Expected Loss Customer Risk Grading

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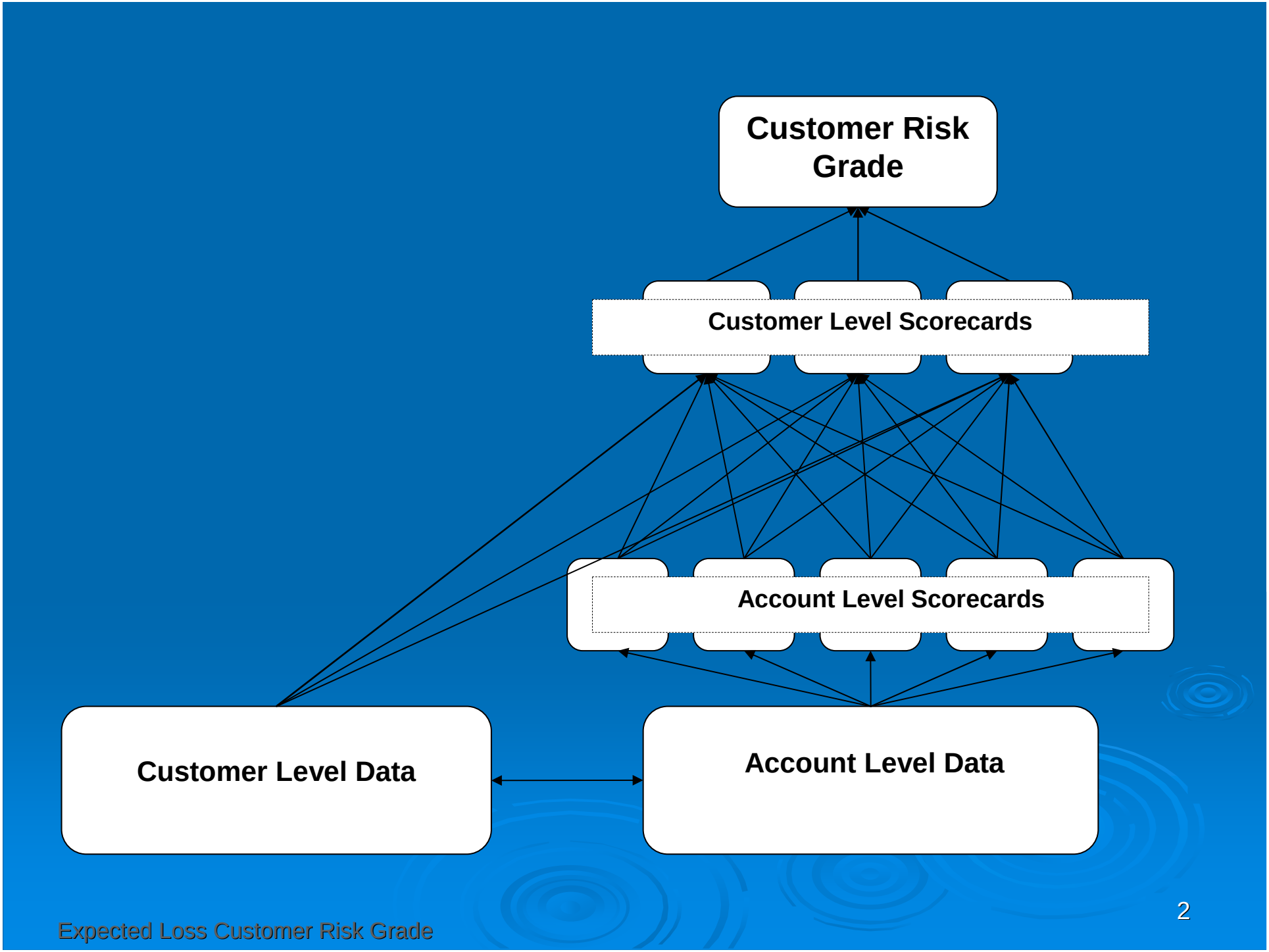
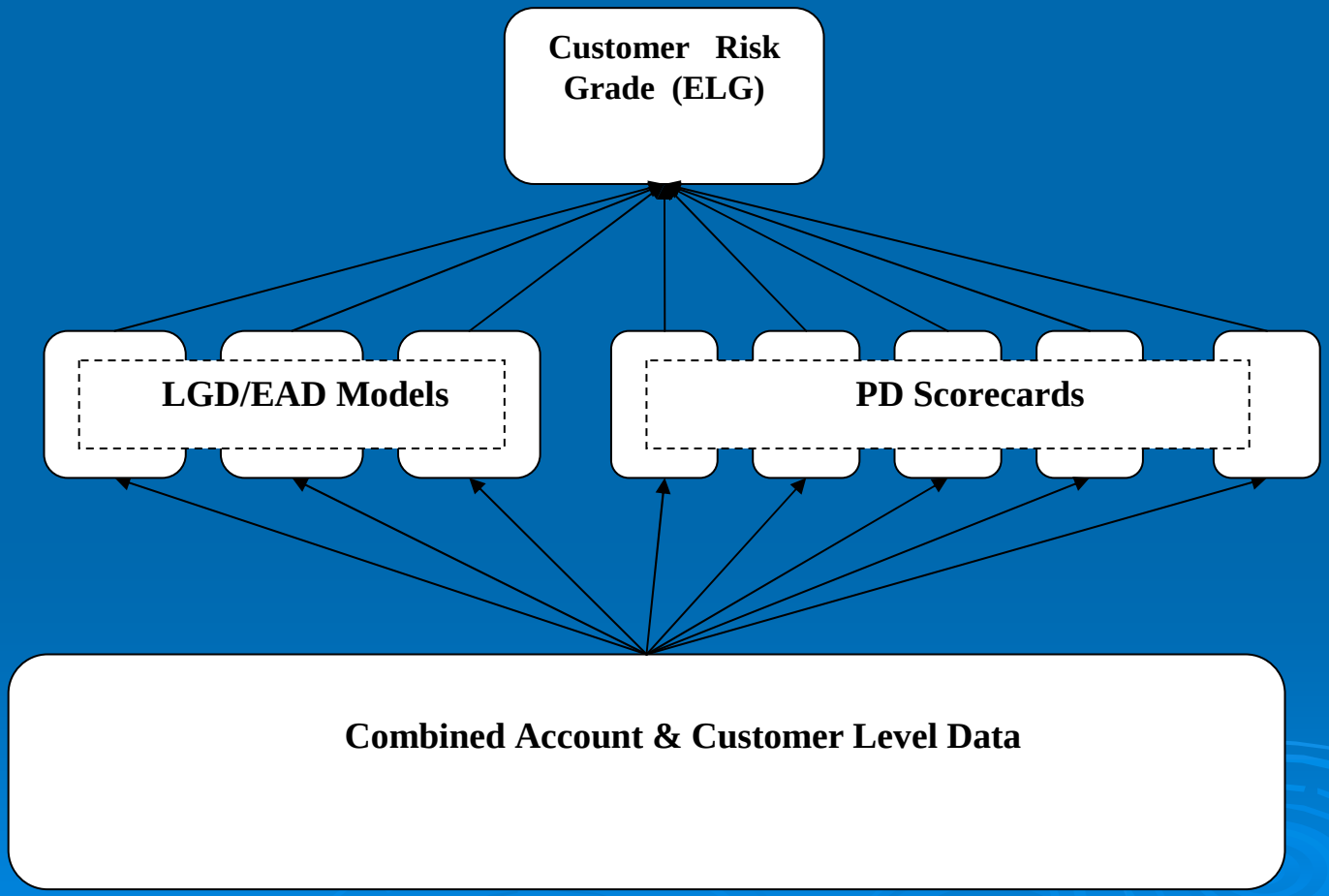

Customer Risk Grade
Customer Level Scorecards
Account Level Scorecards
Customer Level Data
Account Level Data

Simplification of Risk Modelling Structure



Agenda

- Customer Scorecards
- Exposure Default Rates & Generalized PDs
- Expected Loss Risk Grade

Customer Scorecards

Customer Scorecards

- Regression Model designed to predict probability of a customer defaulting.
- Requires a customer default to be defined – generally based on based on combinations of account level defaults
- Customer default generally involves a product based hierarchy of account level defaults favouring some product groups over others.

Example Customer Default Definition

		Tier 1 – Loan Products		
		G	B	No Loan Account
Tier 2 Transaction Accounts	G	G	B	G
	B	I	B	B
	No Transaction account	G	B	

Expected Loss Customer Risk Grade

- Consequences of defining a binary customer default….

Example 1 – Tier 1 & Tier 2

Consider a customer holding a Tier 1 and a Tier 2 product:

	Outstanding Balance	Tier	PD
Personal Loan	£12,500	1	0.9%
Credit Card	£10,000	2	7.5%

- The customer Level PD is simply an account level PD for only one of the products the customer holds (defaults on the other product are ignored).

$$PD_{CUST} \equiv PD_{PL}$$

- Is this a customer or account level measure of risk?
- How does this tie in with customer expected Loss?

$$EL_{CUST} = PD_{PL} EAD_{PL} LGD_{PL} + PD_{CC} EAD_{CC} LGD_{CC}$$

Example 2 - Low Balance High PD

Consider a customer holding 3 Credit Cards, one of which is used infrequently by the customer and has a small arrears balance due to an overlooked fee.

	Outstanding Balance	Tier	PD
Card 1	£1,520.11	2	0.5%
Card 2	£25.10	2	20.0%
Card 3	£8,502.11	2	0.4%

- Customer PD in this case is the probability of defaulting on any one of the three credit cards – which is greater than any of the individual default probabilities

$$PD_{CUST} \geq \max(PD_1 + PD_2 + PD_3) = 20\%$$

- Is this really such a high risk customer?

Example 3 - Paying off a loan

	Exposure	Tier	PD
Personal Loan	£122.00	1	2.5%
Card 1	£1,520.10	2	0.5%
Card 2	£25.1	2	20.0%
Card 3	£8,502.11	2	0.4%

$$PD_{CUST} = 2.5\%$$

Pays off loan next month….

	Exposure	Tier	PD
Card 1	£1,520.10	2	0.5%
Card 2	£25.10	2	20.0%
Card 3	£8,502.11	2	0.4%

$$PD_{CUST} \geq 20\%$$

Summary of Issues with Customer Scorecards

- **Inconsistent** – Customer Scores provided an inconsistent measure of risk depending on the products a customer holds
- **Complex** - Interconnected and Multi-layered structure of models is difficult to build and maintain.
- **Arbitrary** – Measure of risk is heavily dependent on arbitrary choice of default definition – how do you know you have chosen the “right” one? Score is difficult to interpret or combine with other loss or revenue estimates because of this inconsistency.

Cause of these Problems:

Attempting to define a customer default.

Solution:

Define a measure of customer risk in terms of something that is common to all accounts ….

Exposure Default Rates
&
Generalized PDs

Exposure Default Rate

Definition: For a group of accounts, the **Exposure Default Rate** is simply the portion of the entire group's exposure that is connected to defaulted accounts. (Portion of exposure in default)

A family of generalized customer level PDs can be constructed based on Predicted Exposure Default Rates.

Customer level risk metrics constructed in this way take into consideration all accounts held by the customer to derive a more fundamental and less ambiguous measure of customer risk.

Back to Basics

$$E[L] = p(D)\,E[L \mid D]$$

Expected Loss

Fundamental measure of absolute risk.

Dollar Value

Probability of Default

Dimensionless measure of relative risk,

Link that ties two dollar quantities together

Loss Exposure

Fundamental measure of the level of exposure attached to the account.

"Cost of Default"

Dollar Value

Absolute Risk = Relative Risk * Exposure

Expected Loss for Multiple Accounts

$$\sum_{i=1}^{n} \mathrm{E}\left[L_i\right] = \sum_{i=1}^{n} p\left(D_i\right) E\left[L_i \middle| D_i\right]$$

A Little Algebra...

$$\sum_{i=1}^{n} \mathrm{E}\left[L_i\right] = \sum_{i=1}^{n} w_i\, p\left(D_i\right) \sum_{i=1}^{n} E\left[L_i \middle| D_i\right]$$

$$\text{where} \quad w_i = \frac{E\left[L_i \middle| D_i\right]}{\sum_{j=1}^{n} E\left[L_j \middle| D_j\right]} \in [0,1] \quad \text{and} \quad \sum_{i=1}^{n} w_i = 1$$

Expected Loss for Multiple Accounts

$$\sum_{i=1}^{n} \mathrm{E}\left[L_i\right] = \sum_{i=1}^{n} w_i\, p\left(D_i\right) \sum_{i=1}^{n} E\left[L_i \middle| D_i\right]$$

Expected Loss

Fundamental measure of absolute risk.

Dollar Value

Generalized PD – "Expected Exposure Default Rate"

Dimensionless measure of relative risk,

Link that ties two dollar quantities together

Loss Exposure

Fundamental measure of the level of exposure attached to the group of accounts.

"Cost of Default on all accounts"

Dollar Value

Absolute Risk = Relative Risk * Exposure

How to interpret the generalized PD

$$\sum_{i=1}^{n} w_i \, p\left(D_i\right)$$

How to interpret the generalized PD

Expected Exposure Default Rate:

The generalized PD is the predicted portion of customer loss exposure that will flow through to default.

$$\sum_{i=1}^{n} w_i \, p\left(D_i\right) = E\left[\frac{\sum_{i=1}^{n} L_i}{\sum_{i=1}^{n} E\left[L_i \,\middle|\, D_i\right]}\right]$$

The quantity inside the expectation can be thought of as a random variable that takes on a fixed value between zero and one when it is observed at the end of the performance period defined by the chosen default definition.

How to interpret the generalized PD

Heuristic Interpretation: Weighted average of the account level PDs where the weightings are based on relative loss exposure

$$w_i = \frac{E\left[L_i \middle| D_i\right]}{\sum_{j=1}^{n} E\left[L_j \middle| D_j\right]} = \frac{\text{Loss Exposure for account i}}{\text{Total Loss Exposure for all accounts}}$$

Bigger Exposure = Bigger the Contribution to overall PD

Expected Loss Risk Grade (ELG)

Expected Loss Risk Grade

- The ELG belongs to the broader family of predicted exposure default rate estimates with total losses as the particular choice of loss measure

$$E[L] = EL \Leftrightarrow E[L|D] = EAD.LGD$$

- ELG is a direct extension of the Basel PD to multiple accounts.

$$\sum_{i=1}^{n} EL_i = \sum_{i=1}^{n} w_i PD_i \sum_{i=1}^{n} EAD_i LGD_i$$

$$w_i = \frac{EAD_i LGD_i}{\sum_{j=1}^{n} EAD_j LGD_j}$$

Expected Loss Risk Grade

Measure	Single Account	Multiple Accounts
Default Probability - Expected portion of loss exposure that will flow through to default.	PD	$\sum_{i=1}^{n} w_i PD_i$
Loss Exposure - Expected Dollar Loss given a 100% exposure default rate is observed	$EAD.LGD$	$\sum_{i=1}^{n} EAD_i LGD_i$
Expected Loss – Expected Dollar Loss on the account(s)	$EL = PD.EAD.LGD$	$\sum_{i=1}^{n} EL_i = \sum_{i=1}^{n} w_i PD_i \sum_{i=1}^{n} EAD_i LGD_i$

How ELG Works

	Exposure	Portion of Exposure	PD
Personal Loan	£12,500.00	55.6%	**1.1%**
Credit Card	£10,000.00	44.4%	**7.5%**

$$PD_{CUST} = 55.6\% * PD_{PL} + 44.4\% * PD_{CC}$$
$$= 55.6\% * 1.1\% + 44.4\% * 7.5\% = 3.94\%$$

	Exposure	Portion of Exposure	PD
Card 1	£1,520.10	15.1%	0.5%
Card 2	£25.10	0.2%	20.0%
Card 3	£8,502.11	84.8%	0.4%

$$PD_{CUST} = 15.1\% * PD_1 + 0.2\% * PD_2 + 84.2\% * PD_3$$
$$= 15.1\% * 0.5\% + 0.2\% * 20\% + 84.2\% * 0.4\% = 0.46\%$$

Why is the ELG a good measure of risk?

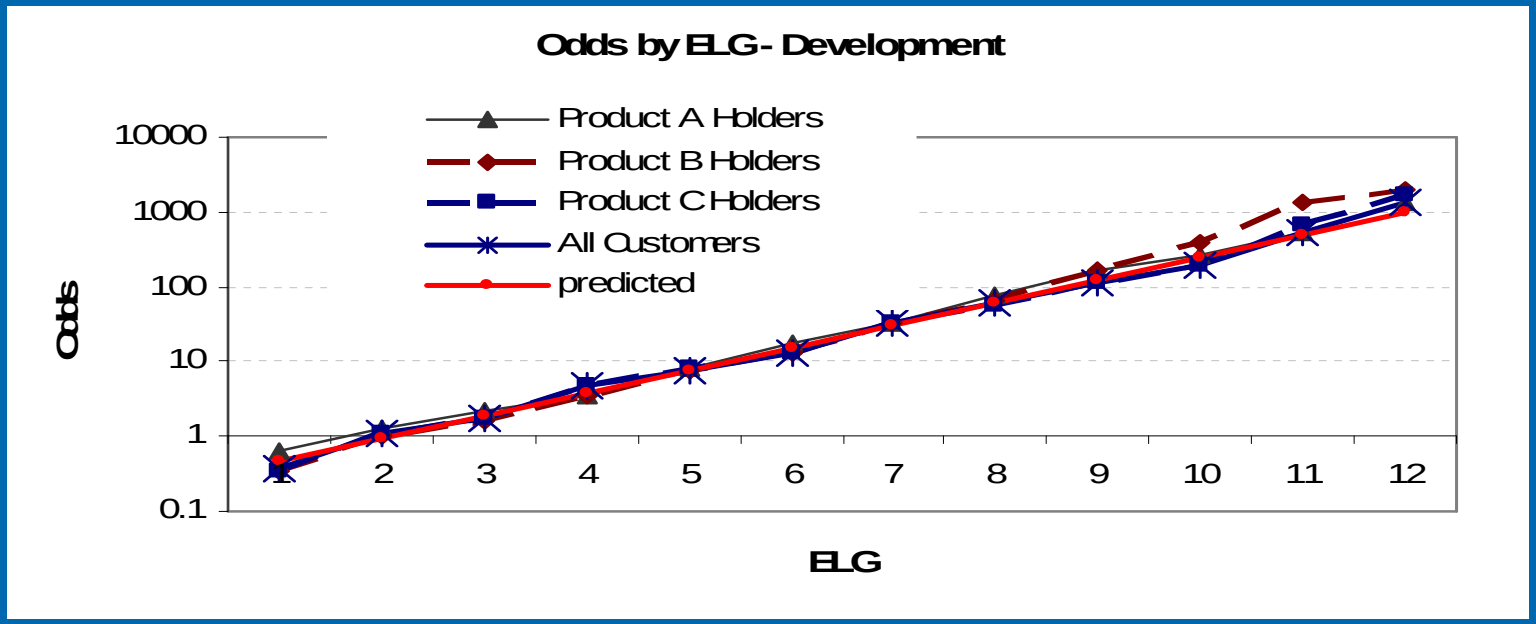
- **Fundamental:** Can be tied to expected dollar loss in a simple and understandable way.
- **Consistent:** Estimates exactly the same quantity for every customer (or any group of accounts)
- **Simple:** Easy to construct and maintain, requires no additional regression modelling at the customer level

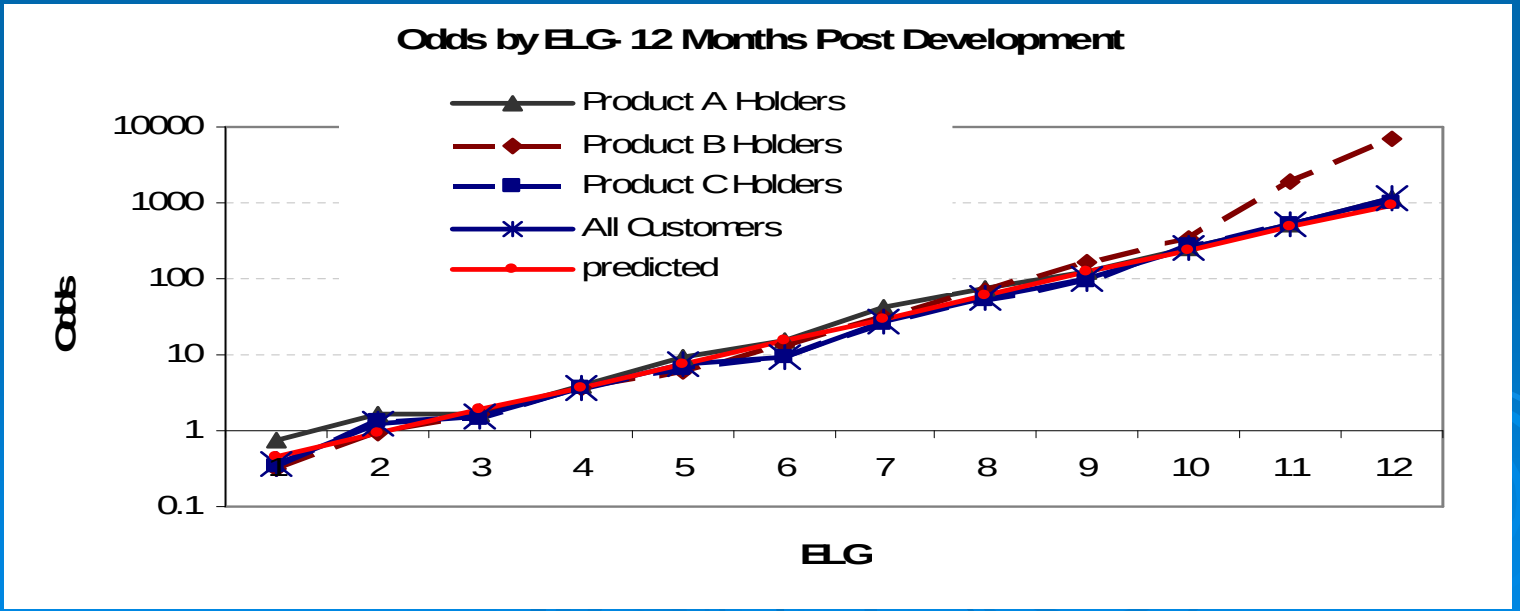
…..and very accurate!

Performance of the EL Risk Grade

"The best model is the one for which the Average (Mean) PD equals the default rate for every subset of accounts defined by the data …… All validation and monitoring should be based around this principle "

- Alan Lucas, Director Rhino Risk


Odds by ELG- Development
Product A Holders
Product B Holders
Product C Holders
All Customers
predicted
10000
1000
100
10
1
0.1
Odds
1
2
3
4
5
6
7
8
9
10
11
12
ELG


Odds by ELG- 12 Months Post Development
Product A Holders
Product B Holders
Product C Holders
All Customers
predicted
10000
1000
100
10
1
0.1
Odds
1
2
3
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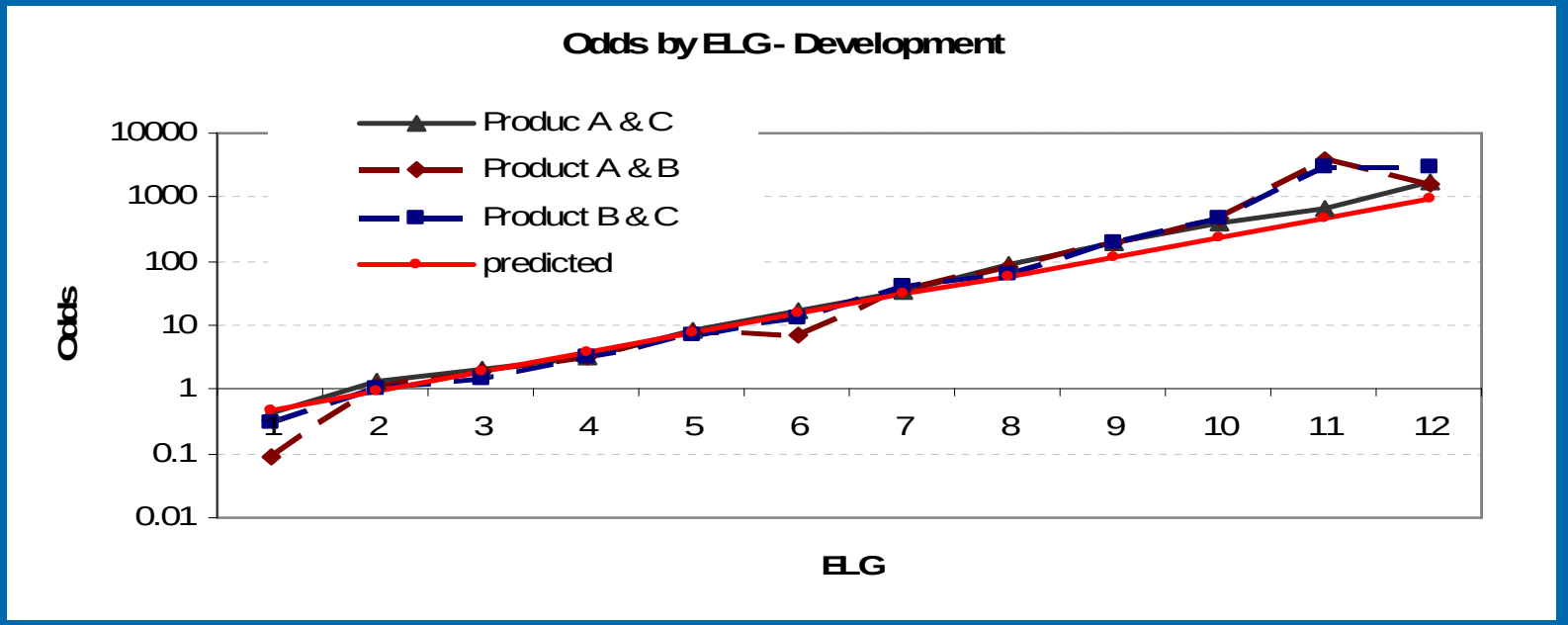
12
ELG


Odds by ELG- Development
Produc A & C
Product A & B
Product B & C
predicted
Odds
10000
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0.01
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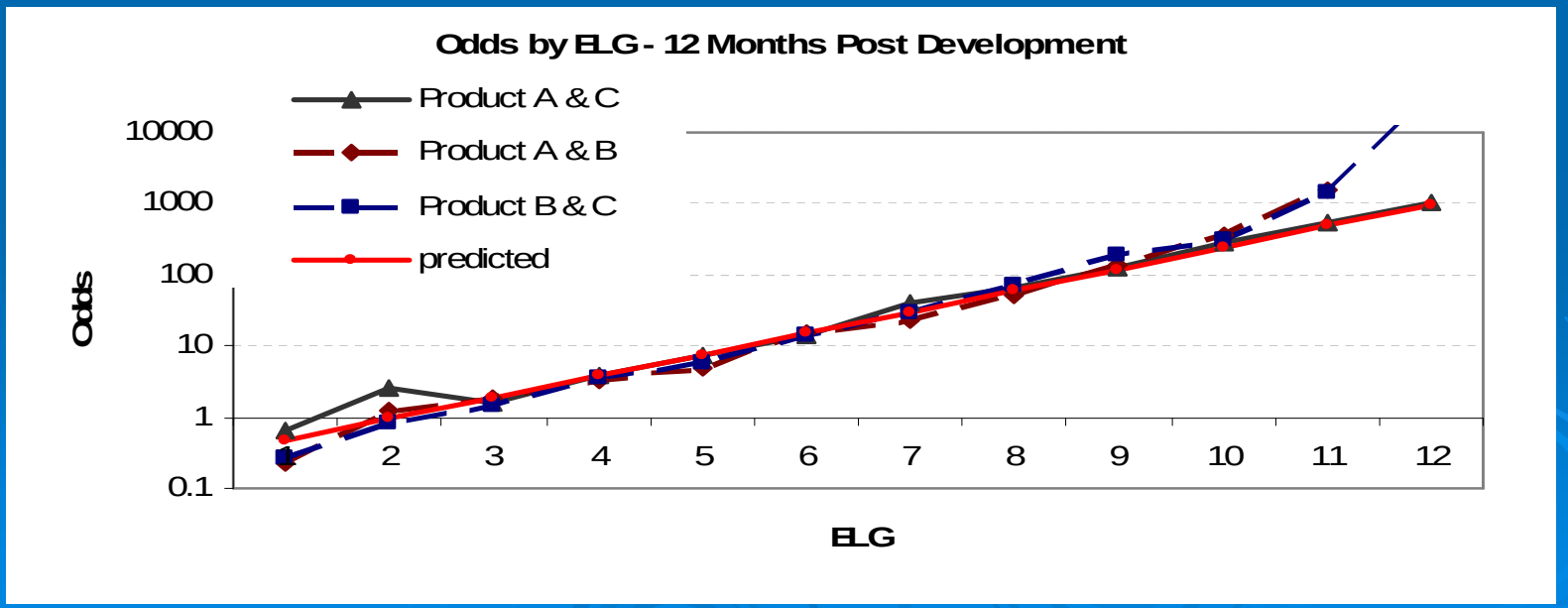
ELG


Odds by ELG - 12 Months Post Development
Product A & C
Product A & B
Product B & C
predicted
Odds
10000
1000
100
10
1
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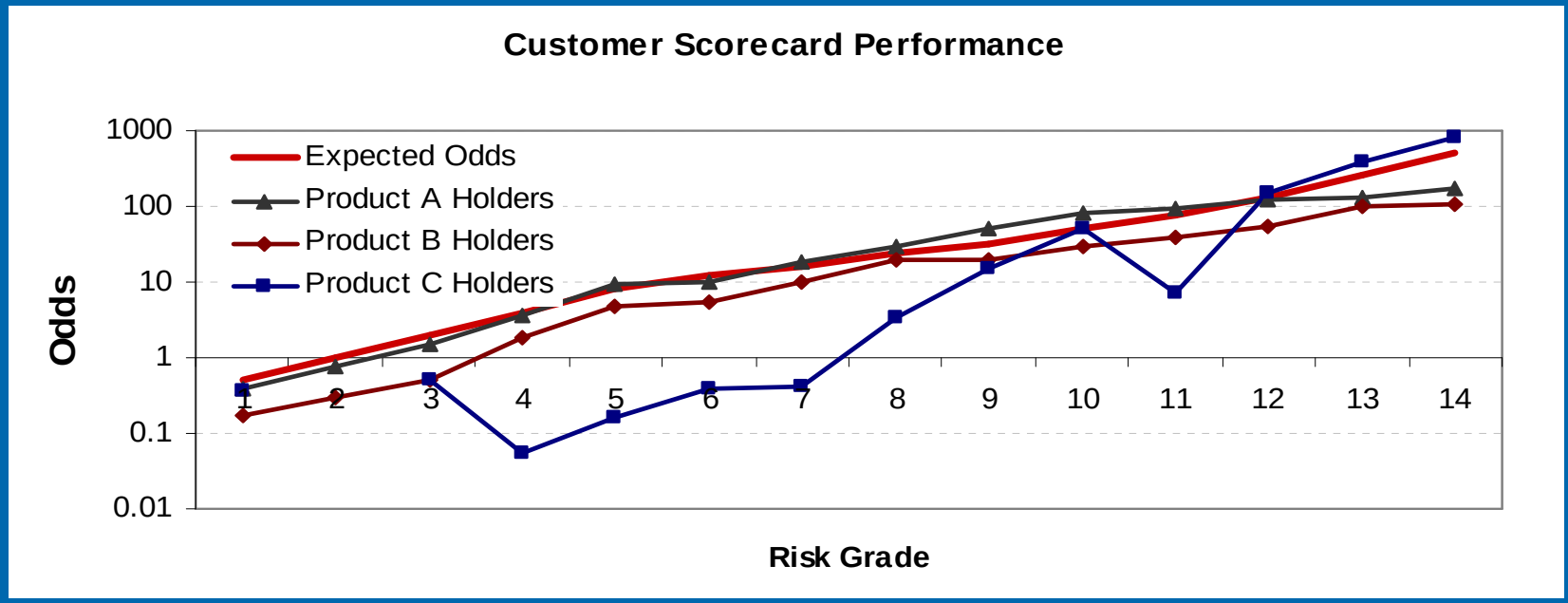
ELG

Customer Scorecard Performance on sub populations…..


Customer Scorecard Performance
Odds
1000
100
10
1
0.1
0.01
Expected Odds
Product A Holders
Product B Holders
Product C Holders
1
2
3
4
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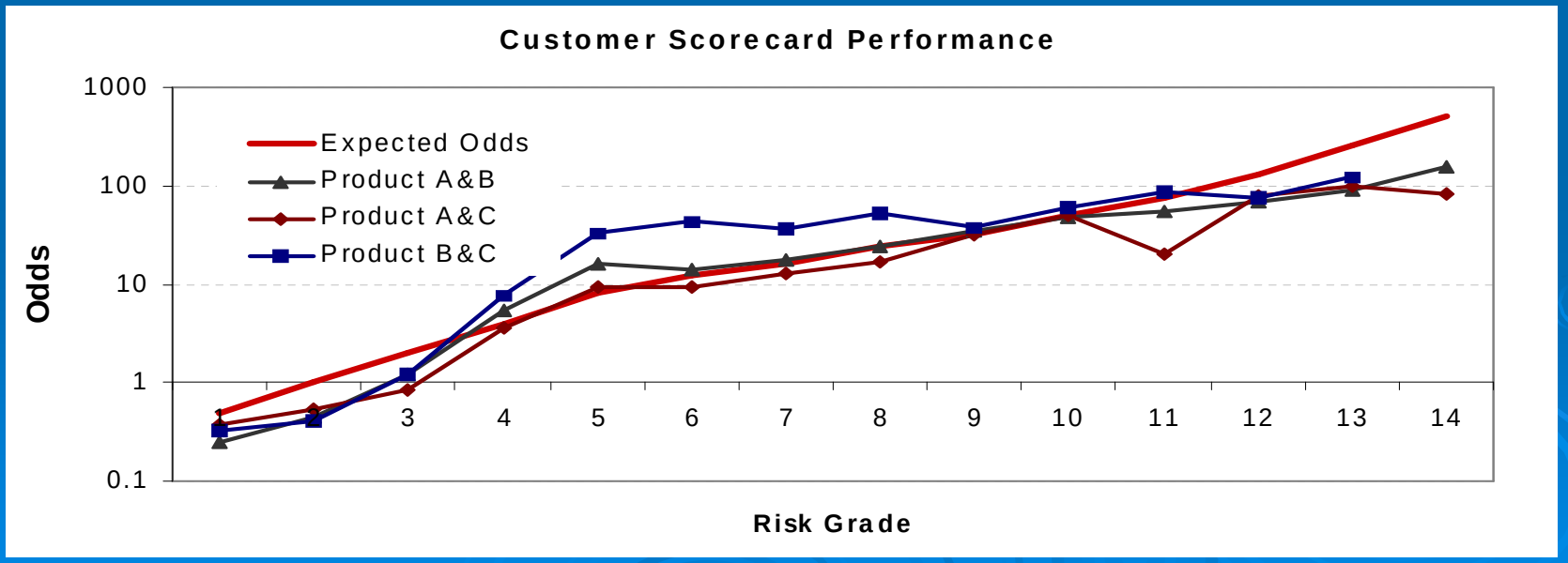
10
11
12
13
14
Risk Grade


Customer Scorecard Performance
Odds
1000
100
10
1
0.1
Expected Odds
Product A&B
Product A&C
Product B&C
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6
7
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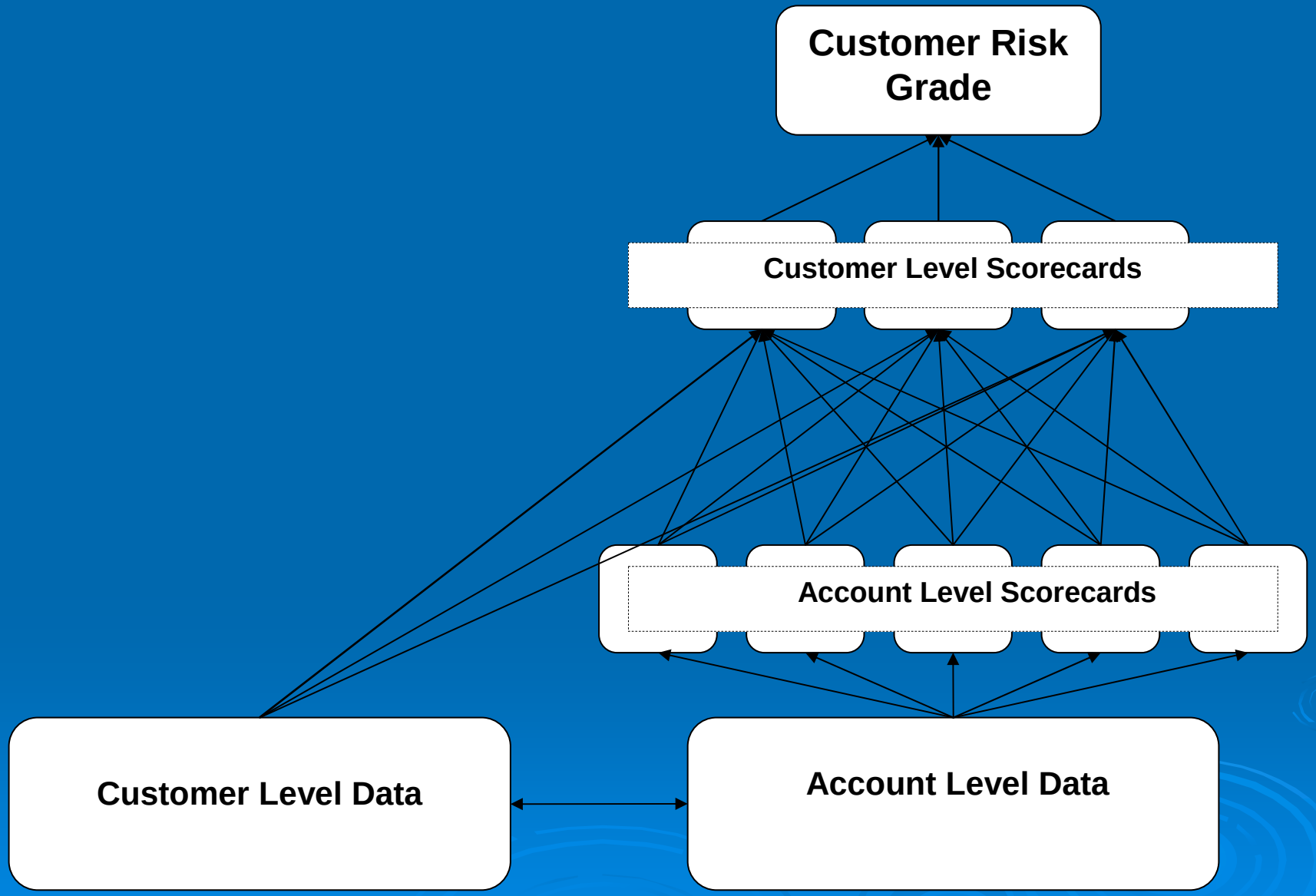
13
14
Risk Grade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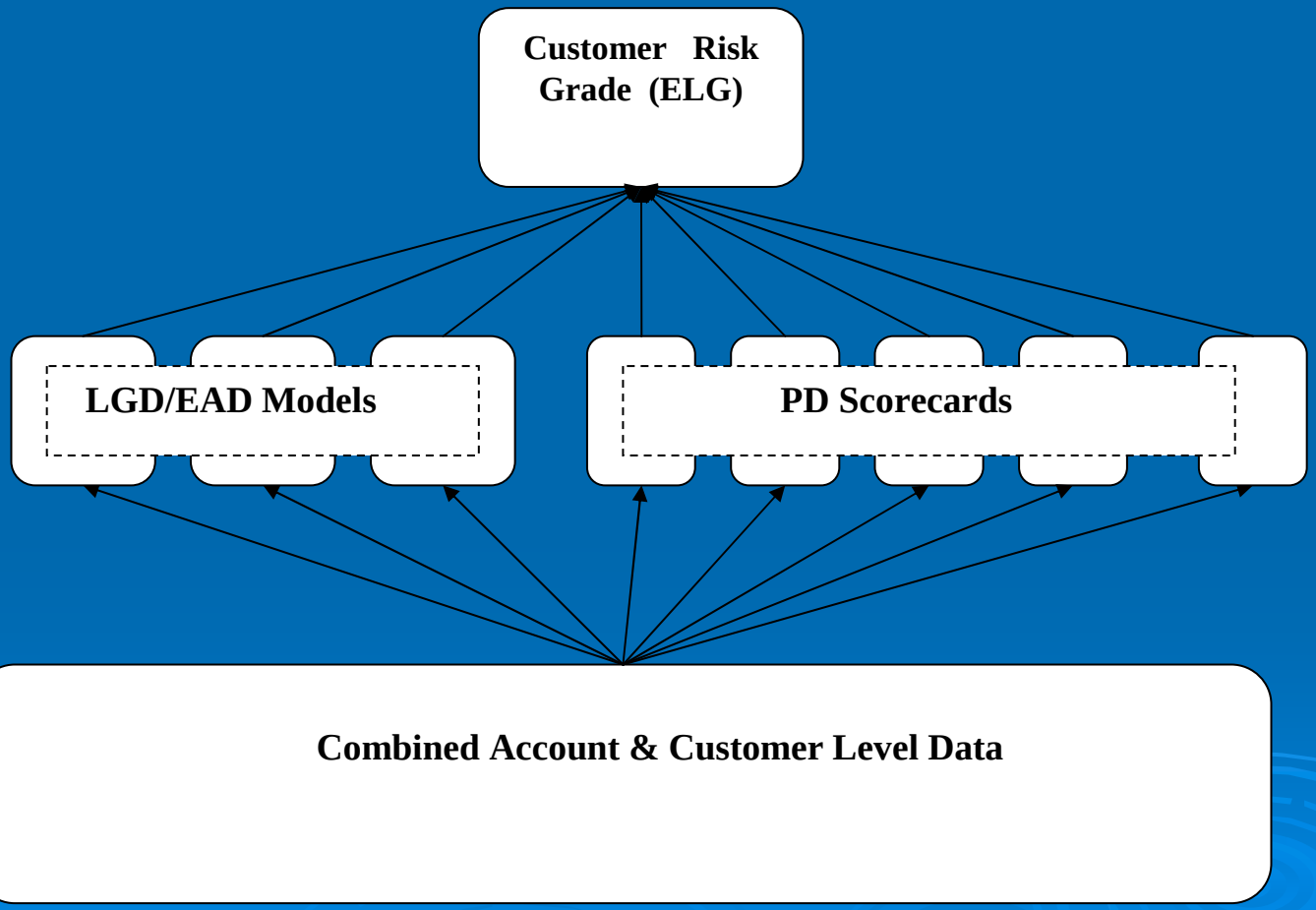
ELG – It's easy and it works. Give it a go!



Thankyou.
Questions?