



# Credit risk models: why they failed in the credit crisis

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What is the credit crisis?

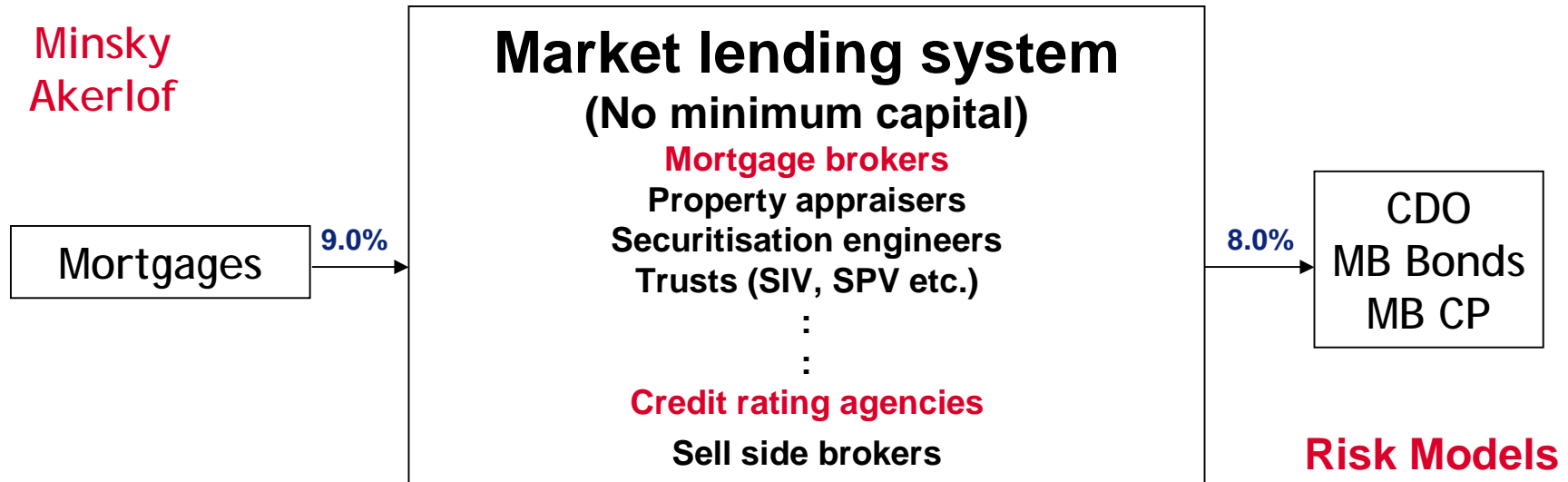
How did credit risk models play a key part?

Why did credit risk models failed to work?

What is needed for credit risk models to work?



Minsky  
Akerlof



Market has low quality loans and wrong prices from credit risk models:  
Securities buyer's strike

The Lucas critique: inability of inductive econometric models

$$y_{t+1} = F(y_t, x_t, q, e_t)$$

to predict in new environments **different from the estimated model**.

**Reduced form** credit risk models are a linear subset valid near an equilibrium

$$y_{t+1} = c_0(q) + c_1(q)x_t + e_t$$

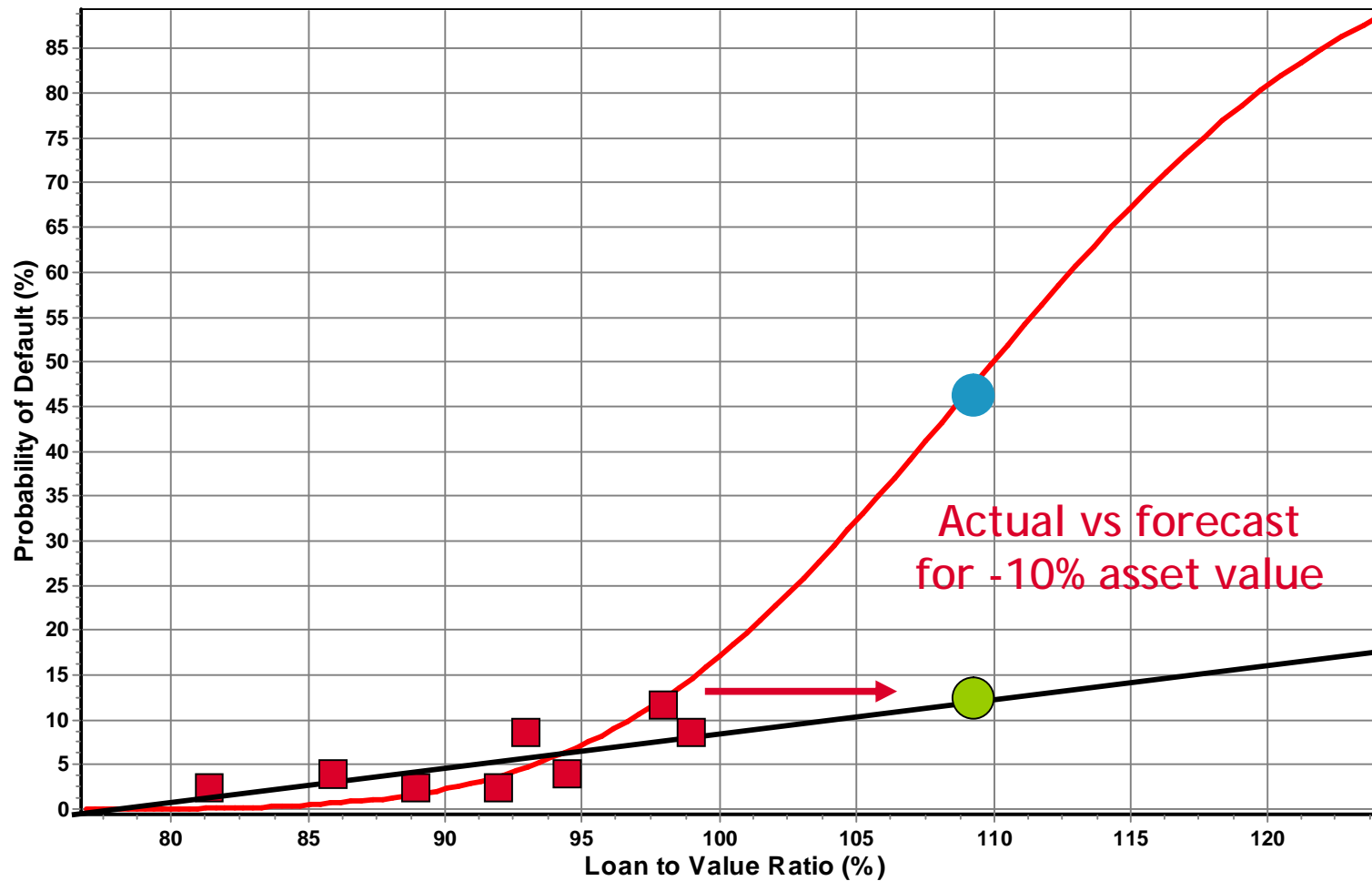
They are valid only if:

- Risk factors are small (non-linear term neglected)
- Environment is stable (stable coefficients)

# One Year Default Probability in Rising Market if the risk factor is not small



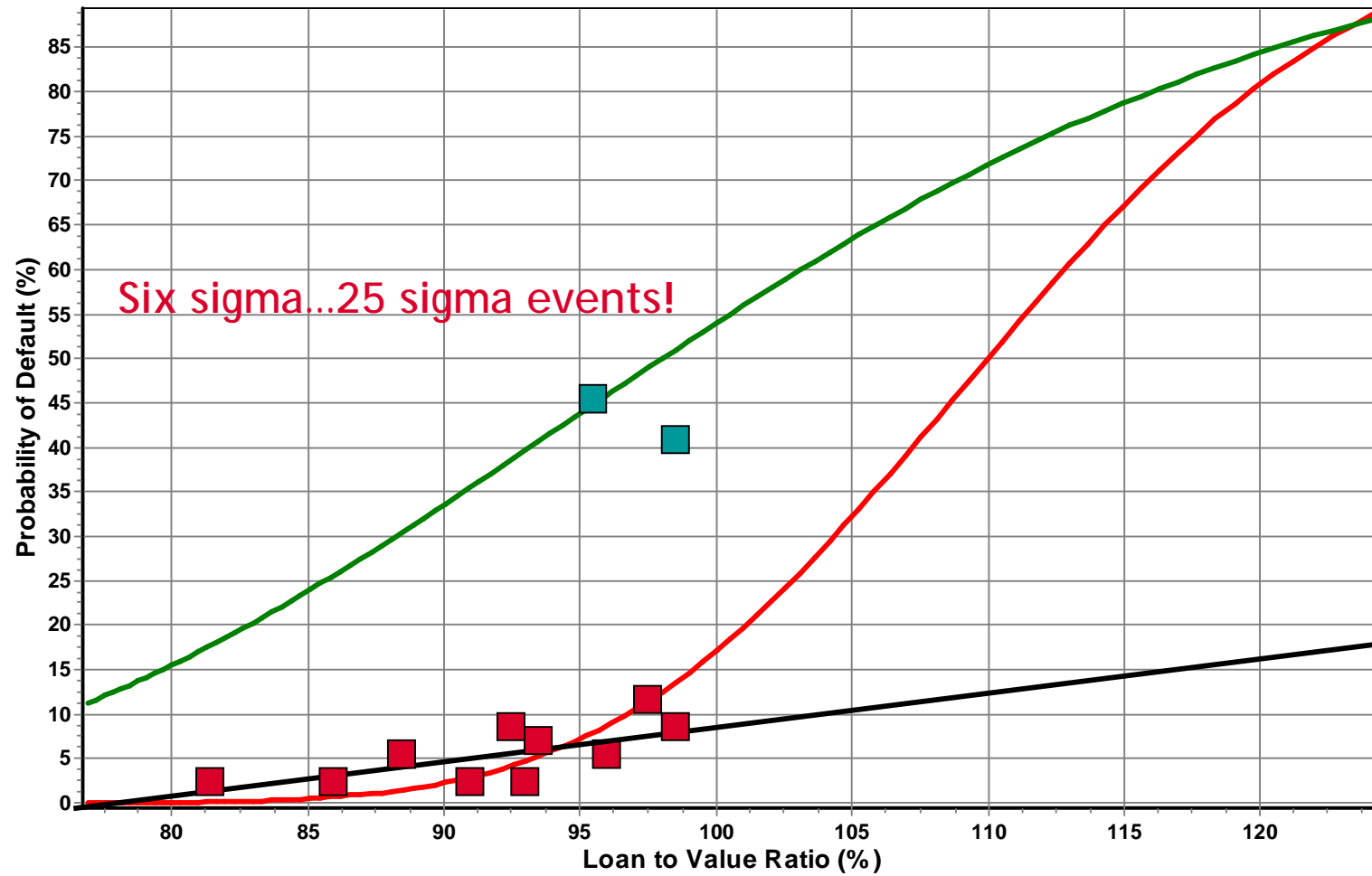
Simple Merton Model  
Rising (10%) Market with 10% volatility



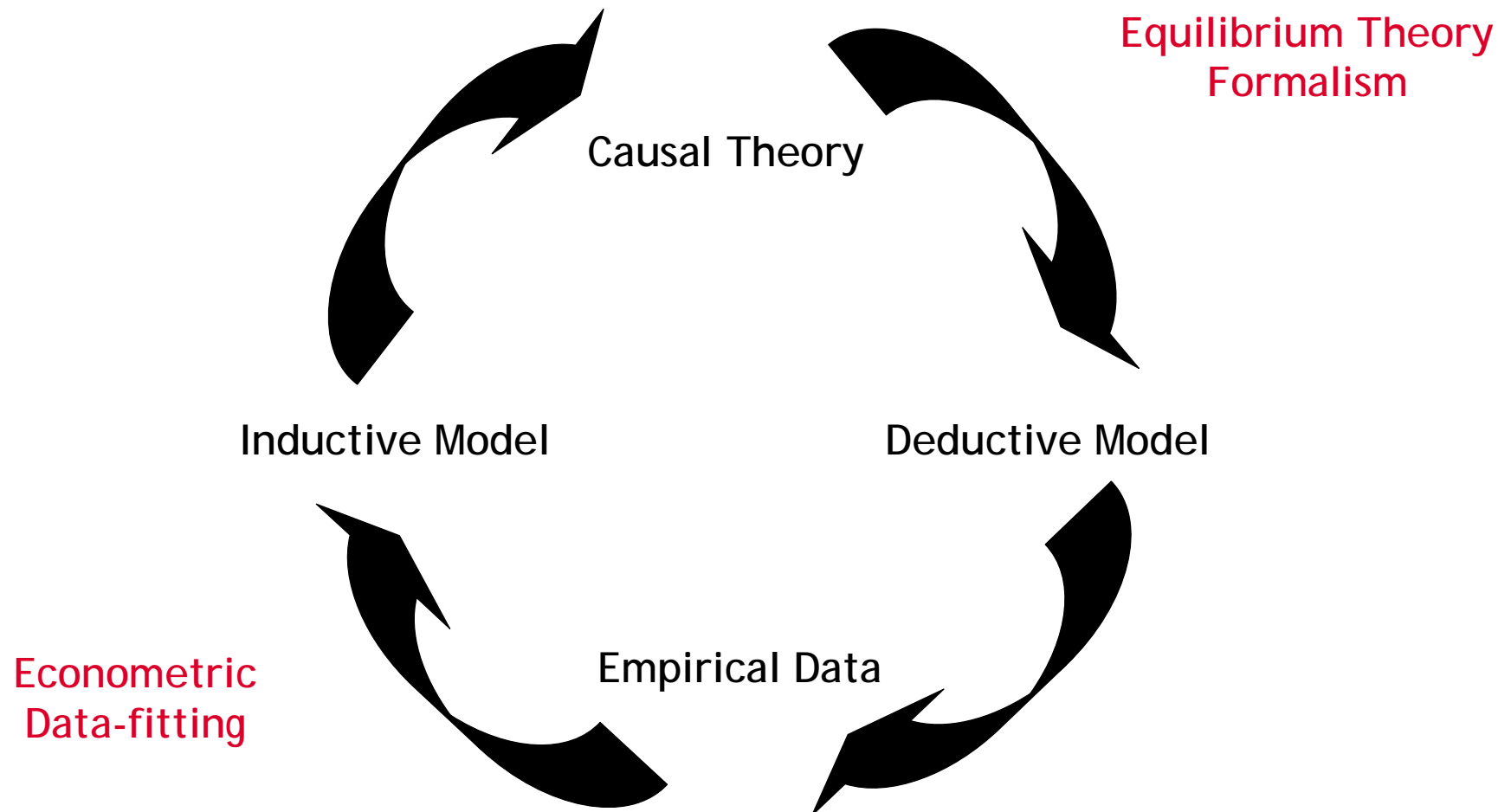
# If the environment changes



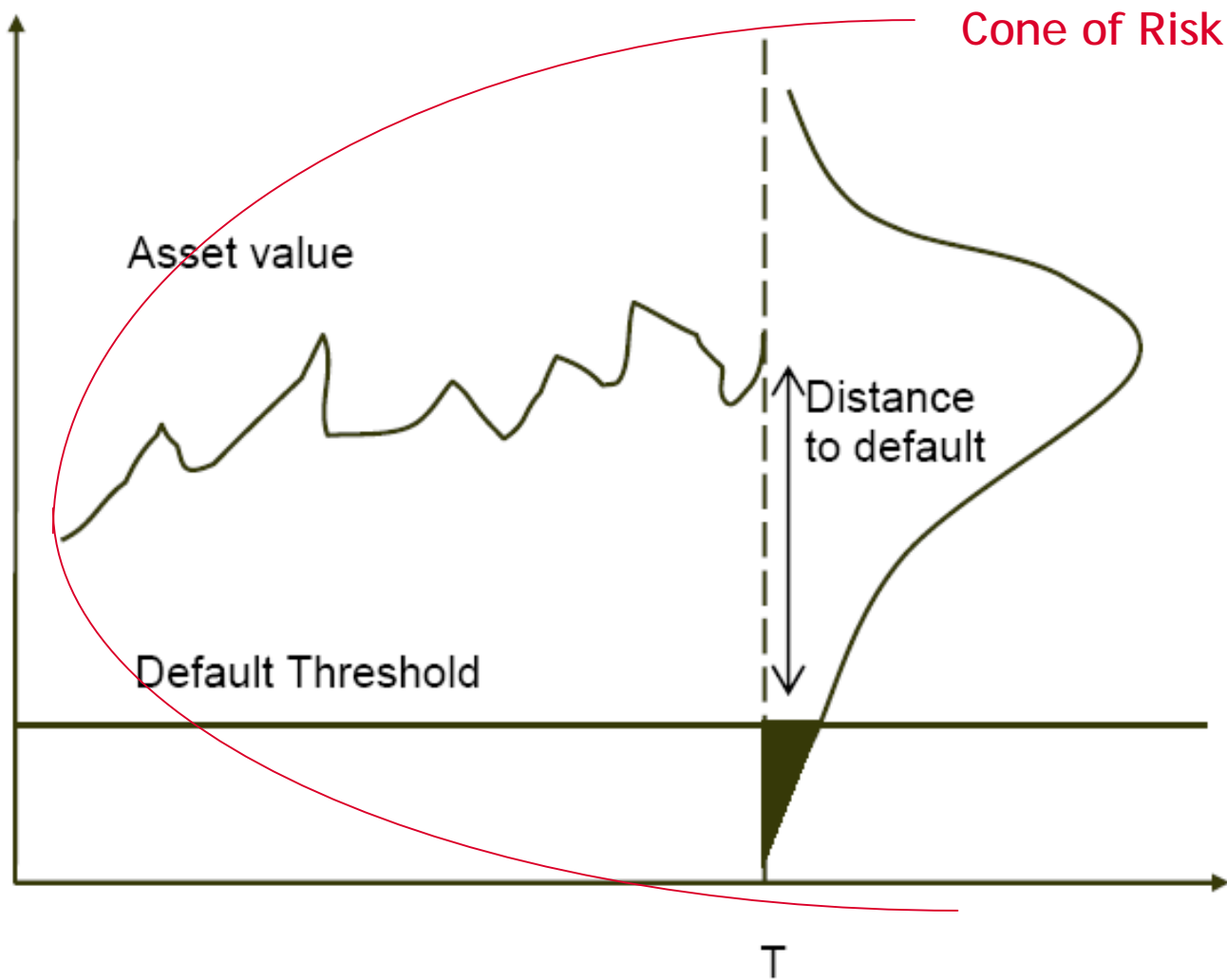
Simple Merton Model  
Rising (10%) to Flat Market with 10% volatility to 20%



Six sigma...25 sigma events!



Deductive causal methods  
Structural models (Merton, 1974)



Probability of Default  
and expected loss  
given by option  
pricing theory at  
Market equilibrium



Not applicable to the unsecured loans (Grameen, credit-card) or non-traded markets (Mortgages)

Insolvency is NOT the only cause of credit default (serviceability)

Forecasts do NOT match well with empirical data (or not at all)

**No natural way to include some risk factors (e.g. interest rates)**

To get agreement with observations some structural models end up like reduced form models with econometric methods needed

**The Merton model has inappropriate or incomplete causality**

A credit default (secured loans) is **defined** as the occurrence of both **delinquency** and **insolvency**.

$$\text{Delinquency variable} = \frac{\text{Cash flow available to service loan}}{\text{Loan payment}}$$

$$\text{Solvency variable} = \frac{\text{Value of secured asset}}{\text{Value of loan}}$$

A necessary and sufficient condition for credit default is when both variables fall below one



Serviceability:  $x_s = \frac{\textit{After tax income} - \textit{Living costs} - \textit{Other payments}}{\textit{Mortgage payment}}$

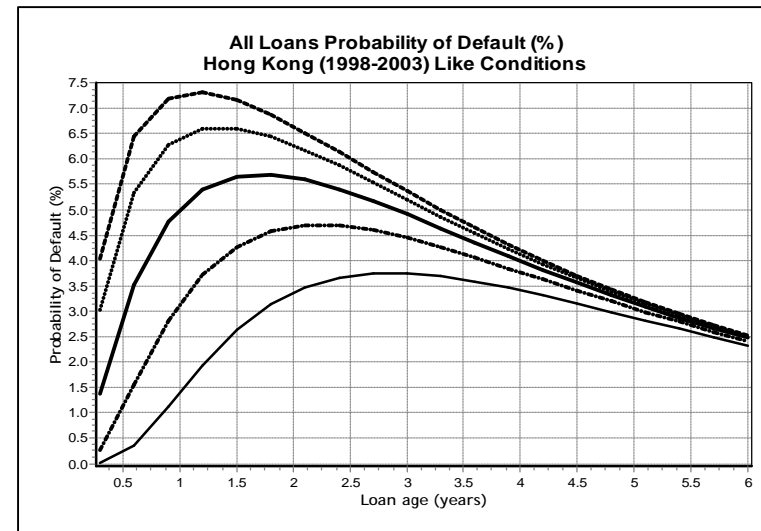
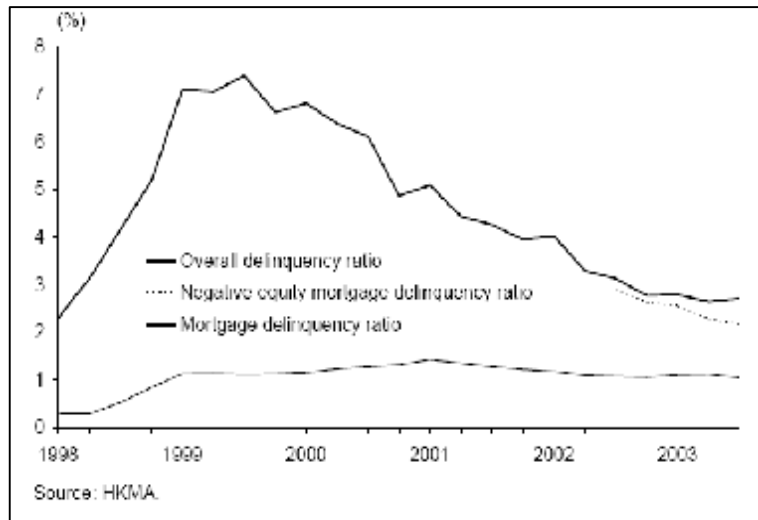
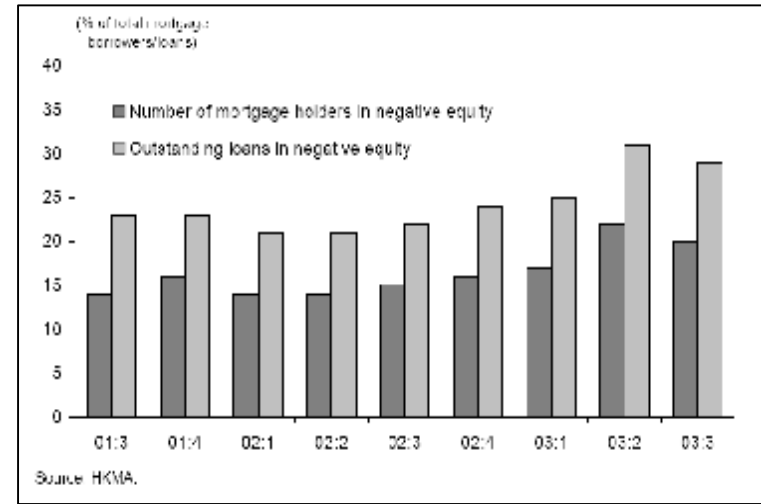
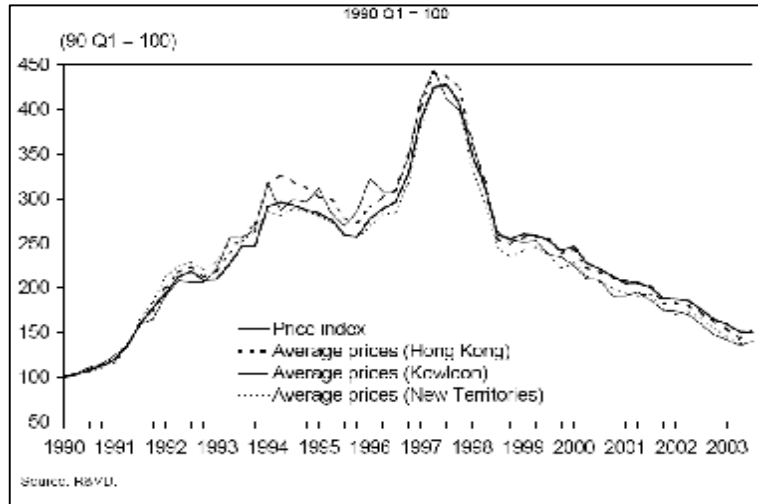
Value to Loan:  $x_v = \frac{\textit{Property Value}}{\textit{Loan Value}}$

Changes in risk factors determine likelihoods in delinquency or insolvency through the model parameters

$$\{m_s, s_s, m_v, s_v\}$$

Mortgage risk can be priced by a choice of model parameters with only a few general assumptions

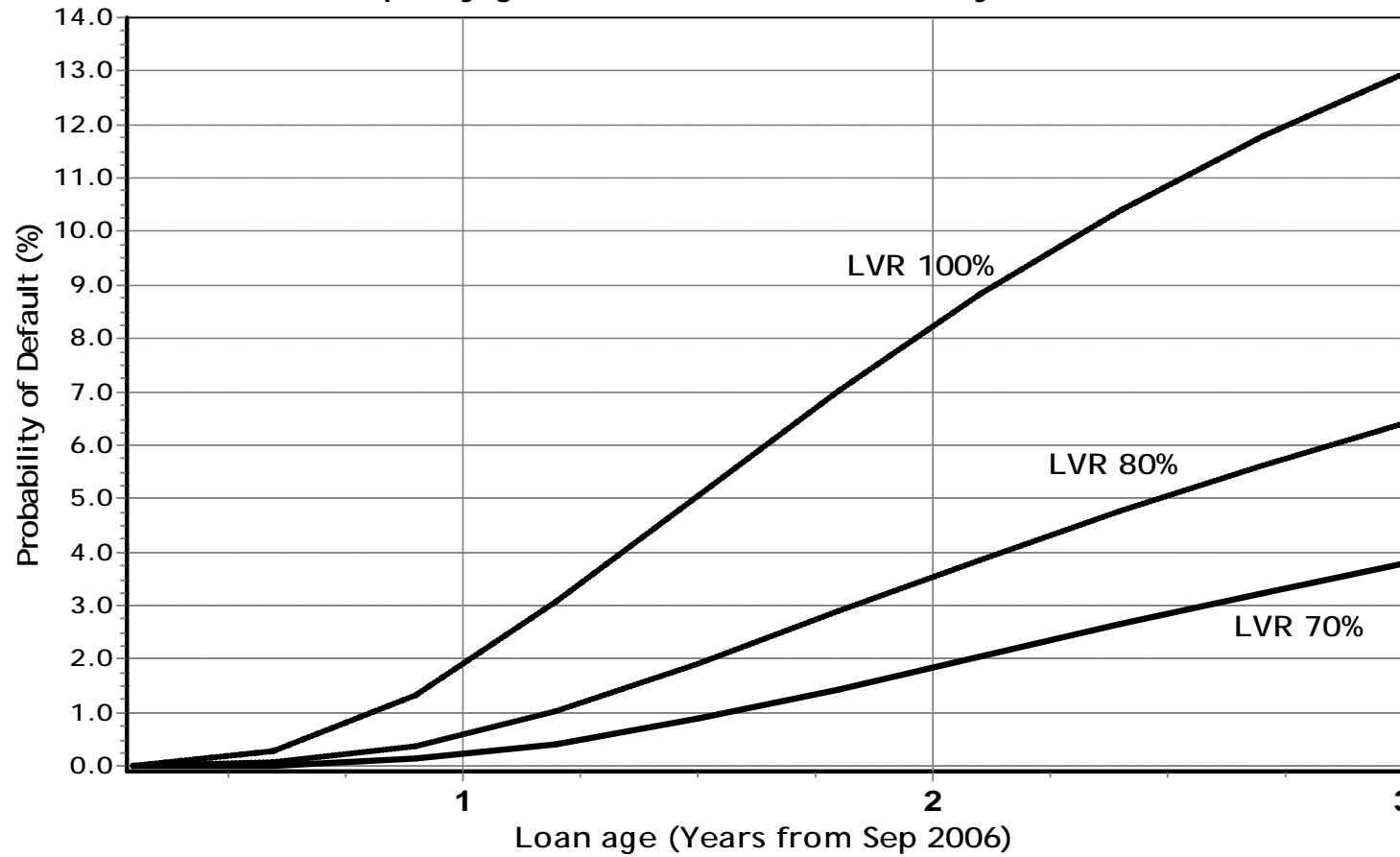
# The Hong Kong SAR Property Puzzle



# Predictions from actual loan data (September 2006)



Default Probability of Non-traditional Loans  
LSR 1.6, LSR growth rate -12% , volatility 20%  
Property growth rate 11%, volatility 25%



LSR  
Loan Serviceability Ratio

LVR  
Loan-to-Value Ratio

Merton would predict falling defaults

The credit crisis is a credit market failure due to the existence of low quality loans backing securities which could not be accurately priced by credit risk models.

**Reduced form models** cannot make predictions in changing environments, because of estimation problems.

**Structural models** have inappropriate or incomplete causality, leading to inaccurate predictions.

A proposed **new causal framework** can be used to develop credit risk models which are applicable in changing environments where little empirical data are available.