREE MONTH MOVING AVERAGE	0.97	14	5	110	34	0.71	0.04	0.5	0.15	0.7	0.05	0.25
19	CREDIT MARKET FROM 6 SECTOR CFSI	1.33	13	4	111	35	0.73	0.03	0.1	0.13	0.7	0.05	0.24
20	CFNAI: SALES, ORDERS, AND INVENTORIES	0.52	20	22	93	28	0.58	0.19	0.31	0.46	0.7	0.05	0.22
21	CFNAI: PRODUCTION AND INCOME	0.65	15	18	97	33	0.69	0.16	0.19	0.5	0.7	0.03	0.15
22	FX MARKET FROM 6 SECTOR CFSI	0.53	18	31	84	30	0.63	0.27	0.78	0.72	0.7	0.02	0.1
23	NFCI: LEVERAGE SUBINDEX	2	0	0	115	48	1	0	0.1		0.6	0	0
Panel 3: Weekly ($\tau_{B,W}^{lev} = 1.2$ and 4 bins were used for IV)													
1	6 SECTOR CFSI	0.52	136	83	444	45	0.25	0.16	0.59	0.21	0.7	0.1	0.55
2	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.62	128	72	455	53	0.29	0.14	1.07	0.19	0.7	0.1	0.54
3	ST LOUIS FINANCIAL STRESS INDEX	0.5	106	48	479	75	0.41	0.09	0.86	0.16	0.7	0.08	0.47
4	RE MARKET FROM 6 SECTOR CFSI	0.71	114	70	457	67	0.37	0.13	1.07	0.21	0.7	0.08	0.46
5	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.5	97	36	491	84	0.46	0.07	1.43	0.13	0.7	0.08	0.45
6	NATIONAL FINANCIAL CONDITIONS INDEX	0.5	83	29	498	98	0.54	0.06	0.43	0.12	0.7	0.07	0.39
7	EQUITY MARKET FROM 6 SECTOR CFSI	0.52	128	139	388	53	0.29	0.26	1.17	0.37	0.7	0.07	0.38
8	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	1.06	75	19	508	106	0.59	0.04	0.58	0.09	0.7	0.07	0.37
9	FUNDING MARKET FROM 6 SECTOR CFSI	0.8	71	30	497	110	0.61	0.06	0.08	0.15	0.7	0.06	0.32
10	NFCI: LEVERAGE SUBINDEX	0.5	74	50	477	107	0.59	0.09	0.22	0.23	0.7	0.05	0.29
11	SRISK FROM VLAB	0.89	85	77	450	96	0.53	0.15	0.45	0.31	0.7	0.05	0.29
12	CREDIT MARKET FROM 6 SECTOR CFSI	0.94	75	62	465	106	0.59	0.12	0.24	0.28	0.7	0.05	0.27
13	FX MARKET FROM 6 SECTOR CFSI	1.98	10	5	522	171	0.94	0.01	0.08	0.17	0.7	0.01	0.04
14	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	2	0	0	527	181	1	0	0.25		0.1	0	0
Panel 4: Daily ($\tau_{B,D}^{lev} = 1.2$ and 4 bins were used for IV)													
1	6 SECTOR CFSI	0.52	1027	501	3047	386	0.27	0.14	0.38	0.19	0.7	0.11	0.57
2	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.58	942	523	3025	471	0.33	0.15	1	0.22	0.7	0.1	0.51
3	RE MARKET FROM 6 SECTOR CFSI	0.71	842	449	3099	571	0.4	0.13	0.85	0.21	0.7	0.09	0.46
4	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.5	698	212	3336	715	0.51	0.06	1.16	0.12	0.7	0.09	0.43
5	EQUITY MARKET FROM 6 SECTOR CFSI	0.52	978	875	2673	435	0.31	0.25	0.77	0.36	0.7	0.09	0.43
6	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.97	602	171	3377	811	0.57	0.05	0.59	0.11	0.7	0.07	0.37
7	FUNDING MARKET FROM 6 SECTOR CFSI	0.8	507	204	3344	906	0.64	0.06	0.13	0.16	0.7	0.06	0.3
8	SRISK FROM VLAB	0.91	605	502	3046	808	0.57	0.14	0.27	0.33	0.7	0.06	0.28
9	CREDIT MARKET FROM 6 SECTOR CFSI	0.94	558	421	3127	855	0.61	0.12	0.25	0.3	0.7	0.05	0.27
10	FX MARKET FROM 6 SECTOR CFSI	0.79	376	688	2860	1037	0.73	0.19	0.51	0.73	0.7	0.01	0.06

Table 6

Comparison of financial stress indices' ability to signal stress based on the differenced imbalance and maximization of Usefulness.

	Name	$\tau_{F,I}^{lev}$	TP	FP	TN	FN	T1	T2	IV	NTSR	μ	$U_A(\mu)$	$U_R(\mu)$
Panel 1: Quarterly ($\tau_{B,Q}^{lev} = 1$ and 3 bins were used for IV)													
1	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.08	10	12	29	2	0.17	0.29	1.11	0.35	0.8	0.08	0.51
2	6 SECTOR CFSI	0.51	8	5	36	4	0.33	0.12	0.2	0.18	0.7	0.08	0.49
3	RE MARKET FROM 6 SECTOR CFSI	0.22	8	5	36	4	0.33	0.12	0.48	0.18	0.7	0.08	0.49
4	CFNAI: THREE MONTH MOVING AVERAGE	0.04	10	16	25	2	0.17	0.39	1.32	0.47	0.8	0.06	0.41
5	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	0.2	8	8	33	4	0.33	0.2	0.6	0.29	0.8	0.06	0.41
6	CREDIT MARKET FROM 6 SECTOR CFSI	0.46	6	3	38	6	0.5	0.07	0.1	0.15	0.7	0.06	0.39
7	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.04	9	13	28	3	0.25	0.32	1.39	0.42	0.8	0.06	0.39
8	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.02	8	10	31	4	0.33	0.24	1.11	0.37	0.8	0.06	0.37
9	EQUITY MARKET FROM 6 SECTOR CFSI	0.16	8	10	31	4	0.33	0.24	1.31	0.37	0.8	0.06	0.37
10	ST LOUIS FINANCIAL STRESS INDEX	0.14	7	6	35	5	0.42	0.15	0.3	0.25	0.7	0.06	0.37
11	NATIONAL FINANCIAL CONDITIONS INDEX	0.1	6	4	37	6	0.5	0.1	0.42	0.2	0.7	0.06	0.36
12	CFNAI: PRODUCTION AND INCOME	0.24	9	15	26	3	0.25	0.37	1.16	0.49	0.8	0.05	0.34
13	SRISK FROM VLAB	0.04	8	11	30	4	0.33	0.27	1.12	0.4	0.8	0.05	0.34
14	CFNAI: DIFFUSION INDEX	0.73	4	0	41	8	0.67	0	0.35	0	0.3	0.02	0.33
15	KAMAKURA'S TROUBLED COMPANY INDEX	0.06	7	8	33	5	0.42	0.2	0.58	0.33	0.8	0.05	0.32
16	FUNDING MARKET FROM 6 SECTOR CFSI	0.02	8	13	28	4	0.33	0.32	1.55	0.48	0.8	0.05	0.29
17	KANSAS CITY FINANCIAL STRESS INDEX	0.06	6	8	33	6	0.5	0.2	0.4	0.39	0.8	0.03	0.22
18	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.2	6	10	31	6	0.5	0.24	1.16	0.49	0.8	0.03	0.17
19	CFNAI: SALES, ORDERS, AND INVENTORIES	1.15	2	1	40	10	0.83	0.02	0.03	0.15	0.7	0.02	0.13
20	CFNAI: PERSONAL CONSUMPTION AND HOUSING	0.36	2	2	39	10	0.83	0.05	0.09	0.29	0.7	0.02	0.1
21	LEADING INDEX FOR THE US	1.29	1	0	41	11	0.92	0	0.09	0	0.5	0.01	0.08
22	FX MARKET FROM 6 SECTOR CFSI	2	0	0	41	12	1	0	0.32		0.7	0	0
23	NFCI: LEVERAGE SUBINDEX	2	0	0	41	12	1	0	0.28		0.7	0	0
Panel 2: Monthly ($\tau_{B,M}^{lev} = 0.6$ and 3 bins were used for IV)													
1	NATIONAL FINANCIAL CONDITIONS INDEX	0.08	17	15	114	16	0.48	0.12	0.77	0.23	0.8	0.06	0.39
2	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.12	20	31	98	13	0.39	0.24	1.15	0.4	0.8	0.06	0.36
3	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.16	15	12	117	18	0.55	0.09	0.24	0.2	0.8	0.06	0.35
4	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.08	19	30	99	14	0.42	0.23	1.15	0.4	0.8	0.05	0.33
5	FUNDING MARKET FROM 6 SECTOR CFSI	0.12	16	20	109	17	0.52	0.16	0.46	0.32	0.8	0.05	0.32
6	ST LOUIS FINANCIAL STRESS INDEX	0.04	18	28	101	15	0.45	0.22	1.22	0.4	0.8	0.05	0.32
7	EQUITY MARKET FROM 6 SECTOR CFSI	0.04	21	44	85	12	0.36	0.34	1.4	0.54	0.8	0.05	0.29
8	6 SECTOR CFSI	0.2	16	26	103	17	0.52	0.2	0.66	0.42	0.8	0.04	0.27
9	KANSAS CITY FINANCIAL STRESS INDEX	0.06	16	26	103	17	0.52	0.2	0.72	0.42	0.8	0.04	0.27
10	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.06	17	31	98	16	0.48	0.24	0.98	0.47	0.8	0.04	0.26
11	SRISK FROM VLAB	0.06	14	25	104	19	0.58	0.19	0.77	0.46	0.8	0.03	0.22
12	CFNAI: SALES, ORDERS, AND INVENTORIES	0.67	15	35	94	18	0.55	0.27	1.16	0.6	0.8	0.03	0.17
13	CFNAI: PERSONAL CONSUMPTION AND HOUSING	0.04	20	57	72	13	0.39	0.44	1.08	0.73	0.8	0.02	0.16
14	RE MARKET FROM 6 SECTOR CFSI	0.18	11	22	107	22	0.67	0.17	0.44	0.51	0.8	0.02	0.15
15	CREDIT MARKET FROM 6 SECTOR CFSI	0.61	6	3	126	27	0.82	0.02	0.04	0.13	0.7	0.02	0.14
16	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	0.4	11	23	106	22	0.67	0.18	0.35	0.53	0.8	0.02	0.14
17	KAMAKURA'S TROUBLED COMPANY INDEX	0.14	9	17	112	24	0.73	0.13	0.31	0.48	0.8	0.02	0.12
18	CFNAI: PRODUCTION AND INCOME	1.8	4	4	125	29	0.88	0.03	0.07	0.26	0.8	0.01	0.07
19	CFNAI: THREE MONTH MOVING AVERAGE	0.3	5	10	119	28	0.85	0.08	0.09	0.51	0.8	0.01	0.05
20	LEADING INDEX FOR THE US	0.3	5	11	118	28	0.85	0.09	0.06	0.56	0.8	0.01	0.05
21	CFNAI: DIFFUSION INDEX	0.53	4	9	120	29	0.88	0.07	0.05	0.58	0.8	0	0.03
22	FX MARKET FROM 6 SECTOR CFSI	2	0	0	129	33	1	0	0.11		0.1	0	0
23	NFCI: LEVERAGE SUBINDEX	2	0	0	129	33	1	0	0.35		0.1	0	0
Panel 3: Weekly ($\tau_{B,W}^{lev} = 0.3$ and 4 bins were used for IV)													
1	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.1	51	30	499	127	0.71	0.06	0.12	0.2	0.7	0.04	0.21
2	NATIONAL FINANCIAL CONDITIONS INDEX	0.04	48	38	491	130	0.73	0.07	0.2	0.27	0.7	0.03	0.18
3	ST LOUIS FINANCIAL STRESS INDEX	0.06	54	53	476	124	0.7	0.1	0.14	0.33	0.7	0.03	0.18
4	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.1	45	34	495	133	0.75	0.06	0.11	0.25	0.7	0.03	0.17
5	NFCI: LEVERAGE SUBINDEX	0.04	56	77	452	122	0.69	0.15	0.41	0.46	0.7	0.02	0.13
6	SRISK FROM VLAB	0.06	38	36	493	140	0.79	0.07	0.12	0.32	0.7	0.02	0.13
7	6 SECTOR CFSI	0.16	58	90	439	120	0.67	0.17	0.52	0.52	0.7	0.02	0.11
8	CREDIT MARKET FROM 6 SECTOR CFSI	0.26	27	27	502	151	0.85	0.05	0.09	0.34	0.7	0.02	0.09
9	FUNDING MARKET FROM 6 SECTOR CFSI	0.12	30	36	493	148	0.83	0.07	0.17	0.4	0.7	0.01	0.08
10	EQUITY MARKET FROM 6 SECTOR CFSI	0.34	38	59	470	140	0.79	0.11	0.21	0.52	0.7	0.01	0.07
11	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.34	20	31	498	158	0.89	0.06	0.1	0.52	0.7	0.01	0.04
12	RE MARKET FROM 6 SECTOR CFSI	0.06	36	72	457	142	0.8	0.14	0.26	0.67	0.7	0.01	0.03
13	FX MARKET FROM 6 SECTOR CFSI	0.34	29	62	467	149	0.84	0.12	0.21	0.72	0.7	0	0.01
14	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	2	0	0	529	178	1	0	0.43		0.1	0	0
Panel 4: Daily ($\tau_{B,D}^{lev} = 0.1$ and 4 bins were used for IV)													
1	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.02	390	627	3566	377	0.49	0.15	1.46	0.29	0.8	0.04	0.3
2	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.04	293	312	3881	474	0.62	0.07	0.62	0.19	0.8	0.03	0.28
3	SRISK FROM VLAB	0.02	250	500	3693	517	0.67	0.12	0.92	0.37	0.8	0.02	0.16
4	6 SECTOR CFSI	0.02	378	1064	3129	389	0.51	0.25	1.79	0.51	0.8	0.02	0.15
5	EQUITY MARKET FROM 6 SECTOR CFSI	0	420	1282	2911	347	0.45	0.31	2.14	0.56	0.8	0.02	0.13
6	FUNDING MARKET FROM 6 SECTOR CFSI	0.02	227	594	3599	540	0.7	0.14	1.01	0.48	0.8	0.01	0.1
7	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.06	209	628	3565	558	0.73	0.15	1.04	0.55	0.8	0.01	0.07
8	CREDIT MARKET FROM 6 SECTOR CFSI	0.02	317	1085	3108	450	0.59	0.26	1.84	0.63	0.8	0.01	0.06
9	RE MARKET FROM 6 SECTOR CFSI	0	369	1383	2810	398	0.52	0.33	2.23	0.69	0.8	0	0.03
10	FX MARKET FROM 6 SECTOR CFSI	0.46	47	115	4078	720	0.94	0.03	0.27	0.45	0.8	0	0.02

Table 7

Accuracy of forecasts.

Name	RMSE	MAE	MAPE
NATIONAL FINANCIAL CONDITIONS INDEX	0.56	0.36	0.73
KANSAS CITY FINANCIAL STRESS INDEX	0.64	0.41	0.78
KAMAKURA'S TROUBLED COMPANY INDEX	0.41	0.3	0.95
GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.59	0.36	1.02
LEADING INDEX FOR THE US	1.07	0.61	3.03
6 SECTOR CFSI	1.7	1.24	3.15
CFNAI: DIFFUSION INDEX	0.64	0.51	5.02
BLOOMBERG FINANCIAL CONDITIONS INDEX	0.84	0.51	5.23

Table 8

Evaluation of the Usefulness of a collection of stress measures in sample and out of sample.

Name	$\tau_{M,i}^{lev}$	TP	FP	TN	FN	T1	T2	IV	NTSR	μ	$U_a(\mu)$	$U_R(\mu)$
Panel 1: In Sample (1992M05 to 2004M01)												
KAMAKURA'S TROUBLED COMPANY INDEX	1.23	18	4	87	32	0.64	0.04	0.19	0.12	0.6	0.07	0.31
6 SECTOR CFSI	1.19	16	3	88	34	0.68	0.03	0.13	0.1	0.6	0.06	0.28
BLOOMBERG FINANCIAL CONDITIONS INDEX	1	19	8	83	31	0.62	0.09	0.06	0.23	0.6	0.06	0.27
GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.68	17	9	82	33	0.66	0.1	0.19	0.29	0.6	0.05	0.22
CFNAI: DIFFUSION INDEX	0.62	16	9	82	34	0.68	0.1	0.17	0.31	0.6	0.04	0.2
LEADING INDEX FOR THE US	0.58	18	14	77	32	0.64	0.15	0.14	0.43	0.6	0.04	0.17
KANSAS CITY FINANCIAL STRESS INDEX	1.04	16	13	78	34	0.68	0.14	0.08	0.45	0.6	0.03	0.15
NATIONAL FINANCIAL CONDITIONS INDEX	1.57	2	0	91	48	0.96	0	0.06	0	0.5	0.01	0.04
Panel 2: Out of Sample (2004M02 to 2013M12)												
KANSAS CITY FINANCIAL STRESS INDEX	1.04	15	4	84	12	0.52	0.05	0.42	0.09	0.6	0.06	0.4
6 SECTOR CFSI	1.19	11	0	88	15	0.65	0	0.72	0	0.6	0.06	0.35
KAMAKURA'S TROUBLED COMPANY INDEX	1.23	10	0	88	18	0.68	0	0.19	0	0.6	0.05	0.32
GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.68	11	2	86	18	0.65	0.02	0.4	0.06	0.6	0.05	0.31
NATIONAL FINANCIAL CONDITIONS INDEX	1.57	9	0	88	13	0.71	0	0.87	0	0.5	0.04	0.29
BLOOMBERG FINANCIAL CONDITIONS INDEX	1	0	5	83	31	1	0.06	1.06		0.6	-0.02	-0.11
CFNAI: DIFFUSION INDEX	0.62	6	28	60	28	0.81	0.32	1.98	1.64	0.6	-0.06	-0.41
LEADING INDEX FOR THE US	0.58	4	28	60	30	0.87	0.32	1.8	2.47	0.6	-0.07	-0.47

Appendix A. Robustness testing

Table A.1

Comparison of financial stress indices' ability to signal stress based on the imbalance level and optimal IV for the robustness sample.

	Name	$\tau_{F,I}^{lev}$	TP	FP	TN	FN	T1	T2	IV	NTSR	μ	$U_A(\mu)$	$U_R(\mu)$
Panel 1: Quarterly ($\tau_{B,Q}^{lev} = 1$ and 3 bins were used for IV)													
1	SECURITIZATION MARKET FROM 6 SECTOR CFSI	2	3	0	68	15	0.83	0		0	0.2	0.01	0.17
2	BLOOMBERG FINANCIAL CONDITIONS INDEX	2	3	1	67	15	0.83	0.01		0.09	0.7	0.02	0.14
3	KANSAS CITY FINANCIAL STRESS INDEX	2	3	1	67	15	0.83	0.01		0.09	0.7	0.02	0.14
4	FX MARKET FROM 6 SECTOR CFSI	2	1	3	65	17	0.94	0.04	1.33	0.79	0.7	0	-0.02
5	CFNAI: DIFFUSION INDEX	2	4	1	67	14	0.78	0.01	0.77	0.07	0.7	0.03	0.2
6	NATIONAL FINANCIAL CONDITIONS INDEX	0.62	8	3	65	10	0.56	0.04	0.73	0.1	0.7	0.05	0.37
7	NFCI: LEVERAGE SUBINDEX	0.59	3	14	54	15	0.83	0.21	0.54	1.24	0.8	-0.01	-0.09
8	CFNAI: PERSONAL CONSUMPTION AND HOUSING	0.94	9	9	59	9	0.5	0.13	0.53	0.26	0.8	0.05	0.34
9	KAMAKURA'S TROUBLED COMPANY INDEX	1.88	2	2	66	16	0.89	0.03	0.53	0.26	0.7	0.01	0.06
10	RE MARKET FROM 6 SECTOR CFSI	1.68	0	5	63	18	1	0.07	0.53		0.7	-0.02	-0.12
11	6 SECTOR CFSI	1.09	10	3	65	8	0.44	0.04	0.52	0.08	0.8	0.08	0.49
12	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	2	3	0	68	15	0.83	0	0.5	0	0.2	0.01	0.17
13	EQUITY MARKET FROM 6 SECTOR CFSI	1.21	11	8	60	7	0.39	0.12	0.5	0.19	0.8	0.07	0.47
14	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	1.11	3	7	61	15	0.83	0.1	0.49	0.62	0.8	0	0.01
15	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.8	5	8	60	13	0.72	0.12	0.48	0.42	0.8	0.02	0.12
16	CFNAI: THREE MONTH MOVING AVERAGE	2	3	0	68	15	0.83	0	0.47	0	0.2	0.01	0.17
17	CREDIT MARKET FROM 6 SECTOR CFSI	0.67	9	9	59	9	0.5	0.13	0.47	0.26	0.8	0.05	0.34
18	LEADING INDEX FOR THE US	0.95	6	6	62	12	0.67	0.09	0.41	0.26	0.8	0.03	0.21
19	FUNDING MARKET FROM 6 SECTOR CFSI	1.09	5	1	67	13	0.72	0.01	0.35	0.05	0.7	0.04	0.25
20	CFNAI: SALES, ORDERS, AND INVENTORIES	0.71	5	7	61	13	0.72	0.1	0.22	0.37	0.8	0.02	0.13
21	CFNAI: PRODUCTION AND INCOME	0.79	5	6	62	13	0.72	0.09	0.19	0.32	0.8	0.02	0.15
Panel 2: Monthly ($\tau_{B,M}^{lev} = 1$ and 3 bins were used for IV)													
1	FX MARKET FROM 6 SECTOR CFSI	2	4	8	195	53	0.93	0.04	1.35	0.56	0.7	0	0.01
2	EQUITY MARKET FROM 6 SECTOR CFSI	1.39	20	20	183	37	0.65	0.1	0.89	0.28	0.7	0.03	0.2
3	SECURITIZATION MARKET FROM 6 SECTOR CFSI	1.26	31	10	193	26	0.46	0.05	0.74	0.09	0.7	0.07	0.47
4	KANSAS CITY FINANCIAL STRESS INDEX	1.06	16	3	200	41	0.72	0.01	0.61	0.05	0.7	0.04	0.26
5	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.8	28	9	194	29	0.51	0.04	0.56	0.09	0.7	0.07	0.42
6	6 SECTOR CFSI	1.06	27	8	195	30	0.53	0.04	0.52	0.08	0.7	0.06	0.41
7	CFNAI: DIFFUSION INDEX	1.91	12	4	199	45	0.79	0.02	0.51	0.09	0.7	0.03	0.18
8	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	1.47	12	5	198	45	0.79	0.02	0.5	0.12	0.7	0.03	0.17
9	CFNAI: THREE MONTH MOVING AVERAGE	1.26	14	9	194	43	0.75	0.04	0.5	0.18	0.7	0.03	0.18
10	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.62	19	31	172	38	0.67	0.15	0.5	0.46	0.7	0.02	0.1
11	CREDIT MARKET FROM 6 SECTOR CFSI	0.65	21	35	168	36	0.63	0.17	0.5	0.47	0.8	0.02	0.12
12	NFCI: LEVERAGE SUBINDEX	0.52	13	49	154	44	0.77	0.24	0.5	1.06	0.8	-0.02	-0.11
13	RE MARKET FROM 6 SECTOR CFSI	2	0	4	199	57	1	0.02	0.5		0.7	0	-0.03
14	NATIONAL FINANCIAL CONDITIONS INDEX	0.52	23	16	187	34	0.6	0.08	0.49	0.2	0.7	0.04	0.28
15	LEADING INDEX FOR THE US	1.45	11	8	195	46	0.81	0.04	0.49	0.2	0.7	0.02	0.13
16	CFNAI: PERSONAL CONSUMPTION AND HOUSING	1.02	22	26	177	35	0.61	0.13	0.49	0.33	0.7	0.03	0.19
17	KAMAKURA'S TROUBLED COMPANY INDEX	1.98	5	6	197	52	0.91	0.03	0.49	0.34	0.7	0.01	0.04
18	CFNAI: PRODUCTION AND INCOME	0.52	23	38	165	34	0.6	0.19	0.48	0.46	0.8	0.02	0.14
19	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.5	27	27	176	30	0.53	0.13	0.47	0.28	0.8	0.04	0.28
20	CFNAI: SALES, ORDERS, AND INVENTORIES	0.85	16	27	176	41	0.72	0.13	0.44	0.47	0.7	0.01	0.08
21	FUNDING MARKET FROM 6 SECTOR CFSI	1.11	14	5	198	43	0.75	0.02	0.08	0.1	0.7	0.03	0.21
Panel 3: Weekly ($\tau_{B,W}^{lev} = 1.2$ and 4 bins were used for IV)													
1	EQUITY MARKET FROM 6 SECTOR CFSI	2	6	17	891	217	0.97	0.02	1.19	0.7	0.8	0	0.01
2	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.88	111	40	868	112	0.5	0.04	0.66	0.09	0.8	0.07	0.45
3	6 SECTOR CFSI	0.97	127	51	857	96	0.43	0.06	0.64	0.1	0.8	0.08	0.51
4	RE MARKET FROM 6 SECTOR CFSI	2	0	19	889	223	1	0.02	0.58		0.8	0	-0.02
5	FX MARKET FROM 6 SECTOR CFSI	2	16	28	880	207	0.93	0.03	0.55	0.43	0.8	0.01	0.04
6	SECURITIZATION MARKET FROM 6 SECTOR CFSI	1.32	106	42	866	117	0.52	0.05	0.53	0.1	0.8	0.07	0.43
7	NFCI: LEVERAGE SUBINDEX	0.7	82	114	794	141	0.63	0.13	0.5	0.34	0.8	0.04	0.24
8	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	1	45	136	772	178	0.8	0.15	0.5	0.74	0.8	0.01	0.05
9	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.74	88	70	838	135	0.61	0.08	0.49	0.2	0.8	0.05	0.32
10	CREDIT MARKET FROM 6 SECTOR CFSI	0.89	75	83	825	148	0.66	0.09	0.49	0.27	0.8	0.04	0.24
11	FUNDING MARKET FROM 6 SECTOR CFSI	0.5	87	108	800	136	0.61	0.12	0.48	0.3	0.8	0.04	0.27
12	NATIONAL FINANCIAL CONDITIONS INDEX	1.98	43	5	903	180	0.81	0.01	0.43	0.03	0.8	0.03	0.19
Panel 4: Daily ($\tau_{B,D}^{lev} = 1.2$ and 4 bins were used for IV)													
1	EQUITY MARKET FROM 6 SECTOR CFSI	0.82	1086	1096	5025	708	0.39	0.18	0.89	0.3	0.8	0.06	0.36
2	RE MARKET FROM 6 SECTOR CFSI	2	0	132	5989	1794	1	0.02	0.54	65535	0.7	-0.01	-0.03
3	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.59	804	675	5446	990	0.55	0.11	0.51	0.25	0.7	0.05	0.29
4	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.77	902	340	5781	892	0.5	0.06	0.5	0.11	0.7	0.07	0.42
5	6 SECTOR CFSI	0.73	1122	548	5573	672	0.37	0.09	0.5	0.14	0.7	0.08	0.49
6	SECURITIZATION MARKET FROM 6 SECTOR CFSI	1.09	958	560	5561	836	0.47	0.09	0.5	0.17	0.7	0.06	0.4
7	FX MARKET FROM 6 SECTOR CFSI	1.88	147	251	5870	1647	0.92	0.04	0.5	0.5	0.7	0	0.02
8	CREDIT MARKET FROM 6 SECTOR CFSI	0.82	607	675	5446	1187	0.66	0.11	0.49	0.33	0.7	0.03	0.18
9	FUNDING MARKET FROM 6 SECTOR CFSI	0.5	627	729	5392	1167	0.65	0.12	0.36	0.34	0.7	0.03	0.18

Table A.2

Comparison of financial stress indices' ability to signal stress based on the differenced imbalance and optimal IV for the robustness sample.

	Name	$\tau_{F,I}^{lev}$	TP	FP	TN	FN	T1	T2	IV	NTSR	μ	$U_A(\mu)$	$U_R(\mu)$
Panel 1: Quarterly ($\tau_{B,Q}^{lev} = 1$ and 3 bins were used for IV)													
1	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	2	1	0	68	16	0.94	0	0.89	0	0.2	0	0.06
2	EQUITY MARKET FROM 6 SECTOR CFSI	1.64	3	2	66	14	0.82	0.03	0.79	0.17	0.8	0.02	0.15
3	6 SECTOR CFSI	1.7	3	0	68	14	0.82	0	0.6	0	0.2	0.01	0.18
4	CFNAI: PERSONAL CONSUMPTION AND HOUSING	0.16	4	15	53	13	0.76	0.22	0.57	0.94	0.8	0	0.01
5	KAMAKURA'S TROUBLED COMPANY INDEX	0.14	6	13	55	11	0.65	0.19	0.55	0.54	0.8	0.03	0.16
6	CFNAI: DIFFUSION INDEX	0.42	5	12	56	12	0.71	0.18	0.55	0.6	0.8	0.02	0.12
7	CREDIT MARKET FROM 6 SECTOR CFSI	0.36	10	11	57	7	0.41	0.16	0.54	0.28	0.8	0.07	0.43
8	NATIONAL FINANCIAL CONDITIONS INDEX	0.34	6	7	61	11	0.65	0.1	0.54	0.29	0.8	0.04	0.25
9	FX MARKET FROM 6 SECTOR CFSI	0.77	2	10	58	15	0.88	0.15	0.54	1.25	0.8	0	-0.03
10	RE MARKET FROM 6 SECTOR CFSI	0.16	7	8	60	10	0.59	0.12	0.53	0.29	0.8	0.05	0.29
11	CFNAI: SALES, ORDERS, AND INVENTORIES	0.61	5	12	56	12	0.71	0.18	0.53	0.6	0.8	0.02	0.12
12	FUNDING MARKET FROM 6 SECTOR CFSI	0.61	3	8	60	14	0.82	0.12	0.53	0.67	0.8	0.01	0.06
13	CFNAI: THREE MONTH MOVING AVERAGE	0.44	4	7	61	13	0.76	0.1	0.52	0.44	0.8	0.02	0.13
14	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.69	5	1	67	12	0.71	0.01	0.51	0.05	0.8	0.04	0.28
15	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.65	2	6	62	15	0.88	0.09	0.51	0.75	0.8	0	0.03
16	KANSAS CITY FINANCIAL STRESS INDEX	0.28	4	9	59	13	0.76	0.13	0.49	0.56	0.8	0.02	0.1
17	LEADING INDEX FOR THE US	0.28	3	13	55	14	0.82	0.19	0.48	1.08	0.8	0	-0.01
18	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.57	3	7	61	14	0.82	0.1	0.47	0.58	0.8	0.01	0.07
19	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	0.55	4	8	60	13	0.76	0.12	0.46	0.5	0.8	0.02	0.12
20	CFNAI: PRODUCTION AND INCOME	0.95	1	4	64	16	0.94	0.06	0.46	1	0.8	0	0
21	NFCI: LEVERAGE SUBINDEX	0.14	2	13	55	15	0.88	0.19	0.39	1.63	0.8	-0.01	-0.07
Panel 2: Monthly ($\tau_{B,M}^{lev} = 0.6$ and 3 bins were used for IV)													
1	NFCI: LEVERAGE SUBINDEX	0.04	9	47	155	48	0.84	0.23	0.6	1.47	0.8	-0.03	-0.18
2	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	0.36	16	48	154	41	0.72	0.24	0.57	0.85	0.8	-0.01	-0.05
3	KAMAKURA'S TROUBLED COMPANY INDEX	0.1	20	38	164	37	0.65	0.19	0.56	0.54	0.8	0.01	0.08
4	KANSAS CITY FINANCIAL STRESS INDEX	0.12	19	34	168	38	0.67	0.17	0.53	0.5	0.8	0.01	0.08
5	CFNAI: PERSONAL CONSUMPTION AND HOUSING	0.4	14	40	162	43	0.75	0.2	0.53	0.81	0.8	-0.01	-0.05
6	FUNDING MARKET FROM 6 SECTOR CFSI	0.42	9	13	189	48	0.84	0.06	0.52	0.41	0.7	0.01	0.06
7	LEADING INDEX FOR THE US	0.18	10	48	154	47	0.82	0.24	0.51	1.35	0.8	-0.03	-0.17
8	EQUITY MARKET FROM 6 SECTOR CFSI	0.48	20	30	172	37	0.65	0.15	0.5	0.42	0.7	0.02	0.13
9	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.24	18	24	178	39	0.68	0.12	0.49	0.38	0.7	0.02	0.14
10	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.12	26	38	164	31	0.54	0.19	0.49	0.41	0.8	0.03	0.2
11	FX MARKET FROM 6 SECTOR CFSI	0.3	11	36	166	46	0.81	0.18	0.49	0.92	0.7	-0.01	-0.08
12	NATIONAL FINANCIAL CONDITIONS INDEX	0.1	23	26	176	34	0.6	0.13	0.48	0.32	0.7	0.03	0.21
13	6 SECTOR CFSI	0.42	20	26	176	37	0.65	0.13	0.48	0.37	0.7	0.02	0.16
14	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.14	21	36	166	36	0.63	0.18	0.47	0.48	0.8	0.02	0.11
15	CREDIT MARKET FROM 6 SECTOR CFSI	0.26	17	39	163	40	0.7	0.19	0.47	0.65	0.8	0	0.01
16	CFNAI: SALES, ORDERS, AND INVENTORIES	1.47	10	27	175	47	0.82	0.13	0.47	0.76	0.7	0	-0.03
17	RE MARKET FROM 6 SECTOR CFSI	0.1	14	40	162	43	0.75	0.2	0.47	0.81	0.8	-0.01	-0.05
18	CFNAI: PRODUCTION AND INCOME	0.79	11	46	156	46	0.81	0.23	0.46	1.18	0.8	-0.02	-0.14
19	CFNAI: THREE MONTH MOVING AVERAGE	0.24	7	41	161	50	0.88	0.2	0.44	1.65	0.7	-0.03	-0.19
20	CFNAI: DIFFUSION INDEX	0.34	7	37	165	50	0.88	0.18	0.43	1.49	0.7	-0.02	-0.16
21	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.12	21	33	169	36	0.63	0.16	0.42	0.44	0.8	0.02	0.12
Panel 3: Weekly ($\tau_{B,W}^{lev} = 0.3$ and 4 bins were used for IV)													
1	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	2	0	0	860	270	1	0			0.3	0	0
2	NATIONAL FINANCIAL CONDITIONS INDEX	0.02	116	198	662	154	0.57	0.23	0.65	0.54	0.7	0.02	0.12
3	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.06	94	162	698	176	0.65	0.19	0.6	0.54	0.7	0.02	0.09
4	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.16	56	142	718	214	0.79	0.17	0.52	0.8	0.7	0	-0.02
5	CREDIT MARKET FROM 6 SECTOR CFSI	0.2	46	129	731	224	0.83	0.15	0.52	0.88	0.7	-0.01	-0.03
6	6 SECTOR CFSI	0.24	66	122	738	204	0.76	0.14	0.51	0.58	0.7	0.01	0.05
7	FX MARKET FROM 6 SECTOR CFSI	0.18	62	157	703	208	0.77	0.18	0.5	0.8	0.7	0	-0.02
8	EQUITY MARKET FROM 6 SECTOR CFSI	0.3	68	146	714	202	0.75	0.17	0.49	0.67	0.7	0	0.02
9	FUNDING MARKET FROM 6 SECTOR CFSI	0.1	60	133	727	210	0.78	0.15	0.48	0.7	0.7	0	0.01
10	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.08	77	100	760	193	0.71	0.12	0.39	0.41	0.7	0.02	0.13
11	NFCI: LEVERAGE SUBINDEX	0.04	73	118	742	197	0.73	0.14	0.38	0.51	0.7	0.01	0.08
12	RE MARKET FROM 6 SECTOR CFSI	0.04	48	114	746	222	0.82	0.13	0.35	0.75	0.7	0	0
Panel 4: Daily ($\tau_{B,D}^{lev} = 0.1$ and 4 bins were used for IV)													
1	FUNDING MARKET FROM 6 SECTOR CFSI	0.06	127	427	6392	968	0.88	0.06	0.55	0.54	0.8	0	0.02
2	CREDIT MARKET FROM 6 SECTOR CFSI	0.14	129	461	6358	966	0.88	0.07	0.53	0.57	0.8	0	0.01
3	EQUITY MARKET FROM 6 SECTOR CFSI	0.24	186	364	6455	909	0.83	0.05	0.51	0.31	0.8	0.01	0.09
4	FX MARKET FROM 6 SECTOR CFSI	0.24	111	399	6420	984	0.9	0.06	0.51	0.58	0.8	0	0.01
5	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.1	116	47	6772	979	0.89	0.01	0.5	0.07	0.8	0.01	0.1
6	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.1	151	424	6395	944	0.86	0.06	0.5	0.45	0.8	0	0.04
7	6 SECTOR CFSI	0.2	175	289	6530	920	0.84	0.04	0.47	0.27	0.8	0.01	0.09
8	BLOOMBERG FINANCIAL CONDITIONS INDEX	2	0	0	6819	1095	1	0	0.47		0.6	0	0
9	RE MARKET FROM 6 SECTOR CFSI	0.02	43	211	6608	1052	0.96	0.03	0.3	0.79	0.8	0	-0.01

Table A.3

Comparison of financial stress indices' ability to signal stress based on the imbalance level and maximization of Usefulness for the robustness sample.

	Name	$\tau_{F,I}^{lev}$	TP	FP	TN	FN	T1	T2	IV	NTSR	μ	$U_A(\mu)$	$U_R(\mu)$
Panel 1: Quarterly ($\tau_{B,Q}^{lev} = 1$ and 3 bins were used for IV)													
1	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.89	15	6	62	3	0.17	0.09		0.11	0.8	0.12	0.74
2	6 SECTOR CFSI	0.85	13	4	64	5	0.28	0.06	0.37	0.08	0.8	0.1	0.65
3	EQUITY MARKET FROM 6 SECTOR CFSI	1.02	12	9	59	6	0.33	0.13	0.5	0.2	0.8	0.08	0.51
4	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	0.62	10	5	63	8	0.44	0.07	0.31	0.13	0.8	0.07	0.46
5	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.82	9	4	64	9	0.5	0.06		0.12	0.8	0.07	0.41
6	CFNAI: PERSONAL CONSUMPTION AND HOUSING	1.55	9	4	64	9	0.5	0.06	0.25	0.12	0.8	0.07	0.41
7	FX MARKET FROM 6 SECTOR CFSI	0.67	12	16	52	6	0.33	0.24	1.57	0.35	0.8	0.07	0.41
8	CREDIT MARKET FROM 6 SECTOR CFSI	0.83	9	5	63	9	0.5	0.07	0.32	0.15	0.8	0.06	0.4
9	NATIONAL FINANCIAL CONDITIONS INDEX	0.62	8	3	65	10	0.56	0.04	0.73	0.1	0.7	0.05	0.37
10	LEADING INDEX FOR THE US	0.62	9	7	61	9	0.5	0.1	0.24	0.21	0.8	0.06	0.37
11	CFNAI: DIFFUSION INDEX	0.53	9	8	60	9	0.5	0.12	0.91	0.24	0.8	0.06	0.35
12	KANSAS CITY FINANCIAL STRESS INDEX	0.62	8	7	61	10	0.56	0.1		0.23	0.8	0.05	0.31
13	KAMAKURA'S TROUBLED COMPANY INDEX	0.79	9	11	57	9	0.5	0.16	0.7	0.32	0.8	0.05	0.31
14	CFNAI: THREE MONTH MOVING AVERAGE	0.53	7	5	63	11	0.61	0.07	0.56	0.19	0.8	0.04	0.28
15	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	1.24	5	1	67	13	0.72	0.01	0.17	0.05	0.7	0.04	0.25
16	FUNDING MARKET FROM 6 SECTOR CFSI	1.09	5	1	67	13	0.72	0.01	0.35	0.05	0.7	0.04	0.25
17	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.79	7	8	60	11	0.61	0.12	0.25	0.3	0.8	0.04	0.24
18	CFNAI: PRODUCTION AND INCOME	1.5	5	2	66	13	0.72	0.03	0.01	0.11	0.7	0.03	0.23
19	CFNAI: SALES, ORDERS, AND INVENTORIES	1.85	4	1	67	14	0.78	0.01	0.04	0.07	0.7	0.03	0.2
20	RE MARKET FROM 6 SECTOR CFSI	0.5	4	12	56	14	0.78	0.18	0.82	0.79	0.8	0	0
21	NFCI: LEVERAGE SUBINDEX	0.98	3	11	57	15	0.83	0.16	0.3	0.97	0.8	-0.01	-0.04
Panel 2: Monthly ($\tau_{B,M}^{lev} = 1$ and 3 bins were used for IV)													
1	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.56	46	38	165	11	0.19	0.19	1.32	0.23	0.8	0.09	0.6
2	6 SECTOR CFSI	0.56	40	24	179	17	0.3	0.12	0.64	0.17	0.8	0.09	0.55
3	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.73	33	16	187	24	0.42	0.08	0.64	0.14	0.7	0.07	0.46
4	EQUITY MARKET FROM 6 SECTOR CFSI	0.67	36	42	161	21	0.37	0.21	1.11	0.33	0.8	0.06	0.38
5	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	0.5	31	26	177	26	0.46	0.13	0.56	0.24	0.8	0.06	0.36
6	CFNAI: DIFFUSION INDEX	0.56	29	24	179	28	0.49	0.12	0.62	0.23	0.8	0.05	0.33
7	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	1.11	19	1	202	38	0.67	0	0.05	0.01	0.7	0.05	0.33
8	NATIONAL FINANCIAL CONDITIONS INDEX	0.71	22	7	196	35	0.61	0.03	0.24	0.09	0.7	0.05	0.33
9	LEADING INDEX FOR THE US	0.5	28	22	181	29	0.51	0.11	0.4	0.22	0.7	0.05	0.33
10	KANSAS CITY FINANCIAL STRESS INDEX	0.5	28	27	176	29	0.51	0.13	1.07	0.27	0.8	0.05	0.3
11	FX MARKET FROM 6 SECTOR CFSI	0.5	32	53	150	25	0.44	0.26	2.01	0.47	0.8	0.04	0.25
12	CFNAI: PERSONAL CONSUMPTION AND HOUSING	1.58	19	12	191	38	0.67	0.06	0.19	0.18	0.7	0.04	0.24
13	CFNAI: THREE MONTH MOVING AVERAGE	0.53	20	15	188	37	0.65	0.07	0.5	0.21	0.7	0.04	0.24
14	FUNDING MARKET FROM 6 SECTOR CFSI	0.76	17	9	194	40	0.7	0.04	0.06	0.15	0.7	0.04	0.23
15	CREDIT MARKET FROM 6 SECTOR CFSI	1.15	15	7	196	42	0.74	0.03	0.25	0.13	0.7	0.03	0.21
16	KAMAKURA'S TROUBLED COMPANY INDEX	1.17	22	23	180	35	0.61	0.11	0.49	0.29	0.7	0.03	0.21
17	CFNAI: SALES, ORDERS, AND INVENTORIES	0.64	22	30	173	35	0.61	0.15	0.35	0.38	0.8	0.03	0.16
18	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.77	19	24	179	38	0.67	0.12	0.31	0.35	0.7	0.02	0.15
19	CFNAI: PRODUCTION AND INCOME	0.55	23	36	167	34	0.6	0.18	0.42	0.44	0.8	0.02	0.15
20	RE MARKET FROM 6 SECTOR CFSI	0.5	16	36	167	41	0.72	0.18	1.07	0.63	0.8	0	0.01
21	NFCI: LEVERAGE SUBINDEX	2	5	16	187	52	0.91	0.08	0.04	0.9	0.7	-0.01	-0.03
Panel 3: Weekly ($\tau_{B,W}^{lev} = 1.2$ and 4 bins were used for IV)													
1	6 SECTOR CFSI	0.56	158	126	782	65	0.29	0.14	1.19	0.2	0.8	0.09	0.57
2	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.52	143	93	815	80	0.36	0.1	0.92	0.16	0.8	0.08	0.54
3	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.85	152	141	767	71	0.32	0.16	1.19	0.23	0.8	0.08	0.52
4	EQUITY MARKET FROM 6 SECTOR CFSI	0.5	156	224	684	67	0.3	0.25	1.32	0.35	0.8	0.07	0.45
5	NATIONAL FINANCIAL CONDITIONS INDEX	0.52	110	64	844	113	0.51	0.07	0.37	0.14	0.8	0.07	0.42
6	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.5	110	127	781	113	0.51	0.14	0.85	0.28	0.8	0.06	0.35
7	FUNDING MARKET FROM 6 SECTOR CFSI	0.7	77	53	855	146	0.65	0.06	0.18	0.17	0.8	0.05	0.29
8	CREDIT MARKET FROM 6 SECTOR CFSI	0.73	89	121	787	134	0.6	0.13	0.69	0.33	0.8	0.04	0.26
9	NFCI: LEVERAGE SUBINDEX	0.67	85	117	791	138	0.62	0.13	0.5	0.34	0.8	0.04	0.25
10	FX MARKET FROM 6 SECTOR CFSI	0.52	108	261	647	115	0.52	0.29	1.63	0.59	0.8	0.03	0.19
11	RE MARKET FROM 6 SECTOR CFSI	0.52	61	163	745	162	0.73	0.18	1.37	0.66	0.8	0.01	0.09
12	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.62	53	156	752	170	0.76	0.17	0.61	0.72	0.8	0.01	0.06
Panel 4: Daily ($\tau_{B,D}^{lev} = 1.2$ and 4 bins were used for IV)													
1	6 SECTOR CFSI	0.73	1122	548	5573	672	0.37	0.09	0.5	0.14	0.7	0.08	0.49
2	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.5	1070	595	5526	724	0.4	0.1	0.63	0.16	0.7	0.07	0.45
3	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.55	1249	1348	4773	545	0.3	0.22	0.82	0.32	0.8	0.07	0.42
4	EQUITY MARKET FROM 6 SECTOR CFSI	0.5	1199	1472	4649	595	0.33	0.24	0.97	0.36	0.8	0.06	0.37
5	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.67	775	532	5589	1019	0.57	0.09	0.37	0.2	0.7	0.05	0.3
6	FUNDING MARKET FROM 6 SECTOR CFSI	0.71	563	344	5777	1231	0.69	0.06	0.15	0.18	0.7	0.04	0.23
7	CREDIT MARKET FROM 6 SECTOR CFSI	1.11	475	240	5881	1319	0.74	0.04	0.27	0.15	0.7	0.03	0.21
8	FX MARKET FROM 6 SECTOR CFSI	0.5	919	1715	4406	875	0.49	0.28	1.17	0.55	0.8	0.02	0.15
9	RE MARKET FROM 6 SECTOR CFSI	0.61	388	865	5256	1406	0.78	0.14	0.91	0.65	0.7	0	0.01

Table A.4

Comparison of financial stress indices' ability to signal stress based on the differenced imbalance and maximization of Usefulness for the robustness sample.

	Name	$\tau_{F,I}^{lev}$	TP	FP	TN	FN	T1	T2	IV	NTSR	μ	$U_A(\mu)$	$U_R(\mu)$
Panel 1: Quarterly ($\tau_{B,Q}^{lev} = 1$ and 3 bins were used for IV)													
1	6 SECTOR CFSI	0.36	12	14	54	5	0.29	0.21	1.22	0.29	0.8	0.08	0.5
2	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.16	12	16	52	5	0.29	0.24	1.51	0.33	0.8	0.08	0.47
3	CREDIT MARKET FROM 6 SECTOR CFSI	0.48	9	5	63	8	0.47	0.07	0.11	0.14	0.8	0.07	0.46
4	NATIONAL FINANCIAL CONDITIONS INDEX	0.1	10	11	57	7	0.41	0.16	0.54	0.28	0.8	0.07	0.43
5	EQUITY MARKET FROM 6 SECTOR CFSI	0.18	12	20	48	5	0.29	0.29	1.97	0.42	0.8	0.07	0.41
6	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.06	12	21	47	5	0.29	0.31	1.75	0.44	0.8	0.06	0.4
7	RE MARKET FROM 6 SECTOR CFSI	0.14	8	9	59	9	0.53	0.13	0.53	0.28	0.8	0.05	0.34
8	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.02	11	22	46	6	0.35	0.32	1.72	0.5	0.8	0.05	0.32
9	CFNAI: THREE MONTH MOVING AVERAGE	0.26	9	16	52	8	0.47	0.24	0.96	0.44	0.8	0.05	0.29
10	CFNAI: PRODUCTION AND INCOME	0.28	11	25	43	6	0.35	0.37	1.11	0.57	0.8	0.04	0.28
11	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	0.24	8	14	54	9	0.53	0.21	0.65	0.44	0.8	0.04	0.26
12	FUNDING MARKET FROM 6 SECTOR CFSI	0.34	8	14	54	9	0.53	0.21	0.62	0.44	0.8	0.04	0.26
13	KANSAS CITY FINANCIAL STRESS INDEX	0.08	8	15	53	9	0.53	0.22	0.68	0.47	0.8	0.04	0.25
14	KAMAKURA'S TROUBLED COMPANY INDEX	0.26	6	7	61	11	0.65	0.1	0.11	0.29	0.8	0.04	0.25
15	CFNAI: DIFFUSION INDEX	0.67	5	4	64	12	0.71	0.06	0.04	0.2	0.8	0.04	0.24
16	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.22	7	16	52	10	0.59	0.24	0.88	0.57	0.8	0.03	0.18
17	CFNAI: SALES, ORDERS, AND INVENTORIES	1.15	3	1	67	14	0.82	0.01	0	0.08	0.8	0.03	0.16
18	CFNAI: PERSONAL CONSUMPTION AND HOUSING	0.44	2	2	66	15	0.88	0.03	0.03	0.25	0.8	0.01	0.09
19	LEADING INDEX FOR THE US	0.32	3	6	62	14	0.82	0.09	0.05	0.5	0.8	0.01	0.09
20	FX MARKET FROM 6 SECTOR CFSI	0.26	6	20	48	11	0.65	0.29	1.2	0.83	0.8	0.01	0.06
21	NFCI: LEVERAGE SUBINDEX	2	0	0	68	17	1	0	0.34		0.1	0	0
Panel 2: Monthly ($\tau_{B,M}^{lev} = 0.6$ and 3 bins were used for IV)													
1	FUNDING MARKET FROM 6 SECTOR CFSI	0.12	30	43	159	27	0.47	0.21	0.79	0.4	0.8	0.04	0.25
2	6 SECTOR CFSI	0.22	30	45	157	27	0.47	0.22	0.77	0.42	0.8	0.04	0.24
3	EQUITY MARKET FROM 6 SECTOR CFSI	0.04	36	72	130	21	0.37	0.36	1.18	0.56	0.8	0.04	0.23
4	NATIONAL FINANCIAL CONDITIONS INDEX	0.04	31	54	148	26	0.46	0.27	1.19	0.49	0.8	0.03	0.22
5	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.12	26	38	164	31	0.54	0.19	0.49	0.41	0.8	0.03	0.2
6	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.1	29	49	153	28	0.49	0.24	0.96	0.48	0.8	0.03	0.2
7	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.18	20	22	180	37	0.65	0.11	0.2	0.31	0.7	0.03	0.19
8	KANSAS CITY FINANCIAL STRESS INDEX	0.26	14	9	193	43	0.75	0.04	0.06	0.18	0.7	0.03	0.18
9	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	0.36	9	4	198	48	0.84	0.02	0.05	0.13	0.7	0.02	0.13
10	KAMAKURA'S TROUBLED COMPANY INDEX	0.12	20	32	170	37	0.65	0.16	0.38	0.45	0.7	0.02	0.11
11	CREDIT MARKET FROM 6 SECTOR CFSI	0	32	82	120	25	0.44	0.41	1.11	0.72	0.8	0.02	0.1
12	CFNAI: PRODUCTION AND INCOME	1.96	6	4	198	51	0.89	0.02	0.11	0.19	0.7	0.01	0.08
13	CFNAI: SALES, ORDERS, AND INVENTORIES	1.84	10	13	189	47	0.82	0.06	0.13	0.37	0.7	0.01	0.08
14	CFNAI: PERSONAL CONSUMPTION AND HOUSING	1.43	2	2	200	55	0.96	0.01	0.01	0.28	0.7	0	0.02
15	CFNAI: THREE MONTH MOVING AVERAGE	0.51	3	4	198	54	0.95	0.02	0.03	0.38	0.7	0	0.02
16	CFNAI: EMPLOYMENT, UNEMPLOYMENT, AND HOURS	2	1	0	202	56	0.98	0	0	0	0.1	0	0.02
17	LEADING INDEX FOR THE US	0.51	2	2	200	55	0.96	0.01	0.06	0.28	0.7	0	0.02
18	CFNAI: DIFFUSION INDEX	0.69	2	4	198	55	0.96	0.02	0	0.56	0.7	0	0.01
19	FX MARKET FROM 6 SECTOR CFSI	0.63	6	13	189	51	0.89	0.06	0.09	0.61	0.7	0	0.01
20	NFCI: LEVERAGE SUBINDEX	2	0	0	202	57	1	0	0.11		0.1	0	0
21	RE MARKET FROM 6 SECTOR CFSI	2	0	0	202	57	1	0	0.01		0.1	0	0
Panel 3: Weekly ($\tau_{B,W}^{lev} = 0.3$ and 4 bins were used for IV)													
1	NATIONAL FINANCIAL CONDITIONS INDEX	0.04	83	79	781	187	0.69	0.09	0.22	0.3	0.7	0.03	0.18
2	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.12	65	60	800	205	0.76	0.07	0.09	0.29	0.7	0.02	0.15
3	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.08	77	100	760	193	0.71	0.12	0.39	0.41	0.7	0.02	0.13
4	NFCI: LEVERAGE SUBINDEX	0.04	73	118	742	197	0.73	0.14	0.38	0.51	0.7	0.01	0.08
5	6 SECTOR CFSI	0.16	96	181	679	174	0.64	0.21	0.78	0.59	0.7	0.01	0.07
6	EQUITY MARKET FROM 6 SECTOR CFSI	0.42	54	93	767	216	0.8	0.11	0.23	0.54	0.7	0.01	0.05
7	FUNDING MARKET FROM 6 SECTOR CFSI	0.12	54	96	764	216	0.8	0.11	0.26	0.56	0.7	0.01	0.05
8	CREDIT MARKET FROM 6 SECTOR CFSI	0.57	11	7	853	259	0.96	0.01	0.05	0.2	0.7	0	0.03
9	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.4	12	12	848	258	0.96	0.01	0.05	0.31	0.7	0	0.03
10	FX MARKET FROM 6 SECTOR CFSI	0.24	50	104	756	220	0.81	0.12	0.2	0.65	0.7	0	0.02
11	RE MARKET FROM 6 SECTOR CFSI	0.06	26	55	805	244	0.9	0.06	0.13	0.66	0.7	0	0.01
12	NFCI: NONFINANCIAL LEVERAGE SUBINDEX	2	0	0	860	270	1	0			0.3	0	0
Panel 4: Daily ($\tau_{B,D}^{lev} = 0.1$ and 4 bins were used for IV)													
1	GOLDMAN SACHS FINANCIAL CONDITIONS INDEX	0.02	520	972	5847	575	0.53	0.14	1.61	0.3	0.8	0.03	0.25
2	BLOOMBERG FINANCIAL CONDITIONS INDEX	0.04	443	805	6014	652	0.6	0.12	1.06	0.29	0.8	0.02	0.22
3	6 SECTOR CFSI	0.1	345	826	5993	750	0.68	0.12	1.04	0.38	0.8	0.01	0.13
4	EQUITY MARKET FROM 6 SECTOR CFSI	0.12	335	846	5973	760	0.69	0.12	1.02	0.41	0.8	0.01	0.11
5	SECURITIZATION MARKET FROM 6 SECTOR CFSI	0.14	99	194	6625	996	0.91	0.03	0.3	0.31	0.8	0.01	0.05
6	FX MARKET FROM 6 SECTOR CFSI	0.42	53	131	6688	1042	0.95	0.02	0.28	0.4	0.8	0	0.02
7	FUNDING MARKET FROM 6 SECTOR CFSI	0.02	333	1225	5594	762	0.7	0.18	1.54	0.59	0.8	0	0.02
8	CREDIT MARKET FROM 6 SECTOR CFSI	0.24	60	182	6637	1035	0.95	0.03	0.29	0.49	0.8	0	0.01
9	RE MARKET FROM 6 SECTOR CFSI	0.04	7	23	6796	1088	0.99	0	0.16	0.53	0.8	0	0