Global Credit Review
Vol. 2 (2012) 109–167

DOI: 10.1142/S2010493612500079

NUS-RMI Credit Research Initiative Technical Report

Version: 2012 update 2

RMI staff article
For any questions or comments on this article, please contact Oliver Chen at
ochen@nus.edu.sg

INTRODUCTION

This document describes the implementation of the system which the NUS Risk Management Institute's Credit Research Initiative uses to produce probabilities of default (PDs). As of this version of the Technical Report, these PDs cover exchange listed firms in 44 economies in Asia, Asia-Pacific, North America, Europe and Latin America. Currently, RMI covers over 35,000 listed companies. Of these, over 28,000 firms have sufficient data to release daily updated PDs. The full list of firms is freely available to users who can give evidence of their professional qualifications to ensure that they will not misuse the data. General users who do not request global access are restricted to a list of 2,300 firms. The individual company PD data along with aggregate PDs at the economy and sector level can be accessed at http://rmicri.org.

The primary goal of this initiative is to drive research and development in the critical area of credit rating systems. As such, a transparent methodology is essential to this initiative. Having the details of the methodology available to everybody means that there is a base from which suggestions and improvements can be made. The objective of this Technical Report is to provide a full exposition of the CRI system. Readers of this document who have access to the necessary data and who have a sufficient level of technical expertise will be able to implement a similar system on their own. For a full exposition of the conceptual framework of the CRI, see Duan and Van Laere (2012).

The system used by the CRI will evolve as new innovations and enhancements are applied. The most substantial changes to the 2011 technical report and operational implementation of our model are (1) the default definition which now excludes covenant breaches and some default corporate actions that are specific to Taiwan (e.g., bounced checks); (2) priority of financial statements and treatment of net income, with the latter now being included on a quarterly basis when available; (3) treatment of stale market capitalization prices; (4) regrouping of economies for calibration purposes; (5) increased coverage to include Latin America and the rest of the eurozone countries; and (6) treatment of relative size. This version of the technical report provides an update on the operational implementation of the CRI and includes all changes to the system that had been implemented by July 2012. The latest version of the Technical Report is available via the web portal and will include any changes to the system that have been implemented since the publication of this version.

The remainder of this Technical Report is organized as follows. The next section describes the quantitative model that is currently used to compute PDs from the CRI. The model was first described in Duan *et al*. (2012). The description includes calibration procedures, which are performed on a monthly basis, and individual firm PD computations, which are performed on a daily basis.

Section 2 describes the input variables of the model as well as the data used to produce the variables for input into the model. This model uses both input variables that are common to all firms in an economy and input variables that are firm-specific. Another critical component when calibrating a probability of default estimation system is the default data, and this is also described in this section.

While Section 1 provides a broader description of the model, Section 3 describes the implementation details that are necessary to apply given real world issues of, for example, bad or missing data. The specific technical details needed to develop an operational system are also given, including details on the monthly calibration, daily computation of individual firm PDs and aggregation of the individual firm PDs. Distance-to-default (DTD) in a Merton-type model is one of the firm-specific variables. The calculation for DTD is not the standard one, and has been modified to allow a meaningful computation of the DTD for financial firms. While most academic studies on default prediction exclude financial firms from consideration, it is important to include them given that the financial sector is a critical component in every economy. The calculation for DTD is detailed in this section.

Section 4 shows an empirical analysis for those economies that are currently covered. While the analysis shows excellent results in several economies, there is room for improvement in a few others. This is because, at the CRI's current stage of development, the economies all use the variables used in the academic study of US firms in Duan *et al*. (2012). Future development within the CRI will deal with variable selection specific to different economies, and the performance is then expected to improve. Variable selection and other planned developments are discussed in Section 5.

I. MODEL DESCRIPTION

The quantitative model that is currently being used by the CRI is a forward intensity model that was introduced in Duan *et al*. (2012). This model allows probability of default forecasts to be made at a range of horizons. In the current CRI implementation of this model, PDs are made from a horizon of one month up to a horizon of two years. In other words, for every firm, the probability of that firm defaulting within one month, three months, six months, one year, eighteen months and two years is given. The ability to assess credit quality for different horizons is a useful tool for risk management, credit portfolio management, policy setting and regulatory purposes, since short- and long-term credit risk profiles can differ greatly depending on a firm's liquidity, debt structures and other factors.

The forward intensity model is a reduced form model in which the probability of default is computed as a function of different input variables. These can be firm-specific or common to all firms within an economy. The other category of default prediction model is the structural model, whereby the corporate structure of a firm is modeled in order to assess the firm's probability of default.

A similar reduced form model by Duffie *et al*. (2007) relied on modeling the time series dynamics of the input variables in order to make PD forecasts for different horizons. However, there is little consensus on assumptions for the dynamics of variables such as accounting ratios, and the model output will be highly dependent on these assumptions. In addition, the time series dynamics will be of very high dimension. For example, with the two common variables and two firm-specific variables that Duffie *et al*. (2007) use, a sample of 10,000 firms gives a dimension of the state variables of 20,002.

Given the complexity in modeling the dynamics of variables such as accounting ratios, this model will be diffcult to implement if different forecast horizons are required. The key innovation of the forward intensity model is that PD for different horizons can be consistently and effciently computed based only on the value of the input variables at the time the prediction is made. Thus, the model specification becomes far more tractable.

Fully specifying a reduced form model includes the specification of the function that computes a PD from the input variables. This function is parameterized, and finding appropriate parameter values is called calibrating the model. The forward intensity model can be calibrated by maximizing a pseudo-likelihood function. The calibration is carried out by economy and all firms within an economy will use the same parameter values along with each firm's variables in order to compute the firm's PD.

Subsection 1.1 will describe the modeling framework, including the way PDs are computed based on a set of parameter values for the economy and a set of input variables for a firm. Subsection 1.2 explains how the model can be calibrated.

1.1. Modeling Framework

While the model can be formulated in a continuous time framework, as done in Duan *et al*. (2012), an operational implementation will require discretization in time. Since the model is more easily understood in discrete time, the following exposition of the model will begin in a discrete time framework.

Variables for default prediction can have vastly different update frequencies. Financial statement data is updated only once a quarter or even once a year, while market data like stock prices are available at frequencies of seconds. A way of compromising between these two extremes is to have a fundamental time period Δt of one month in the modeling framework. As will be seen later, this does not preclude updating the PD forecasts on a daily basis. This is important since, for example, large daily changes in a firm's stock price can signal changes in credit quality even when there is no change in financial statement data.

Thus, for the purposes of calibration and subsequently for computing time series of PD, the input variables at the end of each month will be kept for each firm. The input variables associated with the i^{th} firm at the end of the n^{th} month (at time $t = n\Delta t$) is denoted by $X_i(n)$. This is a vector consisting of two parts: $X_i(n) = (W(n), U_i(n))$. Here, $W(n)$ is a vector of variables at the end of month n that is common to all firms in the economy and $U_i(n)$ is a vector of variables specific to firm i.

In the forward intensity model, a firm's default is signaled by a jump in a Poisson process. The probability of a jump in the Poisson process is determined by the intensity of the Poisson process. The forward intensity model draws an explicit dependence of intensities at time periods in the future (that is, forward intensities) to the value of input variables at the time of prediction. With forward intensities, PDs for any forecast horizon can be computed knowing only the value of the input variable at the time of prediction, without needing to simulate future values of the input variables.

There is a direct analogy in interest rate modeling. In spot rate models where dynamics on a short-term spot rate are specified, bond pricing requires expectations on realizations of the short rate. Alternatively, bond prices can be computed directly if the forward rate curve is known.

One issue in default prediction is that firms can exit public exchanges for reasons other than default. For example, in mergers and acquisitions involving two public companies, there will be one company that delists from its stock exchange. This is important in predicting defaults because a default cannot happen if a firm has been previously delisted. An exception is if the exit is a distressed exit and is followed soon after by a credit event. See Subsection 2.4 for details on how this case is handled in the CRI system.

In order to take these other exits into account, defaults and other exits are modeled as two independent Poisson processes, each with their own intensity. While defaults and exits classified as non-defaults are mutually exclusive by definition, the assumption of independent Poisson processes does not pose a problem since the probability of a simultaneous jump in the two Poisson processes is negligible. In the discrete time framework, the probability of simultaneous jumps in the same time interval is non-zero. As a modeling assumption, a simultaneous jump in the same time interval by both the default Poisson process and the non-default type exit Poisson process is considered as a default. In this way, there are three mutually exclusive possibilities during each time interval: survival, default and non-default exit. As with defaults, the forward intensity of the Poisson process for other exits is a function of the input variables. The parameters of this function can also be calibrated.

To further illustrate the discrete framework, the three possibilities for a firm at each time point are diagrammed. Either the firm survives for the next time period Δt, or it defaults within Δt, or it has a non-default exit within Δt. This setup is pictured in Figure 1. Information about firm i is known up until time $t = m\Delta t$ and the figure illustrates possibilities in the future between $t = (n - 1)\Delta t$ and $(n + 1)\Delta t$. Here, m and n are integers with $m < n$.

The probabilities of each branch are, for example: $p_i(m, n)$ the conditional probability viewed from $t = m\Delta t$ that firm i will default before $(n + 1)\Delta t$, conditioned on firm i surviving up until $n\Delta t$. Likewise, $\bar{p}_i(m, n)$ is the conditional probability viewed from $t = m\Delta t$ that firm i will have a non-default exit before $(n + 1)\Delta t$, conditioned on firm i surviving up until $n\Delta t$. It is the modeler's objective to determine $p_i(m, n)$ and $\bar{p}_i(m, n)$, but for now it is assumed that these quantities are known. With the conditional default and other exit probabilities known, the corresponding conditional survival probability of firm i is $1 - p_i(m, n) - \bar{p}_i(m,n)$.

With this diagram in mind, the probability that a particular path will be followed is the product of the conditional probabilities along the path. For example, the probability at time $t = m\Delta t$ of firm i surviving until $(n - 1)\Delta t$ and then defaulting between $(n - 1)\Delta t$ and $n\Delta t$ is:

$$Prob_{t=m\Delta t}[\tau_i = n, \tau_i < \bar{\tau}_i] = p_i(m, n-1) \prod_{j=m}^{n-2} [1 - p_i(m, j) - \bar{p}_i(m, j)]. \qquad (1)$$

Here, τ_i is the default time for firm i measured in units of months, $\bar{\tau}_i$ is the other exit time measured in units of months, and the product is equal to one if there are no terms in the product. The condition $\tau_i < \bar{\tau}_i$ is the requirement that the firm defaults before it has a non-default type of exit. Note that by measuring exits in units of months, if, for example, a default occurs at any time in the interval $((n - 1)\Delta t, n\Delta t]$ then $\tau_i = n$.

Using equation (1), cumulative default probabilities can be computed. At $m\Delta t$ the probability of firm i defaulting at or before $n\Delta t$ and not having

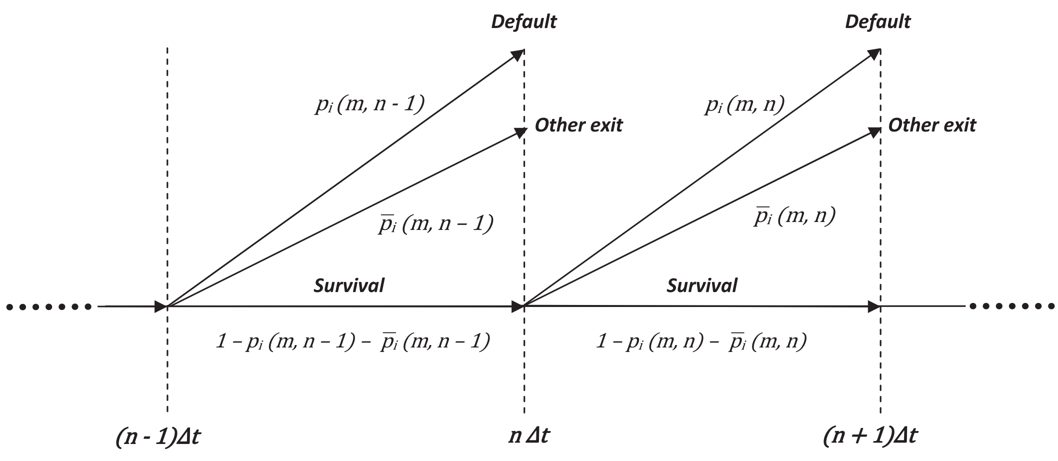

Figure 1. Default-other exit-survival tree for firm i, viewed from time $t = m\Delta t$.

another exit before $t = n\Delta t$ is obtained by taking the sum of all of the paths that lead to default at or before $n\Delta t$:

$$Prob_{t=m\Delta t}[m < \tau_i \le n, \tau_i < \overline{\tau}_i] = \sum_{k=m}^{n-1} \left\{ p_i(m,k) \prod_{j=m}^{k-1} [1 - p_i(m,j) - \overline{p}_i(m,j)] \right\}. \quad (2)$$

While it is convenient to derive the probabilities given in equations (1) and (2) in terms of the conditional probabilities, expressions for these in terms of the forward intensities need to be found, since the forward intensities will be functions of the input variable $X_i(m)$. The forward intensity for the default of firm i that is observed at time $t = m\Delta t$ for the forward time interval from $t = n\Delta t$ to $(n + 1)\Delta t$, is denoted by $h_i(m, n)$ where $m \le n$. The corresponding forward intensity for a non-default exit is denoted in $\overline{h}_i(m, n)$. Because default is signaled by a jump by a Poisson process, its conditional probability is a simple function of its forward intensity:

$$p_i(m,n) = 1 - \exp[-\Delta t\, h_i(m,n)]. \quad (3)$$

Since joint jumps in the same time interval are assigned as defaults, the conditional other exit probability needs to take this into account:

$$\overline{p}_i(m,n) = \exp[-\Delta t\, h_i(m,n)]\{1 - \exp[-\Delta t\, \overline{h}_i(m,n)]\}. \quad (4)$$

The conditional survival probabilities in equations (1) and (2) are computed as the conditional probability that the firm does not default in the period and the firm does not have a non-default exit either:

$$Prob_{t=m\Delta t}[\tau_i, \overline{\tau}_i > n+1 \,|\, \tau_i, \overline{\tau}_i > n] = \exp\{-\Delta t[h_i(m,n) + \overline{h}_i(m,n)]\}. \quad (5)$$

It remains to specify the dependence of the forward intensities on the input variable $X_i(m)$. The forward intensities need to be positive so that the conditional probabilities are non-negative. A standard way to impose this constraint is to specify the forward intensities as exponentials of a linear combination of the input variables:

$$h_i(m,n) = \exp[\beta(n-m) \cdot Y_i(m)],$$
$$\overline{h}_i(m,n) = \exp[\overline{\beta}(n-m) \cdot Y_i(m)]. \quad (6)$$

Here, β and $\bar{\beta}$ are coefficient vectors that are functions of the number of months between the observation date and the beginning of the forward period $(n - m)$, and $Y_i(m)$ is simply the vector $X_i(m)$ augmented by a preceding unit element: $Y_i(m) = (1, X_i(m))$. The unit element allows the linear combination in the argument of the exponentials in equation (6) to have a non-zero intercept.

In the current implementation of the forward intensity model in the CRI, the maximum forecast horizon is 24 months and there are 12 input variables plus the intercept. So there are 24 sets of each of the coefficient vectors denoted by $\beta(0), \ldots, \bar{\beta}(23)$ and $\bar{\beta}(0), \ldots, \bar{\beta}(23)$ and each of these coefficient vectors has 13 elements. While this is a large set of parameters, as will be seen in the next part, the calibration is tractable because the parameters for each horizon can be done independently from each other, and the default parameters can be calibrated separately from the other exit parameters.

Before giving the probabilities in (1) and (2) in terms of the forward intensities, a notation is introduced for the forward intensities that makes clear which parameters are needed for the forward intensity in question:

$$H(\beta(n-m), X_i(m)) := \exp[\beta(n-m) \cdot Y_i(m)]. \quad (7)$$

This is the forward default intensity. The corresponding notation for other exit forward intensities is then just $H(\bar{\beta}(n - m), X_i(m))$. So, the probability in (1) is expressed in terms of the forward intensities, using

(3) for the conditional default probability and (5) for the conditional survival probability:

$$
\begin{aligned}
&Prob_{t=m\Delta t}[\tau_i = n, \tau_i < \bar{\tau}_i] \\
&\quad = \{1 - \exp[-\Delta t\, H(\beta(n-1-m), X_i(m))]\} \\
&\qquad \times \prod_{j=m}^{n-2} \exp\{-\Delta t\,[H(\beta(j-m), X_i(m)) \\
&\qquad + H(\bar{\beta}(j-m), X_i(m))]\} \\
&\quad = \{1 - \exp[-\Delta t\, H(\beta(n-m-1), X_i(m))]\} \\
&\qquad \times \exp\left\{-\Delta t \sum_{j=m}^{n-2} [H(\beta(j-m), X_i(m)) \right. \\
&\qquad \left. + H(\bar{\beta}(j-m), X_i(m))]\right\}. \quad (8)
\end{aligned}
$$

This probability will be relevant in the next part during the calibration. The cumulative default probability given in equation (2) in terms of the forward intensities is then:

$$
\begin{aligned}
&Prob_{t=m\Delta t}[m < \tau_i \le n, \tau_i < \bar{\tau}_i] \\
&\quad = \sum_{k=m}^{n-1} \left\{ \{1 - \exp[-\Delta t\, H(\beta(k-m), X_i(m))]\} \right. \\
&\qquad \times \exp\left\{-\Delta t \sum_{j=m}^{k-1} [H(\beta(j-m), X_i(m)) \right. \\
&\qquad \left.\left. + H(\bar{\beta}(j-m), X_i(m))] \right\}\right\}. \quad (9)
\end{aligned}
$$

This formula is used to compute the main output of the CRI: an individual firm's PD within various time horizons. The β and $\bar{\beta}$ parameters are obtained when the firm's economy is calibrated, and using those together with the firm's input variables yields the firm's PD.

1.2. Model Calibration

The empirical dataset used for calibration can be described as follows. For the economy as a whole, there are N end of month observations, indexed as $n = 1,\ldots, N$. Of course, not all firms will have observations for each of the N months as they may start later than the start of the economy's dataset or they may exit before the end of the economy's dataset. There are a total of I firms in the economy, and they are indexed as $i = 1,\ldots, I$. As before, the input variables for the i^{th} firm in the n^{th} month is $X_i(n)$. The set of all observations for all firms is denoted by X.

In addition, the default times τ_i and non-default exit times $\bar{\tau}_i$ for the i^{th} firm are known if the default or other exit occurs after time $t = \Delta t$ and at or before $t = N\Delta t$. The possible values for τ_i and $\bar{\tau}_i$ are integers between 2 and N, inclusive. If a firm exits before the month end, then the exit time is recorded as the first month end after the exit. If the firm does not exit before $t = N\Delta t$, then the convention can be used such that both of these values are infinite. If the firm has a default type of exit within the dataset, then $\bar{\tau}_i$ can be considered as infinite. If instead the firm has a non-default type of exit within the dataset, then τ_i can be considered as infinite. The set of all default times and non-default exit times for all firms is denoted by τ and $\bar{\tau}$, respectively. The first month in which firm i has an observation is denoted by t_{0i}. Except for cases of missing data, these observations continue until the end of the dataset if the firm never exits. If the firm does exit, the last needed input variable $X_i(n)$ is for $n = \min(\tau_i, \bar{\tau}_i) - 1$.

The calibration of the β and $\bar{\beta}$ parameters is done by maximizing a pseudo-likelihood function. The function to be maximized violates the standard assumptions of likelihood functions, but Appendix A in Duan *et al*. (2012) derives the large sample properties of the pseudo-likelihood function.

In formulating the pseudo-likelihood function, the assumption is made that the firms are conditionally independent from each other. In other words, correlations arise naturally from sharing common factors $W(n)$ and any correlations there are between different firms' firm-specific variables. With this assumption, the pseudo-likelihood function for a horizon of ℓ months, a set of parameters β and $\bar{\beta}$ and the dataset $(\tau, \bar{\tau}, X)$ is:

$$
\mathcal{L}_\ell(\beta,\bar{\beta};\tau,\bar{\tau},X) = \prod_{m=1}^{N-\ell}\prod_{i=1}^{I} P_\ell(\beta,\bar{\beta};\tau_i,\bar{\tau}_i,X_i(m)). \quad (10)
$$

Here, $P_\ell(\beta, \bar{\beta}; \tau_i, \bar{\tau}_i, X_i(m))$ is a probability for firm i, with the nature of the probability depending on what happens to the firm during the period from month m to month $m + \ell$. This is defined as:

$$
\begin{aligned}
&P_\ell(\beta,\bar{\beta};\tau_i,\bar{\tau}_i,X_i(m)) \\
&= 1_{\{t_{0i}\le m,\min(\tau,\bar{\tau})>m+\ell\}} \\
&\quad \times \exp\left\{-\Delta t \sum_{j=0}^{\ell-1}[H(\beta(j),X_i(m))+H(\bar{\beta}(j),X_i(m))]\right\} \\
&+ 1_{\{t_{0i}\le m,\tau_i\le\bar{\tau}_i,\tau_i\le m+\ell\}}\{1-\exp[-\Delta t\, H(\beta(\tau_i-m-1),X_i(m))]\} \\
&\quad \times \exp\left\{-\Delta t \sum_{j=0}^{\tau_i-m-2}[H(\beta(j),X_i(m))+H(\bar{\beta}(j),X_i(m))]\right\} \\
&+ 1_{\{t_{0i}\le m,\bar{\tau}_i\le\tau_i,\bar{\tau}_i\le m+\ell\}}\{1-\exp[-\Delta t\, H(\bar{\beta}(\bar{\tau}_i-m-1),X_i(m))]\} \\
&\quad \times \exp[-\Delta t\, H(\beta(\tau_i-m-1),X_i(m))] \\
&\quad \times \exp\left\{-\Delta t \sum_{j=0}^{\bar{\tau}_i-m-2}[H(\beta(j),X_i(m))+H(\bar{\beta}(j),X_i(m))]\right\} \\
&+ 1_{\{t_{0i}>m\}} + 1_{\{\min(\tau_i,\bar{\tau}_i)\le m\}}. \qquad (11)
\end{aligned}
$$

In words, if firm i survives from the observation time at month m for the full horizon ℓ until at least $m + \ell$, then the probability is the model-based survival probability for this period. This is the first term in (11). The second term handles the cases where the firm has a default within the horizon, in which case the probability is the model-based probability of the firm defaulting at the month that it ends up defaulting, as given in equation (8). The third term handles the cases where the firm has a non-default exit within the horizon, in which case the probability is the model-based probability of the firm having a non-default type exit at the month that the exit actually does occur. The expression for this probability uses the conditional non-default type exit probability given in equation (4). The final two terms handle the cases where the firm is not in the data set at month m — either the first observation for the firm is after m or the firm has already exited. A constant value is assigned in this case so that this firm will not affect the maximization at this time point.

The pseudo likelihood function given in (10) can be numerically maximized to give estimates for the coefficients β and $\bar{\beta}$. Notice though that the sample observations for the pseudo-likelihood function are overlapping if the horizon is longer than one month. For example, when $\ell = 2$, default over the next two periods from month m is correlated to default over the next two periods from month $m + 1$ due to the common month in the two sample observations. However, in Appendix A of Duan *et al*. (2012), the maximum pseudo-likelihood estimator is shown to be consistent, in the sense that the estimators converge to the "true" parameter value in the large sample limit.

It would not be feasible to numerically maximize the pseudo-likelihood function using the expression given in (11), due to the large dimension of the β and $\bar{\beta}$ parameters. Notice though that each of the terms in (11) can be written as a product of terms containing only β and terms containing only $\bar{\beta}$. This will allow separate maximizations with respect to β and with respect to $\bar{\beta}$.

The β and $\bar{\beta}$ specific versions of (11) are:

$$
\begin{aligned}
&P_\ell^{\beta}(\beta;\tau_i,\bar{\tau}_i,X_i(m)) \\
&= 1_{\{t_{0i}\le m,\min(\tau,\bar{\tau}_i)>m+\ell\}}\exp\left\{-\Delta t\sum_{j=0}^{\ell-1}H(\beta(j),X_i(m))\right\} \\
&\quad + 1_{\{t_{0i}\le m,\tau_i\le\bar{\tau}_i,\tau_i\le m+\ell\}}\exp\left\{-\Delta t\sum_{j=0}^{\tau_i-m-2}H(\beta(j),X_i(m))\right\} \\
&\quad \times\{1-\exp[-\Delta t\, H(\beta(\tau_i-m-1),X_i(m))]\} \\
&\quad + 1_{\{t_{0i}\le m,\bar{\tau}_i\le\tau_i,\bar{\tau}_i\le m+\ell\}}\exp\left\{-\Delta t\sum_{j=0}^{\bar{\tau}_i-m-2}H(\beta(j),X_i(m))\right\} \\
&\quad \times\exp[-\Delta t\, H(\beta(\tau_i-m-1),X_i(m))] \\
&\quad + 1_{\{t_{0i}>m\}} + 1_{\{\min(\tau_i,\bar{\tau}_i)\le m\}}, \\
&P_\ell^{\bar{\beta}}(\bar{\beta};\tau_i,\bar{\tau}_i,X_i(m)) \\
&= 1_{\{t_{0i}\le m,\min(\tau,\bar{\tau})>m+\ell\}}\exp\left\{-\Delta t\sum_{j=0}^{\ell-1}H(\bar{\beta}(j),X_i(m))\right\} \\
&+ 1_{\{t_{0i}\le m,\tau_i\le\bar{\tau}_i,\tau_i\le m+\ell\}}\exp\left\{-\Delta t\sum_{j=0}^{\tau_i-m-2}H(\bar{\beta}(j),X_i(m))\right\} \\
&+ 1_{\{t_{0i}\le m,\bar{\tau}_i\le\tau_i,\bar{\tau}_i\le m+\ell\}}\exp\left\{-\Delta t\sum_{j=0}^{\bar{\tau}_i-m-2}H(\bar{\beta}(j),X_i(m))\right\} \\
&\quad \times\{1-\exp[-\Delta t\, H(\bar{\beta}(\bar{\tau}_i-m-1),X_i(m))]\} \\
&+ 1_{\{t_{0i}>m\}} + 1_{\{\min(\tau_i,\bar{\tau}_i)\le m\}}. \qquad (12)
\end{aligned}
$$

Then, the β and $\bar{\beta}$ specific versions of the pseudo-likelihood function are given by:

$$\mathcal{L}_\ell^\beta\left(\beta;\tau,\bar{\tau},X\right)=\prod_{m=1}^{N-\ell}\prod_{i=1}^{I}P_\ell^\beta\left(\beta;\tau_i,\bar{\tau}_i,X_i(m)\right)$$
$$\mathcal{L}_\ell^{\bar{\beta}}\left(\bar{\beta};\tau,\bar{\tau},X\right)=\prod_{m=1}^{N-\ell}\prod_{i=1}^{I}P_\ell^{\bar{\beta}}\left(\bar{\beta};\tau_i,\bar{\tau}_i,X_i(m)\right). \quad (13)$$

With the definitions given in (12) and (13), it can be seen that:

$$\mathcal{L}_\ell(\beta,\bar{\beta};\tau,\bar{\tau},X)=\mathcal{L}_\ell^\beta(\beta;\tau,\bar{\tau},X)\mathcal{L}_\ell^{\bar{\beta}}(\bar{\beta};\tau,\bar{\tau},X). \quad (14)$$

Thus, $\mathcal{L}_\ell^{\bar{\beta}}$ and $\mathcal{L}_\ell^\beta$ can be separately maximized to find their respective parameters. A further important separation is a separation by horizons. Notice that we can decompose P_ℓ^β and $P_\ell^{\bar{\beta}}$ as:

$$P_\ell^\beta\left(\beta;\tau_i,\bar{\tau}_i,X_i(m)\right)=\prod_{\ell'=0}^{\ell-1}P^{\beta(\ell')}\left(\beta(\ell');\tau_i,\bar{\tau}_i,X_i(m)\right),$$
$$P_\ell^{\bar{\beta}}\left(\bar{\beta};\tau_i,\bar{\tau}_i,X_i(m)\right)=\prod_{\ell'=0}^{\ell-1}P^{\bar{\beta}(\ell')}\left(\bar{\beta}(\ell');\tau_i,\bar{\tau}_i,X_i(m)\right), \quad (15)$$

where

$$\begin{aligned}
&P^{\beta(\ell')}(\beta(\ell');\tau_i,\bar{\tau}_i,X_i(m))\\
&=1_{\{t_{0i}\le m,\min(\tau_i,\bar{\tau}_i)>m+\ell'+1\}}\exp\left[-\Delta t\,H(\beta(\ell'),X_i(m))\right]\\
&\quad+1_{\{t_{0i}\le m,\tau_i\le\bar{\tau}_i,\tau_i=m+\ell'+1\}}\left\{1-\exp\left[-\Delta t\,H(\beta(\ell'),X_i(m))\right]\right\}\\
&\quad+1_{\{t_{0i}\le m,\bar{\tau}_i<\tau_i,\bar{\tau}_i=m+\ell'+1\}}\exp\left[-\Delta t\,H(\beta(\ell'),X_i(m))\right]\\
&\quad+1_{\{t_{0i}>m\}}+1_{\{\min(\tau_i,\bar{\tau}_i)<m+\ell'+1\}},\\
&P^{\bar{\beta}(\ell')}(\bar{\beta}(\ell');\tau_i,\bar{\tau}_i,X_i(m))\\
&=1_{\{t_{0i}\le m,\min(\tau_i,\bar{\tau}_i)>m+\ell'+1\}}\exp\left[-\Delta t\,H(\bar{\beta}(\ell'),X_i(m))\right]\\
&\quad+1_{\{t_{0i}\le m,\tau_i\le\bar{\tau}_i,\tau_i=m+\ell'+1\}}\\
&\quad+1_{\{t_{0i}\le m,\bar{\tau}_i\le\tau_i,\bar{\tau}_i=m+\ell'+1\}}\{1-\exp[-\Delta t\,H(\bar{\beta}(\ell'),X_i(m))]\}\\
&\quad+1_{\{t_{0i}>m\}}+1_{\{\min(\tau_i,\bar{\tau}_i)<m+\ell'+1\}}.
\end{aligned} \quad (16)$$

Thus, the β and $\bar{\beta}$ specific pseudo-likelihood functions can be decomposed as:

$$\mathcal{L}_\ell^\beta\left(\beta;\tau,\bar{\tau},X\right)=\prod_{\ell'=0}^{\ell-1}L^{\beta(\ell')}\left(\beta(\ell');\tau,\bar{\tau},X\right)$$
$$\mathcal{L}_\ell^{\bar{\beta}}\left(\bar{\beta};\tau,\bar{\tau},X\right)=\prod_{\ell'=0}^{\ell-1}L^{\bar{\beta}(\ell')}\left(\bar{\beta}(\ell');\tau,\bar{\tau},X\right). \quad (17)$$

Where

$$\mathcal{L}^{\beta(\ell')}\left(\beta(\ell');\tau,\bar{\tau},X\right)=\prod_{m=1}^{N-\ell}\prod_{i=1}^{\ell}P^{\beta(\ell')}\left(\beta(\ell');\tau_i,\bar{\tau}_i,X_i(m)\right)$$
$$\mathcal{L}^{\bar{\beta}(\ell')}\left(\bar{\beta}(\ell');\tau,\bar{\tau},X\right)=\prod_{m=1}^{N-\ell}\prod_{i=1}^{\ell}P^{\bar{\beta}(\ell')}\left(\bar{\beta}(\ell');\tau_i,\bar{\tau}_i,X_i(m)\right). \quad (18)$$

Thus, for every horizon ℓ', $\mathcal{L}^{\beta(\ell')}(\beta(\ell');\tau,\bar{\tau},X)$ and $\mathcal{L}^{\bar{\beta}(\ell')}(\bar{\beta}(\ell');\tau,\bar{\tau},X)$ can be separately maximized. In summary, for the current CRI implementation where the horizons are from one month to 24 months, and where there are 13 variables, a $2\times24\times13$ dimensional maximization is turned into a 13 dimensional maximization done 2×24 times. This makes the calibration problem tractable. Additional implementation details on the calibration are given in Section 3.

II. INPUT VARIABLES AND DATA

Subsection 2.1 describes the input variables used in the quantitative model. Currently, the same set of input variables is common to all of the economies under the CRI's coverage. Future enhancements to the CRI system will allow different input variables for different economies. The effect of each of the variables on the PD output is discussed in the empirical analysis of Section 4.

Subsection 2.2 gives the data sources and relevant details of the data sources. There are two categories of data sources: current and historical. Data sources used for current data need to be updated in a timely manner so that daily updates of PD forecasts are meaningful. They also need to be comprehensive in their current coverage of firms. Data sources that are comprehensive for current data may not necessarily have comprehensive historical coverage for different economies. Other data sources are thus merged in order to obtain comprehensive coverage for historical and current data.

Subsection 2.3 indicates the fields from the data sources that are used to construct the input variables. For some of the fields, proxies need to be used for a firm if the preferred field is not available for that firm.

Subsection 2.4 discusses the definition and sources of defaults and of other exits used in the CRI.

2.1. Input Variables

Following the notation that was introduced in Section 1, firm *i*'s input variables at time $t = n\Delta t$ are represented by the vector $X_i(n) = (W(n), U_i(n))$ consisting of a vector $W(n)$ that is common to all firms in the same economy, and a firm-specific vector $U_i(n)$ which is observable from the date the firm's first financial statement is released, until the month end before the month in which the firm exits, if it does exit.

In Duan *et al*. (2012), different variables that are commonly used in the literature were tested as candidates for the elements of $W(n)$ and $U_i(n)$. Two common variables and ten firm-specific variables, as described below, were selected as having the greatest predictive power for corporate defaults in the United States. In the current stage of development, this same set of twelve input variables is used for all economies. Future development will include variable selection for firms in different economies.

- Common variables

  The vector $W(n)$ contains two elements, consisting of:

  1. Stock index return: the trailing one-year simple return on a major stock index of the economy.
  2. Interest rate: a representative three-month short-term interest rate with the historical mean subtracted to obtain a de-meaned time series.

- Firm-specific variables

  The ten firm-specific input variables are transformations of measures of six different firm characteristics. The six firm characteristics are: (i) volatility-adjusted leverage; (ii) liquidity; (iii) profitability; (iv) relative size; (v) market misvaluation/future growth opportunities; and (vi) idiosyncratic volatility.

Volatility-adjusted leverage is measured as the distance-to-default (DTD) in a Merton-type model. The calculation of DTD used by the CRI allows a meaningful DTD for financial firms, a critical group that must be excluded from most DTD computations. This calculation is detailed in Section 3.

Liquidity is measured as a ratio of cash and short-term investments to total assets, profitability is measured as a ratio of net income to total assets, and relative size is measured as the logarithm of the ratio of market capitalization to the economy's median market capitalization.

Duan *et al*. (2012) transformed these first four characteristics into level and trend versions of the measures. For each of these, the level is computed as the one-year average of the measure, and the trend is computed as the current value of the measure minus the one-year average of the measure. The level and trend of a measure has seldom been used in the academic or industry literature for default prediction, and Duan *et al*. (2012) found that using the level and trend significantly improves the predictive power of the model for short-term horizons.

To understand the intuition behind using level and trend of a measure as opposed to using just the current value, consider the case of two firms with the same current value for all measures. If the level and trend transformations were not performed, then only the current values would be used and the two firms would have identical PD. Suppose that for the first firm the DTD had reached its current level from a high level, and for the second firm the DTD had reached its current level from a lower level (see Figure 2). The first firm's leverage is increasing (worsening) and the second firm's leverage is decreasing (improving). If there is a momentum effect in DTD, then firm 1 should have a higher PD than firm 2.

Duan *et al*. (2012) found evidence of the momentum effect in DTD, liquidity, profitability and size. For the other two firm characteristics, applying the level and trend transformation did not improve the predictive power of the model.

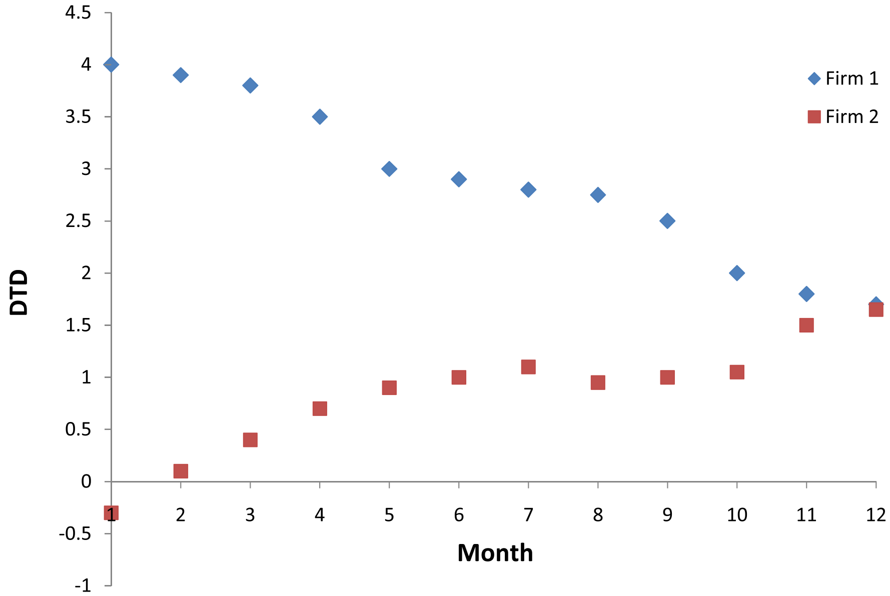

Figure 2. Two firms with all current values equal to each other, but DTD trending in the opposite direction.

One of the remaining two firm characteristics is the market mis-valuation/future growth opportunities characteristic, which is taken as the market-to-book asset ratio and measured as a ratio of market capitalization and total liabilities to total assets. One can see whether the market mis-valuation effect or the future growth opportunities effect dominates this measure by looking at whether the parameter for this variable is positive or negative. This is further discussed in the empirical analysis of Section 4.

The final firm characteristic is the idiosyncratic volatility which is taken as sigma, following Shumway (2001). Sigma is computed by regressing the monthly returns of the firm's market capitalization on the monthly returns of the economy's stock index, for the previous 12 months. Sigma is defined to be the standard deviation of the residuals of this regression. Shumway (2001) reasons that sigma should be logically related to bankruptcy since firms with more variable cash flows and therefore more variable stock returns relative to a market index are likely to have a higher probability of bankruptcy.

Finally, the vector $U_i(n)$ contains ten elements, consisting of:

1. Level of DTD.
2. Trend of DTD.
3. Level of (Cash + Short-term investments)/Total assets, abbreviated as CASH/TA.
4. Trend of CASH/TA.
5. Level of Net income / Total Assets, abbreviated as NI/TA.
6. Trend of NI/TA.
7. Level of log (Firm market capitalization/ Economy's median market capitalization), abbreviated as SIZE.
8. Trend of SIZE.
9. Current value of (Market capitalization + total liabilities)/Total asset, abbreviated as M/B.
10. Current value of SIGMA.

The data fields that are needed to compute DTD and short-term investments are described in Subsection 2.3. The remaining data fields required are straightforward and standard. The computation for DTD is explained in Section 3.

2.2. Data Sources

There are two data sources that are used for the daily PD forecast updates: Thomson Reuters Datastream and the Bloomberg Data License Back Office Product. Many of the common factors such as stock index prices and short-term interest rates are retrieved from Datastream.

Firm-specific data comes from Bloomberg's Back Office Product which delivers daily update files by region via FTP after respective market closes. All relevant data is extracted from the FTP files and uploaded into the CRI database for storage. From this, the necessary fields are extracted and joined with previous months of data.

The Back Office Product includes daily market capitalization data based on closing share prices and also includes new financial statements as companies release them. Firms will often have multiple versions of financial statements within the same period, with different accounting standards, filing statuses (most recent, preliminary, original, reclassified or restated), currencies or consolidated/unconsolidated indicators. A major challenge lies in prioritizing these financial statements to decide which data should be used. The priority rules are described in Section 3.

The firm coverage of the Back Office Product is of sufficient quality that over 28,000 firms' PD can be updated on a daily basis in the 44 economies under the CRI's coverage. While the current coverage is quite comprehensive, historical data from the Back Office Product can be sparse for certain economies. For this reason, various other databases are merged in order to fill out the historical data. The other databases used for historical data are: a database from the Taiwan Economics Journal (TEJ) for Taiwanese firms; a database provided by Korea University for South Korean firms; and data from Prowess for Indian firms.

With all of the databases merged together and for the 44 economies under CRI's coverage, over 53,000 exchange listed firms are in the CRI database. This includes over 20,000 delisted firms. The historical coverage of the firm data goes back to the early 1990's.

2.3. Constructing Input Variables

The chosen stock indices and short-term interest rates for the 44 economies under the CRI's current coverage are listed in Tables A.2 and A.3, respectively. All economies are listed by their three letter ISO code given in Table A.1.

Most of the firm-specific variables can be readily constructed from standard fields within firms' financial statements in addition to daily market capitalization values. The only two exceptions are the DTD and the liquidity measure.

The calculation for DTD is explained in Section 3. In the calculation, several variables are required. One variable is a proxy for a one-year risk-free interest rate, and the choices for each of the 44 economies are listed in Table A.4. Total assets, long-term borrowing and total liabilities are also required, but are standard financial statement fields and present no difficulties.

Total current liabilities are also required, and due to the relatively large numbers of firms that are missing this value, proxies had to be found. The preferred Bloomberg field for this is BS_CUR_LIAB. If this is missing, then the sum of BS_ST_BORROW, BS_OTHER_ST_LIAB and BS_CUST_ACCPT_LIAB_CUSTDY_SEC (customers' acceptance and liabilities/custody securities) is used. If one or two of these are missing, zero is inserted for those fields, but at least one field is required.

The liquidity measure requires different fields between financial and non-financial firms. For non-financial firms, the numerator of the ratio (Cash + Short-term investments) is taken as the sum of BS_CASH_NEAR_CASH_ITEM and BS_MKT_SEC_OTHER_ST_INVEST (marketable securities and other short-term investments). If BS_MKT_SEC_OTHER_ST_INVEST is missing, we substitute with zero but the field BS_CASH_NEAR_CASH_ITEM is required.

It was found that this sum frequently overstated the liquidity for financial firms. In place of BS_MKT_SEC_OTHER_ST_INVEST, financial firms use the sum of ARD_SEC_PURC_UNDER_AGR_TO_RESELL (securities purchased under agreement to re-sell), ARD_ST_INVEST and BS_INTERBANK_ASSET. If one or two of these are missing, zero is inserted for those fields, but at least one field is required. The "ARD" prefix indicates that these are "as reported" numbers directly from the financial statements. As such, for some firms these fields may need to be adjusted to the same units before adding them to other fields.

Summary statistics of the firm-specific variables: DTD, CASH/TA, NI/TA, SIZE, M/B, and Sigma, with the summary statistics provided for firms grouped by economy are listed in Table A.5.

2.4. Data for Defaults

The Credit Research Initiative database contains credit events of over 4,000 firms from 1990 to the present. The default events come from numerous sources, including Bloomberg, Compustat, CRSP, Moody's reports, TEJ, exchange web sites and news sources.

The default events that are recognized by the CRI can be classified under one of the following events:

1. Bankruptcy filing, receivership, administration, liquidation or any other legal impasse to the timely settlement of interest and/or principal payments;
2. A missed or delayed payment of interest and/or principal, excluding delayed payments made within a grace period;
3. Debt restructuring/distressed exchange, in which debt holders are offered a new security or package of securities that result in a diminished financial obligation (e.g., a conversion of debt to equity, debt with lower coupon or par amount, debt with lower seniority, debt with longer maturity).

The more precise sub-categories of default corporate actions are listed in Table A.6.

Delisting due to other reasons such as failure to meet listing requirements, inactive stock prices or M&A are counted as "other exits" and are not considered as default. However, firms that are delisted from an exchange and which experience a default event within 365 calendar days of the delisting will have an exit event reclassified as credit default. Technical defaults such as covenant violations are not included in our definition of default. The exit events that are not considered as defaults in the CRI system are listed in Table A.7.

In addition to the aforementioned events, there are still cases that require special attention and will be assessed on a case-by-case basis, e.g., subsidiary default. As a general rule, the CRI does not consider related party-default (e.g., subsidiary bankruptcy) as a default event. However, when a non-operating holding parent company relies heavily on its subsidiary, bankruptcy by the subsidiary will cause a considerable economic impact on the parent company. Such cases are reviewed and final classifications made.

The total number of firms, number of defaults and number of other exits in each of the 44 economies each year from 1992 to 2012 are listed in Table A.8. Note that the total number of firms here includes all firms where the primary listing of the shares are on an exchange in that economy and may include firms where there are too many missing data values for a PD estimate to be made. However, the number of firms listed on the CRI web portal under the tab Aggregate forecast includes firms that are domiciled in that economy and excludes firms where a PD cannot be produced due to missing data.

III. IMPLEMENTATION DETAILS

Section 1 describes the modeling framework underlying the current implementation of the CRI system. It focuses on theory rather than the details encountered in an operational implementation. The present section describes how the CRI system handles these more specific issues.

Subsection 3.1 describes implementation details related to data, mainly dealing with data cleaning and missing data. Subsection 3.2 describes the specific computation of distance-to-default (DTD) used by the CRI system that leads to meaningful DTD for financial firms. Subsection 3.3 explains how the calibration previously described in Subsection 2.2 can be implemented. Subsection 3.4 gives the implementation details relevant to the daily output. This includes an explanation of the various modifications needed to compute daily PD so that the daily PD is consistent with the usual month end PD, and a description of the computation of the aggregate PDs provided by the CRI.

3.1. Data Treatment

Fitting data to monthly frequency: Historical end of month data for every firm in an economy is required to calibrate the model. For daily data such as market capitalization, interest rates and stock index values, the last day of the month for which there is valid data is used.

For financial statement variables, data is used starting from the period end of the statement lagged by three months. This is to ensure (insofar as is possible) that predictions are made based on information that was available at the time the prediction was made. Of course, for more recent data where the CRI database contains the financial statement but the period end lagged by three months is after the current day, the financial statement is used in making PD forecasts. The CRI considers financial statement variables to be valid for one year without restriction after they are first used.

Currency conversions are required if the market capitalization or any of the financial statement variables are reported in a currency different than the currency of the economy. If a currency conversion is required, the foreign exchange rate used is that reported at the relevant market close. For firms traded in Asia and Asia-Pacific, the Tokyo closing rate is used; for firms traded in Western Europe, the London closing rate is used; and for firms traded in North America and Latin America, the New York closing rate is used. For market capitalizations, the FX rate used is for the date that the market capitalization is reported. For financial statement variables, the FX rate used is for the date of the period end of the statement.

Priority of financial statements: As described in Subsection 2.2, data provided in Bloomberg's Back Office Product can include numerous versions of financial statements within the same period. If there are multiple financial statements with the same period end, priority rules must be followed in order to determine which to use. The formulation and implementation of these rules is a major challenge and an area of continuing development.

The first rule prioritizes by consolidated/unconsolidated status. This status is relevant only to firms in India, Japan, South Korea and Taiwan, so this rule is only relevant in those economies. Most firms in these economies issue unconsolidated financial statements more frequently than consolidated ones, so these are given higher priority. This simple prioritization can, however, lead to cases where the financial statements used switch from consolidated statements to unconsolidated statements and back again. A more complex prioritization rule is currently under development, with the intention of avoiding this situation.

If, after the first prioritization rule has been applied, there are still multiple financial statements, the second rule is applied. This is prioritization by fiscal period. In most economies, annual statements are required to be audited, whereas other fiscal periods are not necessarily audited. The order of priority from highest to lowest is, therefore: annual, semi-annual, quarterly, cumulative, and finally other fiscal periods.

The third prioritization rule is based on filing status. The "Most Recent" statement is used before the "Original" statement, which is used before the "Preliminary" statement.

The final prioritization rule is based on the accounting standard. Here, financial statements that are reported using Generally Accepted Accounting Principles (GAAP) are given higher priority than financial statements that are reported using International Financial Reporting Standards (IFRS). If an accounting standard is not indicated at all, the financial statement is not used.

Financial statement entries with all other descriptors being the same but with different filing statuses will be grouped together. For each variable separately, the variable value is taken from the highest priority financial statement within the group where the value is non-null.

For example, suppose two financial statement entries have the same period end, are both annual statements, are both consolidated statements, and both use the same accounting standard, but the first entry is classified as the "Most Recent" and the second is classified as the "Original" entry. Suppose the total assets and total liabilities are reported in the "Original" entry, and in the "Most Recent" entry only the total liabilities have been updated with a null value for the "Original" entry. Then, the total liabilities will be taken from the "Most Recent" entry while the total assets will be taken from the "Original" entry.

This allows for the grouping of, for example, "Most Recent" and "Original" entries together because Bloomberg occasionally only updates values that change without updating other values. If the entries are not grouped, then most of the variables would have null values.

One variable that needs special attention is net income. Net income is a flow variable and needs to be adjusted based on the period of the financial statement. More specifically we transform the net income into a monthly net income by dividing the net income by the number of months that the financial statement covers. Due to the different coverage periods, several sources for the net income may be available. For example, the monthly net income can be computed from the annual net income divided by 12, the semi-annual net income divided by six and the quarterly net income divided by three. When the monthly net income can be obtained from different sources simultaneously, the quarterly net income will have higher priority than any other because it covers a more recent period.

Treatment of stale market capitalization prices: The market capitalization of a firm is required in a few input variables: DTD, SIZE, M/B and SIGMA. For most firms, the market capitalization is available from Bloomberg on a daily basis.

A check on the trading volume of shares is used to remove stale prices. Specifically, if there are more than two consecutive days of identical market capitalization prices, subsequent identical prices are removed only if the trading volume is equal to zero. This is to avoid, for example, cases where the shares of a company are under a trading suspension but the market capitalization data is incorrectly carried forward.

An exception is for Indian companies, where it is common for some companies to have market capitalizations reported only once a month with several consecutive months having identical prices and positive trading volume. These prices are very likely not to be accurate reflections of the firms' value. So, the trading volume is not checked for Indian firms and market capitalizations are excluded after more than two repeated prices.

For some firms, there are gaps in the market capitalization data provided by Bloomberg. Previously, the first recourse was to use the share price multiplied by the shares outstanding listed in the balance sheet and multiplied by an adjustment factor that Bloomberg provides to account for splits, dividends, etc. However, this data is frequently in error and using the shares outstanding as the previous available market capitalization divided by the price on that day was found to be more reliable.

If the gap in market capitalization data is more than a year, then the previous computation using the shares outstanding from the balance sheet is again used. If there are still remaining gaps in the data, then shares outstanding from Compustat data is used.

Provisions for missing values and outliers: Missing values and outliers are dealt with by a three step procedure. In the first step, the ten firm-specific input variables are computed for all firms and all months. In the second step, outliers are eliminated by winsorization. In the final step, missing values are replaced under certain conditions.

The first step is to compute the input variables and determine which are missing. As mentioned previously, financial statement variables are carried forward for one year after the date that they are first used. This is generally three months after the period end of the statement. If no financial statement is available for the company within this year, then the financial statement variable will be missing. For market capitalization, if there is no valid market capitalization value within the calendar month, then the value is set to missing.

For illiquid stocks, if there has been no valid market capitalization value for a firm within the last 90 calendar days, then the market capitalization is deemed to not properly reflect the value of the firm. The firm is considered to have exited with a non-default event. Once the firm starts trading again and a new financial statement is released, the firm can enter back into the calibration. With regard to historical PD, the PD can be reported again once there are enough valid variables.

With regard to the level variables, the current month and the last eleven months are averaged to compute the level. There is no lower limit on the number of valid observations. Only if all of the values are missing is the level variable considered to be missing.

For the trend variable, the level is subtracted from the current month. If the current month is missing, then the trend variable is set to missing.

The value of M/B is set to missing if any of the following values are missing: market capitalization, total liabilities or total assets of the firm. For the computation of SIGMA, seven valid returns over the last twelve months of possible returns are required for the regression. If there are less than seven valid returns, SIGMA is set to missing.

In this way, the eight trend and level variables plus M/B and SIGMA are computed and evaluated as missing or present. Winsorization can then be performed as a second step to eliminate outliers. The volume of outliers is too large to be able to determine whether each one is valid or not, so winsorization applies a floor and a cap on each of the variables. The historical 0.1 percentile and 99.9 percentile for all firms in the economy are recorded for each of the ten variables. Any values that exceed these levels are set to equal these boundary values.

With a winsorization level and 0.1 percentile and 99.9 percentile, the boundary values still may not be reasonable. For example, NI/TA levels of nearly −25 have been observed at this stage. In these cases, a more aggressive winsorization level is applied, until the boundary values are reasonable. Thus, the winsorization level is economy and variable specific, and will depend on the data quality for that economy and variable. The applied winsorization levels different from the default of 0.1 percentile and 99.9 percentile are indicated in the tables on our web portal.

A third and final step can be taken to deal with missing values. If, during a particular month, no variables for a firm are missing, then the PD can be computed. If six or more of these ten variables are missing, there is deemed to be too many missing observations and no replacements are made.

If between one and five variables are missing out of the ten, the first step is to trace back for at most twelve months to use previous values of these variables instead. If this does not succeed in replacing all of the variables, a replacement by sector medians is done. The median is for the financial or non-financial firms (as indicated by their Bloomberg industry sector code) within the economy during that month. Replacement by the sector median should have a neutral effect on the PD of the firm; the firm is assessed by the other variables that it does have values for. This sector median is always performed in calibration. However, when reporting historical PD, the sector replacement is not done if it results in a relative change in PD of 10% or more where the initial PD was at or above 100bps, or an absolute change in PD of 10bps or more where the initial PD was below 100bps.

Inclusion/exclusion of companies for calibration: Firms are included within an economy for calibration when the primary listing of the firm is on an exchange in the economy. This ensures that all firms within the economy are subject to the same disclosure and accounting rules.

There are a relatively small number of firms that are dual listed, in which two corporations listed in different exchanges operate as a single entity but retain separate legal status. In the CRI system, a combined company will be assigned to the single economy it is most associated with. An example is the Rio Tinto Group. This consists of Rio Tinto plc, listed in the UK; and Rio Tinto Limited, listed in Australia. Most of Rio Tinto's operations are in Australia rather than the UK, so Rio Tinto is assigned to Australia.

In the US, firms traded on the OTC markets or the Pink Sheets are not considered as exchange listed so are not included in calibration or in the reporting of PD forecasts. Many of these firms are small or start-up firms. Including this large group of companies would skew the calibration and the aggregate results. The TSX Venture Exchange in Canada also contains only small and start-up firms, so firms listed on that exchange are also excluded.

Other examples include Taiwan's GreTai Securities Market and Singapore's Catalist. The challenge for markets outside of the US or Canada is that the data on whether firms are listed on the smaller markets rather than the main board is diffcult to obtain. For all economies besides the US and Canada, there is continuing work being done in the CRI system to exclude firms that are not listed on major exchanges within a country.

Firms that record an exit (other than due to no trading for 90 calendar days) are not entered back into the calibration even if the firm continues to trade and issue financial statements, as can happen after firms declare bankruptcy. There are two exceptions to this exclusion. The first, determined on a case by case basis, is if the firm should be deemed to have re-emerged from bankruptcy. The second exception is for all firms in China, where two situations are prevalent. The first situation is that the firm experiences few repercussions from the default and continues operating normally. The other situation is for one firm to take over a defaulted firm's listing. This happens due to the limited supply of exchange listings. Both of these situations can be considered as emerging from default, so the CRI system enters all of these companies back into the calibration as new companies.

3.2. Distance-to-Default Computation

The distance-to-default (DTD) computation used in the CRI system is not a standard one. Standard computations exclude financial firms, but excluding the financial sector means neglecting a critical part of any economy. So the standard DTD computation must be extended to give meaningful estimates for financial firms as well. Duan and Wang (2012) provide a review of different DTD calculations with several examples for financial and non-financial firms.

The description of the specialized DTD computation starts with a brief description of the Merton (1974) model. Merton's model makes the simplifying assumption that firms are financed by equity and a single zero-coupon bond with maturity date T and principal L. The asset value of the firm V_t follows a geometric Brownian motion:

$$dV_t = \mu V_t dt + \sigma V_t dB_t. \tag{19}$$

Here, B_t is standard Brownian motion, μ is the drift of the asset value in the physical measure and σ is the volatility of the asset value. Equity holders receive the excess value of the firm above the principal of the zero-coupon bond and have limited liability, so the equity value at maturity is: $E_T = \max(V_T - L, 0)$. This is just a call option payoff on the asset value with a strike value of L. Thus, the Black–Scholes option pricing formula can be used for the equity value at times t before T:

$$E_t = V_t N(d_1) - e^{-r(T-t)} L N(d_2)\cdot \tag{20}$$

where r is the risk-free rate, $N(\cdot)$ is the standard normal cumulative distribution function, and:

$$d_{1,2} = \frac{\log\left(\frac{V_t}{L}\right) + \left(r \pm \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}} \tag{21}$$

In Merton's model, DTD is defined as volatility scaled distance of the expected asset value under the physical measure at maturity T from the default point L:

$$DTD_t = \frac{\log\left(\frac{V_t}{L}\right) + \left(\mu - \frac{\sigma^2}{2}\right)(T-t)}{\sigma\sqrt{T-t}}\cdot \tag{22}$$

The standard KMV assumptions given in Crosbie and Bohn (2003) are to set the time to maturity $T - t$ at a value of one year and the principal of the zero-coupon bond L to a value equal to the firms current liabilities plus one half of its long-term debt. Here, the current liabilities and long-term debt are taken from the firm's financial statements. If the firm is missing the current liabilities field, then various substitutes for this field can be used, as described in Subsection 2.3.

This is a poor assumption of the debt level for financial firms, since they typically have large liabilities, such as deposit accounts, that are neither classified as current liabilities nor long-term debt. Thus, using these standard assumptions means ignoring a large part of the debt of financial firms.

To properly account for the debt of financial firms, Duan (2010) includes a fraction δ of a firm's other liabilities. The other liabilities are defined as the firm's total liabilities minus both the short and long-term debt. The debt level L then becomes the current liabilities plus half of the long-term debt plus the fraction δ multiplied by the other liabilities, so that the debt level is a function of δ. The standard KMV assumptions are then a special case where $\delta = 0$.

The fraction δ can be optimized along with and in the maximum likelihood estimation method developed in Duan (1994, 2000). Following Duan *et al.* (2012), the firm's market value of assets is standardized by its book value A_t so that the scaling effect from a major investment or financing by the firm will not distort the time series from which the parameter values are estimated. Thus, the log-likelihood function is:

$$\begin{aligned}
&\mathcal{L}(\mu, \sigma, \delta) \\
&= -\frac{n-1}{2}\log(2\pi) - \frac{1}{2}\sum_{t=2}^{n}\log(\sigma^2 h_t) - \sum_{t=2}^{n}\log\left(\frac{\hat{V}_t(\sigma,\delta)}{A_t}\right) \\
&\quad - \sum_{t=2}^{n}\log\left[N\left(\hat{d}_1\left(\hat{V}_t(\sigma,\delta),\sigma,\delta\right)\right)\right] \\
&\quad - \sum_{t=2}^{n}\frac{1}{2\sigma^2 h_t}\left[\log\left(\frac{\hat{V}_t(\sigma,\delta)}{A_t} \times \frac{A_{t-1}}{\hat{V}_{t-1}(\sigma,\delta)}\right) - \left(\mu - \frac{\sigma^2}{2}\right)h_t\right]^2.
\end{aligned} \tag{23}$$

Here, n is the number of days with observations of the equity value in the sample, $\hat{V}_t$ is the implied asset value found by solving equation (20), $\hat{d}_1$, is computed with equation (21) using the implied asset value, and h_t is the number of trading days as a fraction of the year between observations $t-1$ and t. Notice that the implied asset value and $\hat{d}_1$ are dependent on δ by virtue of the dependence of L on δ.

Implementation of DTD computation: The DTD at the end of each month is needed for every firm in order to calibrate the forward intensity model. A moving window, consisting of the last one year of data before each month end is used to compute the month end DTD. Daily market capitalization data based on closing prices is used for the equity value in the implied asset value computation of equation (20). If there are fewer than 50 days of valid observations for the market capitalization, then the DTD value is set to missing. An observation is valid if there is positive trading volume that day. If the trading volume is not available, the observation is assumed to be valid if the value for the market capitalization changes often enough. The precise criterion is as follows: if the market capitalization does not change for three days or more in a row, the first day is taken as a valid observation and the remaining days with the same value are set to missing.

The log-likelihood function given in (23) can be maximized as a three dimensional maximization problem over μ, σ and δ. After estimates for these three variables are made, the DTD can be computed from equation (22).

However, with quarterly financial statements there will never be more than three changes in the corporate structure (defined in this model by L and A_t) throughout the year, leading to possibly unstable estimates of δ. This problem is mitigated by performing a two stage optimization for μ, σ and δ.

In the first stage, the optimization for each firm is performed over all three variables. For each firm, in the first month in which DTD can be computed the optimization is unconstrained in μ and σ, while δ is constrained to being in the unit interval $[0, 1]$. Thereafter, at month n, the optimization is still unconstrained in μ and σ while δ is constrained to the interval $[\max(0,\hat{\delta}_{n-1} - 0.05),\min(1,\hat{\delta}_{n-1} + 0.05)]$, where $\hat{\delta}_{(n-1)}$ is the estimate of δ made in the previous month. In other words, a 10% band around the previous estimate of δ (where that band is floored with 0 and capped with 1) is applied so that the estimates do not fluctuate too much from month to month.

It was found that this was not enough to obtain stable estimates of δ. For many firms, the estimate of δ would frequently lie on the boundary of the constraining interval. To impose greater stability, a second stage is added. At each month end, the average estimate for δ in all financial sector firms in the economy is used for every financial sector firm in the economy, meaning the optimization is only over μ and σ. The same is done for non-financial firms. In fact, the optimization can be reduced to be only over σ by using the sample mean of the log returns of the implied asset values in place of μ.

Since the first stage is done to obtain a stable sector average estimate of δ, the criteria used to include a firm-month is more strict. In the first stage, a two-year window is used instead of one year, and a minimum of 250 days of valid observations of the market capitalization are required instead of 50. If a firm has less than 250 days of valid observations within the last two years of a particular month end, δ will not be estimated for that firm and that month end.

It was found that the estimate of μ was frequently unstable and could lower the explanatory power of DTD. For example, suppose a firm has a large drop in its implied asset value in January 2011, so that the estimated μ is negative for the DTD calculation at the end of December 2011. If there is little change in the company in January 2012, then the drop in implied asset value in January 2011 is no longer within the observation window for the DTD calculation at the end of January 2012. There will be a large increase in the estimated μ, resulting in a substantial improvement of the DTD just because of the moving observation window.

To avoid this problem, we now set μ to be equal to $\sigma^2/2$. So in calculating DTD, the second term in the numerator of Equation (22) is eliminated.

In summary, the DTD for each firm is computed using the economy and sector (financial or non-financial) average for δ in that month, and the estimate of σ is based on the last year of data for the firm.

Carrying out this two-stage procedure would take several months of computation time on a single PC, given the millions of firm months that are required. However, each of the stages is parallelizable. In the first stage the DTD can be computed independently between firms. In the second stage, once the sector averages of the δ have been computed for each month, the DTD can again be computed independently between firms. In the CRI system, a grid of several hundred computers administered by the NUS Computer Center is used. With this, the DTD computation can be performed for all firms over the full history of twenty years in less than one day.

3.3. Calibration

Implementation: As shown in Section 1, the calibration of the forward intensity model involves multiple maximum pseudo-likelihood estimations, where the pseudo-likelihood functions are given in equation (18). The maximizations are of the logarithm of these expressions, and they are performed independently between the default parameters and the exit parameters, and between parameters for different horizons. In the notation of Section 1, the vectors of parameters $\beta(0),\ldots,\beta$ (23) and $\bar{\beta}(0),\ldots,\bar{\beta}(23)$ are independently estimated.

A few input variables have an unambiguous effect on a firm's probability of default. Increasing values of both the level and trend of DTD, CASH/TA, and NI/TA all indicate that a firm is becoming more credit worthy and should lead to a decreased PD. For large and relatively clean datasets such as the US, an unconstrained optimization leads to parameter values which largely have the expected sign. For each of DTD level and trend, CASH/TA level and trend, and NI/TA level, the default parameters at all horizons are negative. A negative default parameter at a horizon means that if the variable increases, the forward intensity will decrease (by equation (6)), so that the conditional default probability at that horizon will decrease. The one exception is the NI/TA trend variable.

For some of the smaller economies and economies with lower quality datasets, an unconstrained optimization leads to the default parameters for some of these variables to be positive at several horizons. This leads to counter-intuitive results. For example, if the default parameters for CASH/TA are positive, a firm that increases its cash reserves, all other factors being equal, will have a PD that increases. To prevent such situations, the CRI system performs a constrained optimization with only non-positive values allowed for the default parameters associated with the level and trend of DTD, CASH/TA, and NI/TA.

For this, the Matlab function "fmincon" from the Optimization Toolbox is used. The analytic gradient and Hessian are supplied and the algorithm used by "fmincon" is the trust-region-reflective optimization.

Notice that at each time point and at any horizon, there are orders of magnitude more surviving firms than exiting firms. Thus, from equations (16) and (18), it can be seen that the most time-consuming part of evaluating the pseudo-log-likelihood function is the term for the surviving firms. Evaluating the forward intensity function of equation (7) can be formulated as a matrix-vector multiplication, where the rows of the matrix are the different surviving firms variables, and the vector is the vector of parameters. The matrix will typically have several hundreds of thousands of rows and does not change during the optimization (though it will change for different optimizations at different horizons). This type of problem is well-suited for a programmable graphics processing unit (GPU). The analytic expressions for the gradient and Hessian can similarly be computed efficiently on a GPU. The CRI system runs the calibrations on an NVIDIA Tesla C2050 card. For each economy, the calibrations for the default and other exit parameters for horizons up to 24 months typically require five minutes or less.

Grouping for economies: There are not enough defaults in some small economies and calibrations of these individual economies are not statistically meaningful. In order to ensure that there are enough defaults for calibration, the 44 economies are categorized into groups according to similarities in their stage of development and their geographic locations. Within these groups the economies are combined and calibrated together.

Starting from the May 2011 calibration, Canada and the US remain in the same calibration group, and the developed economies of Asia-Pacific (Australia, Hong Kong, Japan, Singapore, South Korea and Taiwan) form another calibration group. China and India, the two major emerging economies of Asia Pacific are each calibrated as an individual group. Starting from June 2012, all 16 of the European countries covered by the CRI are in a single calibration group and the other emerging economies of Asia Pacific (Indonesia, Malaysia, Philippines and Thailand) are grouped together with the 7 Latin American countries (Argentina, Brazil, Colombia, Chile, Mexico, Peru and Venezuela) to form the calibration group "emerging markets".

All economies in these new calibrations groups share the same coefficients for all variables except for the benchmark risk-free interest rate variable. The benchmark interest rate's coefficients will be allowed to vary, because different economies based in different currencies naturally have different dependencies on their interest rates, and the interest rate levels can differ significantly across economies. After adopting the euro, all eurozone countries use Germany's three-month Bubill rate as this is more reflective of monetary rather than sovereign credit conditions in each economy, which is the intent of this variable. For the period before joining the eurozone, their own interest rates are used.

In addition, the benchmark interest rate is entered as the current value minus the historical month-end mean. This allows the variable to reflect its value relative to the historical average. When an economy does not have enough default events to identify a separate interest rate coefficient, the interest rate variable will be disabled for that economy by inputting a zero value for the whole time series. In fact, that is also why we de-mean all interest rate series so that setting the interest rate series of a particular economy to zero, when necessary, does not induce a bias by the base economy in the same group.

Since all eurozone countries except Germany do not have enough default events prior to joining the eurozone, their benchmark interest rate is entered as zero for that period. Among the non-eurozone members of the European group, Denmark, Norway, Sweden and the UK each have separate coefficients for the benchmark interest rate. Switzerland and Iceland do not use this variable for their whole history.

In the Developed Asia-Pacific group, all economies have their own coefficient for the benchmark interest rate. For the North American group, both Canada and the US have their own coefficient for the benchmark interest rate. In the Emerging Markets group, there are insufficient defaults in the Latin American economies to calibrate individual economy benchmark interest rate coefficients in a statistically significant way, so all Latin American economies share the same benchmark interest rate coefficient. Each of the Asian economies in the Emerging Markets group, namely Indonesia, Malaysia, Philippines and Thailand, have their own coefficient for the benchmark interest rate.

Relative Size: For the calibration dataset, the median market cap of firms in an economy for each month end includes the market cap from the last trading day of each firm in the month. If a firm does not trade in a particular month, the firm's market cap is not included in the median. For certain economies, many firms are illiquid and the median market cap experiences large variations due to the change in composition of firms rather than the market value of the firms. Another problem is data quality at the beginning of the historical sample: if a data provider starts including the market cap for a large number of firms in one month compared to the previous, there can be a large jump in the median market cap.

To avoid this problem, we use a combination of the economy's stock index and the economy's median market cap as the divisor in the Relative Size variable:

1. We choose a recent month where there is a more complete set of firms in the economy that have trading activity, and calculate the ratio of the economy's median market cap to stock index value at the end of the month.
2. For each month, the divisor for the Relative Size variable of firms in the economy is taken as the month end stock index multiplied by that ratio.

3.4. Daily Output

Individual firms' PD: In computing the pseudo-log-likelihood functions in equation (18), only end of month data is needed. The data needs to be extended to daily values in order to produce daily PDs.

For the level variables, the last twelve end of month observations (before averaging) are combined with the current value. The current value is scaled by a fraction equal to the current day of the month divided by the number of calendar days in the month. The earliest monthly value is scaled by one minus this fraction. The sum is then divided by the number of valid monthly observations, with the current value and the earliest monthly value counting as a single observation if either or both are not missing. Not performing this scaling can lead to an artificial jump in PD at the beginning of the month. When performing the scaling, the change in level is more gradual throughout the month.

A similar procedure is done for SIGMA. Here the earliest month is not scaled, but the return from the current day to the previous month end is scaled by the square root of the fraction equal to the current day of the month divided by the number of calendar days in the month.

Computing the DTD for all firms on a daily basis using the two stage process described in Subsection 3.2 would be time consuming, even on the grid. Since there should be little change to σ and δ on a day to day basis, for the daily computation of DTD these are assumed to have the same value as in the previous month's DTD calculation. In other words, the previous month's values for σ and δ together with the new day's equity value are used in equation (20) to obtain the implied asset value. This implied asset value with the previous month's values for σ and δ is used in equation (22) to obtain the new day's DTD, with μ set to equal to $\sigma^2/2$.

Aggregating PD: The CRI provides term structures of the probability distributions for the number of defaults as well as the expected number of defaults for different groups of firms. The companies are grouped by economy (using each firm's country of domicile), by sector (using the firm's Bloomberg industrial sector code) and sectors within economies. With the individual firms' PD, the expected number of defaults is trivial to compute. The algorithm used to compute the probability distribution of the number of defaults was originally reported in Anderson *et al*. (2003). It assumes conditional independence and uses a fast recursive scheme to compute the necessary probability distribution.

Note that while this algorithm is currently used to produce the probability distribution of the number of defaults within an economy or sector, it can easily be generalized to compute loss distributions for a portfolio manager, where the exposure of the portfolio to each firm needs to be input.

Inclusion of firms in aggregation: As explained in Subsection 3.1, firms are included in an economy for calibration if the firms' primary listing is on an exchange in that economy. This is to ensure that all firms in an economy are subject to the same disclosure and accounting requirements. In contrast, a firm is included in an economy's aggregate results if the firm is domiciled in that economy. This is because users typically associate firms with their economy of domicile rather than the economy where their primary listing is, if they are different. For example, the Bank of China has its primary listing in Hong Kong, but its economy of domicile is China so the Bank of China is included in the aggregation forecasts for China, and is included under China when searching for the individual PDs.

IV. EMPIRICAL ANALYSIS

This section presents an empirical analysis of the CRI outputs for the 44 economies that are currently being covered. In Subsection 4.1, an overview is given of the default parameter estimates. Subsection 4.2 explains and provides the accuracy ratios for the different countries under the CRI cover.

4.1. Parameter Estimates

With 24 months of forecast horizons, 13 variables and 6 different groups of economies, tables of the parameter estimates occupy over 20 pages and are not included in this Technical Report. They are available in the section on the technical report at the CRI web portal. In Figures B.1 and B.2, the parameter estimates are from calibrations performed in July 2012 using data up until the end of June 2012. As an example, plots of the default parameters for the US are given in figures included in Figures B.1 and B.2 in Appendix B. In this part, a brief overview is given of the general traits and patterns seen in the default parameter estimations of the economies covered by the CRI.

Recall that if a default parameter for a variable at a particular horizon is estimated to be positive (resp. negative) from the maximum pseudo-likelihood estimate, then an increasing value in the associated variable will lead to an increasing (decreasing) value of the forward intensity at that horizon, which in turn means an increasing (decreasing) value for the conditional default probability at that horizon.

For the stock index one-year trailing return variable, most groups have default parameters that are slightly negative in the shorter horizons and then become positive in the longer horizons. When the equity market performs well, this is only a short-term positive for firms and in the longer term, firms are actually more likely to default. This seemingly counterintuitive result could be due to correlation between the market index and other firm-specific variables. For example, Duffie *et al.* (2009) suggested that a firm's distance-to-default (DTD) can overstate its creditworthiness after a strong bull market. If this is the case, then the stock index return serves as a correction to the DTD levels at these points in time.

The default parameters for the short-term interest rate variable are significantly positive at one- to two-year horizons for most of the economies. This is consistent with the intuition that increasing short-term interest rates typically signal increased funding costs for companies in the future, increasing the probability of default. The values at shorter horizons are varied between economies from slightly negative to significantly positive, possibly indicating different lead-lag relationships between credit conditions and the raising and cutting of short-term interest rates.

DTD is a measure of the volatility-adjusted leverage of a firm. Low or negative DTD indicates high leverage and high DTD indicates low leverage. Therefore, PD would be expected to increase with decreasing DTD. Indeed, almost all of the calibrations for the different groups lead to negative default parameters for the DTD level, with only China's default parameter estimations hitting the constraint at zero for longer horizons.

The ratio of the sum of cash and short-term investments to total assets (CASH/TA) measures liquidity of a firm. This indicates the availability of a firm's funds and its ability to make interest and principal payments. As expected, for almost all economies (Indonesia being the only exception) the default parameters for CASH/TA level in shorter horizons are significantly negative. The magnitude of the default parameters decreases for longer horizons, indicating that CASH/TA level is a better indicator of a firm's ability to make payments in the short term than the long term.

The ratio of net income to total assets (NI/TA) measures profitability of a firm. The relationship between PD and NI/TA is as expected: the default parameters for NI/TA level is significantly negative for most economies and most horizons.

The logarithm of the market capitalization of a firm over the median market capitalization of firms within the economy (SIZE) does not have a consistent effect on PD across different economies. For example, in the US the default parameters for SIZE level are negative for shorter horizons and positive for longer horizons, suggesting that the advantages enjoyed by larger firms, such as diversified business lines and funding sources, are a benefit in the shorter term but not in the longer term. On the other hand, in Japan the default parameters for SIZE level are negative across all horizons. These differences may reflect differences in the business environments in the respective economies.

The default parameters associated with DTD Trend, CASH/TA Trend and SIZE Trend, are negative across almost all economies and horizons. The trend variables reflect momentum. The momentum effect is a short-term effect, and evidence of this is seen in the lower magnitude of the default parameters at longer horizons than at shorter horizons. The remaining trend variable is the NI/TA Trend. The current implementation of the CRI system retrieves net income only from annual financial statements. The default parameters for NI/TA Trend are constrained to be negative, but for most economies there is no clear relationship between the NI/TA Trend and the horizon. Once

NI/TA from quarterly statements can be used, this will likely be more informative.

The ratio of the sum of market capitalization and total liabilities to total assets (M/B) can either indicate the market mis-valuation effect or the future growth effect. This default parameter is positive in most economies, indicating that higher M/B implies higher PD, and the market mis-valuation effect dominates.

Shumway (2001) argued that a high level of the idiosyncratic volatility (SIGMA) indicates highly variable stock returns relative to the market index, indicating highly variable cash flows. Volatile cash flows suggest a heightened PD, and this finding is consistent across all economies and most horizons, with the exception of India.

4.2. Prediction Accuracy

In-sample and out-of-sample testing: Various tests are carried out to test the prediction accuracy of the CRI PD forecasts. These tests are conducted either in-sample or out-of-sample.

A single calibration is conducted for the in-sample tests, using data to the end of the data sample. As an example, one-year PD forecasts are made for December 31, 2000 by using the data at or before December 31, 2000 and the parameters from the calibration. These PD forecasts can be compared to actual defaults that occurred at any time in 2001.

The out-of-sample analysis is done over time. The first calibration is conducted using only data up to the end of December 2000. For example, one-year PD forecasts can be made for December 31, 2000 using the data at or before December 31, 2000 with the parameters from this first calibration. These are PD forecasts that could have been made at the time, since the parameters are not based on data available after that date. This process is repeated every month. That is, the second calibration is conducted using only data up to the end of January 2001, and so on.

It should be noted that for these repeated calibrations based on an expanding window of data, nothing else is changed besides the dataset. In other words, the same choice of input variables and the same choice of economy dummies within the groups are used throughout all of the calibrations.

Some of the calibration groups have too few defaults in the period before December 2000 to be able to produce stable calibration results. If this is the case, the start date is advanced. Subsequently, if there are too few defaults after the start date to perform meaningful tests, only in-sample tests are performed for that calibration group. Out-of-sample tests are performed for (starting month of calibration in parentheses): China (12/2000), Japan (12/2003), India (12/2001), South Korea (12/2000), Developed Asia (12/2000), Emerging Markets (12/2000), North America group (12/2000), Europe group (12/2002).

Accuracy Ratio: The accuracy ratio (AR) is one of the most popular and meaningful tests of the discriminatory power of a rating system (BCBS, 2005). The AR and the equivalent Area Under the Receiver Operating Characteristic (AUROC) are described in Duan and Shrestha (2011). In short, if defaulting firms had been assigned among the highest PD of all firms before they defaulted, then the model has discriminated well between "safe" and "distressed" firms. This leads to higher values of AR and AUROC. The range of possible AR values is in [0,1], where 0 is a completely random rating system and 1 is a perfect rating system. The range of possible AUROC values is in [0.5, 1]. AUROC and AR values are related by: $AR = 2 \times AUROC - 1$.

The AR and AUROC values for different horizons are available in Table B.1 of this technical report. Both in-sample and out-of-sample results are available for calibration groups where out-of-sample testing could be performed. Other calibration groups include only in-sample results. The in-sample AR and AUROC are computed only from the starting date of the corresponding out-of-sample tests, so that the results between in-sample and out-of-sample are comparable. Only economies with more than 20 defaults entering into the AR and AUROC computation are listed. The PD are taken to be non-overlapping. For example, the one-year AR is based on PDs computed on 31/12/2000, 31/12/2001, … , 31/12/2009 and firms defaulting within one year of those dates, while the two-year AR is based on PDs computed on 31/12/2000, 31/12/2002, … , 31/12/2008 and firms defaulting within two years of those dates.

The AUROC values have been provided only for the purpose of comparison, if other rating systems report their results in terms of AUROC. The discussion will focus only on AR. The model is able to achieve strong AR results mostly greater than 0.80 at the one and six-month horizons for developed economies. There is a drop in AR at one and two-year horizons, but the AR are still mostly acceptable. Australia, the UK and Singapore have sharp drops in AR at the two-year horizon. Hong Kong has comparatively worse AR over all horizons as compared to other developed economies.

The AR in emerging market economies such as China, India, Indonesia, Malaysia, Philippines and Thailand are noticeably weaker than the results in the developed economies. This can be due to a number of issues. The quality of data is worse in emerging markets, in terms of availability and data errors. This may be due to lower reporting and auditing standards. Also, variable selection is likely to play a more important role in emerging markets. The variables were selected based on the predictive power in a developed economy, the US. Performing variable selections specific to the calibration group are expected to improve predictive accuracy, especially in emerging market economies. Finally, there could be structural differences in how defaults and bankruptcies occur in emerging market economies. If the judicial system is weak and there are no repercussions for default, firms may be less reluctant to default. The AR for the Latin American economies inside the emerging economies group are generally greater than 0.80 at horizons shorter than one year. However, these AR are for a small number of defaults.

At horizons of one and six-months, out-of-sample AR are comparable to their in-sample counterparts. At horizons of one and two-years, out-of-sample AR can be substantially lower than the in-sample AR.

Finally, the US has a sufficient number of financial firms and financial defaults to produce separate AR and AUROC. These are also listed in Table B.1 as out-of-sample results. The financial sector ARs are actually stronger than the non-financial sector AR. This is achieved by having only minimal differences between how financial and non-financial firms are treated.

The AR is a test of discriminatory power, or how well the rating system ranks firms in terms of credit worthiness. In a separate article included in the GCR Volume 2, we provide a more qualitative check on the CRI PD in which we compare the behaviour of CRI PD to the rating actions of external credit rating agencies such as Moody's and S&P for some well known default cases.

Aggregate defaults: The time series of aggregate predicted number of defaults and actual number of defaults in each calibration group are also available in Figure B.3.

V. ONGOING DEVELOPMENTS

The CRI can be developed along a number of directions. We now comment on obvious ones that in our view are likely to bring meaningful and measurable benefits. Besides modifications to the current modeling framework of the forward intensity, a change in modeling platform will be undertaken if another model proves more promising in terms of accuracy and robustness of results. For this type of development we also rely on the collective efforts by the worldwide credit research community to challenge and improve the existing modeling platform.

The current CRI default prediction model is based on the econometric platform of modeling forward intensities developed by Duan *et al*. (2012). As noted by them, the forward-intensity model exhibits systematic bias in predicting longer-term defaults of the US corporate sector. In general, it overestimates (underestimates) defaults when default rates were low (high). Introducing a frailty variable to the model to capture default contagion appears to be one possibility to further improve the model.

In addition, some of the likely future developments of CRI fall in the domain of further infrastructure developments at RMI. For example, by end 2012, all exchange-listed firms in all economies around the globe should be covered. Furthermore, in terms of variable selection, more experiments are needed to identify common risk factors and RMI specific attributes that are more indicative of defaults in different economies. Also in terms of grouping, further tests should be conducted, especially as new economies will be covered. It is also worth noting that all variables used thus far in the CRI implementation are the quantitative type. Soft credit information as reflected in qualitative opinions of credit analysts may add an important dimension to future improvement. To this end, the CRI has been conducting a continuous credit analysts survey, and at this point of writing there are about 100 analysts participating in the survey. It is quite obvious that we have to expand this base of this survey in order to allow meaningful incorporation into the default prediction.

****

The RMI Credit Research Initiative is premised on the concept of credit ratings as a "public good". Being a non-profit undertaking allows a high level of transparency and collaboration that other commercial credit rating systems can not replicate. The research and support infrastructure is in place and researchers from around the world are invited to contribute to this initiative. Any methodological improvements that researchers develop will be incorporated into the CRI system. In essence, the initiative operates as a "selective wikipedia" where many can contribute but implementation control is retained.

If you have feedback on this technical report or wish to work with us in this endeavor, please contact us at rmicri@globalcreditreview.com

REFERENCES

Anderson, L., J. Sidenius and S. Basu (2003), All your Hedges in one Basket. *Risk*, pp. 67–72.

Crosbie, P. and J. Bohn (2003), Modeling Default Risk. Moody's KMV technical document.

Duan, J.-C. (1994), Maximum Likelihood Estimation Using Price Data of the Derivative Contract. *Mathematical Finance*, 4, pp. 155–167.

Duan, J.-C. (2000), Correction: "Maximum Likelihood Estimation Using Price Data of the Derivative Contract". *Mathematical Finance*, 10, pp. 461–462.

Duan, J.-C. (2010), Clustered Defaults. National University of Singapore Working Paper.

Duan, J.-C. and K. Shrestha (2011), Statistical Credit Rating Methods, *Global Credit Review*, pp. 43–64.

Duan, J.-C., J. Sun and T. Wang (2012), Multiperiod Corporate Default Prediction — A Forward Intensity Approach. *Journal of Econometrics*, forthcoming (DOI: 10.1016/j.jeconom.2012.05.002).

Duan, J.-C. and E. Van Laere (2012), A Public Good Approach to Credit Ratings: From Concept to Reality. *Journal of Banking & Finance*, forthcoming (DOI: 10.1016/j.jbankfin.2012.03.012).

Duan, J.-C. and T. Wang (2012), Measuring Distance-to-Default for Financial and Non-financial Firms. *Global Credit Review*, pp. 95–108.

Duffie, D., A. Eckner, G. Horel and L. Saita (2009), Frailty Correlated Default. *Journal of Finance*, 64, pp. 2089–2123.

Duffie, D., L. Saita, and K. Wang (2007), Multi-Period Corporate Default Prediction with Stochastic Covariates. *Journal of Financial Economics*, 83, pp. 635–665.

Merton, R. C. (1974), On the Pricing of Corporate Debt: The Risk Structure of Interest Rates. *Journal of Finance*, 29, pp. 449–470.

Shumway, T. (2001), Forecasting Bankruptcy More Accurately: A Simple Hazard Model. *Journal of Business*, 74, pp. 101–124.

APPENDIX A

Table A.1 ISO codes for economies currently covered by the CRI and the group that each economy is calibrated in.

ISO Code	Economy	Calibration Group
ARG	Argentina	Emerging
AUS	Australia	Developed Asia-Pacific
AUT	Austria	Europe
BEL	Belgium	Europe
BRA	Brazil	Emerging
CAN	Canada	North America
CHE	Switzerland	Europe
CHL	Chile	Emerging
CHN	China	China
COL	Colombia	Emerging
CYP	Cyprus	Europe
DEU	Germany	Europe
DNK	Denmark	Europe
ESP	Spain	Europe
EST	Estonia	Europe
FIN	Finland	Europe
FRA	France	Europe
GBR	United Kingdom	Europe
GRC	Greece	Europe
HKG	Hong Kong	Developed Asia-Pacific
IDN	Indonesia	Emerging
IND	India	India
IRL	Ireland	Europe
ISL	Iceland	Europe
ITA	Italy	Europe
JPN	Japan	Developed Asia-Pacific
KOR	South Korea	Developed Asia-Pacific
LUX	Luxemburg	Europe
MEX	Mexico	Emerging
MLT	Malta	Europe
MYS	Malaysia	Emerging
NLD	Netherlands	Europe
NOR	Norway	Europe
PER	Peru	Emerging
PHL	Philippines	Emerging
PRT	Portugal	Europe
SGP	Singapore	Developed Asia-Pacific
SVK	Slovakia	Europe
SVN	Slovenia	Europe
SWE	Sweden	Europe
THA	Thailand	Emerging
TWN	Taiwan	Developed Asia-Pacific
USA	United States	North America
VEN	Venezuela	Emerging

Table A.2 The stock indices used for each economy in computing the first common variable.

Country	Stock Exchange	Period Used
ARG	Buenos Aires Stock Exchange Merval Index	
AUS	All Ordinaries Index	
AUT	Austrian Traded ATX Index	
BEL	Belgian All Shares Return Index	
BRA	Brazil Bovespa Stock Index	
CAN	S&P/TSX Composite Index	
CHE	SPI Swiss Performance Index	
CHL	Santiago Stock Exchange IPSA Index	
CHN	Shanghai Stock Exchange Composite Index	
COL	FTSE All World Series Colombia Local	
CYP	Cyprus Stock Exchange General Index	9/3/2004–Present
	Cyprus Stock Exchange General	4/2/1996–9/2/2004
DEU	CDAX Performance Index	
DNK	OMX Copenhagen 20 Index	
ESP	IBEX 35 Index	
EST	OMX Tallinn OMXT	
FIN	OMX Helsinki Index	
FRA	CAC 40 Index	
GBR	FTSE 100 Index	
GRC	Athex Composite Share Price Index	
HKG	Hang Seng Index	
IDN	Jakarta Composite Index	
IND	BSE Sensex 30 Index	
IRL	Irish Overall Index	
ISL	OMX Iceland All-Share Price Index	
ITA	Italy Stock Market BCI Comit Global	
JPN	Nikkei 500	
KOR	KOSPI Index	
LUX	Luxembourg Stock Exchange LuxX Index	1/4/1999–Present
	Luxembourg Stock Exchange13 'Dead'	1/2/1998–1/3/1999
MEX	Mexico Bolsa Index	
MLT	Malta Stock Exchange	
MYS	FTSE Bursa Malaysia KLCI	
NLD	AEX Index	
NOR	OBX Price Index	
PER	Bolsa de Valores de Lima General Sector Index	
PHL	PSEI-Philippine Stock Exchange Index	
PRT	PSI General Index	
SGP	Straits Times Index	1/10/2008–Present
	Straits Times Old Index	8/31/1999–1/9/2008
SVK	Slovak Share Index	
SVN	HSBC Slovenia Dollar	
SWE	OMX Stockholm All-Share Index	
THA	Stock Exchange of Thailand Index	
TWN	Taiwan Taiex Index	
USA	S&P 500 Index	
VEN	Caracas Stock Exchange Stock Market Index	

*A blank Period Used column indicates that there is only a single index that is used throughout the whole period.

Table A.3 The interest rates used for each economy as the second common variable.

Country	Short Term Interest Rate	Period Used
ARG	Argentina Deposit 90 Day	
AUS	Australia Dealer Bill 90 Day	
AUT	Germany 3 Month Bubill	1/1/1999–Present
	—	–12/31/1998
BEL	Germany 3 Month Bubill	1/1/1999–Present
	—	–12/31/1998
BRA	Andima Brazil Govt Bond Fixed Rate 3 Months	4/3/2000–Present
	Brazil CDB (up to 30 Days)	10/10/1994–3/31/2000
CAN	Canada Treasury Bill 3 Month	
CHE	—	
CHL	Chile TAB UF Interbank Rate 90 Days	
CHN	China Time Deposit Rate 3 Month	
COL	Colombia CD Rate 90-Day	
CYP	Germany 3 Month Bubill	1/1/2008–Present
	—	–12/31/2007
DEU	Germany 3 Month Bubill	5/25/1993–Present
	Germany Interbank 3 Month	1/2/1986–5/24/1993
DNK	Denmark Interbank 3 Month	
ESP	Germany 3 Month Bubill	1/1/1999–Present
	—	–12/31/1998
EST	Germany 3 Month Bubill	1/1/2001–Present
	—	–12/31/2010
FIN	Germany 3 Month Bubill	1/1/1999–Present
	—	–12/31/1998
FRA	Germany 3 Month Bubill	1/1/1999–Present
	—	–12/31/1998
GBR	UK Treasury Bill Tender 3 Month	
GRC	Germany 3 Month Bubill	1/1/2001–Present
	—	–12/31/2000
HKG	Hong Kong Exchange Fund Bill 3 Month	
IDN	Indonesia SBI 90 Day	7/10/2003–Present
	Indonesia SBI/DISC 90 Day	1/1/1985–7/9/2003
IND	India T-Bill Secondary 91 Day	
IRL	Germany 3 Month Bubill	1/1/1999–Present
	—	–12/31/1998
ISL	—	
ITA	Germany 3 Month Bubill	1/1/1999–Present
	—	–12/31/1998
JPN	Japan Treasury Discount Bills 3 Month	7/10/1992–Present
	Japanese Government Bond Interest Rate-1 Year Maturity	9/24/1974–7/9/1992
KOR	Korea Commercial Paper 91 Day	
LUX	Germany 3 Month Bubill	1/1/1999–Present
	—	–12/31/1998
MEX	Mexico Cetes 2ND MKT. 90 Day	6/26/1996–Present
	Mexico Cetes 91 Dat AVG.RET.AT AUC.	3/9/1989–6/25/1996
MLT	Germany 3 Month Bubill	1/1/2008–Present
	—	–12/31/2007
MYS	Malaysia Deposit 3 Month	
NLD	Germany 3 Month Bubill	1/1/1999–Present
	—	–12/31/1998
NOR	Norway Govt Treasury Bills 3 Month	6/27/1995–Present
	Norway Interbank 3 Month(effective)	1/2/1986–6/26/1995

(*Continued*)

Table A.3 (*Continued*)

Country	Short Term Interest Rate	Period Used
PER	Peru Savings Rate	
PHL	Philippine Treasury Bill 91 Day	
PRT	Germany 3 Month Bubill	1/1/1999–Present
	—	–12/31/2008
SGP	Singapore T-Bill 3 Month	
SVK	Germany 3 Month Bubill	1/1/2009–Present
	—	–12/31/2008
SVN	Germany 3 Month Bubill	1/1/2007–Present
	—	–12/31/2006
SWE	Sweden T-Bill 3 Month	5/25/1993–Present
	Sweden Treasury Bill 90 Day	4/25/1989–5/24/1993
THA	Thailand Repo 3 Month(BOT)	
TWN	Taiwan Money Market 90 Day	
USA	US Generic Govt 3-Month Yield	
VEN	Venezuela Overnight	

*A blank Period Used column indicates that there is only a single interest rate that is used throughout the whole period.

Table A.4 The interest rates used for each economy in the DTD calculation.

Country	Interest Rate Name	Period Used
ARG	Argentina Deposit 90 Day (PA.)	
AUS	Australia Govt. Bonds Generic Mid Yield 1 Year	
AUT	German Government Bonds 1 Year BKO	1/1/1999–Present
	Austria VIBOR 12 Month	6/10/1991–12/31/1998
BEL	German Government Bonds 1 Year BKO	1/1/1999–Present
	Belgium Treasury Bill 1 Year	4/2/1991–12/31/1998
BRA	Andima Brazil Govt Bond Fixed Rate 1 Year	4/3/2000–Present
	BRAZIL CDB (UP TO 30 DAYS)	10/10/1994–3/31/2000
CAN	Canada Treasury Bill 1 Year	
CHE	Swiss Interbank 1 Year (ZRC:SNB)	
CHL	Chile TAB UF Interbank Rates 360 Days	8/1/1996–Present
	Chile TAB UF Interbank Rate 90 Days	11/2/1992–7/30/1996
CHN	China Household Savings Deposits 1-Year Rate	
COL	Colombia Government Generic Bond 1 Year Yield	3/1/2001–Present
	Colombia CD Rate 360-Dat	7/12/1993–2/8/2001
CYP	Cyprus Treasury Bill Rate — 13 Week	
DEU	German Government Bonds 1 Year BKO	1/10/1995–Present
	Germany Interbank 12 Month	11/2/1990–1/9/1995
DNK	Denmark Government Bonds 1 Year Note Generic Bid Yield	6/1/2008–Present
	Denmark Euro-Krone 1 Year(FT/ICAP/TR)	6/14/1985–5/31/2008
ESP	German Government Bonds 1 Year BKO	1/1/1999–Present
	Spain 12 Month Treasury Bill Yield	11/30/1992–12/31/1998
	Spain Interbank 12 Month	12/19/1991–11/29/1992
EST	Estonia, Interest Rates, Prices, Production & Labour, Interest Rates, Deposit Rate	
FIN	German Government Bonds 1 Year BKO	1/1/1999–Present
	Finland Interbank Close 12 Month	4/2/1992–12/31/1998
FRA	German Government Bonds 1 Year BKO	1/1/1999–Present
	France Treasury Bill 12 Months	1/3/1989–12/31/1998

(*Continued*)

Table A.4 (*Continued*)

Country	Interest Rate Name	Period Used
GBR	UK Govt. Bonds 1 Year Note Generic	9/12/2001–Present
	UK Govt. Liability Nominal Spot Curve 12 Month	12/13/1985–9/11/2001
GRC	German Government Bonds 1 Year BKO	1/1/2001–Present
	Greece Treasury Bill 1 Year	1/2/1990-12/31/2000
HKG	HKMA Hong Kong Exchange Fund Bill 12 Month	
IDN	Indonesia SBI 90 Day	7/10/2003–Present
	Indonesia SBI/DISC 90 Day	1/1/1985–7/9/2003
IND	India T-Bill Secondary 1 Year	
IRL	UK Govt. Liability Nominal Spot Curve 12 Month	
ISL	Iceland Interbank 12 Month	2/1/2000–Present
	Iceland Interbank 3 Month	8/4/1998–1/31/2000
	Iceland 90-day CB Notes	5/12/1987–8/3/1998
ITA	German Government Bonds 1 Year BKO	1/1/1999–Present
	Italy Bots Treasury Bill 12 Month Gross Yields	9/5/1994–12/31/1998
	Italy T-Bill Auction Gross 12 Month	3/31/1987–9/4/1994
JPN	Japan Treasury Bills 12 Month	12/14/1999–Present
	Japanese Government Bond Interest Rate-1 Year Maturity	9/24/1979–12/13/1999
KOR	Korea Monetary Stabilization Bonds 1 Year	
LUX	Long Term Government Bond Yields — Maastricht Definition (Avg.)	
MEX	Mexico Cetes 2ND MKT. 360 Day	6/26/1996–Present
	Mexico Cete 91 DAY AVG.RET.AT AUC.	3/9/1989–6/25/1996
MLT	Long Term Government Bond Yields — Maastricht Definition (Avg.)	
MYS	Bank Negara Malaysia 1 Year Govt. Securities Indicative YTM	6/21/2005–Present
	Malaysia Deposit 1 Year	1/1/1985–6/20/2005
NLD	German Government Bonds 1 Year BKO	1/1/1999–Present
	Netherland Interbank 1 Year	1/2/1987–12/31/1998
NOR	Norway Govt. Treasury Bills 12 Month	7/1/1997–Present
	Norway Interbank 1 Year	1/2/1986–6/30/1997
PER	Peru Savings Rate	
PHL	Philippine Treasury Bill 364 Day	
PRT	German Government Bonds 1 Year BKO	1/1/1999–Present
	Portugal 1-Year-LISBOR-Act/365 Day convention	8/16/1993–12/31/1998
SGP	Singapore T-Bill 3 Month	
SVK	Slovak Rep. Interbank 1 Year	
SVN	Slovenia Treasury Bill 3 Month 'Dead'	
SWE	Sweden Interbank 1 Year	5/25/1993–Present
	Sweden Treasury Bill 1 Year Note	4/25/1989–5/24/1993
THA	Thailand Govt. Bond 1 Year Note	8/7/2000–Present
	Thailand Deposit 12 Month(KT)	1/2/1991–8/6/2000
TWN	Taiwan Deposit 12 Month	
USA	US Treasury Constant Maturities 1 Year	
VEN	Venezuela Overnight	

*A blank Period Used column indicates that there is only a single interest rate that is used throughout the whole period.

Table A.5 Summary statistics of input variables (based on data from Jan 1991 to June 2012).

	DTD Level							
	Min	25%	Median	75%	Max	Mean	StdDev	# Observations
ARG	−1.75	1.69	2.88	4.05	19.86	3.10	2.25	10999
AUS	−1.41	1.84	2.98	4.21	17.73	3.30	2.20	261380
AUT	−2.95	1.90	3.12	5.05	25.82	4.12	4.29	20524
BEL	−2.95	2.51	4.42	6.82	25.82	5.08	3.81	27834
BRA	−1.86	0.93	2.45	4.80	23.38	3.36	3.68	43815
CAN	−1.13	1.92	3.26	4.92	25.00	3.69	2.55	202772
CHE	−2.95	2.65	4.05	5.82	23.69	4.44	2.83	50531
CHL	−0.81	3.51	5.18	6.84	23.38	5.60	3.45	26644
CHN	0.03	3.05	4.11	5.64	16.88	4.59	2.27	232944
COL	−1.03	2.26	3.77	5.53	20.47	4.13	2.83	5378
CYP	−1.27	0.88	1.55	2.47	23.81	2.07	2.30	16110
DEU	−2.95	1.61	2.89	4.39	25.82	3.32	2.71	166977
DNK	−2.95	1.82	3.15	4.72	25.82	3.60	2.85	41748
ESP	−2.95	2.20	3.58	5.11	25.82	4.01	3.04	33473
EST	−0.30	1.45	2.50	3.94	11.20	3.08	2.38	766
FIN	−2.95	2.26	3.44	4.95	20.19	3.80	2.38	27101
FRA	−2.95	1.80	3.00	4.58	25.82	3.47	2.74	154055
GBR	−2.95	2.19	3.55	5.29	25.82	4.03	2.77	356876
GRC	−2.95	1.48	2.49	3.81	23.59	2.82	2.14	52254
HKG	−1.41	1.48	2.51	3.94	17.73	3.00	2.28	186450
IDN	−1.86	0.56	1.53	2.59	23.38	1.83	2.02	50991
IND	−1.61	0.82	1.70	2.79	15.42	2.04	1.97	399715
IRL	−1.74	1.97	3.30	4.86	13.63	3.53	2.24	9735
ISL	−1.48	1.75	2.93	4.25	20.01	3.22	2.25	4274
ITA	−2.95	1.61	2.85	4.36	25.82	3.19	2.49	56269
JPN	−1.41	2.05	3.10	4.44	17.73	3.49	2.15	744685
KOR	−1.41	1.20	2.11	3.26	17.73	2.45	2.03	251921
LUX	−0.17	3.19	4.94	7.62	24.75	6.14	4.44	2797
MEX	−1.86	1.99	3.58	5.41	23.38	4.04	3.08	16289
MLT	−0.65	2.32	3.62	5.19	15.32	4.35	3.37	842
MYS	−1.86	1.57	2.84	4.55	23.38	3.46	2.84	170119
NLD	−2.95	2.49	4.03	5.86	25.82	4.47	3.09	35057
NOR	−2.95	1.24	2.37	3.79	20.49	2.62	2.05	40996
PER	−1.86	1.87	3.00	4.44	22.72	3.44	2.50	10507
PHL	−1.86	1.05	2.19	3.54	23.38	2.56	2.21	33701
PRT	−2.95	1.18	2.35	3.84	20.09	2.81	2.41	13055
SGP	−1.19	1.55	2.65	4.30	17.73	3.17	2.33	104474
SVK	−0.24	1.40	2.27	3.18	25.82	2.79	3.38	776
SVN	−2.47	2.18	3.68	5.89	16.88	4.10	2.98	5797
SWE	−2.95	1.75	3.04	4.55	25.82	3.38	2.46	73447
THA	−1.71	1.58	2.81	4.26	23.38	3.19	2.48	84238
TWN	−1.41	2.60	3.68	4.99	17.73	3.98	2.15	202372
USA	−1.13	1.78	3.02	4.63	25.00	3.49	2.60	1421457
VEN	−1.86	0.37	1.36	2.31	13.37	1.38	1.73	3503

(*Continued*)

Table A.5 (*Continued*)

	DTD Trend							
	Min	25%	Median	75%	Max	Mean	StdDev	# Observations
ARG	–7.83	–0.54	–0.02	0.42	6.69	–0.05	1.03	10999
AUS	–5.47	–0.48	–0.02	0.38	5.08	–0.06	0.98	261380
AUT	–8.09	–0.58	–0.03	0.44	7.62	–0.15	1.63	20521
BEL	–8.09	–0.64	–0.04	0.55	7.62	–0.06	1.49	27833
BRA	–7.83	–0.45	0.00	0.40	6.69	–0.15	1.44	43815
CAN	–6.37	–0.54	–0.02	0.44	5.34	–0.06	1.10	202763
CHE	–8.09	–0.61	0.00	0.59	7.62	–0.01	1.26	50531
CHL	–7.83	–0.68	0.04	6.56	6.69	–0.05	1.46	26644
CHN	–6.13	–0.57	–0.02	0.48	5.51	–0.07	1.05	232944
COL	–7.83	–0.45	0.03	0.66	6.69	0.08	1.29	5247
CYP	–8.09	–0.36	–0.07	0.15	7.62	–0.13	0.75	16104
DEU	–8.09	–0.51	–0.04	0.40	7.62	–0.06	1.10	166943
DNK	–8.09	–0.52	–0.01	0.43	7.62	–0.05	1.19	41701
ESP	–8.09	–0.50	0.01	0.48	7.62	–0.01	1.28	33473
EST	–2.26	–0.01	0.12	0.47	3.70	0.26	0.70	590
FIN	–8.09	–0.47	0.03	0.52	7.62	0.02	1.05	27100
FRA	–8.09	–0.48	–0.00	0.44	7.62	–0.03	1.09	153986
GBR	–8.09	–0.57	–0.02	0.40	7.62	–0.10	1.26	356876
GRC	–8.09	–0.55	–0.09	0.32	7.62	–0.11	0.97	52254
HKG	–5.47	–0.49	–0.01	0.42	5.08	–0.04	0.97	186450
IDN	–7.83	–0.31	0.01	0.31	6.69	–0.01	0.76	50991
IND	–5.87	–0.35	–0.02	0.33	4.82	–0.01	0.78	399485
IRL	–6.47	–0.52	0.00	0.43	7.25	–0.07	1.02	9735
ISL	–8.09	–0.74	–0.07	0.39	6.76	–0.18	1.35	4273
ITA	–8.09	–0.58	–0.04	0.46	7.62	–0.07	1.13	56269
JPN	–5.47	–0.47	–0.02	0.41	5.08	–0.03	0.87	744685
KOR	–5.47	–0.44	–0.01	0.38	5.08	–0.04	0.87	251918
LUX	–8.09	–0.67	0.00	0.52	7.62	–0.11	1.43	2791
MEX	–7.67	–0.46	0.05	0.61	6.69	0.08	1.12	16206
MLT	–6.66	–0.62	–0.10	0.54	4.26	0.01	1.36	783
MYS	–7.83	–0.49	–0.02	0.41	6.69	–0.05	1.07	170119
NLD	–8.09	–0.66	–0.03	0.55	7.62	–0.06	1.25	35055
NOR	–8.09	–0.44	–0.01	0.36	7.62	–0.05	0.90	40933
PER	–7.83	–0.45	0.00	0.50	6.69	0.02	1.17	10441
PHL	–7.83	–0.35	0.00	0.32	6.69	–0.02	0.88	33701
PRT	–8.09	–0.46	–0.04	0.33	7.34	–0.06	0.94	13055
SGP	–5.47	–0.48	–0.02	0.39	5.08	–0.06	0.96	104474
SVK	–8.03	–0.21	0.02	0.37	7.62	0.09	1.09	681
SVN	–5.14	–0.68	–0.12	0.22	7.62	–0.19	1.06	5777
SWE	–8.09	–0.49	–0.03	0.42	7.62	–0.04	1.03	73434
THA	–7.83	–0.51	–0.01	0.43	6.69	–0.05	1.03	84238
TWN	–5.47	–0.57	–0.03	0.49	5.08	–0.05	0.98	202372
USA	–6.37	–0.47	0.00	0.43	5.34	–0.03	0.97	1421430
VEN	–6.72	–0.27	0.00	0.31	6.69	0.01	0.73	3368

(*Continued*)

Table A.5 (*Continued*)

	CASH/TA Level							
	Min	**25%**	**Median**	**75%**	**Max**	**Mean**	**StdDev**	**# Observations**
ARG	0.00	0.02	0.05	0.10	0.69	0.07	0.08	11240
AUS	0.00	0.04	0.13	0.35	0.97	0.23	0.25	267774
AUT	0.00	0.03	0.07	0.15	0.96	0.11	0.13	21080
BEL	0.00	0.03	0.08	0.19	0.99	0.15	0.18	29341
BRA	0.00	0.02	0.07	0.16	0.91	0.11	0.13	45844
CAN	0.00	0.01	0.06	0.21	0.99	0.15	0.21	203329
CHE	0.00	0.05	0.10	0.20	0.99	0.15	0.16	51597
CHL	0.00	0.01	0.03	0.08	0.91	0.06	0.09	27864
CHN	0.00	0.08	0.14	0.24	0.88	0.18	0.15	234610
COL	0.00	0.03	0.06	0.10	0.84	0.08	0.10	5659
CYP	0.00	0.01	0.05	0.15	0.91	0.11	0.14	16620
DEU	0.00	0.02	0.07	0.20	0.99	0.15	0.18	170235
DNK	0.00	0.03	0.09	0.18	0.99	0.14	0.17	42980
ESP	0.00	0.02	0.05	0.11	0.73	0.08	0.10	36439
EST	0.00	0.03	0.05	0.12	0.53	0.09	0.09	2265
FIN	0.00	0.03	0.08	0.16	0.99	0.13	0.14	27646
FRA	0.00	0.03	0.08	0.17	0.99	0.13	0.14	156142
GBR	0.00	0.03	0.09	0.22	0.99	0.17	0.21	358220
GRC	0.00	0.02	0.06	0.13	0.83	0.10	0.11	53302
HKG	0.00	0.06	0.14	0.26	0.97	0.19	0.17	190587
IDN	0.00	0.03	0.08	0.17	0.90	0.12	0.12	53184
IND	0.00	0.01	0.03	0.07	0.82	0.06	0.09	562091
IRL	0.00	0.04	0.09	0.21	0.97	0.15	0.17	9954
ISL	0.00	0.02	0.04	0.08	0.53	0.06	0.06	4654
ITA	0.00	0.03	0.07	0.14	0.99	0.10	0.12	57508
JPN	0.00	0.07	0.13	0.22	0.97	0.17	0.13	745312
KOR	0.00	0.04	0.09	0.18	0.97	0.13	0.13	253233
LUX	0.00	0.04	0.11	0.19	0.97	0.16	0.17	3165
MEX	0.00	0.03	0.06	0.12	0.77	0.08	0.08	17301
MLT	0.00	0.03	0.08	0.22	0.50	0.14	0.14	1165
MYS	0.00	0.02	0.07	0.16	0.91	0.11	0.13	171192
NLD	0.00	0.02	0.05	0.13	0.99	0.10	0.13	35909
NOR	0.00	0.04	0.09	0.20	0.99	0.16	0.18	41551
PER	0.00	0.01	0.04	0.13	0.91	0.09	0.11	10810
PHL	0.00	0.02	0.08	0.18	0.91	0.13	0.15	34543
PRT	0.00	0.01	0.03	0.07	0.55	0.06	0.08	13769
SGP	0.00	0.06	0.13	0.24	0.97	0.17	0.15	105424
SVK	0.00	0.03	0.05	0.12	0.57	0.08	0.08	1216
SVN	0.00	0.01	0.04	0.09	0.41	0.07	0.07	6321
SWE	0.00	0.04	0.09	0.22	0.99	0.16	0.19	73727
THA	0.00	0.02	0.06	0.14	0.88	0.10	0.12	85166
TWN	0.00	0.05	0.11	0.21	0.94	0.15	0.14	202800
USA	0.00	0.03	0.07	0.24	0.99	0.18	0.22	1458948
VEN	0.00	0.04	0.07	0.18	0.91	0.12	0.11	3776

(*Continued*)

Table A.5 (*Continued*)

	CASH/TA Trend							
	Min	25%	Median	75%	Max	Mean	StdDev	# Observations
ARG	–0.33	–0.01	0.00	0.01	0.37	00.0	0.04	11240
AUS	–0.42	–0.03	–0.00	0.01	0.44	–0.01	0.09	267703
AUT	–0.48	–0.01	0.00	0.00	0.46	00.0	0.04	21069
BEL	–0.48	–0.01	0.00	0.00	0.46	–0.00	0.05	29334
BRA	–0.33	–0.01	0.00	0.01	0.37	0.00	0.05	45807
CAN	–0.44	–0.02	0.00	0.01	0.42	–0.00	0.07	203310
CHE	–0.48	–0.01	0.00	0.01	0.46	–0.00	0.04	51591
CHL	–0.33	–0.01	–0.00	0.00	0.37	0.00	0.04	27859
CHN	–0.30	–0.02	–0.00	0.01	0.30	–0.01	0.05	234588
COL	–0.33	–0.01	0.00	0.01	0.37	0.00	0.04	5650
CYP	–0.48	–0.01	0.00	0.00	0.46	–0.00	0.05	16593
DEU	–0.48	–0.01	0.00	0.00	0.46	0.00	0.06	170166
DNK	–0.48	–0.01	0.00	0.01	0.46	–0.00	0.06	42969
ESP	–0.48	–0.01	0.00	0.01	0.46	–0.00	0.04	36429
EST	–0.25	–0.01	0.00	0.01	0.17	–0.00	0.04	2258
FIN	–0.48	–0.01	–0.00	0.01	0.46	–0.00	0.05	27643
FRA	–0.48	–0.01	0.00	0.01	0.46	–0.00	0.04	156028
GBR	–0.48	–0.02	0.00	0.01	0.46	–0.01	0.07	358147
GRC	–0.46	–0.01	–0.00	0.01	0.46	–0.00	0.05	53299
HKG	–0.42	–0.02	0.00	0.01	0.44	–0.00	0.07	190587
IDN	–0.33	–0.01	0.00	0.01	0.37	–0.00	0.04	53184
IND	–0.36	–0.00	0.00	0.00	0.35	0.00	0.04	555409
IRL	–0.48	–0.01	0.00	0.01	0.46	–0.00	0.05	9954
ISL	–0.34	–0.01	0.00	0.00	0.40	–0.00	0.03	4644
ITA	–0.48	–0.01	0.00	0.01	0.46	–0.00	0.04	57502
JPN	–0.42	–0.01	–0.00	0.01	0.44	–0.00	0.04	745312
KOR	–0.42	–0.02	–0.00	0.01	0.44	–0.00	0.06	253233
LUX	–0.38	–0.01	0.00	0.00	0.25	–0.00	0.04	3135
MEX	–0.29	–0.01	0.00	0.01	0.37	–0.00	0.03	17275
MLT	–0.32	–0.01	0.00	0.00	0.18	–0.00	0.03	1165
MYS	–0.33	–0.01	0.00	0.01	0.37	–0.00	0.04	171187
NLD	–0.48	–0.01	0.00	0.00	0.46	0.00	0.04	35901
NOR	–0.48	–0.02	–0.00	0.01	0.46	–0.01	0.06	41536
PER	–0.33	–0.01	0.00	0.01	0.37	0.00	0.04	10806
PHL	–0.33	–0.01	0.00	0.01	0.37	–0.00	0.05	34523
PRT	–0.40	–0.01	0.00	0.00	0.46	–0.00	0.03	13727
SGP	–0.42	–0.02	0.00	0.01	0.44	–0.00	0.06	105406
SVK	–0.13	–0.01	0.00	0.00	0.15	–0.00	0.03	1212
SVN	–0.25	–0.01	0.00	0.00	0.28	–0.00	0.03	6319
SWE	–0.48	–0.02	–0.00	0.01	0.46	–0.01	0.07	73717
THA	–0.33	–0.01	–0.00	0.01	0.37	–0.00	0.04	85166
TWN	–0.42	–0.02	0.00	0.02	0.44	0.00	0.05	202800
USA	–0.44	–0.02	–0.00	0.01	0.42	–0.00	0.06	1458777
VEN	–0.19	–0.01	0.00	0.00	0.31	–00.0	0.03	3760

(*Continued*)

Table A.5 (*Continued*)

	NI/TA Level							
	Min	25%	Median	75%	Max	Mean	StdDev	# Observations
ARG*	–0.04	–0.00	0.00	0.01	0.03	0.00	0.01	11240
AUS	–0.44	–0.00	–0.00	0.00	0.10	–0.02	0.05	267973
AUT	–0.50	0.00	0.00	0.00	0.07	–0.00	0.02	21107
BEL	–0.35	0.00	0.00	0.01	0.07	0.00	0.01	29384
BRA*	–0.04	–0.00	0.00	0.01	0.03	0.00	0.01	45874
CAN	–0.35	–0.00	0.00	0.00	0.19	–0.01	0.03	203417
CHE	–0.50	0.00	0.00	0.00	0.07	0.00	0.02	51661
CHL*	–0.04	0.00	0.00	0.01	0.03	0.00	0.01	27900
CHN	–0.22	0.00	0.00	0.01	0.08	0.00	0.01	234634
COL*	–0.04	0.00	0.00	0.01	0.03	0.00	0.01	5659
CYP	–0.50	–0.00	0.00	0.00	0.07	–0.00	0.03	16723
DEU	–0.50	–0.00	0.00	0.00	0.07	–0.00	0.02	170624
DNK	–0.50	0.00	0.00	0.00	0.07	–0.00	0.02	42986
ESP	–0.50	0.00	0.00	0.00	0.07	0.00	0.03	36449
EST	–0.09	0.00	0.00	0.01	0.05	0.00	0.01	2288
FIN	–0.22	0.00	0.00	0.01	0.07	0.00	0.01	27658
FRA	–0.50	0.00	0.00	0.00	0.07	0.00	0.02	156598
GBR	–0.50	–0.00	0.00	0.01	0.07	–0.01	0.04	358414
GRC	–0.50	–0.00	0.00	0.01	0.07	0.00	0.01	53311
HKG	–0.44	0.00	0.00	0.01	0.10	–0.00	0.03	190589
IDN*	–0.04	0.00	0.00	0.01	0.03	0.00	0.01	53188
IND*	–0.04	0.00	0.00	0.01	0.03	0.00	0.01	565026
IRL	–0.50	0.00	0.00	0.01	0.07	0.00	0.02	9955
ISL	–0.13	0.00	0.00	0.01	0.02	0.00	0.01	4670
ITA	–0.14	–0.00	0.00	0.00	0.07	0.00	0.01	57539
JPN	–0.44	0.00	0.00	0.00	0.10	0.00	0.01	745501
KOR	–0.44	–0.00	0.00	0.01	0.10	–0.00	0.02	256265
LUX	–0.36	0.00	0.00	0.01	0.07	–0.00	0.04	3207
MEX*	–0.04	0.00	0.00	0.01	0.03	0.00	0.01	17318
MLT	–0.14	0.00	0.00	0.00	0.04	0.00	0.01	1165
MYS*	–0.04	0.00	0.00	0.01	0.03	0.00	0.01	171226
NLD	–0.50	0.00	0.00	0.01	0.07	0.00	0.02	35940
NOR	–0.50	–0.00	0.00	0.01	0.07	–0.00	0.03	41568
PER*	–0.04	0.00	0.00	0.01	0.03	0.01	0.01	10820
PHL*	–0.04	–0.00	0.00	0.01	0.03	0.00	0.01	34554
PRT	–0.22	–0.00	0.00	0.00	0.06	0.00	0.01	13841
SGP	–0.44	0.00	0.00	0.01	0.10	0.00	0.02	105459
SVK	–0.02	0.00	0.00	0.00	0.03	0.00	0.01	1225
SVN	–0.06	0.00	0.00	0.00	0.02	0.00	0.01	6321
SWE	–0.50	–0.00	0.00	0.01	0.07	–0.01	0.03	73761
THA*	–0.04	0.00	0.00	0.01	0.03	0.00	0.01	85166
TWN	–0.22	0.00	0.00	0.01	0.10	0.00	0.01	202800
USA	–0.35	–0.00	0.00	0.01	0.19	–0.00	0.03	1458082
VEN*	–0.04	0.00	0.00	0.01	0.03	0.00	0.01	3799

*Winsorization levels are at 1 and 99 percentiles instead of 0.1 and 99.9 percentiles.

(*Continued*)

Table A.5 (*Continued*)

	NI/TA Trend							
	Min	**25%**	**Median**	**75%**	**Max**	**Mean**	**StdDev**	**# Observations**
ARG*	–0.03	–0.00	0.00	0.00	0.03	–0.00	0.01	11240
AUS	–0.35	–0.00	0.00	0.00	0.27	–0.00	0.04	267800
AUT	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.01	21077
BEL	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.01	29339
BRA*	–0.03	–0.00	0.00	0.00	0.03	–0.00	0.01	45841
CAN	–0.29	–0.00	0.00	0.00	0.22	0.00	0.03	203336
CHE	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.01	51621
CHL*	–0.03	–0.00	0.00	0.00	0.03	–0.00	0.01	27877
CHN	–0.17	–0.00	–0.00	–0.00	0.14	–0.00	0.01	234628
COL*	–0.03	–0.00	0.00	0.00	0.03	–0.00	0.00	5659
CYP	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.02	16618
DEU	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.02	170230
DNK	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.02	42985
ESP	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.02	36438
EST	–0.30	–0.00	0.00	0.00	0.11	–0.00	0.02	2264
FIN	–0.20	–0.00	0.00	0.00	0.25	–0.00	0.01	27645
FRA	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.01	156149
GBR	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.03	358241
GRC	–0.30	–0.00	–0.00	–0.00	0.25	–0.00	0.01	53301
HKG	–0.35	–0.00	0.00	0.00	0.27	0.00	0.03	190589
IDN*	–0.03	–0.00	0.00	0.00	0.03	–0.00	0.01	53188
IND	–0.11	–0.00	0.00	0.00	0.10	–0.00	0.01	561658
IRL	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.02	9954
ISL	–0.12	–0.00	0.00	0.00	0.13	–0.00	0.01	4657
ITA	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.01	57519
JPN	–0.35	–0.00	0.00	0.00	0.27	0.00	0.01	745501
KOR	–0.35	–0.00	0.00	0.00	0.27	–0.00	0.03	256245
LUX	–0.08	–0.00	0.00	0.00	0.22	0.00	0.01	3165
MEX*	–0.03	–0.00	0.00	0.00	0.03	0.00	0.01	17295
MLT	–0.04	–0.00	–0.00	–0.00	0.02	–0.00	0.00	1165
MYS*	–0.03	–0.00	–0.00	–0.00	0.03	–0.00	0.01	171219
NLD	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.01	35907
NOR	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.02	41552
PER*	–0.03	–0.00	0.00	0.00	0.03	0.00	0.01	10810
PHL*	–0.03	–0.00	0.00	0.00	0.03	–0.00	0.01	34543
PRT	–0.30	–0.00	0.00	–0.00	0.21	–0.00	0.01	13770
SGP	–0.35	–0.00	00.0	0.00	0.27	0.00	0.02	105448
SVK	–0.05	–0.00	0.00	0.00	0.06	–0.00	0.01	1225
SVN	–0.06	–0.00	0.00	0.00	0.05	–0.00	0.00	6321
SWE	–0.30	–0.00	0.00	0.00	0.25	–0.00	0.02	73733
THA*	–0.03	–0.00	–0.00	–0.00	0.03	–0.00	0.01	85166
TWN	–0.35	–0.00	–0.00	–0.00	0.27	–0.00	0.01	202800
USA	–0.29	–0.00	–0.00	0.00	0.22	–0.00	0.02	1458005
VEN*	–0.03	–0.00	0.00	0.00	0.03	–0.00	0.00	3781

* Winsorization levels are at 1 and 99 percentile instead of 0.1 and 99.9 percentile.

Table A.5 (*Continued*)

	SIZE Level							
	Min	25%	Median	75%	Max	Mean	StdDev	# Observations
ARG	–7.41	–1.36	0.27	1.66	7.17	0.20	2.10	12751
AUS	–6.46	–1.20	–0.09	1.57	6.97	0.34	2.06	292540
AUT	–7.52	–1.33	–0.04	1.35	4.50	–0.02	1.99	23723
BEL	–7.52	–1.37	0.14	1.70	8.04	0.18	2.30	36120
BRA	–7.41	–1.75	–0.09	1.31	8.19	–0.13	2.66	55038
CAN	–5.83	–1.47	–0.19	1.32	6.01	–0.03	2.07	226939
CHE	–7.52	–1.13	0.14	1.38	6.31	0.20	1.93	54719
CHL	–7.41	–1.04	0.11	1.30	4.30	0.04	1.83	31129
CHN	–2.51	–0.75	–0.26	0.28	3.66	–0.17	0.87	255956
COL	–5.42	–1.48	–0.09	1.09	4.33	–0.28	1.68	6789
CYP	–4.64	–1.09	–0.06	0.92	5.95	–0.06	1.60	19680
DEU	–7.52	–0.26	1.25	2.93	8.04	1.32	2.51	200115
DNK	–7.52	–0.18	0.98	2.28	7.33	1.12	1.88	46305
ESP	–7.52	–1.64	–0.19	1.29	5.31	–0.31	2.29	39969
EST	–3.55	–0.40	0.42	1.59	4.74	0.55	1.68	2452
FIN	–6.36	–1.72	–0.38	1.19	6.40	–0.26	1.99	29270
FRA	–7.52	–1.28	0.18	1.95	7.67	0.42	2.34	184757
GBR	–7.52	–1.12	0.26	1.89	8.04	0.49	2.23	393113
GRC	–7.51	–0.50	0.47	1.58	6.40	0.58	1.75	56611
HKG	–8.79	–1.52	–0.51	0.82	6.97	–0.23	1.84	205042
IDN	–6.49	–1.02	0.13	1.37	6.17	0.25	1.80	61267
IND	–5.17	–1.17	0.26	2.06	8.33	0.58	2.31	483134
IRL	–6.64	–2.06	–0.83	0.64	4.55	–0.72	1.93	10669
ISL	–7.52	–2.04	–1.11	–0.20	2.76	–1.14	1.52	5780
ITA	–7.52	–0.87	0.28	1.70	6.31	0.43	1.96	60096
JPN	–9.57	–0.78	0.26	1.54	6.97	0.48	1.72	766833
KOR	–12.22	–0.49	0.30	1.36	6.97	0.47	1.92	304093
LUX	–7.52	–2.50	–0.98	0.15	4.33	–1.13	2.06	4375
MEX	–7.24	–1.18	0.18	1.51	5.05	0.08	1.96	19552
MLT	–4.07	–0.97	–0.17	1.01	2.31	–0.03	1.30	1629
MYS	–4.28	–0.14	0.72	1.82	6.44	0.88	1.54	183092
NLD	–7.52	–1.85	–0.33	1.16	5.99	–0.21	2.21	37778
NOR	–7.52	–0.90	0.18	1.43	6.65	0.30	1.73	45882
PER	–7.41	–1.00	0.37	1.81	5.54	0.37	2.03	13225
PHL	–7.41	–1.34	–0.23	1.08	5.15	–0.03	1.80	38770
PRT	–7.52	–1.95	–0.24	1.34	4.68	–0.46	2.61	16134
SGP	–4.37	–0.57	0.39	1.62	6.97	0.62	1.69	114522
SVK	–6.18	–0.21	1.25	3.13	7.96	1.68	2.54	3468
SVN	–5.99	–0.46	0.88	2.41	8.04	1.22	2.45	10014
SWE	–6.03	–0.52	1.16	2.82	8.04	1.25	2.42	80684
THA	–5.94	–0.85	0.12	1.24	6.53	0.31	1.60	94926
TWN	–7.45	–0.66	0.31	1.32	6.66	0.41	1.50	224664
USA	–5.83	–2.01	–0.69	0.75	6.01	–0.55	2.00	1514407
VEN	–7.41	–1.46	–0.02	1.19	7.67	–0.34	2.66	5223

(*Continued*)

Table A.5 (*Continued*)

	SIZE Trend							
	Min	25%	Median	75%	Max	Mean	StdDev	# Observations
ARG	–1.89	–0.15	–0.02	0.11	0.20	–0.01	0.30	12631
AUS	–1.60	–0.17	0.00	0.18	1.85	0.02	0.38	291573
AUT	–2.03	–0.12	–0.01	0.09	2.26	–0.01	0.27	23490
BEL	–2.03	–0.11	–0.01	0.07	2.26	–0.02	0.26	35808
BRA	–1.89	–0.16	0.00	0.15	2.20	–0.01	0.37	53882
CAN	–1.91	–0.16	0.00	0.17	1.84	0.00	0.36	226621
CHE	–2.03	–0.10	–0.01	0.09	2.26	–0.01	0.24	54467
CHL	–1.89	–0.11	–0.01	0.09	2.20	–0.00	0.22	30708
CHN	–1.08	–0.11	–0.00	0.10	1.14	0.01	0.20	255898
COL	–1.34	–0.10	0.00	0.10	1.93	0.01	0.22	6620
CYP	–2.03	–0.19	–0.01	0.16	2.26	–0.01	0.35	19411
DEU	–2.03	–0.17	–0.03	0.09	2.26	–0.05	0.34	198678
DNK	–2.03	–0.14	–0.02	0.09	2.26	–0.03	0.27	46079
ESP	–2.03	–0.10	–0.00	0.10	2.26	0.01	0.28	39620
EST	–2.03	–0.13	0.00	0.14	2.26	0.00	0.33	2444
FIN	–2.03	–0.13	0.00	0.14	2.26	0.00	0.27	29223
FRA	–2.03	–0.11	0.00	0.12	2.26	0.00	0.29	182860
GBR	–2.03	–0.15	–0.00	0.13	2.26	–0.02	0.34	391484
GRC	–2.03	–0.18	–0.03	0.13	2.26	–0.01	0.33	56542
HKG	–1.60	–0.18	–0.02	0.14	1.85	–0.00	0.36	204824
IDN	–1.89	–0.19	–0.03	0.14	2.20	–0.01	0.36	60532
IND	–1.65	–0.22	–0.03	0.14	1.96	–0.03	0.36	476506
IRL	–2.03	–0.10	0.01	0.13	2.26	0.01	0.30	10635
ISL	–2.03	–0.11	0.00	0.12	2.26	0.01	0.31	5687
ITA	–2.03	–0.12	–0.01	0.09	2.26	–0.00	0.25	60029
JPN	–1.60	–0.12	–0.01	0.09	1.85	–0.01	0.22	766748
KOR	–1.60	–0.18	–0.03	0.03	1.85	–0.02	0.34	303753
LUX	–2.03	–0.08	0.01	0.12	2.26	0.03	0.30	4190
MEX	–1.89	–0.14	–0.02	0.09	2.20	–0.03	0.26	19382
MLT	–1.23	–0.08	0.00	0.08	2.05	0.02	0.25	1597
MYS	–1.89	–0.14	–0.03	0.09	2.20	–0.02	0.26	183013
NLD	–2.03	–0.11	0.00	0.11	2.26	–0.00	0.26	37733
NOR	–2.03	–0.13	0.00	0.13	2.26	0.00	0.33	45645
PER	–1.89	–0.14	–0.00	0.12	2.20	–0.00	0.29	12915
PHL	–1.89	–0.15	–0.01	0.14	2.20	0.01	0.33	38283
PRT	–2.03	–0.14	–0.02	0.08	2.26	–0.02	0.26	15794
SGP	–1.60	–0.15	–0.03	0.09	1.85	–0.02	0.26	114335
SVK	–2.03	–0.06	0.02	0.14	2.26	0.05	0.31	3062
SVN	–2.03	–0.16	–0.03	0.07	1.98	–0.06	0.29	9704
SWE	–2.03	–0.15	–0.00	0.14	2.26	–0.01	0.34	80601
THA	–1.89	–0.15	–0.02	0.12	2.20	–0.01	0.28	94755
TWN	–1.60	–0.14	–0.02	0.11	1.85	–0.01	0.25	224535
USA	–1.91	–0.16	–0.01	0.13	1.84	–0.02	0.33	1513978
VEN	–1.89	–0.17	–0.02	0.12	2.20	0.01	0.43	5011

(*Continued*)

Table A.5 (*Continued*)

	M/B							
	Min	**25%**	**Median**	**75%**	**Max**	**Mean**	**StdDev**	**# Observations**
ARG	0.18	0.82	1.01	1.28	157.18	1.68	5.88	11150
AUS*	0.20	0.94	1.35	2.42	14.73	2.31	2.67	267583
AUT	0.20	0.95	1.07	1.37	77.90	1.36	1.92	21059
BEL	0.18	0.94	1.10	1.47	77.90	1.75	4.67	28916
BRA	0.18	0.81	1.05	1.59	787.85	15.40	86.63	45362
CAN	0.23	0.99	1.32	2.10	60.04	2.23	3.98	203058
CHE	0.18	0.99	1.14	1.59	77.90	1.58	2.01	51364
CHL	0.18	0.86	1.14	1.68	787.85	2.92	23.20	27780
CHN	0.63	1.51	2.15	3.22	38.81	2.76	2.37	233648
COL	0.23	0.77	1.01	1.25	787.85	2.15	27.78	5610
CYP	0.18	0.61	0.81	1.06	50.32	1.18	2.40	16567
DEU	0.18	1.00	1.22	1.69	77.90	1.80	3.19	169566
DNK	0.18	0.96	1.05	1.39	77.90	1.53	2.47	42880
ESP	0.18	0.96	1.11	1.47	77.90	1.44	1.97	36140
EST	0.18	0.97	1.18	1.82	43.24	1.66	1.94	2258
FIN	0.19	1.01	1.23	1.72	77.90	1.65	2.10	27561
FRA	0.18	0.95	1.14	1.57	77.90	1.65	3.31	155366
GBR	0.18	0.98	1.33	2.09	77.90	2.22	4.30	357753
GRC	0.18	0.87	1.11	1.64	77.90	1.78	3.70	53237
HKG*	0.20	0.72	1.00	1.56	14.73	1.54	1.90	190508
IDN	0.18	0.85	1.05	1.43	787.85	1.47	8.67	53111
IND**	0.19	0.77	1.00	1.51	10.92	1.47	1.53	411752
IRL	0.18	1.00	1.22	1.72	45.74	1.72	2.09	9915
ISL	0.18	1.09	1.28	1.63	77.90	1.88	5.02	4643
ITA	0.18	0.95	1.06	1.35	77.90	1.36	2.55	57277
JPN*	0.20	0.85	1.01	1.25	14.73	1.22	0.99	745007
KOR*	0.20	0.80	0.98	1.32	14.73	1.33	1.40	253858
LUX	0.18	0.75	0.97	1.20	9.26	1.10	0.68	3078
MEX	0.18	0.76	1.02	1.42	8.65	1.19	0.68	17086
MLT	0.66	0.97	1.08	1.39	15.76	1.35	0.98	1165
MYS	0.18	0.78	1.00	1.43	787.85	1.50	8.52	171084
NLD	0.18	1.00	1.22	1.69	77.90	1.68	1.86	35786
NOR	0.18	0.96	1.15	1.72	77.90	1.85	3.05	41365
PER	0.18	0.80	1.10	1.66	29.63	1.51	1.38	10757
PHL	0.18	0.75	1.03	1.63	787.85	7.16	57.34	34421
PRT	0.18	0.91	1.03	1.26	47.43	1.17	0.82	13722
SGP*	0.20	0.83	1.04	1.46	14.73	1.37	1.26	105342
SVK	0.32	0.75	0.93	1.05	3.18	0.94	0.32	1212
SVN	0.18	0.68	0.86	1.05	8.11	0.95	0.55	6306
SWE	0.18	1.03	1.36	2.19	77.90	2.17	3.24	73655
THA	0.18	0.84	1.05	1.42	77.05	1.28	0.97	85147
TWN*	0.20	0.94	1.18	1.68	14.73	1.49	1.06	202797
USA	0.23	1.02	1.30	2.09	60.04	2.10	3.18	1457333
VEN	0.18	0.58	0.84	1.00	787.85	9.00	61.38	3720

* Winsorization levels are at 0.1 and 99.5 percentiles instead of 0.1 and 99.9 percentiles.
** Winsorization levels are at 1 and 99 percentiles instead of 0.1 and 99.9 percentiles.

(*Continued*)

Table A.5 (*Continued*)

	SIGMA							
	Min	**25%**	**Median**	**75%**	**Max**	**Mean**	**StdDev**	**# Observations**
ARG	0.02	0.07	0.09	0.14	0.43	0.11	0.06	11397
AUS	0.01	0.09	0.15	0.22	0.45	0.16	0.09	271566
AUT	0.01	0.05	0.07	0.11	0.45	0.08	0.06	21996
BEL	0.01	0.05	0.07	0.10	0.45	0.08	0.06	33297
BRA	0.00	0.08	0.12	0.17	0.44	0.14	0.07	47586
CAN	0.02	0.08	0.13	0.19	0.47	0.14	0.08	213387
CHE	0.01	0.05	0.07	0.10	0.45	0.08	0.05	51537
CHL	0.00	0.05	0.07	0.10	0.44	0.08	0.05	28311
CHN	0.02	0.07	0.09	0.13	0.33	0.10	0.05	237070
COL	0.00	0.05	0.08	0.11	0.43	0.09	0.06	5792
CYP	0.01	0.08	0.12	0.17	0.45	0.14	0.08	17454
DEU	0.01	0.06	0.10	0.16	0.45	0.12	0.08	182991
DNK	0.01	0.05	0.08	0.12	0.45	0.09	0.06	43414
ESP	0.01	0.05	0.07	0.11	0.45	0.09	0.06	36225
EST	0.01	0.06	0.09	0.14	0.30	0.10	0.06	2208
FIN	0.01	0.06	0.09	0.12	0.45	0.10	0.06	27861
FRA	0.01	0.06	0.09	0.13	0.45	0.11	0.07	167740
GBR	0.01	0.07	0.11	0.16	0.45	0.13	0.07	363765
GRC	0.01	0.08	0.11	0.16	0.45	0.13	0.07	53735
HKG	0.01	0.09	0.13	0.19	0.45	0.14	0.08	193483
IDN	0.00	0.09	0.13	0.19	0.44	0.15	0.08	53817
IND	0.03	0.11	0.16	0.23	0.50	0.18	0.08	427485
IRL	0.01	0.06	0.09	0.14	0.45	0.11	0.07	10050
ISL	0.02	0.06	0.08	0.11	0.37	0.10	0.05	4819
ITA	0.01	0.05	0.08	0.11	0.42	0.09	0.05	56804
JPN	0.01	0.06	0.08	0.12	0.45	0.10	0.06	745701
KOR	0.01	0.09	0.13	0.19	0.45	0.15	0.08	286449
LUX	0.01	0.05	0.07	0.10	0.35	0.08	0.05	3528
MEX	0.00	0.06	0.09	0.12	0.43	0.10	0.06	17482
MLT	0.01	0.04	0.05	0.08	0.37	0.07	0.05	1377
MYS	0.01	0.07	0.10	0.15	0.44	0.11	0.07	175167
NLD	0.01	0.05	0.08	0.11	0.45	0.09	0.06	35779
NOR	0.01	0.07	0.10	0.16	0.45	0.12	0.07	41999
PER	0.00	0.08	0.11	0.15	0.44	0.12	0.07	11091
PHL	0.00	0.08	0.13	0.19	0.44	0.14	0.08	34948
PRT	0.01	0.05	0.08	0.12	0.45	0.10	0.07	14107
SGP	0.01	0.07	0.10	0.15	0.45	0.12	0.07	107292
SVK	0.01	0.06	0.10	0.14	0.36	0.11	0.06	1903
SVN	0.01	0.05	0.07	0.12	0.45	0.09	0.06	8192
SWE	0.01	0.07	0.11	0.17	0.45	0.13	0.08	75297
THA	0.00	0.07	0.10	0.15	0.44	0.12	0.07	89150
TWN	0.01	0.07	0.10	0.15	0.45	0.12	0.06	212379
USA	0.02	0.08	0.12	0.18	0.47	0.13	0.08	1427608
VEN	0.00	0.09	0.11	0.17	0.42	0.13	0.06	4100

Table A.6 Exits classified as "Defaults".

Defaults	
Action Type	**Subcategory**
Bankruptcy filing	Administration, Arrangement, Canadian CCAA, Chapter 7, Chapter 11, Chapter 15, Conservatorship, Insolvency, Japanese CRL, Judicial Management, Liquidation, Pre-Negotiation Chapter 11, Protection, Receivership, Rehabilitation, Rehabilitation (Thailand 1997), Reorganization, Restructuring, Section 304, Supreme court declaration, Winding up, Work out, Other, Unknown
Delisting	Bankruptcy
Default Corporate Action	Bankruptcy, Coupon & Principal Payment, Coupon Payment Only, Debt Restructuring, Interest Payment, Loan Payment, Principal Payment, ADR (Japan only), Declared Sick (India Only), Unknown

Table A.7 Exits classified as "Other Exits".

Other Exits	
Action Type	**Subcategory**
Delisting	Unknown, Acquired/Merged, Assimilated with underlying shares, Bid price below minimum, Cancellation of listing, End of When-issued trading, Expired, Failure to meet listing requirements, Failure to pay listing fees, Inactive security, Insufficient assets, Insufficient capital and surplus, Insufficient number of market makers, Issue postponed, Lack of market maker interest, Lack of public interest, Liquidated, Matured, Not available, Not current in required filings, NP/FP finished, Privatized, Reorganization security called for redemptions, the company's request, Scheme of arrangement, Insufficient spread of holders, Selective capital reduction of the company

Table A.8 Number of defaults and other exits of 44 economies from 1992 to June 2012.

Economy:ARG

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	1	0	0.00	0	0.00
1993	1	0	0.00	0	0.00
1994	23	0	0.00	2	8.00
1995	87	0	0.00	18	17.14
1996	95	0	0.00	22	18.80
1997	79	0	0.00	31	28.18
1998	66	1	0.94	39	36.79
1999	71	1	1.08	21	22.58
2000	69	0	0.00	22	24.18
2001	51	3	3.41	34	38.64
2002	59	8	9.88	14	17.28
2003	61	2	2.67	12	16.00
2004	56	0	0.00	13	18.84
2005	61	0	0.00	4	6.15
2006	63	0	0.00	8	11.27
2007	67	0	0.00	10	12.99
2008	58	0	0.00	16	21.62
2009	58	1	1.49	8	11.94
2010	62	0	0.00	4	6.06
2011	58	0	0.00	9	13.43
2012	61	0	0.00	2	3.17

Economy:AUS

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	696	0	0.00	118	14.50
1993	829	0	0.00	48	5.47
1994	916	0	0.00	93	9.22
1995	956	1	0.10	82	7.89
1996	1005	2	0.19	66	6.15
1997	1016	3	0.27	103	9.18
1998	1010	4	0.36	109	9.71
1999	1072	3	0.26	100	8.51
2000	1186	11	0.84	105	8.06
2001	1163	27	2.08	109	8.39
2002	1179	8	0.62	102	7.91
2003	1225	8	0.60	94	7.08
2004	1348	3	0.21	75	5.26
2005	1461	6	0.39	87	5.60
2006	1578	5	0.29	117	6.88
2007	1752	5	0.27	114	6.09
2008	1684	27	1.45	149	8.01
2009	1667	30	1.66	115	6.35
2010	1683	4	0.22	136	7.46
2011	1677	0	0.00	176	9.50
2012	1710	1	0.06	45	2.56

Economy:AUT

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	87	0	0.00	3	3.33
1993	101	0	0.00	9	8.18
1994	111	0	0.00	1	0.89
1995	118	0	0.00	2	1.67
1996	117	1	0.81	5	4.07
1997	118	0	0.00	6	4.84
1998	112	0	0.00	15	11.81
1999	108	0	0.00	17	13.60
2000	119	0	0.00	15	11.19
2001	113	2	1.39	29	20.14
2002	109	0	0.00	14	11.38
2003	108	0	0.00	21	16.28
2004	100	0	0.00	23	18.70
2005	99	1	0.85	18	15.25
2006	104	0	0.00	10	8.77
2007	106	0	0.00	11	9.40
2008	105	2	1.71	10	8.55
2009	99	1	0.88	13	11.50
2010	94	1	0.88	19	16.67
2011	83	0	0.00	16	16.16
2012	86	1	1.12	2	2.25

Economy:BEL

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	131	0	0.00	7	5.07
1993	136	0	0.00	6	4.23
1994	143	0	0.00	12	7.74
1995	148	0	0.00	10	6.33
1996	163	0	0.00	9	5.23
1997	162	0	0.00	18	10.00
1998	174	0	0.00	17	8.90
1999	190	2	1.01	6	3.03
2000	191	0	0.00	10	4.98
2001	185	2	1.01	11	5.56
2002	175	3	1.55	15	7.77
2003	176	1	0.52	14	7.33
2004	169	1	0.55	13	7.10
2005	171	2	1.08	12	6.49
2006	182	2	1.04	9	4.66
2007	215	1	0.36	61	22.02
2008	199	1	0.36	79	28.32
2009	199	2	0.79	52	20.55
2010	201	0	0.00	54	21.18
2011	172	1	0.42	63	26.69
2012	201	0	0.00	4	1.95

(*Continued*)

Economy:BRA

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	0	0	NaN	0	NaN
1993	0	0	NaN	0	NaN
1994	261	0	0.00	26	9.06
1995	273	0	0.00	92	25.21
1996	282	0	0.00	99	25.98
1997	258	2	0.51	133	33.84
1998	283	3	0.68	157	35.44
1999	320	2	0.47	103	24.24
2000	293	2	0.48	120	28.92
2001	273	1	0.24	143	34.29
2002	239	3	0.82	126	34.24
2003	260	2	0.57	90	25.57
2004	266	1	0.29	82	23.50
2005	260	1	0.30	71	21.39
2006	276	0	0.00	54	16.36
2007	340	0	0.00	40	10.53
2008	321	0	0.00	56	14.85
2009	324	0	0.00	35	9.75
2010	316	0	0.00	41	11.48
2011	307	1	0.29	40	11.49
2012	310	0	0.00	15	4.62

Economy:CAN

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	951	1	0.09	103	9.76
1993	1159	0	0.00	72	5.85
1994	1331	0	0.00	54	3.90
1995	1451	0	0.00	84	5.47
1996	1637	0	0.00	80	4.66
1997	1782	6	0.31	145	7.50
1998	1754	9	0.45	254	12.59
1999	1185	13	0.68	715	37.38
2000	1095	9	0.69	194	14.95
2001	936	18	1.53	221	18.81
2002	922	5	0.50	73	7.30
2003	920	13	1.29	78	7.72
2004	979	5	0.47	73	6.91
2005	1030	3	0.27	82	7.35
2006	1083	3	0.25	96	8.12
2007	1121	3	0.24	120	9.65
2008	1100	12	0.98	111	9.08
2009	1027	13	1.10	142	12.01
2010	1060	5	0.43	94	8.11
2011	1068	4	0.34	120	10.07
2012	1063	1	0.09	51	4.57

Economy:CHE

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	143	0	0.00	30	17.34
1993	174	0	0.00	10	5.43
1994	177	0	0.00	20	10.15
1995	189	0	0.00	15	7.35
1996	210	0	0.00	15	6.67
1997	221	1	0.43	11	4.72
1998	227	0	0.00	14	5.81
1999	242	0	0.00	16	6.20
2000	261	0	0.00	12	4.40
2001	257	2	0.73	16	5.82
2002	249	0	0.00	17	6.39
2003	243	2	0.78	13	5.04
2004	237	1	0.40	11	4.42
2005	243	1	0.40	7	2.79
2006	248	0	0.00	15	5.70
2007	252	0	0.00	8	3.08
2008	250	0	0.00	14	5.30
2009	252	0	0.00	16	5.97
2010	247	0	0.00	17	6.44
2011	243	1	0.38	18	6.87
2012	250	1	0.39	5	1.95

Economy:CHL

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	0	0	NaN	0	NaN
1993	0	0	NaN	0	NaN
1994	141	0	0.00	9	6.00
1995	166	0	0.00	26	13.54
1996	168	0	0.00	46	21.50
1997	181	0	0.00	35	16.20
1998	168	0	0.00	56	25.00
1999	177	0	0.00	41	18.81
2000	168	0	0.00	43	20.38
2001	168	1	0.47	43	20.28
2002	155	1	0.48	54	25.71
2003	152	0	0.00	57	27.27
2004	164	0	0.00	32	16.33
2005	166	0	0.00	39	19.02
2006	171	0	0.00	41	19.34
2007	187	0	0.00	27	12.62
2008	146	0	0.00	52	26.26
2009	167	0	0.00	28	14.36
2010	161	0	0.00	41	20.30
2011	170	0	0.00	36	17.48
2012	172	0	0.00	22	11.34

(*Continued*)

Table A.8 (*Continued*)

Economy:CHN

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	45	0	0.00	2	4.26
1993	165	0	0.00	0	0.00
1994	283	1	0.35	1	0.35
1995	317	6	1.85	1	0.31
1996	522	10	1.88	0	0.00
1997	727	15	2.02	2	0.27
1998	841	34	3.88	2	0.23
1999	935	23	2.40	1	0.10
2000	1079	26	2.35	1	0.09
2001	1152	50	4.13	8	0.66
2002	1204	48	3.77	21	1.65
2003	1266	45	3.37	23	1.72
2004	1352	109	7.33	26	1.75
2005	1354	93	6.33	22	1.50
2006	1372	66	4.37	71	4.71
2007	1460	49	3.05	98	6.10
2008	1579	35	2.10	52	3.12
2009	1685	38	2.17	30	1.71
2010	1995	23	1.11	47	2.28
2011	2273	6	0.26	62	2.65
2012	2372	0	0.00	16	0.67

Economy:COL

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	0	0	NaN	0	NaN
1993	0	0	NaN	0	NaN
1994	1	0	0.00	0	0.00
1995	50	0	0.00	29	36.71
1996	44	0	0.00	46	51.11
1997	46	0	0.00	43	48.31
1998	58	1	0.81	64	52.03
1999	47	0	0.00	55	53.92
2000	39	0	0.00	40	50.63
2001	49	0	0.00	19	27.94
2002	50	0	0.00	21	29.58
2003	53	0	0.00	15	22.06
2004	53	0	0.00	12	18.46
2005	55	0	0.00	17	23.61
2006	47	0	0.00	18	27.69
2007	50	0	0.00	16	24.24
2008	35	0	0.00	24	40.68
2009	42	0	0.00	10	19.23
2010	44	0	0.00	14	24.14
2011	41	0	0.00	11	21.15
2012	49	0	0.00	1	2.00

Economy:CYP

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	0	0	NaN	0	NaN
1993	0	0	NaN	0	NaN
1994	0	0	NaN	0	NaN
1995	0	0	NaN	0	NaN
1996	35	0	0.00	3	7.89
1997	43	0	0.00	0	0.00
1998	48	0	0.00	2	4.00
1999	58	0	0.00	2	3.33
2000	116	0	0.00	4	3.33
2001	137	0	0.00	6	4.20
2002	144	0	0.00	10	6.49
2003	134	0	0.00	21	13.55
2004	134	0	0.00	29	17.79
2005	139	0	0.00	22	13.66
2006	137	0	0.00	11	7.43
2007	137	0	0.00	8	5.52
2008	121	0	0.00	31	20.39
2009	109	0	0.00	26	19.26
2010	107	0	0.00	27	20.15
2011	81	0	0.00	50	38.17
2012	96	0	0.00	10	9.43

Economy:DEU

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	400	0	0.00	38	8.68
1993	421	0	0.00	28	6.24
1994	573	0	0.00	63	9.91
1995	591	0	0.00	65	9.91
1996	621	4	0.58	63	9.16
1997	627	3	0.43	74	10.51
1998	723	2	0.26	53	6.81
1999	900	1	0.11	51	5.36
2000	1030	2	0.18	57	5.23
2001	1027	26	2.35	55	4.96
2002	945	37	3.42	100	9.24
2003	886	16	1.64	75	7.68
2004	880	8	0.86	46	4.93
2005	909	4	0.42	41	4.30
2006	1069	4	0.36	35	3.16
2007	1214	5	0.39	59	4.62
2008	1267	17	1.21	120	8.55
2009	1236	11	0.78	169	11.94
2010	1288	0	0.00	152	10.56
2011	1304	5	0.30	335	20.38
2012	1290	2	0.15	71	5.21

(*Continued*)

Table A.8 (*Continued*)

Economy:DNK

		Defaults		Others	
Year	Active	#	%	#	%
1992	158	0	0.00	19	10.73
1993	173	0	0.00	13	6.99
1994	176	0	0.00	24	12.00
1995	202	1	0.46	16	7.31
1996	219	0	0.00	11	4.78
1997	212	0	0.00	21	9.01
1998	213	0	0.00	29	11.98
1999	210	0	0.00	24	10.26
2000	208	1	0.44	20	8.73
2001	191	5	2.20	31	13.66
2002	175	3	1.44	30	14.42
2003	174	1	0.52	19	9.79
2004	170	1	0.54	14	7.57
2005	170	1	0.56	9	5.00
2006	192	0	0.00	7	3.52
2007	216	1	0.45	7	3.13
2008	214	1	0.43	18	7.73
2009	210	4	1.79	9	4.04
2010	199	0	0.00	17	7.87
2011	187	2	0.99	13	6.44
2012	184	0	0.00	4	2.13

Economy:EST

		Defaults		Others	
Year	Active	#	%	#	%
1992	0	0	NaN	0	NaN
1993	0	0	NaN	0	NaN
1994	0	0	NaN	0	NaN
1995	0	0	NaN	0	NaN
1996	0	0	NaN	0	NaN
1997	17	0	0.00	0	0.00
1998	19	0	0.00	1	5.00
1999	19	0	0.00	1	5.00
2000	16	0	0.00	4	20.00
2001	14	0	0.00	2	12.50
2002	11	0	0.00	3	21.43
2003	11	0	0.00	0	0.00
2004	11	0	0.00	0	0.00
2005	13	0	0.00	1	7.14
2006	13	0	0.00	2	13.33
2007	16	0	0.00	0	0.00
2008	17	0	0.00	0	0.00
2009	15	0	0.00	2	11.76
2010	15	0	0.00	1	6.25
2011	15	0	0.00	0	0.00
2012	15	0	0.00	0	0.00

Economy:ESP

		Defaults		Others	
Year	Active	#	%	#	%
1992	147	0	0.00	39	20.97
1993	112	0	0.00	96	46.15
1994	238	0	0.00	18	7.03
1995	237	0	0.00	96	28.83
1996	264	0	0.00	65	19.76
1997	272	0	0.00	59	17.82
1998	231	0	0.00	104	31.04
1999	213	0	0.00	78	26.80
2000	212	0	0.00	55	20.60
2001	194	0	0.00	80	29.20
2002	206	2	0.75	60	22.39
2003	171	0	0.00	81	32.14
2004	161	0	0.00	41	20.30
2005	159	0	0.00	47	22.82
2006	162	0	0.00	44	21.36
2007	153	1	0.51	41	21.03
2008	142	1	0.58	28	16.37
2009	137	0	0.00	24	14.91
2010	139	1	0.65	15	9.68
2011	137	0	0.00	15	9.87
2012	137	0	0.00	8	5.52

Economy:FIN

		Defaults		Others	
Year	Active	#	%	#	%
1992	92	0	0.00	0	0.00
1993	94	0	0.00	2	2.08
1994	96	0	0.00	6	5.88
1995	102	0	0.00	5	4.67
1996	110	0	0.00	3	2.65
1997	124	0	0.00	1	0.80
1998	127	1	0.75	6	4.48
1999	146	0	0.00	8	5.19
2000	153	0	0.00	12	7.27
2001	148	1	0.62	13	8.02
2002	142	1	0.65	10	6.54
2003	138	1	0.68	9	6.08
2004	131	0	0.00	11	7.75
2005	132	0	0.00	6	4.35
2006	132	0	0.00	8	5.71
2007	130	0	0.00	5	3.70
2008	127	1	0.76	3	2.29
2009	125	1	0.78	2	1.56
2010	123	0	0.00	4	3.15
2011	121	1	0.81	1	0.81
2012	121	0	0.00	1	0.82

(*Continued*)

Table A.8 (*Continued*)

Economy:FRA

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	627	0	0.00	72	10.30
1993	641	0	0.00	78	10.85
1994	692	0	0.00	103	12.96
1995	719	0	0.00	119	14.20
1996	781	0	0.00	116	12.93
1997	803	1	0.11	142	15.01
1998	814	0	0.00	193	19.17
1999	857	0	0.00	93	9.79
2000	919	2	0.20	97	9.53
2001	916	9	0.88	93	9.14
2002	870	5	0.51	113	11.44
2003	861	4	0.41	102	10.55
2004	841	4	0.42	106	11.15
2005	846	5	0.53	98	10.33
2006	911	7	0.70	75	7.55
2007	950	7	0.66	100	9.46
2008	902	12	1.13	150	14.10
2009	889	6	0.58	142	13.69
2010	847	2	0.20	168	16.52
2011	799	2	0.21	153	16.04
2012	828	0	0.00	39	4.50

Economy:GRC

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	90	0	0.00	0	0.00
1993	97	0	0.00	0	0.00
1994	162	0	0.00	2	1.22
1995	182	0	0.00	2	1.09
1996	196	0	0.00	6	2.97
1997	208	0	0.00	4	1.89
1998	231	0	0.00	5	2.12
1999	264	0	0.00	6	2.22
2000	308	0	0.00	8	2.53
2001	312	0	0.00	14	4.29
2002	309	0	0.00	19	5.79
2003	313	0	0.00	9	2.80
2004	313	0	0.00	10	3.10
2005	299	0	0.00	21	6.56
2006	285	0	0.00	16	5.32
2007	279	0	0.00	13	4.45
2008	274	0	0.00	18	6.16
2009	264	0	0.00	24	8.33
2010	256	0	0.00	30	10.49
2011	231	0	0.00	35	13.16
2012	224	0	0.00	19	7.82

Economy:GBR

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	1075	0	0.00	87	7.49
1993	1188	0	0.00	39	3.18
1994	1280	0	0.00	49	3.69
1995	1411	0	0.00	63	4.27
1996	1620	0	0.00	62	3.69
1997	1718	0	0.00	113	6.17
1998	1686	0	0.00	197	10.46
1999	1557	3	0.16	295	15.90
2000	1672	2	0.11	210	11.15
2001	1683	12	0.65	148	8.03
2002	1638	13	0.71	168	9.24
2003	1598	6	0.34	185	10.34
2004	1785	1	0.05	150	7.75
2005	2035	2	0.09	205	9.14
2006	2185	0	0.00	251	10.30
2007	2221	2	0.08	264	10.62
2008	2026	30	1.25	353	14.65
2009	1824	32	1.47	317	14.59
2010	1783	3	0.15	251	12.32
2011	1658	10	0.51	279	14.33
2012	1653	4	0.23	80	4.61

Economy:HKG

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	356	0	0.00	11	3.00
1993	423	0	0.00	7	1.63
1994	464	0	0.00	13	2.73
1995	491	0	0.00	9	1.80
1996	529	0	0.00	15	2.76
1997	601	0	0.00	25	3.99
1998	628	2	0.30	30	4.55
1999	660	6	0.87	21	3.06
2000	742	2	0.26	21	2.75
2001	812	9	1.06	30	3.53
2002	906	4	0.42	36	3.81
2003	955	4	0.40	51	5.05
2004	993	0	0.00	56	5.34
2005	1026	3	0.27	65	5.94
2006	1078	2	0.18	43	3.83
2007	1167	2	0.17	24	2.01
2008	1171	8	0.66	33	2.72
2009	1231	3	0.24	23	1.83
2010	1303	1	0.08	29	2.18
2011	1359	1	0.07	26	1.88
2012	1376	1	0.07	24	1.71

(*Continued*)

Table A.8 (*Continued*)

Economy:IDN

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	124	0	0.00	30	19.48
1993	155	0	0.00	23	12.92
1994	184	0	0.00	49	21.03
1995	204	0	0.00	41	16.73
1996	236	0	0.00	26	9.92
1997	255	0	0.00	33	11.46
1998	245	17	5.57	43	14.10
1999	244	16	5.63	24	8.45
2000	248	6	2.10	32	11.19
2001	256	8	2.56	48	15.38
2002	252	2	0.64	59	18.85
2003	277	1	0.33	25	8.25
2004	270	2	0.60	59	17.82
2005	261	0	0.00	74	22.09
2006	286	0	0.00	51	15.13
2007	303	0	0.00	68	18.33
2008	265	0	0.00	90	25.35
2009	304	4	1.10	55	15.15
2010	340	1	0.26	38	10.03
2011	366	0	0.00	40	9.85
2012	382	1	0.26	7	1.79

Economy:IRL

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	31	0	0.00	4	11.43
1993	37	0	0.00	4	9.76
1994	37	0	0.00	5	11.90
1995	37	0	0.00	1	2.63
1996	43	0	0.00	0	0.00
1997	51	0	0.00	3	5.56
1998	50	0	0.00	5	9.09
1999	51	0	0.00	6	10.53
2000	59	0	0.00	5	7.81
2001	54	0	0.00	6	10.00
2002	48	0	0.00	6	11.11
2003	43	0	0.00	5	10.42
2004	42	0	0.00	3	6.67
2005	42	0	0.00	2	4.55
2006	47	0	0.00	2	4.08
2007	52	0	0.00	2	3.70
2008	49	0	0.00	3	5.77
2009	44	0	0.00	5	10.20
2010	40	0	0.00	4	9.09
2011	38	0	0.00	2	5.00
2012	34	0	0.00	4	10.53

Economy:IND

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	1497	1	0.06	143	8.71
1993	1844	0	0.00	201	9.83
1994	2805	0	0.00	270	8.78
1995	4078	2	0.05	349	7.88
1996	4082	6	0.12	1062	20.62
1997	3014	12	0.24	1961	39.32
1998	2689	10	0.24	1471	35.28
1999	3060	17	0.41	1112	26.55
2000	2559	10	0.26	1335	34.20
2001	2265	7	0.21	1123	33.08
2002	3353	7	0.17	656	16.33
2003	2681	14	0.34	1387	33.98
2004	2518	5	0.15	923	26.78
2005	2520	13	0.41	617	19.59
2006	2725	12	0.37	480	14.92
2007	2990	17	0.54	130	4.14
2008	3036	24	0.67	531	14.79
2009	3136	35	1.02	276	8.01
2010	3548	9	0.20	908	20.34
2011	3380	4	0.10	784	18.81
2012	3596	4	0.11	73	1.99

Economy:ISL

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	0	0	NaN	0	NaN
1993	0	0	NaN	0	NaN
1994	0	0	NaN	0	NaN
1995	0	0	NaN	0	NaN
1996	26	0	0.00	0	0.00
1997	33	0	0.00	3	8.33
1998	50	0	0.00	3	5.66
1999	59	0	0.00	9	13.24
2000	58	0	0.00	17	22.67
2001	64	0	0.00	12	15.79
2002	55	0	0.00	17	23.61
2003	40	0	0.00	22	35.48
2004	32	0	0.00	13	28.89
2005	25	0	0.00	11	30.56
2006	25	0	0.00	5	16.67
2007	26	0	0.00	5	16.13
2008	11	4	13.79	14	48.28
2009	10	1	6.67	4	26.67
2010	8	0	0.00	4	33.33
2011	9	0	0.00	4	30.77
2012	9	0	0.00	1	10.00

(*Continued*)

Table A.8 (*Continued*)

Economy:ITA

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	185	0	0.00	5	2.63
1993	181	0	0.00	8	4.23
1994	195	0	0.00	13	6.25
1995	209	0	0.00	14	6.28
1996	219	2	0.85	15	6.36
1997	218	0	0.00	28	11.38
1998	227	0	0.00	14	5.81
1999	252	0	0.00	7	2.70
2000	276	0	0.00	25	8.31
2001	279	0	0.00	17	5.74
2002	277	1	0.34	14	4.79
2003	257	5	1.75	23	8.07
2004	256	2	0.75	7	2.64
2005	262	0	0.00	15	5.42
2006	275	0	0.00	15	5.17
2007	295	0	0.00	13	4.22
2008	286	1	0.32	21	6.82
2009	276	4	1.33	20	6.67
2010	280	0	0.00	13	4.44
2011	269	0	0.00	22	7.56
2012	273	1	0.36	6	2.14

Economy:KOR

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	638	0	0.00	1	0.16
1993	647	0	0.00	0	0.00
1994	678	0	0.00	0	0.00
1995	705	0	0.00	2	0.28
1996	750	6	0.79	3	0.40
1997	1000	53	4.95	17	1.59
1998	898	79	7.27	109	10.04
1999	984	26	2.48	39	3.72
2000	1122	12	1.02	43	3.65
2001	1271	16	1.22	23	1.76
2002	1409	14	0.96	28	1.93
2003	1459	11	0.74	25	1.67
2004	1476	7	0.46	53	3.45
2005	1530	8	0.50	48	3.03
2006	1605	2	0.12	10	0.62
2007	1675	0	0.00	15	0.89
2008	1704	7	0.40	34	1.95
2009	1696	6	0.34	87	4.86
2010	1719	7	0.39	91	5.01
2011	1724	2	0.11	88	4.85
2012	1703	1	0.06	41	2.35

Economy:JPN

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	2541	3	0.12	21	0.82
1993	2621	4	0.15	24	0.91
1994	2767	0	0.00	17	0.61
1995	2947	2	0.07	17	0.57
1996	3100	4	0.13	21	0.67
1997	3218	7	0.21	31	0.95
1998	3271	14	0.42	37	1.11
1999	3333	7	0.21	47	1.39
2000	3475	12	0.34	59	1.66
2001	3582	16	0.44	64	1.75
2002	3604	29	0.78	94	2.52
2003	3635	20	0.53	98	2.61
2004	3738	11	0.29	85	2.22
2005	3821	9	0.23	89	2.27
2006	3951	2	0.05	84	2.08
2007	3980	6	0.15	104	2.54
2008	3904	35	0.87	107	2.64
2009	3773	28	0.71	136	3.45
2010	3676	8	0.21	127	3.33
2011	3622	4	0.11	100	2.68
2012	3591	3	0.08	47	1.29

Economy:LUX

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	2	0	0.00	1	33.33
1993	2	0	0.00	1	33.33
1994	2	0	0.00	0	0.00
1995	30	0	0.00	12	28.57
1996	28	0	0.00	15	34.88
1997	37	0	0.00	9	19.57
1998	34	0	0.00	13	27.66
1999	34	0	0.00	14	29.17
2000	32	0	0.00	13	28.89
2001	28	0	0.00	13	31.71
2002	27	0	0.00	10	27.03
2003	28	0	0.00	11	28.21
2004	36	0	0.00	7	16.28
2005	37	0	0.00	7	15.91
2006	36	0	0.00	16	30.77
2007	34	0	0.00	8	19.05
2008	26	0	0.00	14	35.00
2009	23	0	0.00	8	25.81
2010	18	1	3.45	10	34.48
2011	14	0	0.00	8	36.36
2012	14	0	0.00	3	17.65

(*Continued*)

Table A.8 (*Continued*)

Economy:MEX

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	0	0	NaN	0	NaN
1993	0	0	NaN	0	NaN
1994	87	0	0.00	37	29.84
1995	94	0	0.00	22	18.97
1996	105	0	0.00	19	15.32
1997	113	1	0.73	23	16.79
1998	108	0	0.00	21	16.28
1999	107	1	0.76	23	17.56
2000	103	1	0.83	17	14.05
2001	105	1	0.81	18	14.52
2002	93	1	0.82	28	22.95
2003	95	2	1.79	15	13.39
2004	99	0	0.00	10	9.17
2005	92	0	0.00	23	20.00
2006	96	0	0.00	10	9.43
2007	94	0	0.00	16	14.55
2008	86	1	0.93	21	19.44
2009	93	1	0.97	9	8.74
2010	99	0	0.00	12	10.81
2011	94	0	0.00	24	20.34
2012	95	0	0.00	3	3.06

Economy:MYS

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	356	0	0.00	10	2.73
1993	405	0	0.00	0	0.00
1994	466	0	0.00	7	1.48
1995	523	0	0.00	2	0.38
1996	615	0	0.00	0	0.00
1997	702	0	0.00	2	0.28
1998	696	14	1.92	21	2.87
1999	701	8	1.11	14	1.94
2000	728	8	1.07	11	1.47
2001	729	10	1.32	18	2.38
2002	756	7	0.89	26	3.30
2003	819	3	0.36	20	2.38
2004	891	2	0.22	17	1.87
2005	963	0	0.00	27	2.73
2006	972	5	0.49	34	3.36
2007	946	4	0.40	61	6.03
2008	904	12	1.23	61	6.24
2009	897	10	1.06	37	3.92
2010	897	11	1.18	28	2.99
2011	903	1	0.11	27	2.90
2012	898	0	0.00	15	1.64

Economy:MLT

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	0	0	NaN	0	NaN
1993	0	0	NaN	0	NaN
1994	0	0	NaN	0	NaN
1995	0	0	NaN	0	NaN
1996	5	0	0.00	0	0.00
1997	6	0	0.00	0	0.00
1998	7	0	0.00	0	0.00
1999	7	0	0.00	1	12.50
2000	9	0	0.00	0	0.00
2001	9	0	0.00	2	18.18
2002	10	0	0.00	2	16.67
2003	10	0	0.00	3	23.08
2004	11	0	0.00	2	15.38
2005	11	0	0.00	2	15.38
2006	13	0	0.00	0	0.00
2007	14	0	0.00	3	17.65
2008	13	0	0.00	7	35.00
2009	12	0	0.00	3	20.00
2010	12	0	0.00	2	14.29
2011	14	0	0.00	2	12.50
2012	17	0	0.00	0	0.00

Economy:NLD

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	160	0	0.00	6	3.61
1993	170	0	0.00	5	2.86
1994	173	0	0.00	5	2.81
1995	186	0	0.00	5	2.62
1996	195	1	0.50	4	2.00
1997	197	0	0.00	17	7.94
1998	209	0	0.00	10	4.57
1999	212	0	0.00	19	8.23
2000	200	1	0.45	21	9.46
2001	175	7	3.41	23	11.22
2002	157	8	4.42	16	8.84
2003	152	0	0.00	14	8.43
2004	145	0	0.00	10	6.45
2005	141	0	0.00	8	5.37
2006	137	1	0.68	8	5.48
2007	134	0	0.00	9	6.29
2008	126	1	0.72	11	7.97
2009	122	3	2.33	4	3.10
2010	120	0	0.00	5	4.00
2011	115	0	0.00	8	6.50
2012	115	0	0.00	2	1.71

(*Continued*)

Table A.8 (*Continued*)

Economy:NOR					
		Defaults		Others	
Year	Active	#	%	#	%
1992	81	0	0.00	8	8.99
1993	101	0	0.00	2	1.94
1994	115	0	0.00	3	2.54
1995	137	0	0.00	2	1.44
1996	159	0	0.00	4	2.45
1997	201	0	0.00	12	5.63
1998	216	0	0.00	19	8.09
1999	201	0	0.00	28	12.23
2000	195	1	0.44	33	14.41
2001	213	3	1.21	32	12.90
2002	205	4	1.64	35	14.34
2003	183	4	1.75	42	18.34
2004	198	0	0.00	17	7.91
2005	235	0	0.00	23	8.91
2006	261	0	0.00	37	12.42
2007	269	0	0.00	47	14.87
2008	242	4	1.39	42	14.58
2009	224	6	2.24	38	14.18
2010	223	0	0.00	24	9.72
2011	220	1	0.43	13	5.56
2012	214	0	0.00	7	3.17

Economy:PHL					
		Defaults		Others	
Year	Active	#	%	#	%
1992	80	0	0.00	24	23.08
1993	108	1	0.80	16	12.80
1994	128	0	0.00	27	17.42
1995	157	0	0.00	15	8.72
1996	177	0	0.00	14	7.33
1997	186	0	0.00	21	10.14
1998	177	1	0.49	27	13.17
1999	183	4	2.01	12	6.03
2000	170	0	0.00	35	17.07
2001	165	3	1.45	39	18.84
2002	145	7	3.41	53	25.85
2003	161	4	2.02	33	16.67
2004	163	6	2.80	45	21.03
2005	164	2	0.99	37	18.23
2006	174	0	0.00	25	12.56
2007	179	2	0.97	26	12.56
2008	170	1	0.49	33	16.18
2009	189	0	0.00	18	8.70
2010	193	0	0.00	17	8.10
2011	206	0	0.00	12	5.50
2012	211	0	0.00	3	1.40

Economy:PER					
		Defaults		Others	
Year	Active	#	%	#	%
1992	1	0	0.00	0	0.00
1993	1	0	0.00	0	0.00
1994	63	0	0.00	2	3.08
1995	97	0	0.00	22	18.49
1996	94	0	0.00	46	32.86
1997	118	0	0.00	40	25.32
1998	107	0	0.00	59	35.54
1999	92	0	0.00	67	42.14
2000	74	0	0.00	74	50.00
2001	64	0	0.00	54	45.76
2002	75	0	0.00	50	40.00
2003	66	0	0.00	46	41.07
2004	75	0	0.00	40	34.78
2005	78	0	0.00	42	35.00
2006	78	0	0.00	40	33.90
2007	90	0	0.00	26	22.41
2008	78	0	0.00	50	39.06
2009	92	0	0.00	33	26.40
2010	87	0	0.00	31	26.27
2011	76	0	0.00	39	33.91
2012	96	0	0.00	10	9.43

Economy:PRT					
		Defaults		Others	
Year	Active	#	%	#	%
1992	1	0	0.00	0	0.00
1993	69	0	0.00	13	15.85
1994	79	0	0.00	12	13.19
1995	92	0	0.00	18	16.36
1996	96	0	0.00	21	17.95
1997	93	0	0.00	29	23.77
1998	84	0	0.00	34	28.81
1999	88	0	0.00	24	21.43
2000	84	0	0.00	17	16.83
2001	69	0	0.00	20	22.47
2002	62	0	0.00	19	23.46
2003	65	0	0.00	6	8.45
2004	67	0	0.00	7	9.46
2005	64	0	0.00	7	9.86
2006	62	0	0.00	11	15.07
2007	58	0	0.00	9	13.43
2008	57	0	0.00	8	12.31
2009	56	0	0.00	9	13.85
2010	56	0	0.00	7	11.11
2011	52	2	3.33	6	10.00
2012	55	0	0.00	0	0.00

(*Continued*)

Table A.8 (*Continued*)

Economy:SGP

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	177	0	0.00	11	5.85
1993	203	0	0.00	3	1.46
1994	233	0	0.00	4	1.69
1995	250	1	0.39	6	2.33
1996	272	1	0.36	8	2.85
1997	299	1	0.31	18	5.66
1998	318	4	1.19	14	4.17
1999	357	2	0.53	15	4.01
2000	426	0	0.00	18	4.05
2001	435	2	0.43	31	6.62
2002	448	1	0.21	34	7.04
2003	498	1	0.19	15	2.92
2004	574	2	0.34	9	1.54
2005	620	4	0.62	17	2.65
2006	661	1	0.15	25	3.64
2007	703	0	0.00	19	2.63
2008	695	4	0.54	41	5.54
2009	706	13	1.74	29	3.88
2010	708	0	0.00	36	4.84
2011	691	0	0.00	53	7.12
2012	688	0	0.00	16	2.27

Economy:SVN

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	0	0	NaN	0	NaN
1993	0	0	NaN	0	NaN
1994	0	0	NaN	0	NaN
1995	0	0	NaN	0	NaN
1996	0	0	NaN	0	NaN
1997	0	0	NaN	0	NaN
1998	75	0	0.00	1	1.32
1999	98	0	0.00	9	8.41
2000	94	0	0.00	34	26.56
2001	112	0	0.00	29	20.57
2002	103	0	0.00	36	25.90
2003	104	0	0.00	19	15.45
2004	108	0	0.00	22	16.92
2005	87	0	0.00	34	28.10
2006	77	0	0.00	28	26.67
2007	65	0	0.00	22	25.29
2008	67	0	0.00	15	18.29
2009	60	3	3.41	25	28.41
2010	69	0	0.00	11	13.75
2011	59	1	1.33	15	20.00
2012	58	1	1.67	1	1.67

Economy:SVK

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	0	0	NaN	0	NaN
1993	0	0	NaN	0	NaN
1994	0	0	NaN	0	NaN
1995	0	0	NaN	0	NaN
1996	0	0	NaN	0	NaN
1997	0	0	NaN	0	NaN
1998	7	0	0.00	13	65.00
1999	8	0	0.00	24	75.00
2000	12	0	0.00	11	47.83
2001	15	0	0.00	14	48.28
2002	23	0	0.00	15	39.47
2003	40	0	0.00	26	39.39
2004	44	0	0.00	31	41.33
2005	41	0	0.00	26	38.81
2006	48	0	0.00	42	46.67
2007	24	0	0.00	47	66.20
2008	34	0	0.00	26	43.33
2009	38	0	0.00	31	44.93
2010	55	0	0.00	21	27.63
2011	53	0	0.00	41	43.62
2012	57	0	0.00	9	13.64

Economy:SWE

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	121	0	0.00	2	1.63
1993	144	0	0.00	2	1.37
1994	171	0	0.00	2	1.16
1995	184	0	0.00	0	0.00
1996	223	0	0.00	15	6.30
1997	270	0	0.00	28	9.40
1998	299	1	0.31	19	5.96
1999	338	1	0.27	27	7.38
2000	370	1	0.25	35	8.62
2001	362	4	1.01	31	7.81
2002	349	7	1.82	29	7.53
2003	337	3	0.82	26	7.10
2004	352	1	0.27	22	5.87
2005	389	2	0.50	11	2.74
2006	433	0	0.00	22	4.84
2007	501	1	0.19	14	2.71
2008	509	2	0.37	30	5.55
2009	496	4	0.75	32	6.02
2010	500	2	0.38	29	5.46
2011	494	3	0.56	34	6.40
2012	485	0	0.00	21	4.15

(*Continued*)

Table A.8 (*Continued*)

Economy:THA

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	280	0	0.00	1	0.36
1993	331	0	0.00	1	0.30
1994	378	0	0.00	1	0.26
1995	402	1	0.24	9	2.18
1996	421	7	1.56	21	4.68
1997	371	21	4.57	68	14.78
1998	343	17	4.17	48	11.76
1999	318	15	4.13	30	8.26
2000	299	17	4.97	26	7.60
2001	299	7	2.15	19	5.85
2002	317	4	1.18	17	5.03
2003	343	3	0.85	9	2.54
2004	383	1	0.25	21	5.19
2005	419	3	0.68	22	4.95
2006	434	0	0.00	12	2.69
2007	433	2	0.44	19	4.19
2008	432	0	0.00	23	5.05
2009	445	7	1.52	8	1.74
2010	447	3	0.66	8	1.75
2011	451	1	0.22	8	1.74
2012	453	0	0.00	4	0.88

Economy:USA

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	5334	19	0.35	107	1.96
1993	6018	25	0.40	171	2.75
1994	6679	19	0.27	279	4.00
1995	7042	20	0.27	392	5.26
1996	7594	19	0.24	405	5.05
1997	7769	53	0.63	572	6.81
1998	7409	83	0.99	873	10.44
1999	7066	87	1.08	928	11.48
2000	6776	130	1.69	788	10.24
2001	6066	194	2.78	718	10.29
2002	5617	129	2.06	506	8.09
2003	5281	85	1.46	459	7.88
2004	5254	29	0.51	377	6.66
2005	5219	37	0.66	378	6.71
2006	5178	20	0.36	377	6.76
2007	5124	25	0.45	448	8.00
2008	4832	75	1.42	364	6.91
2009	4572	95	1.91	310	6.23
2010	4495	34	0.70	305	6.31
2011	4340	33	0.70	310	6.62
2012	4310	10	0.23	119	2.68

Economy:TWN

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	236	0	0.00	2	0.84
1993	259	0	0.00	1	0.38
1994	291	0	0.00	1	0.34
1995	371	0	0.00	0	0.00
1996	442	0	0.00	1	0.23
1997	496	0	0.00	3	0.60
1998	572	4	0.68	12	2.04
1999	689	7	0.99	8	1.14
2000	787	8	0.99	15	1.85
2001	875	9	0.99	21	2.32
2002	982	7	0.68	36	3.51
2003	1070	2	0.18	19	1.74
2004	1340	6	0.44	26	1.90
2005	1351	8	0.56	66	4.63
2006	1377	3	0.21	41	2.89
2007	1434	3	0.20	33	2.24
2008	1438	6	0.40	48	3.22
2009	1492	1	0.07	22	1.45
2010	1591	0	0.00	24	1.49
2011	1657	0	0.00	40	2.36
2012	1680	0	0.00	12	0.71

Economy:VEN

Year	Active	Defaults #	Defaults %	Others #	Others %
1992	0	0	NaN	0	NaN
1993	7	0	0.00	0	0.00
1994	12	0	0.00	1	7.69
1995	15	0	0.00	3	16.67
1996	15	0	0.00	2	11.76
1997	47	0	0.00	17	26.56
1998	40	0	0.00	25	38.46
1999	39	0	0.00	18	31.58
2000	37	0	0.00	12	24.49
2001	30	1	2.33	12	27.91
2002	20	0	0.00	18	47.37
2003	25	0	0.00	10	28.57
2004	27	0	0.00	8	22.86
2005	29	0	0.00	7	19.44
2006	27	0	0.00	7	20.59
2007	24	0	0.00	8	25.00
2008	24	0	0.00	32	57.14
2009	26	0	0.00	21	44.68
2010	23	0	0.00	14	37.84
2011	31	0	0.00	15	32.61
2012	23	0	0.00	12	34.29

APPENDIX B: PERFORMANCE ANALYSIS

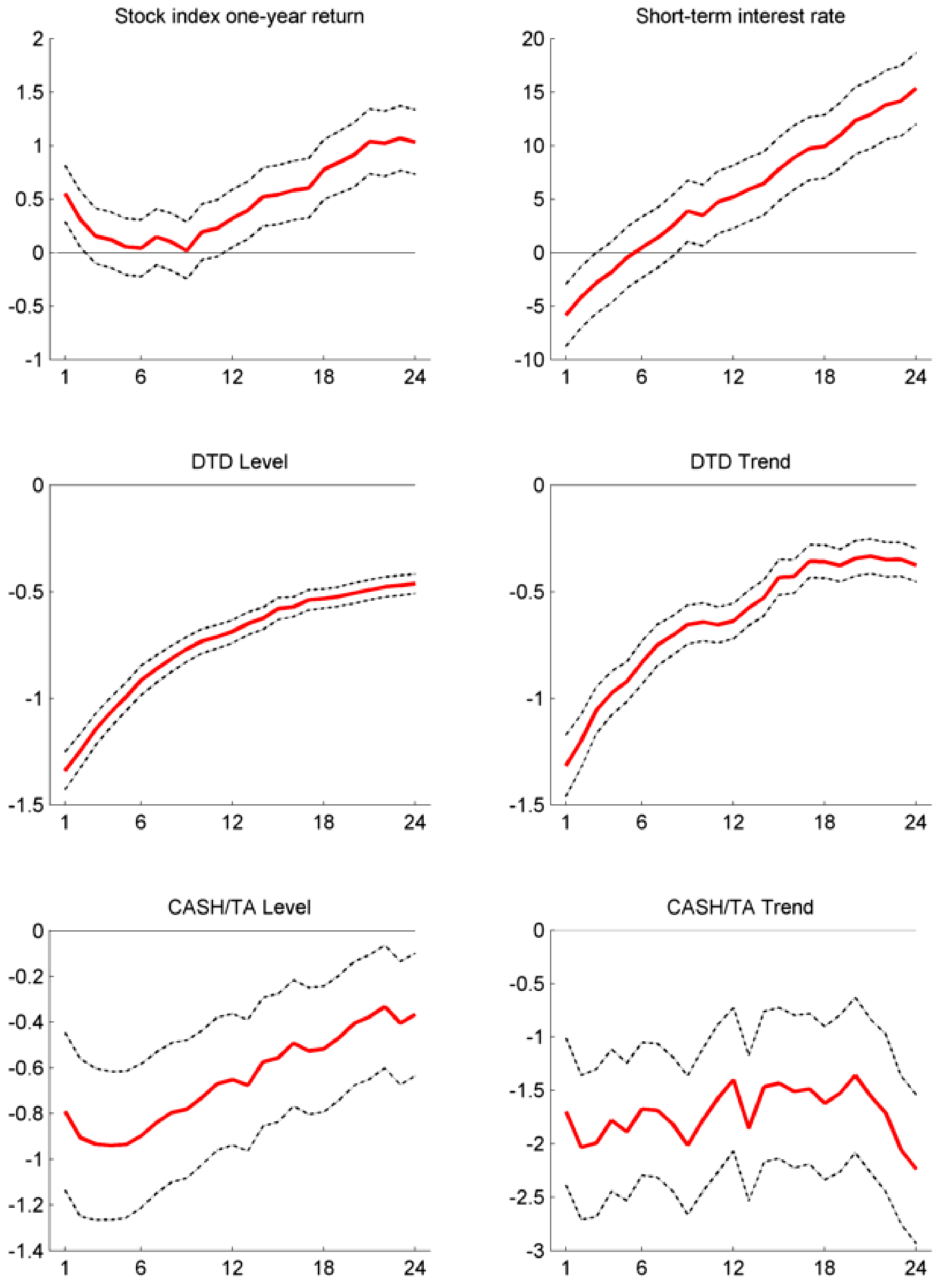

Figure B.1 Plots of US default parameters across all horizons for the Stock index one-year return, Short-term interest rate, DTD Level, DTD Trend, CASH/TA Level and CASH/TA Trend. Solid lines are the parameter estimates and dashed lines are the 90% confidence level. Horizontal axis is the horizon in months.

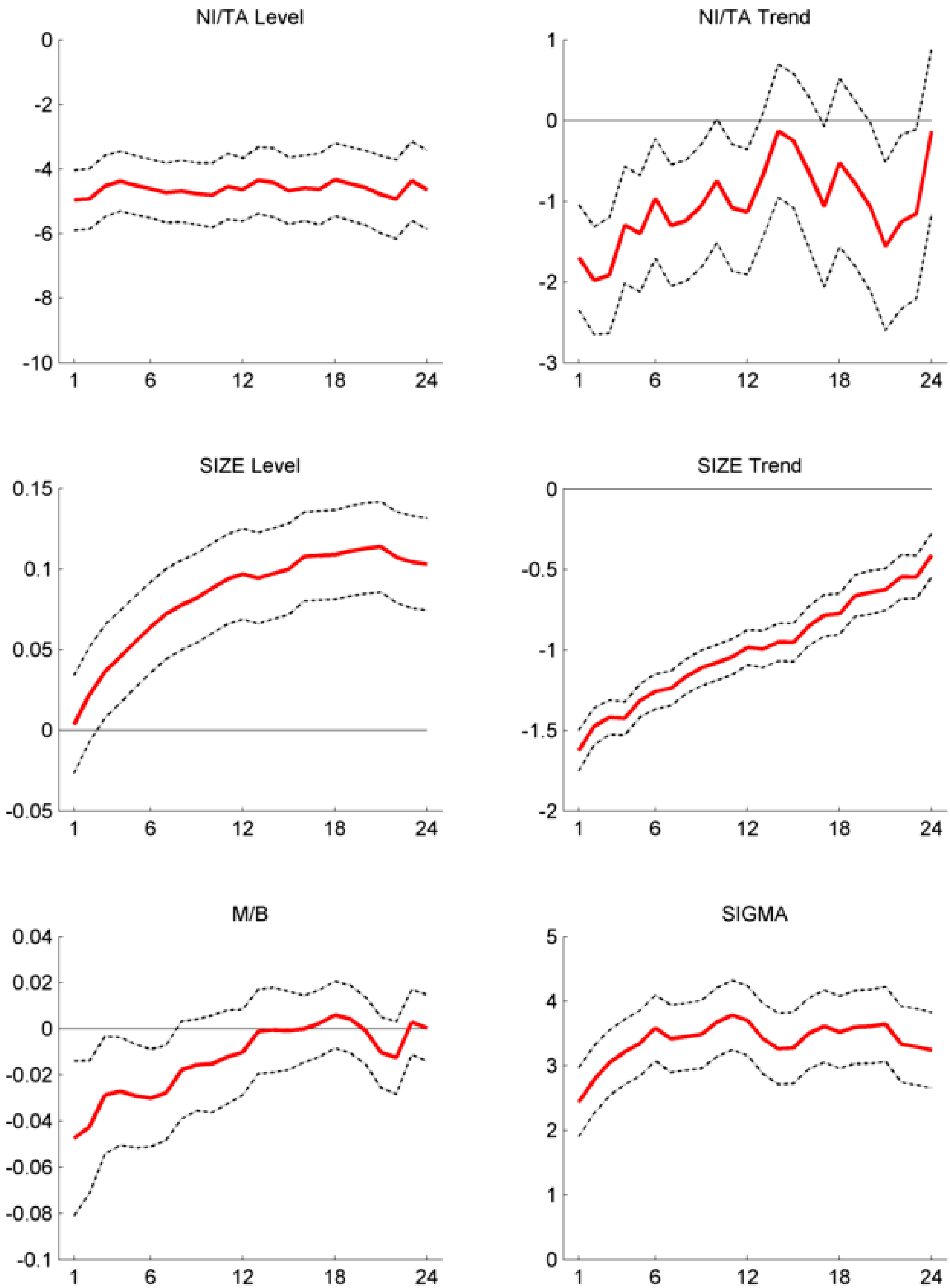

Figure B.2 Plots of US default parameters across all horizons for the NI/TA Level, NI/TA Trend, SIZE Level, SIZE Trend, M/B and SIGMA. Solid lines are the parameter estimates and dashed lines are the 90% confidence level. Horizontal axis is the horizon in months.

Table B.1 Accuracy Ratios (AR) and Area Under Receiver Operating Characteristic(AUROC) for calibration groups and economies with more than 20 defaults in the testing set. Standard errors are reported in parentheses.

	AR				AUROC				In/Out
Economy	1 mth	6 mth	1 yr	2 yr	1 mth	6 mth	1 yr	2 yr	**of sample**
North America	0.940	0.887	0.813	0.719	0.970	0.943	0.907	0.859	In
	(0.007)	(0.009)	(0.011)	(0.013)	(0.003)	(0.004)	(0.006)	(0.007)	
North America	0.944	0.899	0.826	0.755	0.972	0.949	0.913	0.878	Out
	(0.008)	(0.011)	(0.014)	(0.019)	(0.004)	(0.005)	(0.007)	(0.010)	
Europe	0.874	0.797	0.748	0.648	0.937	0.899	0.874	0.824	In
	(0.017)	(0.021)	(0.023)	(0.027)	(0.008)	(0.010)	(0.011)	(0.013)	
Europe	0.881	0.766	0.730	0.661	0.940	0.883	0.865	0.831	Out
	(0.017)	(0.022)	(0.024)	(0.030)	(0.008)	(0.011)	(0.012)	(0.015)	
ADvped	0.861	0.786	0.735	0.673	0.930	0.893	0.867	0.836	In
	(0.014)	(0.017)	(0.018)	(0.020)	(0.007)	(0.008)	(0.009)	(0.010)	
ADvped	0.857	0.756	0.683	0.610	0.929	0.878	0.842	0.805	Out
	(0.017)	(0.021)	(0.024)	(0.028)	(0.008)	(0.010)	(0.012)	(0.014)	
Emerging	0.821	0.774	0.706	0.688	0.910	0.887	0.853	0.844	In
	(0.023)	(0.026)	(0.029)	(0.030)	(0.012)	(0.013)	(0.014)	(0.015)	
Emerging	0.835	0.770	0.717	0.687	0.918	0.885	0.858	0.843	Out
	(0.031)	(0.036)	(0.041)	(0.048)	(0.015)	(0.018)	(0.021)	(0.024)	
AUS	0.815	0.733	0.669	0.581	0.908	0.866	0.835	0.791	In
	(0.036)	(0.042)	(0.046)	(0.052)	(0.018)	(0.021)	(0.023)	(0.026)	
AUS	0.813	0.708	0.641	0.543	0.906	0.854	0.820	0.772	Out
	(0.038)	(0.046)	(0.053)	(0.061)	(0.019)	(0.023)	(0.026)	(0.031)	
CAN	0.934	0.872	0.775	0.676	0.967	0.936	0.888	0.838	In
	(0.025)	(0.034)	(0.044)	(0.051)	(0.013)	(0.017)	(0.022)	(0.025)	
CAN	0.939	0.879	0.773	0.717	0.970	0.939	0.887	0.859	Out
	(0.027)	(0.038)	(0.053)	(0.061)	(0.014)	(0.019)	(0.027)	(0.031)	
CHN	0.563	0.531	0.483	0.398	0.781	0.766	0.741	0.699	In
	(0.024)	(0.026)	(0.028)	(0.031)	(0.012)	(0.013)	(0.014)	(0.015)	
CHN	0.591	0.545	0.490	0.400	0.795	0.773	0.745	0.700	Out
	(0.027)	(0.029)	(0.032)	(0.038)	(0.013)	(0.014)	(0.016)	(0.019)	
DEU	0.898	0.795	0.727	0.575	0.949	0.897	0.864	0.787	In
	(0.027)	(0.037)	(0.041)	(0.051)	(0.014)	(0.018)	(0.021)	(0.025)	
DEU	0.890	0.773	0.722	0.623	0.945	0.886	0.861	0.811	Out
	(0.029)	(0.040)	(0.044)	(0.060)	(0.015)	(0.020)	(0.022)	(0.030)	
DNK	0.918	0.918	0.790	0.782	0.959	0.959	0.895	0.891	In
	(0.064)	(0.064)	(0.097)	(0.101)	(0.032)	(0.032)	(0.048)	(0.050)	
DNK	0.875	0.829	0.838	0.757	0.937	0.914	0.919	0.878	Out
	(0.082)	(0.094)	(0.101)	(0.129)	(0.041)	(0.047)	(0.051)	(0.065)	
FRA	0.892	0.818	0.795	0.737	0.946	0.9	0.897	0.869	In
	(0.049)	(0.062)	(0.065)	(0.073)	(0.025)	(0.031)	(0.033)	(0.036)	
FRA	0.814	0.719	0.765	0.727	0.907	0.860	0.882	0.863	Out
	(0.064)	(0.076)	(0.074)	(0.088)	(0.032)	(0.038)	(0.037)	(0.044)	

(*Continued*)

Table B.1 (*Continued*)

Economy	AR				AUROC				In/Out of sample
	1mth	6mth	1yr	2yr	1mth	6mth	1yr	2yr	
GBR	0.875	0.808	0.733	0.646	0.938	0.904	0.867	0.823	In
	(0.032)	(0.039)	(0.044)	(0.050)	(0.016)	(0.019)	(0.022)	(0.025)	
GBR	0.876	0.759	0.668	0.590	0.938	0.880	0.834	0.795	Out
	(0.032)	(0.043)	(0.050)	(0.058)	(0.016)	(0.022)	(0.025)	(0.029)	
HKG	0.678	0.479	0.437	0.360	0.839	0.740	0.718	0.680	In
	(0.075)	(0.087)	(0.089)	(0.092)	(0.037)	(0.044)	(0.044)	(0.046)	
HKG	0.635	0.384	0.312	0.153	0.817	0.692	0.656	0.577	Out
	(0.086)	(0.100)	(0.108)	(0.117)	(0.043)	(0.050)	(0.054)	(0.059)	
IDN	0.717	0.708	0.555	0.588	0.859	0.854	0.777	0.794	In
	(0.068)	(0.069)	(0.079)	(0.079)	(0.034)	(0.034)	(0.039)	(0.039)	
IDN	0.625	0.613	0.521	0.370	0.812	0.807	0.761	0.685	Out
	(0.131)	(0.132)	(0.162)	(0.210)	(0.065)	(0.066)	(0.081)	(0.105)	
IND	0.657	0.666	0.578	0.478	0.828	0.833	0.789	0.739	In
	(0.065)	(0.064)	(0.071)	(0.076)	(0.032)	(0.032)	(0.035)	(0.038)	
IND	0.603	0.541	0.495	0.306	0.802	0.770	0.747	0.653	Out
	(0.085)	(0.089)	(0.091)	(0.096)	(0.043)	(0.044)	(0.046)	(0.048)	
JPN	0.906	0.866	0.822	0.782	0.953	0.933	0.911	0.891	In
	(0.021)	(0.025)	(0.028)	(0.031)	(0.011)	(0.012)	(0.014)	(0.016)	
JPN	0.907	0.845	0.791	0.797	0.953	0.922	0.895	0.898	Out
	(0.029)	(0.036)	(0.043)	(0.043)	(0.014)	(0.018)	(0.021)	(0.021)	
KOR	0.887	0.786	0.737	0.692	0.943	0.893	0.868	0.846	In
	(0.024)	(0.031)	(0.034)	(0.036)	(0.012)	(0.016)	(0.017)	(0.018)	
KOR	0.908	0.785	0.733	0.696	0.954	0.893	0.867	0.848	Out
	(0.034)	(0.049)	(0.057)	(0.065)	(0.017)	(0.025)	(0.028)	(0.033)	
MYS	0.857	0.795	0.743	0.693	0.928	0.898	0.871	0.846	In
	(0.039)	(0.045)	(0.050)	(0.053)	(0.019)	(0.022)	(0.025)	(0.027)	
MYS	0.846	0.761	0.706	0.654	0.923	0.881	0.853	0.827	Out
	(0.048)	(0.057)	(0.067)	(0.075)	(0.024)	(0.029)	(0.033)	(0.038)	
NLD	0.806	0.735	0.791	0.743	0.903	0.867	0.896	0.871	In
	(0.089)	(0.101)	(0.092)	(0.092)	(0.045)	(0.050)	(0.046)	(0.050)	
NLD	0.783	0.540	0.684	0.643	0.892	0.770	0.842	0.822	Out
	(0.098)	(0.128)	(0.124)	(0.210)	(0.049)	(0.064)	(0.062)	(0.105)	
NOR	0.944	0.952	0.829	0.731	0.972	0.976	0.915	0.865	In
	(0.055)	(0.052)	(0.094)	(0.116)	(0.027)	(0.026)	(0.047)	(0.058)	
NOR	0.931	0.897	0.679	0.685	0.965	0.949	0.840	0.842	Out
	(0.061)	(0.075)	(0.120)	(0.143)	(0.030)	(0.037)	(0.060)	(0.071)	
PHL	0.641	0.600	0.569	0.647	0.820	0.8200	0.784	0.823	In
	(0.103)	(0.107)	(0.109)	(0.107)	(0.052)	(0.053)	(0.053)	(0.054)	
PHL	0.653	0.589	0.587	0.678	0.826	0.795	0.793	0.839	Out
	(0.114)	(0.120)	(0.124)	(0.125)	(0.057)	(0.060)	(0.062)	(0.062)	

(*Continued*)

Table B.1 (*Continued*)

Economy	AR 1mth	AR 6mth	AR 1yr	AR 2yr	AUROC 1mth	AUROC 6mth	AUROC 1yr	AUROC 2yr	In/Out of sample
SGP	0.769	0.759	0.606	0.457	0.884	0.879	0.803	0.729	In
	(0.074)	(0.076)	(0.091)	(0.099)	(0.037)	(0.038)	(0.046)	(0.050)	
SGP	0.781	0.760	0.566	0.393	0.891	0.880	0.783	0.696	Out
	(0.081)	(0.086)	(0.105)	(0.121)	(0.040)	(0.043)	(0.053)	(0.060)	
SWE	0.838	0.761	0.733	0.624	0.919	0.880	0.866	0.812	In
	(0.074)	(0.087)	(0.091)	(0.114)	(0.037)	(0.044)	(0.046)	(0.057)	
SWE	0.849	0.759	0.726	0.689	0.925	0.879	0.863	0.845	Out
	(0.076)	(0.093)	(0.100)	(0.127)	(0.038)	(0.046)	(0.050)	(0.063)	
THA	0.854	0.812	0.742	0.679	0.927	0.906	0.871	0.839	In
	(0.037)	(0.041)	(0.047)	(0.051)	(0.018)	(0.021)	(0.023)	(0.026)	
THA	0.907	0.858	0.768	0.724	0.953	0.929	0.884	0.862	Out
	(0.053)	(0.064)	(0.084)	(0.103)	(0.026)	(0.032)	(0.042)	(0.051)	
TWN	0.866	0.781	0.759	0.697	0.933	0.891	0.880	0.849	In
	(0.046)	(0.056)	(0.056)	(0.056)	(0.023)	(0.028)	(0.028)	(0.028)	
TWN	0.928	0.792	0.664	0.616	0.964	0.896	0.832	0.808	Out
	(0.044)	(0.071)	(0.092)	(0.096)	(0.022)	(0.035)	(0.046)	(0.048)	
USA	0.940	0.888	0.816	0.722	0.970	0.944	0.908	0.861	In
	(0.007)	(0.009)	(0.012)	(0.014)	(0.003)	(0.005)	(0.006)	(0.007)	
USA	0.944	0.901	0.833	0.765	0.972	0.950	0.916	0.882	Out
	(0.008)	(0.011)	(0.015)	(0.020)	(0.004)	(0.005)	(0.007)	(0.010)	
USA(Fin)	0.963	0.933	0.880	0.834	0.981	0.967	0.940	0.917	Out
	(0.021)	(0.029)	(0.038)	(0.047)	(0.011)	(0.014)	(0.019)	(0.023)	
USA(non-Fin)	0.945	0.893	0.832	0.759	0.972	0.946	0.916	0.880	Out
	(0.009)	(0.013)	(0.016)	(0.022)	(0.004)	(0.006)	(0.008)	(0.011)	

Note: North America includes Canada and the US. Europe includes 23 European countries. ADvped stands for Asian developed group, which includes Australia, Hong Kong, Japan, South Korea, Singapore, and Taiwan. Emerging stands for emerging group, which includes Indonesia, Malaysia, Philippines, Thailand, Argentina, Brazil, Colombia, Chile, Mexico, Peru, and Venezuela.

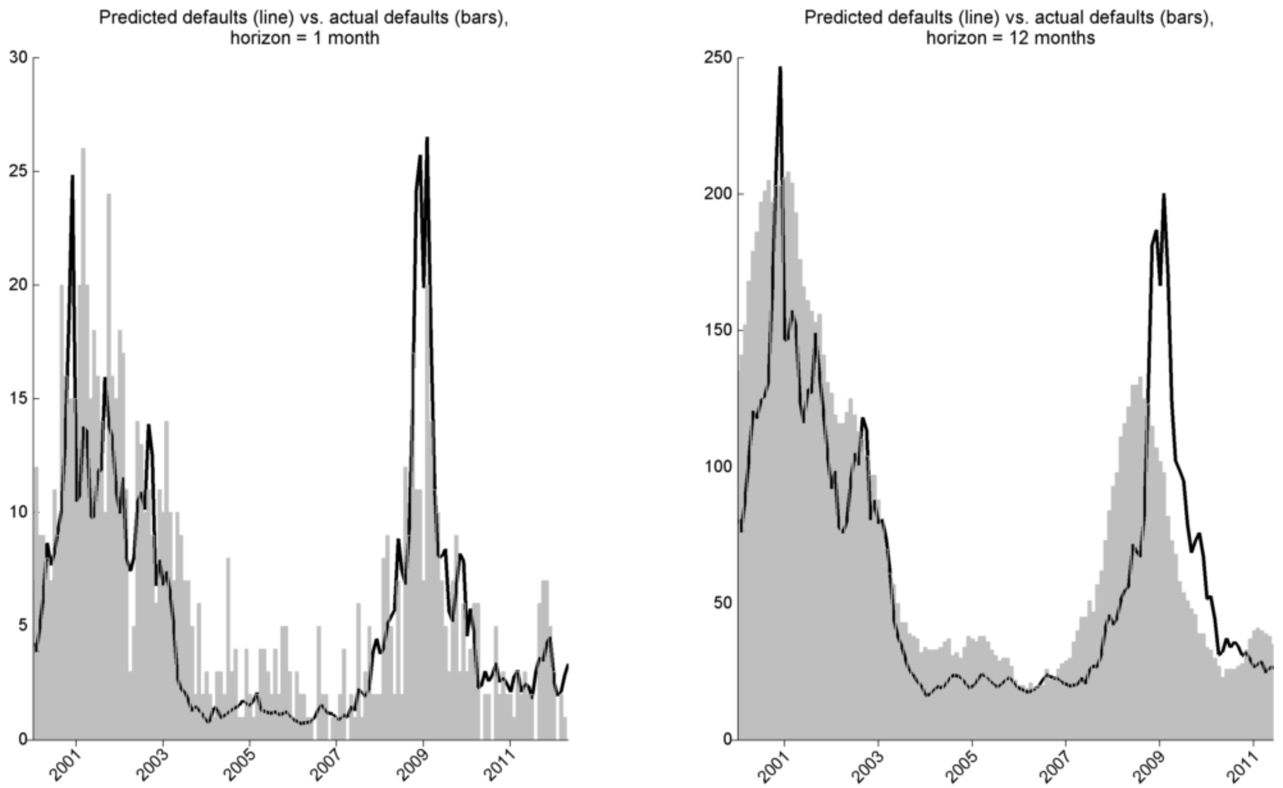

Figure B.3 Performance test for the North America Group, in sample.

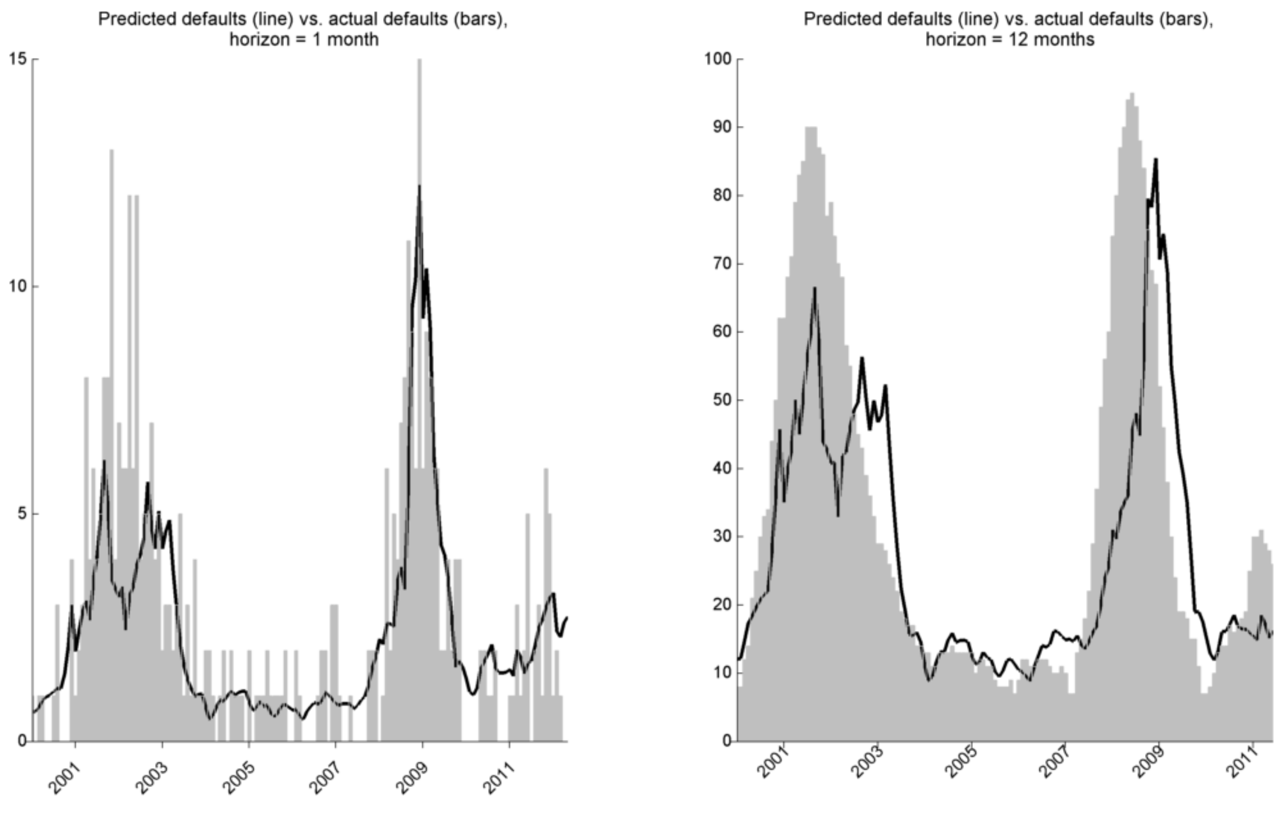

Figure B.4 Performance test for the Europe Group, in sample.

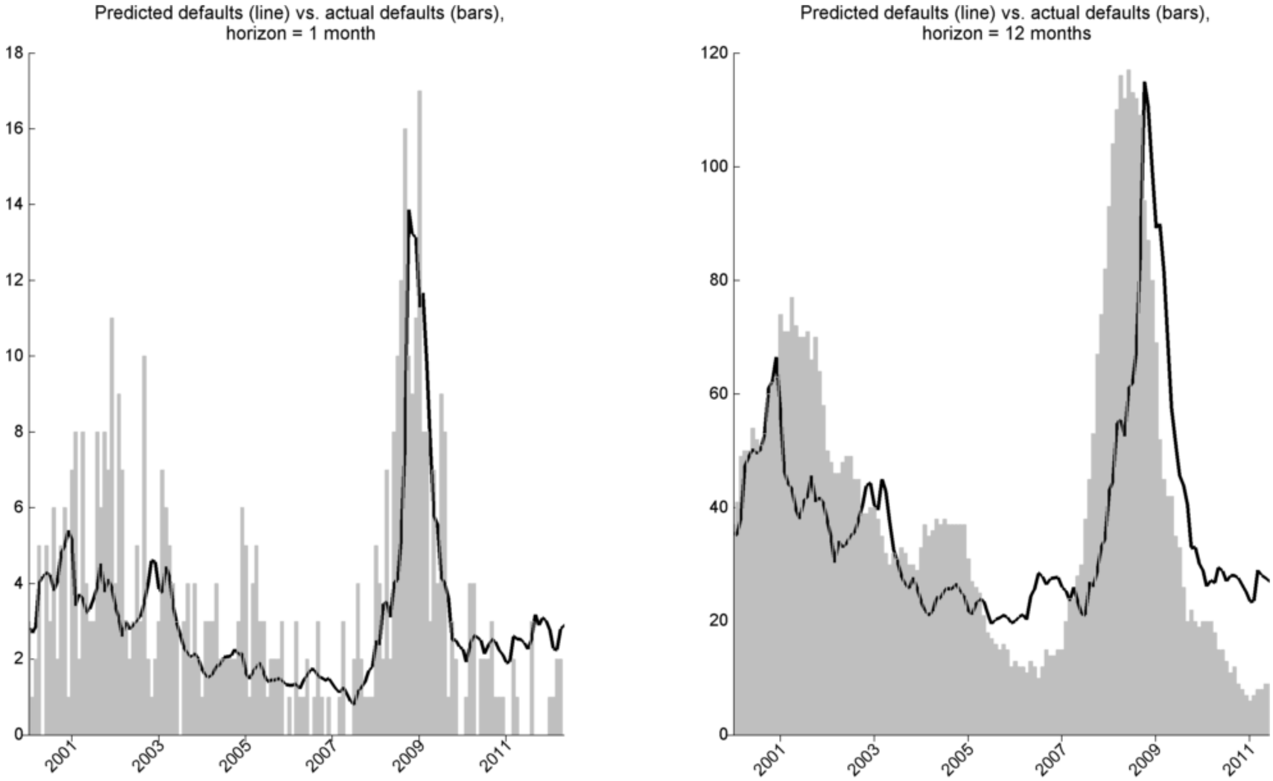

Figure B.5 Performance test for the Asian developed group, in sample.

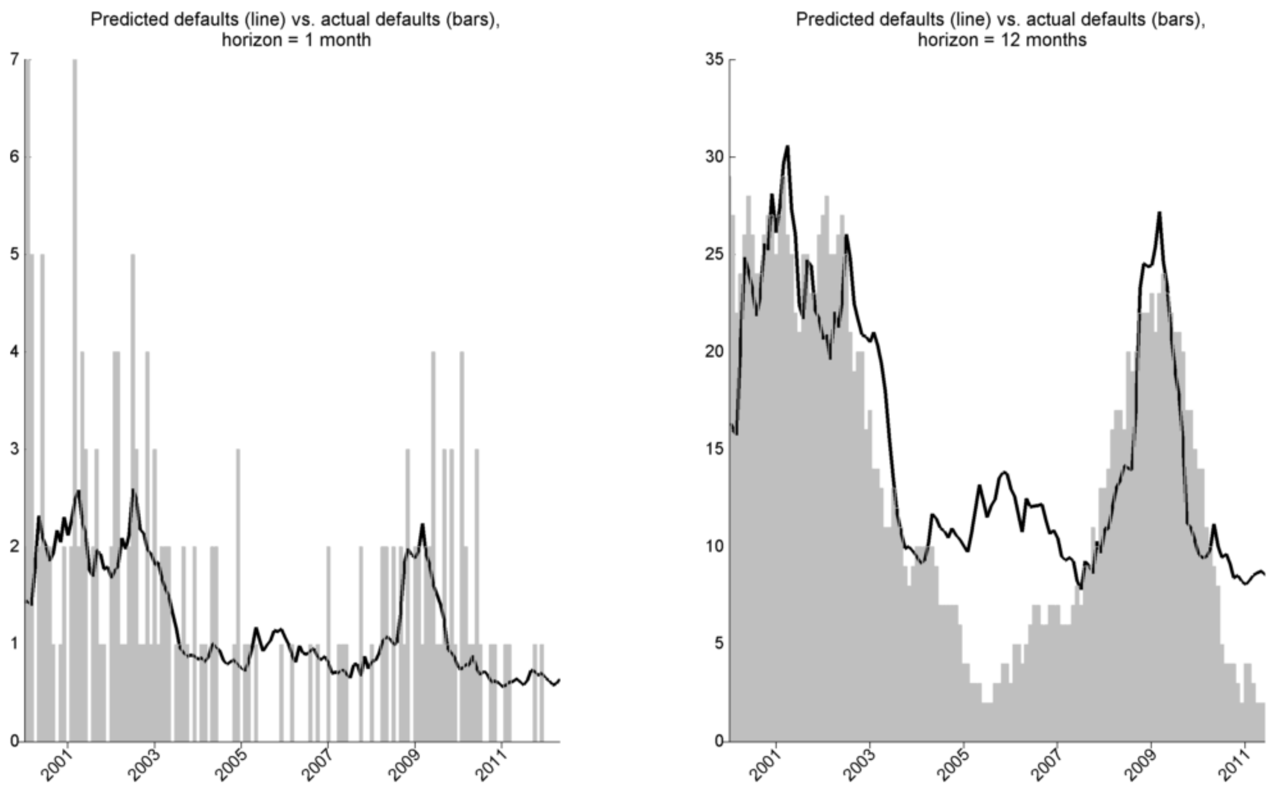

Figure B.6 Performance test for the Emerging group, in sample.

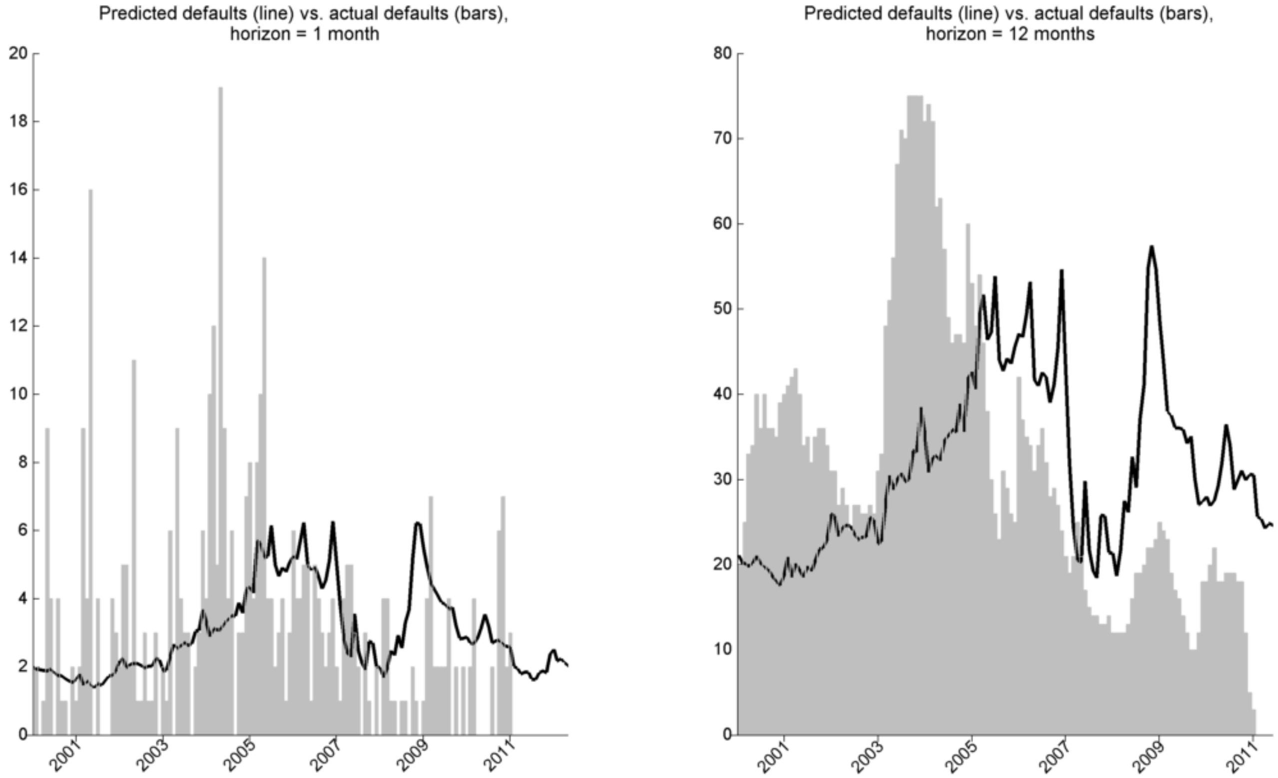

Figure B.7 Performance test for China, in sample.

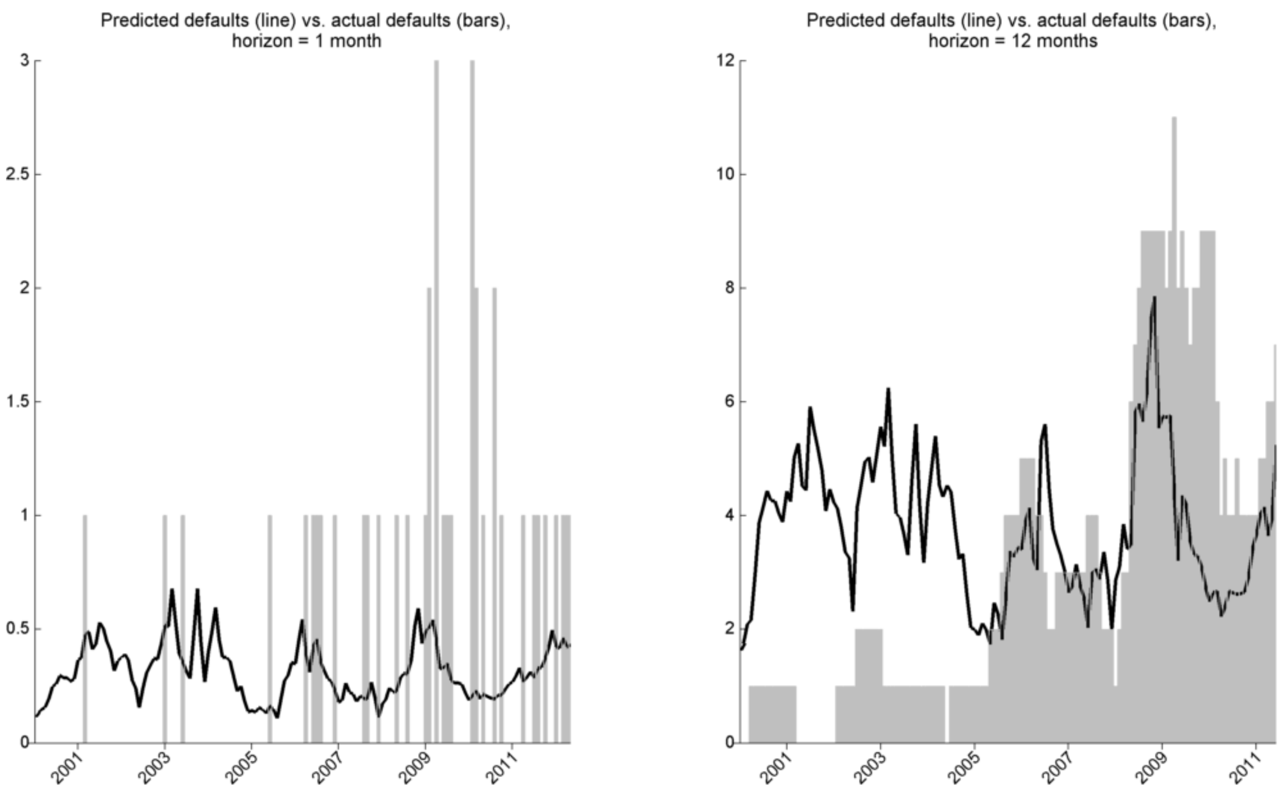

Figure B.8 Performance test for India, in sample.