

The Impact of Basel Accords on the Lender's Profitability under Different Pricing Decisions

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Aim of Project

- Understand the influence of different Basel regulations on pricing decisions
 - . Basel 0 (Bo), Basel 1 (B1), Basel 2 (B2) and Basel 3 (B3).

- . Three pricing strategies:

- . One price model

- . Two prices model

- . Variable pricing model

- Two Cases

the lender has an agreed cost of equity for each unit of equity needed to cover the regulatory capital requirement.

the lender decides in advance how much of its equity capital can be set aside to cover the requirements of this loan portfolio.

Basel regulatory capital requirements

- The minimum capital requirement (MCR) per unit of loan with a probability of being good is defined as $l_E \cdot K(p)$. This is given under four different MCRs:
- Basel 0: Describes the situation pre-1988 when there were no regulatory capital requirements so

$$K(p) = K_0 = 0$$

- Basel 1: Describes the MCR under the first Basel Accord where

$$K(p) = K_1 = \frac{0.08}{l_D}$$

required that banks set aside a fixed percentage of equity capital to cover all their risks in lending.

- Basel 2: Describes the MCR under the second Basel Accord where

$$l_D \cdot K_2(p) = l_D \cdot N \cdot \left[\left(\frac{1}{1-R} \right)^{1/2} \cdot N^{-1} \cdot (1-p) + \left(\frac{R}{1-R} \right)^{1/2} \cdot N^{-1} \cdot (0.999) \right] - l_D \cdot (1-p)$$

where $R = 0.04$ (credit cards)

The capital requirement in Basel 2 was taken as 8% of the risk weighted assets to have the same terminology as Basel 1, where the risk weighted assets were given by a function of the probability of default of the loans.

- Basel 3: the MCR for the third of Basel Accord can be written as:

$$K_3(p) = \left(\frac{13}{8} \right) \cdot K_2(p) = 1.625 \cdot K_2(p)$$

Basel 3 tightens up what is required as capital, introduces liquidity requirements, and increases the capital requirement by factoring up the capital requirements of Basel 2.

Basel 2	Basel 3
Tier 1 Capital	
<p>Tier 1 capital ratio = 4%</p> <p>Core Tier 1 capital ratio = 2%</p> <p>The total capital requirement is 8.0%.</p>	<p>Tier 1 Capital Ratio = 6%</p> <p>Core Tier 1 Capital Ratio (Common Equity after deductions) = 4.5%</p> <p>The total capital requirement is 8.0%.</p>
Capital Conservation Buffer	
<p>There no capital conservation buffer is required.</p>	<p>Banks will be required to hold a capital conservation buffer of 2.5% to absorb losses during periods of financial and economic stress.</p>
Countercyclical Capital Buffer	
<p>There no Countercyclical Capital Buffer is required.</p>	<p>A countercyclical buffer within a range of 0% – 2.5% of common equity or other fully loss absorbing capital will be implemented.</p>

General Model

- We assume the probability p of the borrowers being good has uniform distribution. Thus the probability density function is $f(p) = \frac{1}{1-a}$, $a \leq p \leq 1$, so no one with probability of being good less than a is in the potential borrowers' population.
- We now consider the portfolio where 1 unit is available to be lent over the whole portfolio.
- l_D : loss given default.
- r_F : rate of which lenders borrow money.
- r_Q : rate of return required by equity owner.
- Let B denote the sum of the cost of the regulatory capital $r_Q \cdot l_D \cdot k(p)$ and the risk free rate r_F .
- $q(r, p)$ take probability which is percentage of borrowers with probability p of being good who take loan with interest rate r .

- One price model : the lender only offer a fixed rate r to all borrowers whose probability of being good is $(p_c, 1)$. the optimal solution to cut off point is $p_c = \frac{l_D + B}{r + l_D}$.
- Two prices model: the lender has two different rates, r_1 and r_2 , $r_1 < r_2$. r_1 is made to the borrowers whose probability of being good is $(p^*, 1)$; r_2 is made to borrowers whose probability of being good is (p_c, p^*) .
 Cut off point in two prices model is $p_c = \frac{l_D + B}{r_2 + l_D}$;
 Segment point p^* is achieved from the equality

$$q(r_1, p^*) \cdot [(r_1 + l_D) \cdot p^* - (l_D + B)] = q(r_2, p^*) \cdot [(r_2 + l_D) \cdot p^* - (l_D + B)]$$

- Variable price model: the lender charge the interest rate $r(p)$ on a loan to potential borrower depends on the borrower's probability p of being good.
- Interest rates charged are fractions (so multiply by 100 to get APR%)

Pricing Models at Portfolio Level with Fixed cost of Equity

- Fixed (one) price model:

$$EP(r, a) = \underset{r, p_c}{\text{Max}} \int_{\min(a, p_c)}^1 q(r, p) \cdot \left[(r + l_D) \cdot p - (l_D + r_F + r_Q \cdot l_D \cdot k(p)) \right] \cdot f(p) \cdot dp$$

where $B = r_Q \cdot l_D \cdot k(p) + r_F$

- Two prices model:

$$EP(r, a) = \underset{r_1, r_2, p_c, p^*}{\text{Max}} \left\{ \begin{array}{l} \int_{\min(a, p_c)}^1 q(r_2, p) \cdot [(r_2 + l_D) \cdot p - (l_D + B)] \cdot f(p) \cdot dp \\ + \int_{p^*}^1 q(r_1, p) \cdot [(r_1 + l_D) \cdot p - (l_D + B)] \cdot f(p) \cdot dp \end{array} \right\}$$

- Variable pricing model: To simplify matters a little we assume there is no impact of adverse selection on variable pricing.

$$EP(r, a) = \underset{r, p}{\text{Max}} \int_a^1 q(r, p) \cdot [(r + l_D) \cdot p - (l_D + B)] \cdot f(p) \cdot dp$$

- We now give examples using the take probability

$$q(r, p) = 1 - 2.5 \cdot (r - 0.04) + 2 \cdot (1 - p)$$

The Impact of The Basel Accords on The Different Pricing Models

- Examples for one price model

a	r B0	E(p) B0	r B1	E(p)B1	r B2	E(p)B2	r B3	E(p) B3
0.6	0.3768	0.0618	0.3778	0.0599	0.3782	0.0589	0.3933	0.0571
0.7	0.35	0.0778	0.3523	0.0757	0.3535	0.0747	0.3556	0.0728
0.8	0.3140	0.0886	0.3162	0.0865	0.3169	0.0859	0.3188	0.0842
0.9	0.2791	0.0942	0.2812	0.0922	0.2810	0.0923	0.2823	0.0911

- ❖ Optimal interest rates for Basel 1 , 2 and 3 are always bigger than that for Basel 0.
- ❖ The optimal interest rates charged drop but the expected portfolio profits rise up as the borrower portfolio become less risky.
- ❖ The expected portfolio profits for all Basel regulations are less than that of made with Basel 0.
- ❖ The expected portfolio profits under Basel 2 is smaller than that achieved under Basel 1 until one reaches the a=0.9 portfolio.
- ❖ The expected portfolio profits for Basel 3 is always smaller than that for Basel 1 and 2.

Examples for two prices model

- Under Basel o(Bo)

α	r_2	p_c	r_1	p^*	EP_{B0}
0.6	0.485568	0.6	0.317348	0.790765	0.07506936
0.7	0.415754	0.7	0.297977	0.845737	0.08508152
0.8	0.353758	0.8	0.279661	0.898441	0.09168503
0.9	0.297323	0.9	0.262075	0.94968	0.09493876

- Under Basel 1(B1)

α	r_2	p_c	r_1	p^*	EP_{B1}
0.6	0.488475	0.6	0.319604	0.790703	0.07305781
0.7	0.418356	0.7	0.300156	0.845704	0.08304529
0.8	0.356118	0.8	0.281772	0.898428	0.0896575
0.9	0.299488	0.9	0.264128	0.949676	0.09294516

- ❖ As α increases, the optimal cut off point and segment point increase and the expected portfolio profits increase as well
- ❖ As α increases, both interest rates decrease in order to be able to attract sufficient of the higher quality borrowers.
- ❖ Note that in all four portfolios we make offers to all the potential borrowers and make the offer of the better interest rate to just over half of them.
- There is a small increase in the optimal interest rates being charged by comparing with the solutions for Basel o, while the profits are slightly lower.
- Again there an offer is made to everyone in the portfolio.

- Under Basel 2 (B2)

a	r_2	p_c	r_1	p^*	<i>EP B2</i>
0.6	0.488913	0.6	0.31957	0.791461	0.072208
0.7	0.418609	0.7	0.299716	0.846327	0.082389
0.8	0.355927	0.8	0.280833	0.899	0.089405
0.9	0.298533	0.9	0.262549	0.950295	0.093397

- ❖ The rate r_1 under Basel 2 is always smaller than that for Basel 1, r_2 is higher than that for Basel 1 if $a=0.6$ or 0.7 but lower than it if $a=0.8$ or 0.9 .
- ❖ The expected profit is lower under Basel 2 than Basel 1 except in the case when $a=0.9$ where the potential set of borrowers is the least risky of the four cases.

- Under Basel 3 (B3)

a	r_2	p_c	r_1	p^*	<i>EP B3</i>
0.6	0.491035	0.6	0.320974	0.79186	0.070447
0.7	0.420426	0.7	0.30082	0.846656	0.080727
0.8	0.357323	0.8	0.281591	0.899298	0.087995
0.9	0.299371	0.9	0.262907	0.950565	0.092441

- The expected portfolio profits for Basel 3 is always smaller than that for Basel 1 and 2.
- the rate r_2 under Basel 3 only drops below the Basel 1 rate with the least risky portfolio $a=0.9$. The rate r_1 is higher than the Basel 1 case if $a=0.6$ but then drops below the Basel 1 rate for “better” portfolios.

Examples for variable pricing model

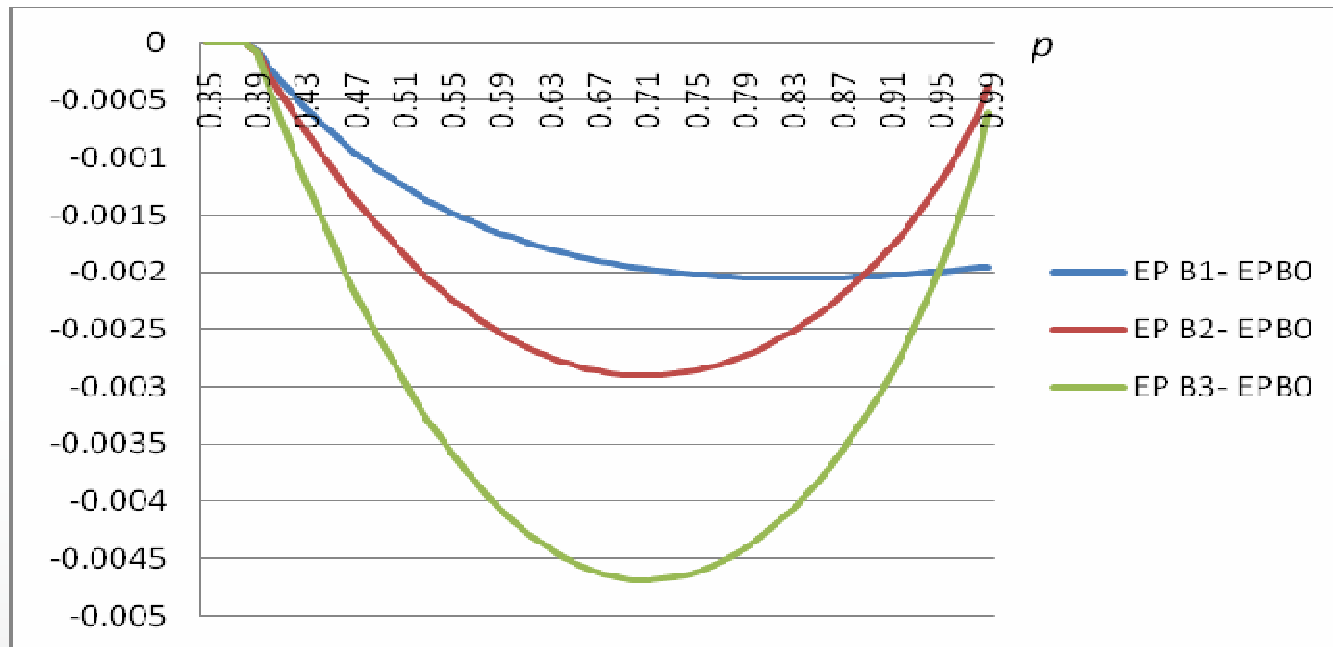
- Optimal interest rates under variable pricing

p	r_{B0}	r_{B1}	r_{B2}	r_{B3}
0.35	1.015714	1.021429	1.022753923	1.027153
0.4	0.897501	0.902501	0.904159744	0.908321
0.5	0.72	0.724	0.725897785	0.729584
0.6	0.588333	0.591667	0.59344082	0.596632
0.7	0.482858	0.485714	0.487108924	0.489765
0.8	0.393751	0.39625	0.397027862	0.399076
0.9	0.315556	0.317778	0.317627495	0.318922
0.95	0.279474	0.281579	0.28075476	0.281555
0.96	0.272458	0.274542	0.27355002	0.274233
0.97	0.265506	0.267567	0.266391431	0.266945
0.98	0.258612	0.260654	0.259268093	0.259678
0.99	0.251778	0.253798	0.252164403	0.252406

- ❖ The optimal interest rates charged decrease as p increases under all Basel regulation rules.
- ❖ The optimal interest rates for Bo are always less than those that for Basel 1, 2 and 3.
- ❖ The interest rates for Basel 2 are higher than that for Basel 1 until the probability of the borrowers being good is over 0.9.
- ❖ The optimal interest rates for Basel 3 also become smaller than that for Basel 1 as p is high enough.

Examples for variable pricing model

The difference in profitability between each Basel Accords and Basel 0



- ❖ The difference between Basel 2 and Basel 0 reaches its largest value when $p = 0.71$, and thereafter the difference starts to lessen until it becomes 0. But the same thing happens to the difference in the profitability of Basel 3 and Basel 0.
- ❖ However the curve of difference for Basel 1 does not diminish much as the probability of the applicant being good increases to 1.

Price Models at Portfolio Level with Fixed Amount of Equity Capital

- Fixed (one) price model

$$EP(r, p) = \underset{r_1, p_c}{\text{Max}} \int_{\max(a, p_c)}^1 q(r, p) \cdot [(r + l_D) \cdot p - (l_D + r_F)] \cdot f(p) \cdot dp$$

subject to

$$\int_{\max(a, p_c)}^1 l_D \cdot k(p) \cdot f(p) \cdot q(r, p) \cdot dp \leq Q$$

- Two prices model

$$EP(r, p) = \underset{r_1, r_2, p_c, p^*}{\text{Max}} \left\{ \begin{array}{l} \int_{\max(a, p_c)}^{p^*} q(r_2, p) \cdot [(r_2 + l_D) \cdot p - (l_D + r_F)] \cdot f(p) \cdot dp \\ + \int_{p^*}^1 q(r_1, p) \cdot [(r_1 + l_D) \cdot p - (l_D + r_F)] \cdot f(p) \cdot dp \end{array} \right\}$$

subject to

$$\int_{\max(a, p_c)}^{p^*} l_D \cdot k(p) \cdot f(p) \cdot q(r_2, p) \cdot dp + \int_{p^*}^1 l_D \cdot k(p) \cdot f(p) \cdot q(r_1, p) \cdot dp \leq Q$$

- Variable pricing model

$$EP(r(p), a) = \underset{r(p)}{\text{Max}} \int_a^1 q(r, p) \cdot [(r(p) + l_D) \cdot p - (l_D + r_F)] \cdot f(p) \cdot dp$$

subject to

$$\int_a^1 l_D \cdot k(p) \cdot f(p) \cdot q(r, p) \cdot dp \leq Q$$

Examples for One Price Model

- Optimal interest rates achieved under Basel 1

a	0.6	0.7	0.8	0.9
Q	r	r	r	r
0.01	0.401949	0.407457	0.414136	0.43
0.02	0.386739	0.393195	0.401949	0.380001
0.03	0.37903	0.384206	0.37	0.330001
0.04	0.376854	0.36	0.32	0.279998

- Optimal interest rates achieved under Basel 2

a	0.6	0.7	0.8	0.9
Q	r	r	r	r
0.01	0.374611	0.369972	0.363238	0.353655
0.02	0.38006	0.378746	0.374369	0.329441
0.03	0.37953	0.380226	0.370705	0.329441
0.04	0.377708	0.379595	0.315316	0.329441
0.05	0.377513	0.351949	0.315316	0.329441

- Optimal interest rates achieved under Basel 2

a	0.6	0.7	0.8	0.9
Q	r	r	r	r
0.01	0.366959	0.362857	0.354892	0.349461
0.02	0.376899	0.374217	0.367484	0.356492
0.03	0.379852	0.378328	0.373242	0.340678
0.04	0.380205	0.37979	0.375172	0.292207
0.05	0.379504	0.380211	0.36719	0.292207
0.06	0.378389	0.380007	0.332626	0.292207
0.07	0.37736	0.379273	0.332626	0.292207
0.08	0.37686	0.355765	0.332626	0.292207

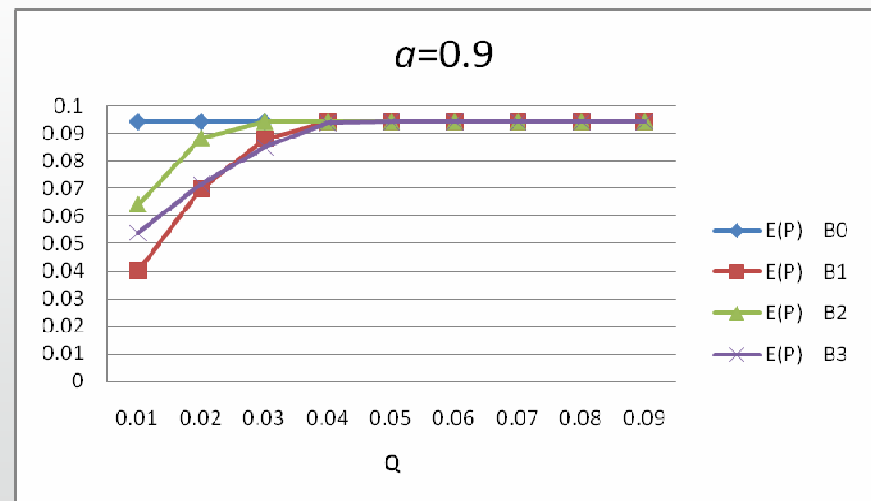
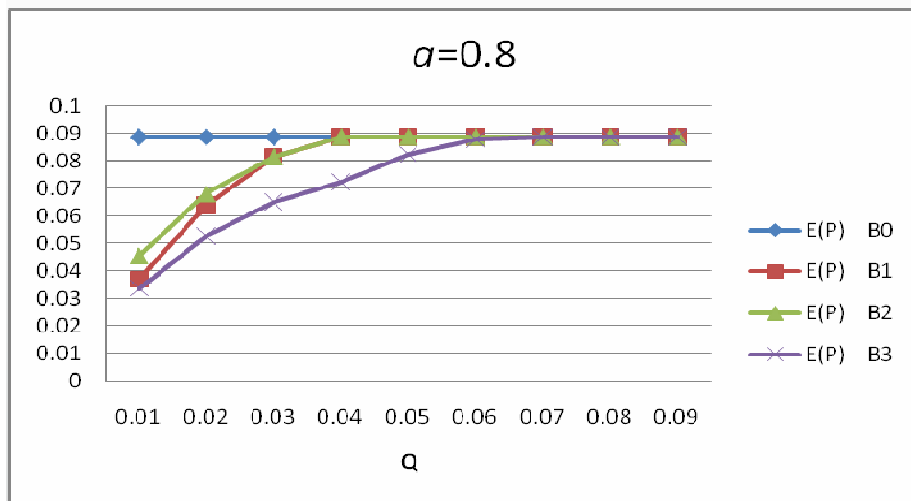
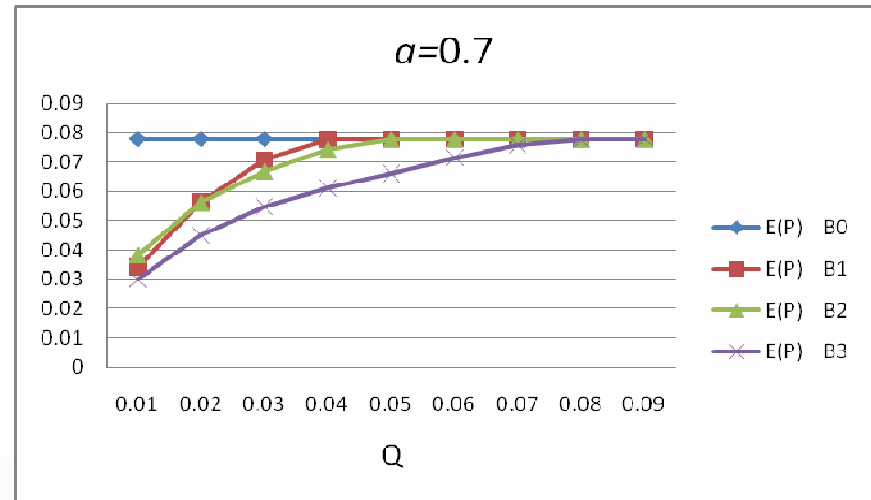
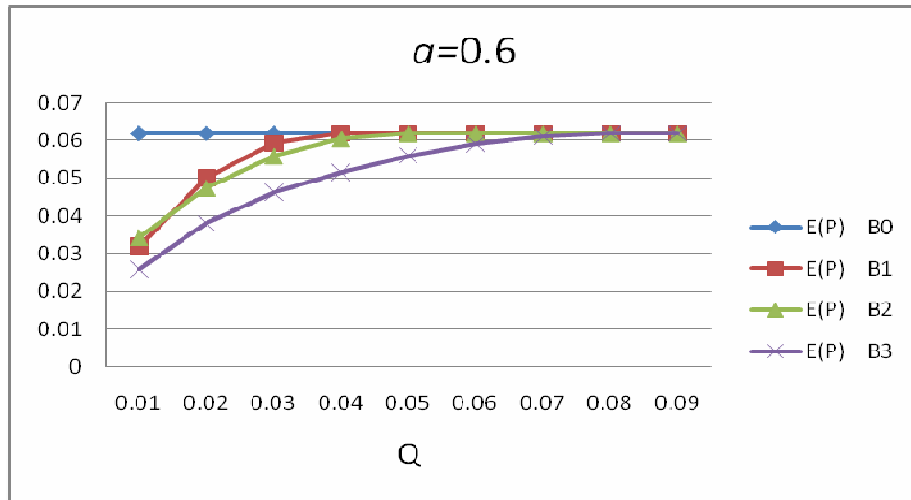
The optimal interest rate to charge drops as the equity available increases under Basel 1 regulation.

Under the Basel 2 and Basel 3 the optimal interest rate increases as the equity available increases when there is very little equity available and then decrease as the equity increases when there is more equity available.

This is because increasing the interest rate has two counterbalancing effects.

Examples for One Price Model

- Compare between results of 4 cases (with no regulatory requirements, Basel 1, Basel 2, and Basel 3) under one price model.



Examples for Two Prices Model

Optimal interest rates achieved under Basel 1

a	0.6		0.7		0.8		0.9	
Q	$r(2)$	$r(1)$	$r(2)$	$r(1)$	$r(2)$	$r(1)$	$r(2)$	$r(1)$
0.01	0.540563	0.380708	0.525008	0.390639	0.511123	0.399903	0.442378	0.39549
0.02	0.561394	0.357092	0.542857	0.362344	0.44645	0.356033	0.381178	0.366709
0.03	0.55149	0.341818	0.452909	0.326015	0.379451	0.325686	0.33	0.33
0.04	0.485568	0.317348	0.415754	0.297977	0.353758	0.279661	0.297324	0.262075

Optimal interest rates achieved under Basel 2

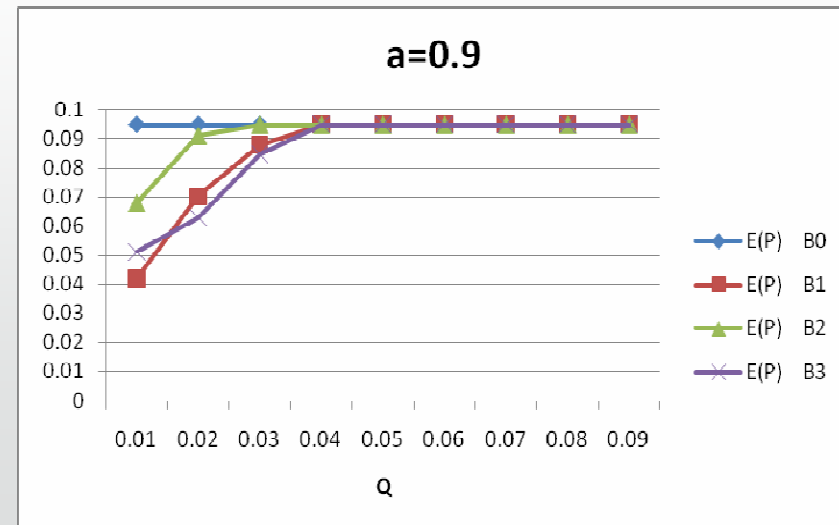
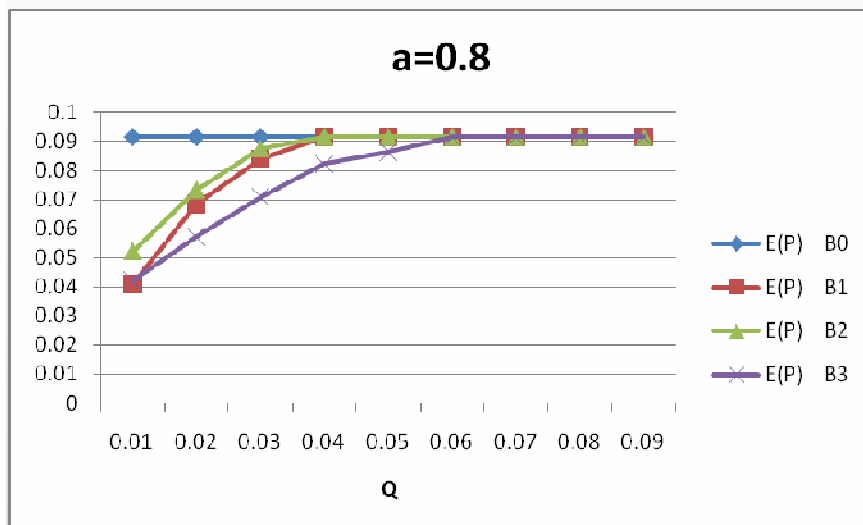
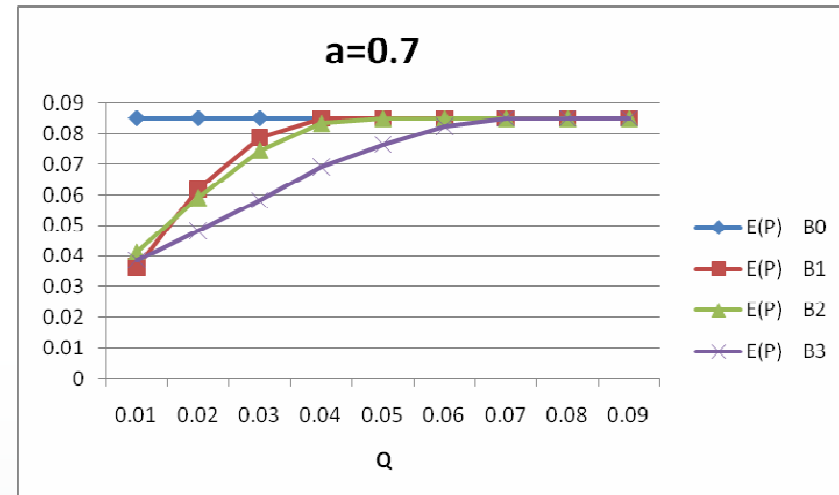
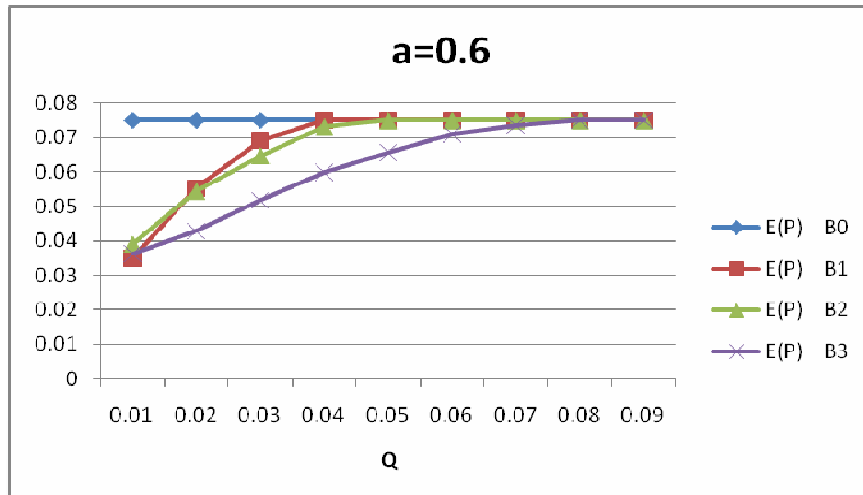
a	0.6		0.7		0.8		0.9	
Q	$r(2)$	$r(1)$	$r(2)$	$r(1)$	$r(2)$	$r(1)$	$r(2)$	$r(1)$
0.01	0.512181	0.336644	0.490955	0.332085	0.474815	0.327972	0.436327	0.31658
0.02	0.538626	0.339834	0.523695	0.338564	0.469353	0.32357	0.330684	0.276542
0.03	0.546024	0.338367	0.505931	0.329949	0.387419	0.294519	0.297324	0.262075
0.04	0.52187	0.328799	0.424307	0.303237	0.353758	0.279661	0.297324	0.262075
0.05	0.485568	0.317348	0.415754	0.297977	0.353758	0.279661	0.297324	0.262075

Optimal interest rates achieved under Basel 3

a	0.6		0.7		0.8		0.9	
Q	$r(2)$	$r(1)$	$r(2)$	$r(1)$	$r(2)$	$r(1)$	$r(2)$	$r(1)$
0.01	0.505367	0.335298	0.48452	0.3305	0.456773	0.323028	0.424242	0.31297
0.02	0.520485	0.338083	0.505367	0.335298	0.483184	0.330188	0.436559	0.316977
0.03	0.535492	0.339766	0.522258	0.338353	0.479349	0.32715	0.368954	0.29095
0.04	0.543507	0.339404	0.535627	0.339774	0.42524	0.307892	0.297324	0.262075
0.05	0.546287	0.338109	0.494346	0.326149	0.397333	0.298001	0.297324	0.262075
0.06	0.546547	0.336141	0.441843	0.308956	0.353758	0.279661	0.297324	0.262075
0.07	0.516254	0.327149	0.415754	0.297977	0.353758	0.279661	0.297324	0.262075
0.08	0.485568	0.317348	0.415754	0.297977	0.353758	0.279661	0.297324	0.262075

Examples for Two Prices Model

- Compare between results of 4 cases (with no regulatory requirements, Basel 1, Basel 2, and Basel 3) under two prices model.



Examples for Variable Pricing Model

p	0.6	0.7	0.8	0.9	0.95	0.96	0.97	0.98	0.99
Q	E(P) B1	E(P) B1	E(P) B1	E(P) B1	E(P) B1	E(P) B1	E(P) B1	E(P) B1	E(P) B1
0.01	0	0.0216	0.044466	0.057945	0.061301	0.061717	0.062051	0.062304	0.062477
0.02	0.020767	0.047925	0.0675	0.07842	0.080698	0.080912	0.081048	0.081107	0.081091
0.03	0.0385	0.063125	0.0808	0.090242	0.091898	0.091995	0.092017	0.091964	0.091838
0.04	0.044204	0.068014	0.085078	0.094044	0.095501	0.095561	0.095545	0.095457	0.095295

- Expected profits achieved under Basel 1

p	0.6	0.7	0.8	0.9	0.95	0.96	0.97	0.98	0.99
Q	r(P) B1	r(P) B1	r(P) B1	r(P) B1	r(P) B1	r(P) B1	r(P) B1	r(P) B1	r(P) B1
0.01	0.778333	0.645714	0.53625	0.442222	0.399474	0.391208	0.383031	0.374939	0.366929
0.02	0.713333	0.59	0.4875	0.398888	0.358421	0.350583	0.342825	0.335143	0.327535
0.03	0.65	0.535714	0.44	0.356667	0.318421	0.311	0.303649	0.296367	0.289151
0.04	0.588334	0.482858	0.393751	0.315556	0.279474	0.272458	0.265506	0.258612	0.251778

- Optimal interest rates achieved under Basel 1

p	0.6	0.7	0.8	0.9	0.95	0.96	0.97	0.98	0.99
Q	E(P) B2	E(P) B2	E(P) B2	E(P) B2	E(P) B2	E(P) B2	E(P) B2	E(P) B2	E(P) B2
0.01	0	0	0.038629	0.073169	0.087079	0.089376	0.091431	0.093178	0.094495
0.02	0.005386	0.036631	0.063762	0.084465	0.091636	0.092722	0.093658	0.094411	0.094928
0.03	0.029328	0.055988	0.07691	0.090373	0.09402	0.094473	0.094822	0.095056	0.095155
0.04	0.041763	0.06604	0.083737	0.093442	0.095258	0.095382	0.095427	0.095391	0.095272
0.05	0.044204	0.068014	0.085078	0.094044	0.095501	0.095561	0.095545	0.095457	0.095295

▪ Expected profits achieved under Basel 2

p	0.6	0.7	0.8	0.9	0.95	0.96	0.97	0.98	0.99
Q	r(P) B2	r(P) B2	r(P) B2	r(P) B2	r(P) B2	r(P) B2	r(P) B2	r(P) B2	r(P) B2
0.01	0.825808	0.680541	0.546147	0.411877	0.33902	0.323222	0.306694	0.289109	0.269755
0.02	0.749203	0.616772	0.496987	0.380806	0.319811	0.306846	0.293407	0.279271	0.263956
0.03	0.68792	0.565757	0.457659	0.355948	0.304445	0.293746	0.282777	0.271401	0.259317
0.04	0.628679	0.516443	0.419642	0.33192	0.289591	0.281083	0.272503	0.263793	0.254833
0.05	0.588334	0.482858	0.393751	0.315556	0.279474	0.272458	0.265506	0.258612	0.251778

• Optimal interest rates achieved under Basel 1

Expected profits achieved under Basel 3

p	0.6	0.7	0.8	0.9	0.95	0.96	0.97	0.98	0.99
Q	E(P) B3	E(P) B3	E(P) B3	E(P) B3	E(P) B3	E(P) B3	E(P) B3	E(P) B3	E(P) B3
0.01	0	0	0.01756	0.063701	0.08326	0.086571	0.089565	0.092145	0.094133
0.02	0	0.012851	0.047611	0.077206	0.088708	0.090572	0.092227	0.093619	0.09465
0.03	0	0.031183	0.060062	0.082802	0.090965	0.09223	0.09333	0.09423	0.094864
0.04	0.017092	0.046096	0.070191	0.087354	0.092802	0.093578	0.094227	0.094726	0.095039
0.05	0.030063	0.056581	0.077313	0.090555	0.094093	0.094527	0.094858	0.095076	0.095162
0.06	0.039142	0.063922	0.082298	0.092795	0.094997	0.09519	0.095299	0.09532	0.095247
0.07	0.043558	0.067492	0.084724	0.093885	0.095436	0.095513	0.095514	0.095439	0.095289
0.08	0.044204	0.068014	0.085078	0.094044	0.095501	0.095561	0.095545	0.095457	0.095295

Optimal interest rates achieved under Basel 3

p	0.6	0.7	0.8	0.9	0.95	0.96	0.97	0.98	0.99
Q	r(P) B3	r(P) B3	r(P) B3	r(P) B3	r(P) B3	r(P) B3	r(P) B3	r(P) B3	r(P) B3
0.01	0.874643	0.721194	0.577487	0.431686	0.351266	0.33366	0.315164	0.295381	0.273453
0.02	0.801613	0.660401	0.530621	0.402064	0.332953	0.31805	0.302497	0.286002	0.267924
0.03	0.762609	0.627932	0.505589	0.386243	0.323173	0.309712	0.295732	0.280993	0.264971
0.04	0.722775	0.594772	0.480027	0.370086	0.313185	0.301197	0.288824	0.275878	0.261956
0.05	0.68543	0.563685	0.456061	0.354939	0.303821	0.293215	0.282346	0.271082	0.259128
0.06	0.646425	0.531216	0.43103	0.339118	0.294041	0.284877	0.275581	0.266073	0.256176
0.07	0.609081	0.500128	0.407064	0.323971	0.284676	0.276894	0.269104	0.261277	0.253349
0.08	0.588334	0.482858	0.393751	0.315556	0.279474	0.272458	0.265506	0.258612	0.251778

Conclusions

- Using variable pricing the resultant profit is always the highest of the three, and profit achieved by using two prices model is always higher than that of using one price model.
- The profit made with B0 is always the greatest among the four cases if there is no any impact of adverse selection. If the borrower has a good quality, then B2 will give more profit to the lender than B1. And if the borrower is more risky, then the lender make more profit with B1. The expected portfolio profits for Basel 3 is always smaller than that for Basel 1 and 2.
- For predetermined equity capital, if the lender only has a little equity then the lender can make more profit with B2 than B1, but if the lender has more equity then they are taking more of the risky applicants and so B1 gives more profit than B2. With higher quality borrowers, the expected profit for Basel 3 lies between the Basel 1 and Basel 2 if the capital restriction of Q is very small.

Thank you for listening

Q & A