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Addendum 9 to the CRI Technical Report (Version: 2017, Update 1)

This addendum presents three main changes to the CRI-PD model documented in Technical Report (Version: 2017, Update 1). These changes are (1) adding of aggregate distance-to-default (DTD) to the model, (2) estimation change for North America, and (3) estimation change for China.

I. Adding of aggregate DTD to CRI-PD model

We add the following two common covariates (i.e., default predictors common to all obligors) to the set of covariates:

- Financial aggregate DTD: median DTD of financial firms in each economy/country inclusive of those foreign financial firms whose primary stock exchange is in this economy/country.
- Non-Financial aggregate DTD: median DTD of non-financial firms in each economy/country inclusive of those foreign non-financial firms whose primary stock exchange is in this economy/country.

Each of the aggregate DTD is only applicable to firms in the corresponding category. Our research has revealed that the incorporation of the two aggregate DTDs into the CRI-PD model helps improve default predictions in general, which will become evident later in the new performance result on North America.

For a typical CRI-PD model, the total number of the covariates has increased to 16 from 14 prior to this change. Among them, four are common covariates (increased from 2 to 4), and the rest are obligor-specific.

China, however, differs from other economies/countries where the two aggregate DTDs are not applicable because they offer no informational value above and beyond what have already been captured. In short, the number of covariates for China is still 14.

II. Estimation change for North America

The North America calibration group (the US and Canada) has incorporated the following two specific changes. First, we include a dummy variable on the intercept for financial firms to account for differences that have not been duly reflected through other covariates. Second, we apply a structural break to this financial-sector intercept dummy to address the change in September 2008 after Lehman Brothers's default.

The structural break is treated as an *impulse response*. The key is to allow the different rates of transition, characterized by $\tilde{\alpha}_1(\tau) > 0$ and $\tilde{\alpha}_2(\tau) > 0$, before and after the break point t_0, respectively. Specifically,

- Before t_0, the coefficient for the financial-sector intercept dummy, $\beta(t,\tau;t_0)$, has the form:

$$\beta(t,\tau;t_0) = \tilde{\beta}(\tau) + \tilde{\gamma}(\tau) \times \frac{1}{1+e^{-\tilde{\alpha}_1(\tau)(t-t_0)}},$$

where t denotes the default prediction time, and τ denotes a forward starting time ranging from 0 (1 month) to 59/12 (5 years). $\tilde{\alpha}_1(\tau)$, $\tilde{\beta}(\tau)$ and $\tilde{\gamma}(\tau)$ are characterized by the following Nelsen-Siegel (NS) function with four parameters $[\rho_0, \rho_1, \rho_2, d]$:

$$\rho_0 + \rho_1 \left[\frac{1 - \exp(-\tau/d)}{\tau/d}\right] + \rho_2 \left[\frac{1 - \exp(-\tau/d)}{\tau/d} - \exp(-\tau/d)\right].$$

- After t_0, the coefficient for the financial-sector intercept dummy is governed by $\tilde{\alpha}_2(\tau)$ instead of $\tilde{\alpha}_1(\tau)$:

$$\beta(t, \tau; t_0) = \tilde{\beta}(\tau) + \tilde{\gamma}(\tau) \times \frac{1}{1 + e^{-\tilde{\alpha}_2(\tau)(t_0 - t)}}.$$

Therefore, $\beta(t, \tau; t_0)$ moves from $\tilde{\beta}(\tau)$ to $\tilde{\beta}(\tau) + \frac{1}{2}\tilde{\gamma}(\tau)$ as t advances toward t_0, and reverts back to $\tilde{\beta}(\tau)$ as t goes past t_0.

After incorporating the two specific treatments described above, the accuracy ratio (AR) for the 1-year CRI PDs (calibrated in April 2018) increases from 83.8% to 85.7%. Although the increase in the AR is not pronounced, the revised model has clearly delivered a meaningful improvement in predicting default rates for the North America calibration group. Figure 1 displays a performance outcome beyond merely risk ranking firms.

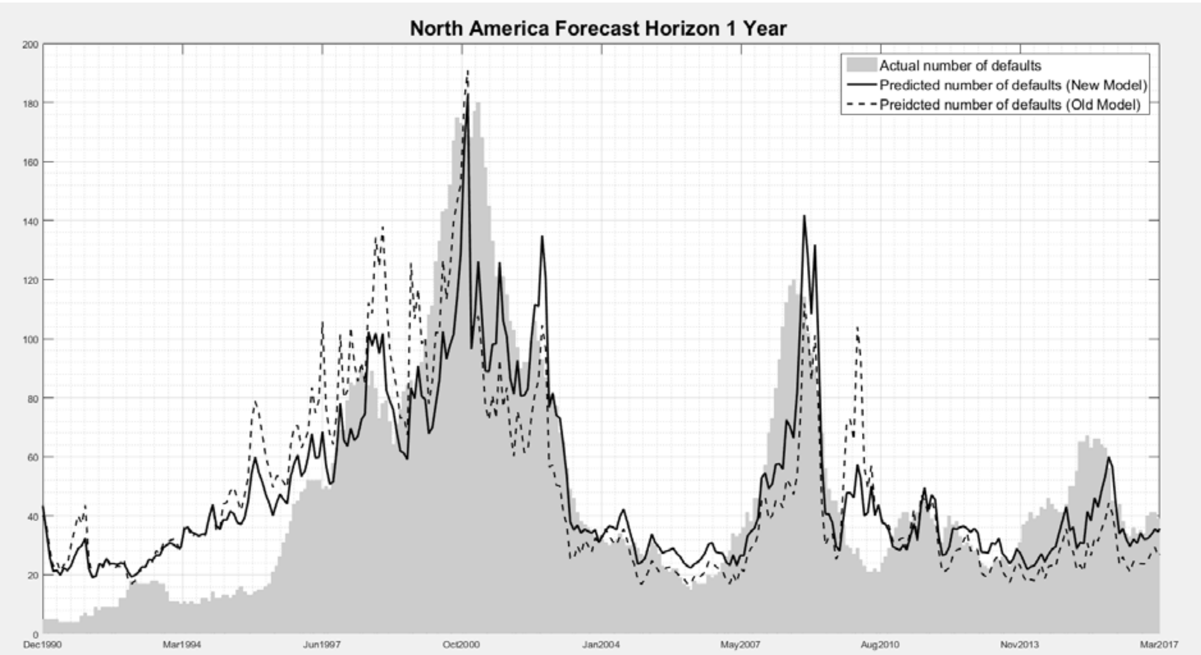

Figure 1

The one-year-ahead model predicted number of defaults on North American firms is compared with the realized number of defaults in the subsequent year. The two curves correspond to two model specifications, i.e., the new and old. Noteworthy is the outcome that the new model has attenuated the spike (the unusual large predicted number of defaults) 1 year after the 2008-09 global financial crisis from the old model.

Our research found that the spike associated with the old model can be largely attributed to the stock index rebound post the financial crisis. The trailing *one-year* stock return is one of the common covariates in the CRI-PD model. The estimated coefficients on stock index return for different prediction horizons are generally positive, and as a result, the stock index rebound causes the model to generate higher PDs. The introduction of the aggregate DTD serves to attenuate the effect of the stock index rebound and to improve the performance in other periods as well.

III. Estimation change for China

Our treatment on Chinese firms differs from that for the North American calibration group in two aspects. First, we apply a structural break to both the intercept and the DTD level (Subsection 1.3.2 of Technical Report (Version: 2017, Update 1) reports the structural break treatment on the DTD level already implemented). Second, we model the structural break by a *step function* allowing for different rates of transition to and away from the break point. The treatment is the same for intercept term and the coefficient for the DTD level, but the transition rates are different. Here, we describe generically for one of these two structural breaks.

- Before t_0 (December 2004), $\beta(t,\tau;t_0)$ has the following form:
$$\beta(t,\tau;t_0) = \tilde{\beta}(\tau) + \tilde{\gamma}(\tau) \times \frac{1}{1+e^{-\tilde{\alpha}_1(\tau)(t-t_0)}}.$$
- After break point t_0, the two variables are governed by $\tilde{\alpha}_2(\tau)$:
$$\beta(t,\tau;t_0) = \tilde{\beta}(\tau) + \tilde{\gamma}(\tau) \times \frac{1}{1+e^{-\tilde{\alpha}_2(\tau)(t-t_0)}}.$$

Therefore, $\beta(t,\tau;t_0)$ smoothly transits from $\tilde{\beta}(\tau)$ to $\tilde{\beta}(\tau)+\frac{1}{2}\tilde{\gamma}(\tau)$ as t moves toward t_0, and then continues to $\tilde{\beta}(\tau)+\tilde{\gamma}(\tau)$ as t moves beyond t_0.

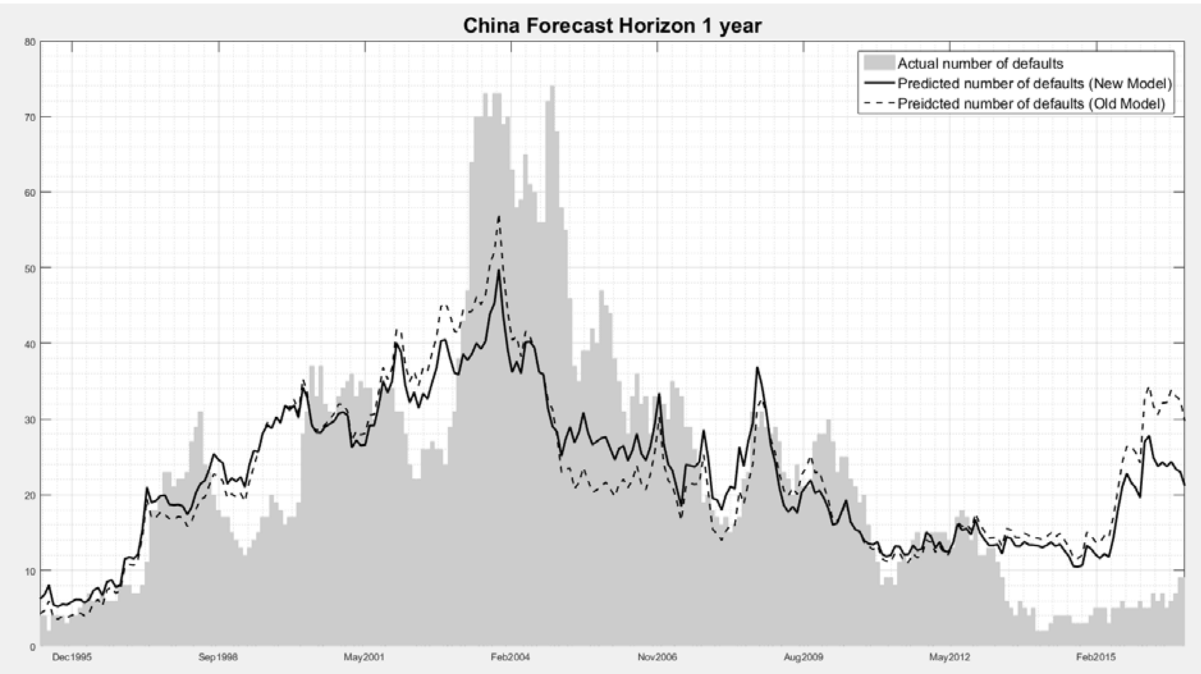

Figure 2

For China, such a structural break treatment to the DTD has already been implemented earlier and its performance improvement reported in the CRI Technical Report. The performance improvement in terms of the AR under the new specification with a structural break on the intercept and DTD level is not pronounced; for example, the ARs for 1-year, 2-year, and 5-year CRI PDs (calibrated in April 2018) increase from 66.8%, 65.4%, and 56.4% under the old method to 68.6%, 66.8%, and 57.2% under the new model. Again, going beyond mere risk ranking firms reveals a more meaningful performance improvement.

Figure 2 plots the one-year-ahead model predicted number of defaults on Chinese firms as compared with the realized number of defaults in the subsequent year. Likewise, the two curves stand for the new and old models, respectively. When it comes to default prediction for the more recent period, the new model obviously performs better even though the new model still overestimates default numbers.

References

Credit Research Initiative, 2017, “NUS-RMI Credit Research Initiative Technical Report Version: 2017 update 1,” National University of Singapore.

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