Quantum Mechanics Framework to Minimize the Lack of Stationary Properties in Markov like Credit Risk Models

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Outline

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01. Motivation

How can I forecast with a Transition Matrix for different economical scenarios?

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02. Introduction
02.01 The Classic Approach

- Is based on the classical statistics paradigm. That implies an event space, with events, probability measures, algebras, etc…(heavy math stuff)
- Stable information means massive data collected cover a timeframe **much** longer than classification revision period.
- Furthermore, if we need forecasting, we need a TM which can be related to economical environment. And this demands even greater amounts of data.

How, then, do we bypass these shortcomings?

02. Introduction
02.02. The Quantum Approach

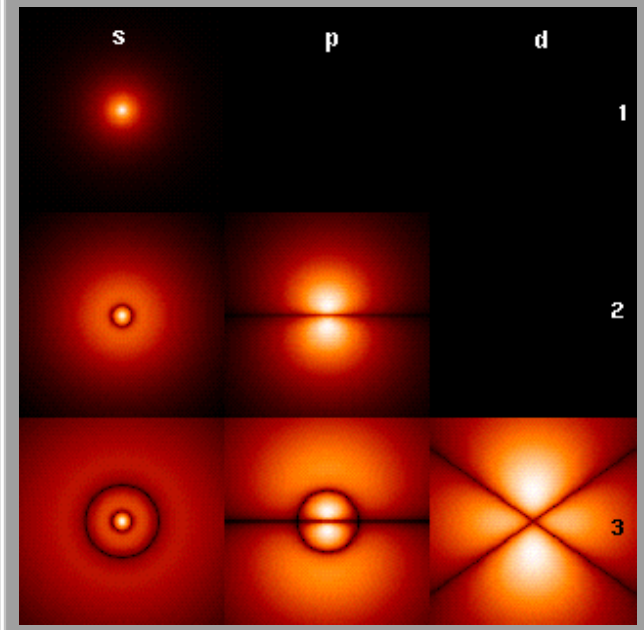
Well … there are **good news** …

There is an alternative paradigm, in which the probabilities are **not** inferred via observation – as happens the classical approach – but by its possibility of occupying different states.

How can we apply this approach to debtors as physicists have been doing to sub-atomic particles for almost a century?

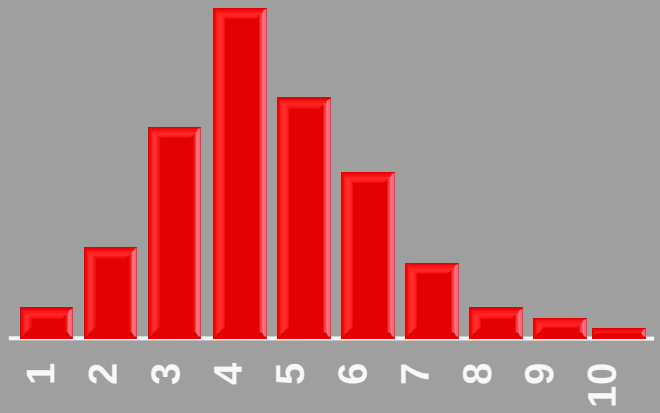
02. Introduction
02.02. The Quantum Approach

In an atom, an electron is given a probability of occupying – at a given **instant** - certain, predictable electron configurations …



Different orbitals for the simplest of all atoms – Hydrogen

Likewise, a debtor can be given a certain probability of occupying – at a given **instant** - certain, predictable credit classifications…



Different credit classifications and it's distribution for a given debtor.

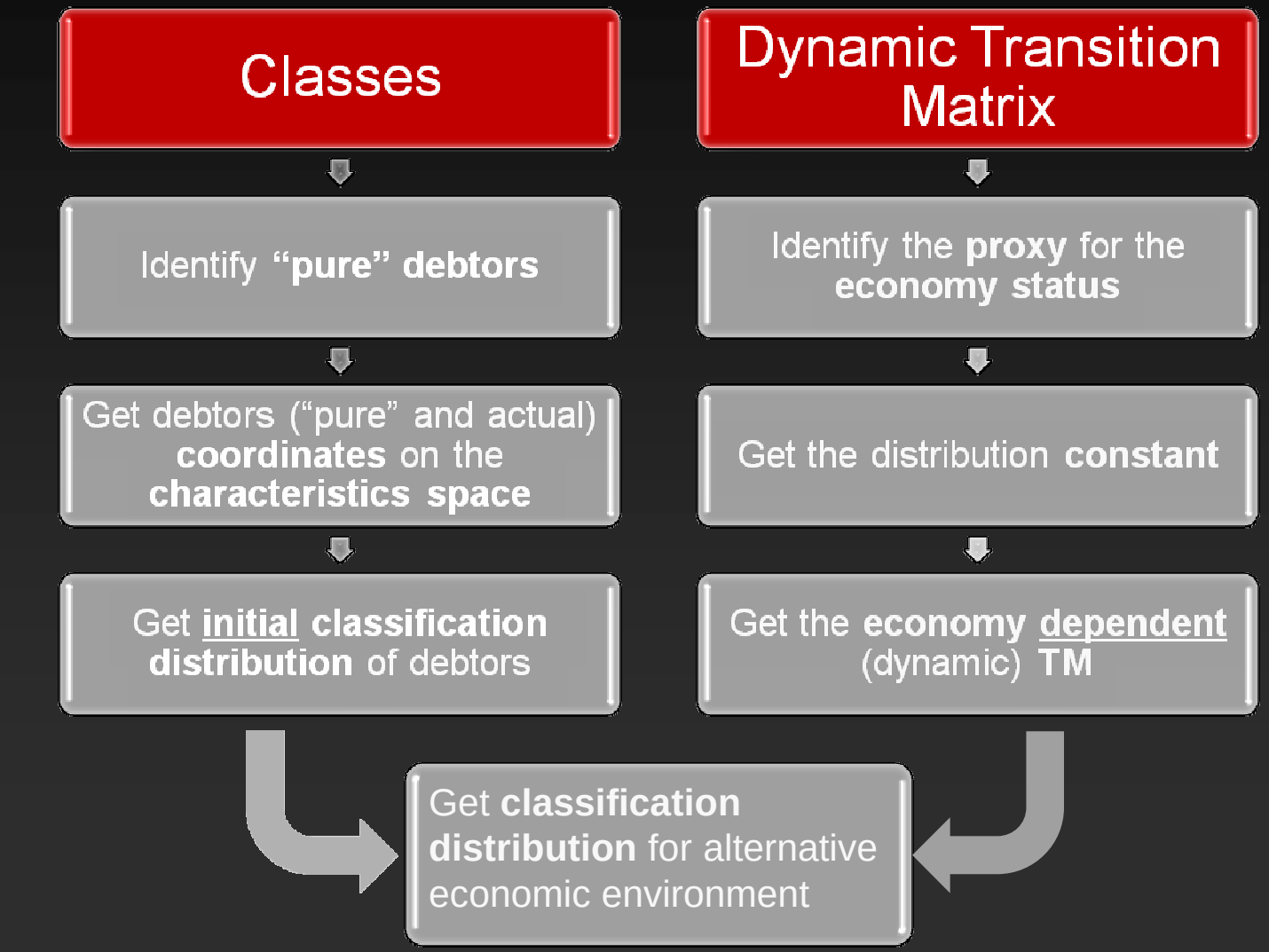
03. The Quantum Approach Core

In a nutshell …

•We no longer care about knowing where a debtor is, based on the few debtors we know.

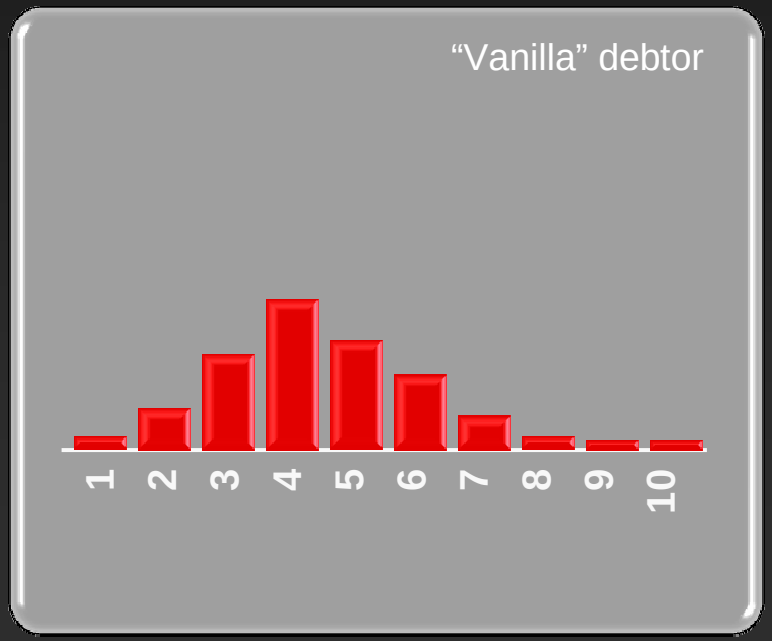
•We only care about where a debtor can be, based on all the debtors we don't know!

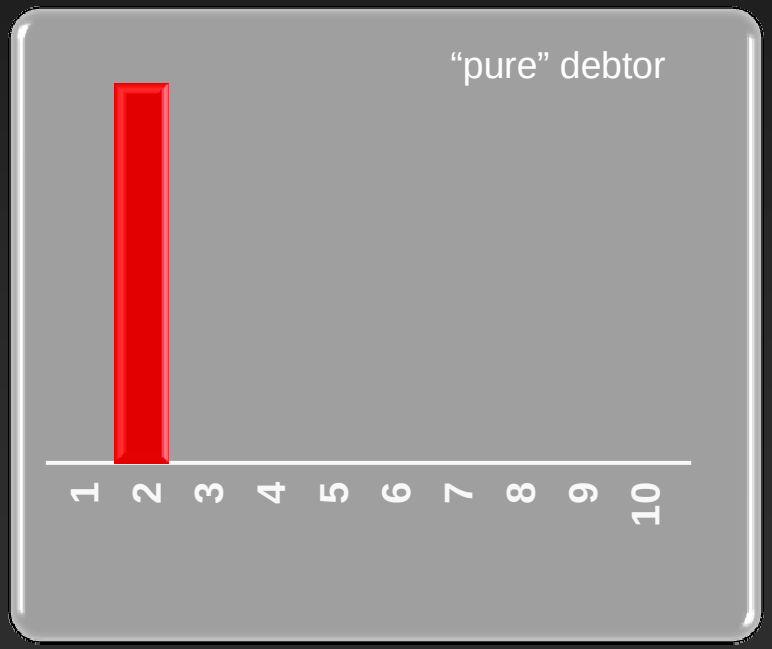
04. Process Description



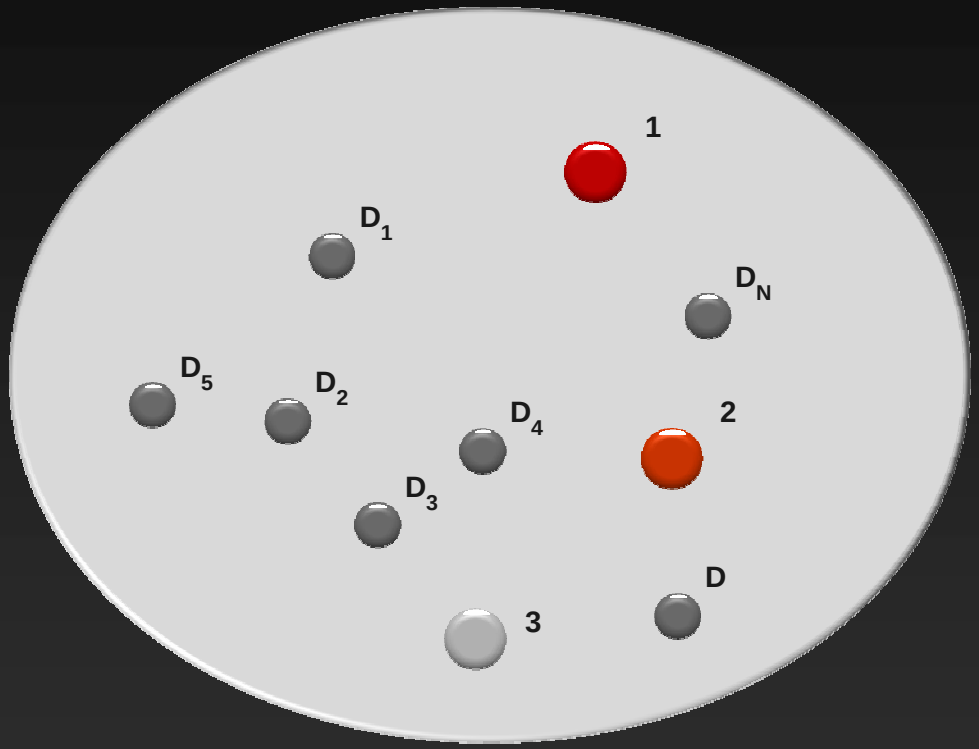
04. Process Description
04.01. Identify “Pure” Debtors

- This task is left to Credit Risk experts;
- It aims to identify debtors (either real or idealized) which can be treated as falling into a single credit classification (with no distribution across different classes);
- They are needed as “references” on the characteristics space.



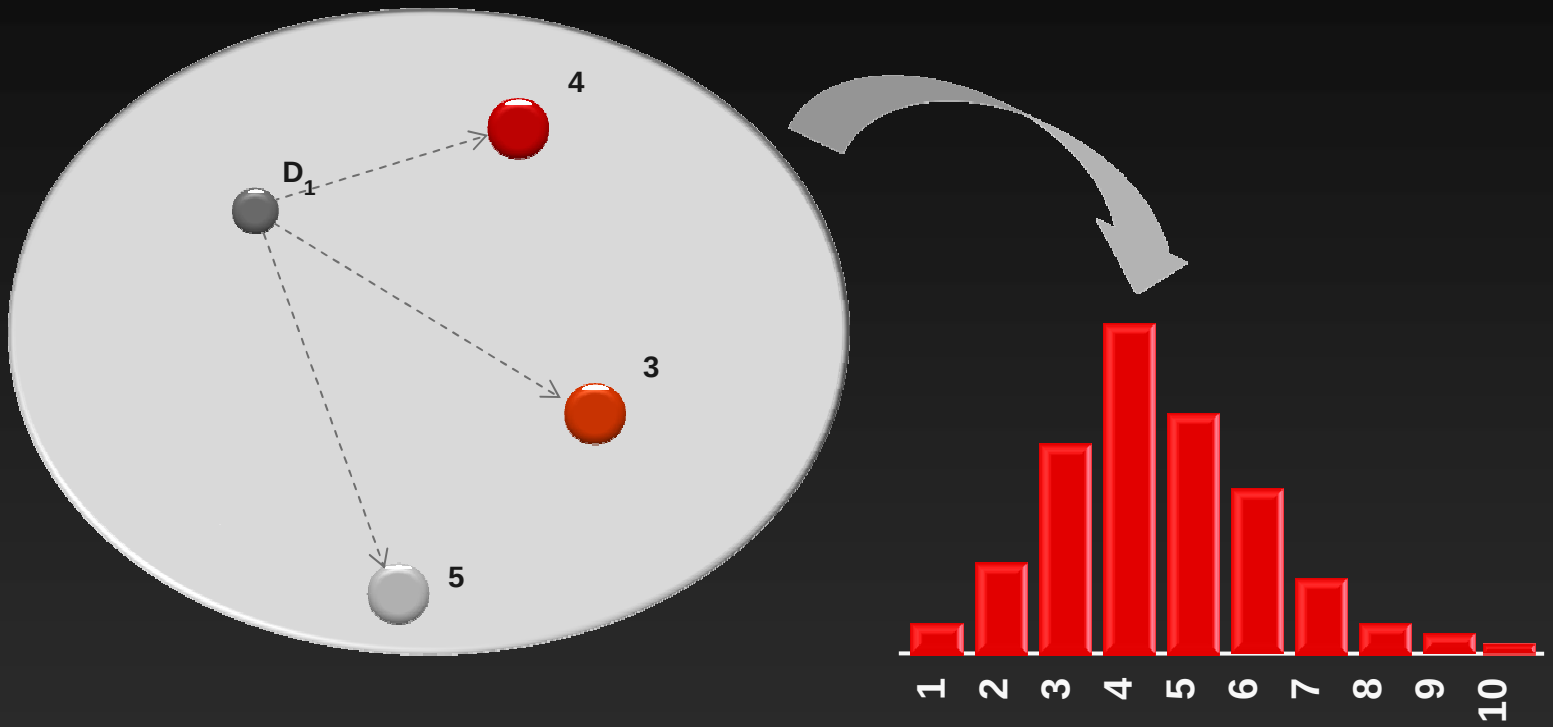


04. Process Description
04.02. Representation on the Characteristics Space



We place the debtors (both the “pure” and actual) on the hyperspace of financial/structural attributes – which we name as “characteristics space”.

04. Process Description
04.03. Getting classification distribution



- The debtor is given a distribution of classifications based upon its position regarding the pure debtors;
- This probability of each state is assigned via proximity algorithms.

04. Process Description
04.04. Identifying a proxy of the economy status

- As we saw, the classification distribution displays an exponential behavior so that the probability that the classification changes to K when the economy changes from β to β_0 is given by:

$$\frac{P(\beta)}{P(\beta_0)} \propto e^{-(\beta-\beta_0)\varepsilon_k}$$

- The parameter β is a composed metric derived from a set of macro-economic indicators.

04. Process Description
04.05. Getting the distribution constant

- The constant in the model is found on the parameter ε_k :

$$V_{kk} = \frac{P(\beta)}{P(\beta_0)} = e^{-(\beta-\beta_0)\varepsilon_k}$$

- This constant can be obtained by performing OLS on empirical data

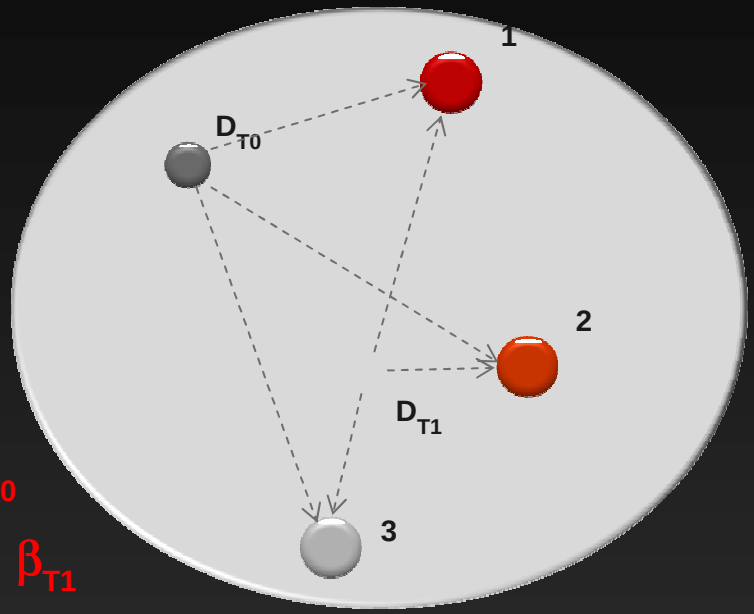
04. Process Description
04.06. Getting dynamic (economy dependent) TM

- The elements of the Dynamic Transition Matrix are computed via Matrix OLS.

$$R \cdot T_M \rightarrow R'$$

04. Process Description

04.07. Classification distribution for alternative economical environment



- By changing the economic environment, our debtor describes a trajectory on the characteristics space.
- This trajectory derives from applying the dynamic transition matrix (expressing different economic environment).
- If we take R as the initial classification distribution; T_M as the dynamic transition matrix, then the classification distribution on na alternative scenario, R' will be

$$R \cdot T_M \rightarrow R'$$

05. Conclusions

- As a result of this approach, our TM is no longer a scalar matrix (it couldn´t be)

$$\begin{bmatrix} V_{11}(\beta) & V_{12}(\beta) & \dots & \dots \\ V_{21}(\beta) & V_{22}(\beta) & \dots & \dots \\ \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & V_{nn}(\beta) \end{bmatrix}$$

- Now it yields the economic dependency but, also important, the uncertainty associated to the lack of homogeneity and stationarity.

Epilogue

"There is one thing stronger than all the armies in the world, and that is an idea whose time has come."

Victor Hugo

Thank you for your attention!

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