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Supervisory Incentives and Credit Portfolio Management: A Field Experiment and Findings

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Abstract

An agency problem regarding moral hazard of individual borrowers within lending contracts is efficiently addressed with supervisory practices, especially sponsorship and endorsement that lead to selecting the optimal project (with higher expected return and lower risk) and the optimal control of borrowers. According to a recent study, there is a liability constraint of the endorsement that plays as an incentive mechanism for better projects selecting and an incentive constraint of the sponsorship that plays for better monitoring of borrowers, (Kamalan, 2018). Although the conclusions are very relevant in economics with a broad range of applications in management field, especially in marketing, the results of the modelling remain theoretical. The overall objective of this study is to analyze the effectiveness of incentive mechanisms on maturity repayment behavior of borrowers and the time of exposure to default. Specifically, the article aims at testing empirically the causal effects of supervisory practices within lending contracts with a focus on the maturity repayment behavior of borrowers.

First, we test the influence of supervisory incentives on the borrower's behavior regarding maturity repayment with Logistic and Poisson regression. Second, we analyze the effects of supervisory incentives on credit' life-time of borrowers with Kaplan-Meier and Cox regression.

The findings attest that supervisory incentives are significantly powerful to lead borrowers to better maturity repayment behavior. The resulting model is significant to introduce into the search for the determinants of categories of "best" customers in maturity repayment and adversely, those mostly considered as vulnerable to delays that will lead to a real strategy of portfolio management.

Keywords: Principal-Supervisor-Agent, Incentives, Logit, Poisson regression, Survival analysis, Censoring, Cox regression

JEL Codes: C14, C24, C25, C41, D91
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1. Introduction

Supervisory practices are defined as social relations networks and better known as non-market institutions within contracts. Since behavioral economists invite to the understanding of the complex economic and behavioral factors (known as non-market institutions) that affect the decisions of individuals within contracts, the understanding of the role of social relations networks within contracts has become a topic of increasing interest. There are pioneering works with Stiglitz (1974) on tenant farming, pursued by Laffont and Matoussi (1995) and renewed by Bidisha and al. (2018). It also concerns the gift-exchange and market nexus (Akerlof, 1982), extended by Bryson and Freeman (2018). Consequently, the impact of non-market institutions in terms of contract efficiency has been a topic of increasing interest in the theories of contracts, regarding transaction costs, property rights, incomplete contracts and agency relationships.

To a better understanding of the role of such non-market institutions within contracts, a relevant method based on the principal-agent paradigm is largely used and address many topics: organization (Ashraf and Bandiera, 2018), management of public goods such as environment (Smith, 2018), etc. A specific concern is devoted to exploring the conditions of effectiveness of lending contracts and this concern is being raised by alternative banking firms such as cooperatives (Banerjee, Besley and Guinnane, 1994; Besley, 1995) and microfinance institutions (Stiglitz, 1990; Varian, 1990; Besley and Coate, 1995, Armendariz de Aghion and Gollier, 2000). In the studies, the neighborhood is supposed to have better information about borrowers and can thus exercise more effective control over them. In a context where information asymmetry (adverse selection and moral hazard) can degrade lending relationships, the commitment of the borrower's acquaintances can be used to solve such an information problem. This is the principle of peer review, first analyzed by Varian and then Stiglitz. These studies unanimously maintain

that taking peer review into account makes it possible to bring out non-opportunistic behaviors through solidarity guarantees, the possibility of social sanctions and long-term interactions. Peer review is then modelled as supervisor in a Principal-Supervisor-Agent model.

Supervisory practices such as endorsement and sponsorship are, in this case, incentive devices that encourage the effort of borrower to not engage in too risky projects, Kamalan (2018) and then are seen as being important tool for reducing loan delinquency, (Cassar, Crowley and Wydick, 2007). Supervisory practices are shown theoretically to be a way of acquiring information on creditworthiness for reducing default risk, (Stiglitz, 1990), (Armendariz de Aghion and Gollier, 2000).

In a model composed of a Principal, a Supervisor and an Agent such as the one developed by Banerjee, Besley and Guinnane (1994), supervisors are likely to have efficient effects on the agent's behaviors due to the incentives that supervisors provide.

The contribution of this article is to take into account supervisory practices known as sponsorship and endorsement within lending contracts, in order to questioning their effect in solving agency problem of moral hazard of borrowers, especially, in testing the effects of those practices on the maturity repayment of borrowers. As proposed in Kamalan (2019), we consider the lending institution (microfinance for example) as the Principal. The Supervisor is a no borrowing member of the same loan. It does not refer to joint liability member. The Endorsers and/or sponsors are considered supervisors engaged in the lending contracts. An endorser is known as a third party who provides a real collateral (salary for example) in return to the debt the borrower receives. According to a recent study, there is a liability constraint of the endorsement that plays as an incentive mechanism for better projects selecting (Kamalan 2018), and the sponsorship given by third parties plays for better monitoring of borrowers. The borrower is considered to be the Agent. Finally, a loan is represented by twelve monthly maturities and the number of maturities per borrower represents his/her total credit life time.

Our analytical model is based on the framework of Bénabou and Tirole (2003). The authors analyze the effects of incentives on individuals' behavioral supply in the short and long term. This framework uses the principal-agent paradigm with asymmetric information. However, our study, which is intended to be applied, differs significantly from Bénabou and Tirole (Op. Cit.) in terms of mathematical modelling.

In our study, we will analyze the effects of incentive mechanisms on borrowers' repayment behavior and on the credit' life-time in four steps. First, we use a Logistic model to test the impact of supervisory practices on the probability of maturity repayment without failure for all borrowers. Second, we use Poisson regression analysis to test the impact of supervisory practices on the frequency of delays occurring in the repayment of maturities by loan borrowers with at least one delay. The number of delays is modelled as occurring at the frequency defined by a Poisson test, based on predictors. Third, we use the duration or survival analysis for the modelling of failures and credit' life-time of borrowers. Credit' life-time is modelled with the Kaplan-Meier graphs that provides failure estimates. Last, we use the Cox regression analysis to test the risk of default.

The article is organized as follows. Section 2 presents the data, the methodological approach and model estimations. Section 3 provides the main findings and section 4 gives some concluding remarks.

2. Data, methods and model estimations

2.1 Data and variables

The data used in the econometric study of this article come from a survey conducted in Cotonou, (Benin, West Africa), in 2006. The study uses cross-sectional data from a sample of 832 borrowers. The sample includes 506 individual loans borrowers, and 272 group loans, covering the population of 21146 customers in a microfinance institution called PADME in Cotonou (Note 1). The survey includes only borrowers in process of credit. We've developed a questionnaire submitted to the 832 people in the sample. We obtained several data concerning the loan relationship with the lending institution. We've produced from these data the variables of the study.
The variables of the study are presented as follows. The dependent variables concern: 1-the delay (delay), it's a binary variable that takes the value 1 for borrowers who have no delay and 0 for those who have at least one delay; 2-the number of delays (nbr_delays) from 0 to 13 and 3-the number of maturities (maturities) from 0 to 132. (Note 2). The explanatory variables are:
- collateral: the type of collateral proposed by borrowers (plots, plots and other collateral, vehicles, salary, no real collateral). No real collateral refers to personal collateral i.e. the presence of supervisors.

- penalty: the assessment of the penalty amount (acceptable, low, too high)

- gift: receiving a gift (having received a gift, not having received a gift)

- amount: the assessment of the received amount (acceptable, not satisfying)
- sponsorship: the sponsorship status (sponsored, not sponsored)
- education: education level (illiterate, primary, secondary, university)
- loan_renewal: loan renewal (wishes for renewal; does not wish for new loan)
- work: the main work (trade, agriculture and livestock, crafts and processing, service, worker for public/private)

2.2 Methodological approaches and model estimations

2.2.1 Logistic regression of default

Let us consider that delay occurs randomly. Using the Logit model, we determine the factors that may explain the non-default of borrowers. This model is particular in explaining discrete variables that have two modalities. It provides the parameters of independent variables. It also provides the elasticity (dy/dx) consisting in the probability of the marginal effects. That indicates the change in the dependent variable relating to the move from the baseline modality of an independent variable to a specific study modality. The Logit model used is as follows:

$$Logit\ Delay_{\_i} = C0 + C1\text{collateral}_{\_ij} + C2\text{penalty}_{\_ij} + C3\text{gift}_{\_ij} + C4\text{amount}_{\_ij} + C5\text{sponsorship}_{\_ij} + C6\text{education}_{\_ij} + C7\text{renewal}_{\_ij} + C8\text{work}_{\_ij} + \varepsilon_{ij}$$

$i = 1, \dots n$ and $j = 1, \dots J$

Table 1. Marginal effects of Logistic regression

	Delta-method dy/dx	Std. Err.	z	P>|z|	[95% Conf.	Interval]
collateral						
plots and other collateral	.0646974	.1289143	0.50	0.616	-.18797	.3173648
vehicles	.0160433	.0769412	0.21	0.835	-.1347587	.1668453
salary	.2040393	.0733119	2.78	0.005	.0603505	.347728
no real collateral	.4027759	.0468463	8.60	0.000	.3109588	.4945931
penalty						
low	.201082	.1059496	1.90	0.058	-.0065754	.4087395
too high	-.1488234	.0453776	-3.28	0.001	-.2377617	-.059885
gift						
having received a gift	.245437	.065727	3.73	0.000	.1166145	.3742595
amount						
not satisfying	-.0496813	.046833	-1.06	0.289	-.1414722	.0421097
sponsorship						
sponsored	.6237135	.0315918	19.74	0.000	.5617946	.6856324
education						
primary	-.1711109	.0642775	-2.66	0.008	-.2970924	-.0451293
secondary	-.0603828	.0624856	-0.97	0.334	-.1828524	.0620868
university	.1146434	.1154171	0.99	0.321	-.1115699	.3408568
2.loan_renewal	-.0533821	.0874795	-0.61	0.542	-.2248387	.1180745
work						
agriculture and livestock	.2690165	.1467824	1.83	0.067	-.0186717	.5567048
crafts and processing	-.2593097	.0768788	-3.37	0.001	-.4099895	-.10863
service	.0056828	.0682189	0.08	0.934	-.1280238	.1393894
worker for public/private	.3569816	.080303	4.45	0.000	.1995905	.5143727

Note: dy/dx for factor levels is the discrete change from the base level.

Author' calculation

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Once the factors that significantly explain the non-failure behavior are known, we focus on the way factors determine the frequency of failures. We use the Poisson model to count the number of delays (nbr_delays) made by borrowers who have experienced at least one default in the maturity repayments.

2.2.2 Poisson regression of the number of delays

The models to be estimated are:

$$Log\ \text{nbr\_delays}_{\_i} = C0 + C1\text{collateral}_{\_ij} + C2\text{penalty}_{\_ij} + C3\text{gift}_{\_ij} + C4\text{amount}_{\_ij} + C5\text{sponsorship}_{\_ij} + C6\text{education}_{\_ij} + C7\text{renewal}_{\_ij} + C8\text{work}_{\_ij} + \varepsilon_{ij}$$

$$Frequency\ of\ \text{delays}_{\_i} = \text{Exp}(C0 + C1\text{collateral}_{\_ij} + C2\text{penalty}_{\_ij} + C3\text{gift}_{\_ij} + C4\text{amount}_{\_ij} + C5\text{sponsorship}_{\_ij} + C6\text{education}_{\_ij} + C7\text{renewal}_{\_ij} + C8\text{work}_{\_ij} + \varepsilon_{ij})$$

Table 2. Parameters of the Poisson regression model

```
Poisson regression                              Number of obs     =        321
                                                LR chi2(16)       =     285.69
                                                Prob > chi2       =     0.0000
Log likelihood = -650.28743                     Pseudo R2         =     0.1801
```

nbr_delays	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
collateral						
plots and other collateral	.0781565	.1112801	0.70	0.482	-.1399485	.2962615
vehicles	.1518812	.1020811	1.49	0.137	-.0481941	.3519565
salary	-.0893201	.1083369	-0.82	0.410	-.3016565	.1230164
penalty						
low	-.1491537	.1714484	-0.87	0.384	-.4851864	.1868789
too high	.129707	.0648553	2.00	0.046	.002593	.256821
gift						
having received a gift	-.1832903	.1026739	-1.79	0.074	-.3845275	.017947
amount						
not satisfying	-.1995117	.0626259	-3.19	0.001	-.3222563	-.0767671
sponsorship						
sponsored	-1.109489	.0812016	-13.66	0.000	-1.268641	-.9503364
education						
primary	-.032122	.099146	-0.32	0.746	-.2264446	.1622007
secondary	.0177286	.0948311	0.19	0.852	-.1681369	.2035941
university	.1942727	.121285	1.60	0.109	-.0434415	.431987
2.loan_renewal	-.3213687	.1258398	-2.55	0.011	-.5680102	-.0747273
work						
agriculture and livestock	-1.029785	.2726292	-3.78	0.000	-1.564128	-.4954412
crafts and processing	-.0489618	.1444502	-0.34	0.735	-.3320791	.2341554
service	-.140194	.0828787	-1.69	0.091	-.3026332	.0222453
worker for public/private	.2377009	.1564171	1.52	0.129	-.0688709	.5442728
_cons	1.715729	.081921	20.94	0.000	1.555167	1.876291

Author' calculation

2.2.3 Failure estimate and survival analysis

Consider three maturities times: t'', t' and t, such that $t'' < t' < t$. The probability of a failure x occurring after time t, is written:

$P(x > t) = P(x > t', x > t); P(x > t) = P(x > t \mid x > t')\ x\ P(x > t')$

$P(x > t) = P(x > t \mid x > t')\ x\ P(x > t' \mid x > t'')\ x\ P(x > t'')$

The delay (failure) times are distinct $T_{(i)}$ $(i = 1, \ldots, n)$ and ranked in ascending order.

$$P(x > T_{(j)}) = \prod_{k=1}^{j} P\left(x > T_{(k)} \middle| x > T_{(k-1)}\right)$$

When $T_{(0)} = 0$, we have:

Y_i: the number of borrowers who may be defaulting just before the time $T_{(i)}$

d_i: the number of "dead" borrowers, i. e. excluded from the loan portfolio at $T_{(i)}$.

Then the p_i probability that a borrower will be removed from the loan portfolio in the interval $\left]T_{(i-1)}, T_{(i)}\right]$, knowing that he was executing credit at $T_{(i-1)}$; i.e. $p_i = P\left(x \leq T_{(i)} \mid x > T_{(i-1)}\right)$

is estimated by:

$\widehat{P}_i = \frac{d_i}{Y_i}$

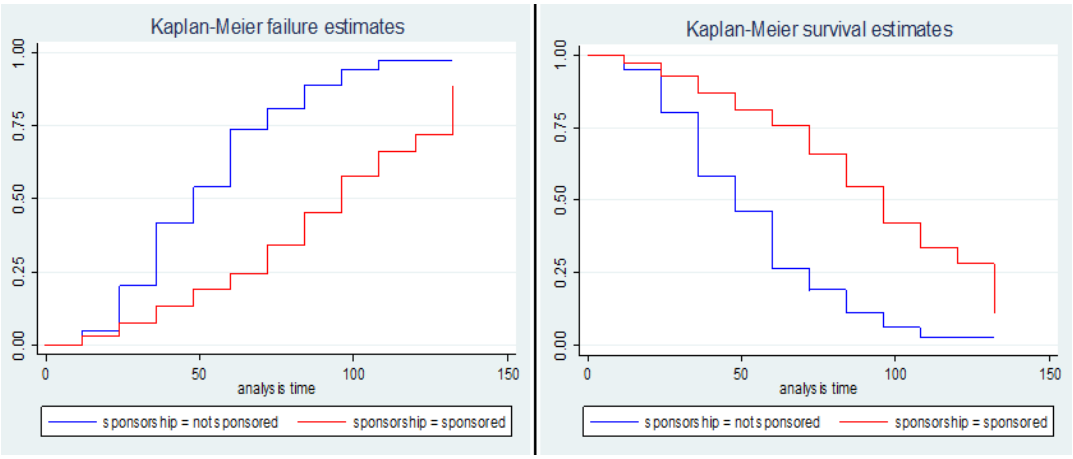

Figure 2: Kaplan-Meier failure and survival estimates with predictor Sponsorship

Table 3. Kaplan-Meier failure Table

Author' calculation

Time	Beg. Total	Fail	Net Lost	Failure Function	Std. Error	[95% Conf.	Int.]
not sponsored							
12	322	16	5	0.0497	0.0121	0.0307	0.0798
24	301	48	13	0.2012	0.0225	0.1612	0.2497
36	240	65	17	0.4176	0.0282	0.3646	0.4749
48	158	33	6	0.5392	0.0292	0.4832	0.5973
60	119	51	2	0.7367	0.0267	0.6832	0.7876
72	66	18	4	0.8085	0.0242	0.7589	0.8534
84	44	18	0	0.8868	0.0202	0.8438	0.9225
96	26	12	5	0.9391	0.0155	0.9038	0.9647
108	9	5	0	0.9729	0.0122	0.9407	0.9901
132	4	0	4	0.9729	0.0122	0.9407	0.9901
sponsored							
12	510	15	68	0.0294	0.0075	0.0178	0.0483
24	427	20	87	0.0749	0.0122	0.0543	0.1029
36	320	20	30	0.1327	0.0170	0.1030	0.1700
48	270	18	59	0.1905	0.0206	0.1537	0.2348
60	193	13	42	0.2450	0.0241	0.2014	0.2962
72	138	18	24	0.3435	0.0301	0.2881	0.4062
84	96	16	14	0.4529	0.0354	0.3866	0.5250
96	66	15	16	0.5773	0.0393	0.5018	0.6549
108	35	7	4	0.6618	0.0425	0.5785	0.7435
120	24	4	0	0.7182	0.0438	0.6306	0.8002
132	20	12	8	0.8873	0.0355	0.8070	0.9448

Table 4. Kaplan-Meier survival Table

Time	Beg. Total	Fail	Net Lost	Survivor Function	Std. Error	[95% Conf.	Int.]
not sponsored							
12	322	16	5	0.9503	0.0121	0.9202	0.9693
24	301	48	13	0.7988	0.0225	0.7503	0.8388
36	240	65	17	0.5824	0.0282	0.5251	0.6354
48	158	33	6	0.4608	0.0292	0.4027	0.5168
60	119	51	2	0.2633	0.0267	0.2124	0.3168
72	66	18	4	0.1915	0.0242	0.1466	0.2411
84	44	18	0	0.1132	0.0202	0.0775	0.1562
96	26	12	5	0.0609	0.0155	0.0353	0.0962
108	9	5	0	0.0271	0.0122	0.0099	0.0593
132	4	0	4	0.0271	0.0122	0.0099	0.0593
sponsored							
12	510	15	68	0.9706	0.0075	0.9517	0.9822
24	427	20	87	0.9251	0.0122	0.8971	0.9457
36	320	20	30	0.8673	0.0170	0.8300	0.8970
48	270	18	59	0.8095	0.0206	0.7652	0.8463
60	193	13	42	0.7550	0.0241	0.7038	0.7986
72	138	18	24	0.6565	0.0301	0.5938	0.7119
84	96	16	14	0.5471	0.0354	0.4750	0.6134
96	66	15	16	0.4227	0.0393	0.3451	0.4982
108	35	7	4	0.3382	0.0425	0.2565	0.4215
120	24	4	0	0.2818	0.0438	0.1998	0.3694
132	20	12	8	0.1127	0.0355	0.0552	0.1930

Author' calculation

2.2.4 Hazard Ratio or instant risk of default with Cox regression

Suppose a borrower defaults over a time interval set to $[0, T]$. Consider T the credit' life-time, which is a random and continuous variable, and $t \geq 0$, a particular value of T.

The survival function $S(t)$ representing the probability of surviving after time t is given by:

$S(t) = P(T > t)$.

The cdf (cumulative distribution function) of the random variable T representing the probability of defaulting before t is defined as follows:

$F(t) = P(T \leq t) = 1 - S(t)$.

The probability density which represents the probability of defaulting in a small time interval after time t is given by:

$$f(t) = \lim_{h \to 0} \frac{P(t \leq T < t + h)}{h} = F'(t) = -S'(t)$$

The instant risk (Hazard ratio) for a fixed time t, indicates the probability of defaulting in a small time interval after t, conditionally to the fact of having survived until time t (i.e. the instant risk of default for those who survived) is:

$$\lambda(t) = \lim_{h \to 0} \frac{P(t \leq T < t + h \mid T \geq t)}{h} = \frac{f(t)}{S(t)} = -\ln(S(t))'$$

Table 5. Parameters of Cox regression model

Cox regression -- Breslow method for ties

No. of subjects =	832	Number of obs =	832
No. of failures =	424		
Time at risk =	40704		
		LR chi2(17) =	196.56
Log likelihood =	-2351.1728	Prob > chi2 =	0.0000

_t	Haz. Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
collateral						
plots and other collateral	.791176	.1896788	-0.98	0.329	.4945425	1.265735
vehicles	1.419616	.2835434	1.75	0.079	.9597503	2.099827
salary	.9787335	.1901043	-0.11	0.912	.668854	1.43218
no real collateral	.6987949	.0878043	-2.85	0.004	.5462549	.8939312
penalty						
low	.5628246	.1874635	-1.73	0.084	.2929936	1.081155
too high	.9275552	.1018448	-0.68	0.493	.7479603	1.150273
gift						
having received a gift	.4732834	.0874953	-4.05	0.000	.3294282	.6799575
amount						
not satisfying	1.160078	.1291669	1.33	0.182	.9326346	1.442988
sponsorship						
sponsored	.296511	.0328854	-10.96	0.000	.238581	.368507
education						
primary	1.442361	.2220883	2.38	0.017	1.06662	1.950465
secondary	1.065974	.158604	0.43	0.668	.7963388	1.426905
university	.8573055	.2186612	-0.60	0.546	.5200334	1.413318
2.loan_renewal	1.190002	.2281939	0.91	0.364	.8171879	1.7329
work						
agriculture and livestock	2.346719	.9843001	2.03	0.042	1.031421	5.339324
crafts and processing	1.505234	.3497764	1.76	0.078	.9545691	2.373562
service	1.487843	.2189146	2.70	0.007	1.115103	1.985176
worker for public/private	1.060939	.3713813	0.17	0.866	.5342288	2.106945

Author' calculation

3. Findings

We performed the following tests to confirm the relevance of our results: the Pearson's test for the Logit model, Pearson's deviance test for the Poisson model, proportional risk test, Wald's test and likelihood ratio test for the Cox model. In addition, we tested the presence of endogeneity and corrected with the instrumental variable method.

3.1 Effects of supervisory practices on borrower's behavior

3.1.1 Effects on maturity repayment behavior with logistic regression

The estimated Logit model is overall significant. 78.73% of the non-delay behavior is significantly related to the explanatory variables of the model.

Supervisory practices known as endorsement and sponsorship positively affects borrowers' behavior for not failing maturities. Sponsorship and endorsement highlight the role of personal collateral in loan efficiency. In Table 1, when moving from borrowers who have given a plot of land as collateral to those who gave any real collateral i.e. who proposed supervisors, the probability of not defaulting increases significantly by 40.3%. Sponsorship positively affects borrowers' behavior for non-delay. Moving from a non-sponsored borrower to a sponsored one, the probability of not defaulting increases significantly by 62.4%.

Several other factors have an attractive incentive effect on the maturity repayment behavior without delay. The reward as incentives given by the principal contribute positively to the payment of maturities without any delay by borrowers. Receiving a gift may increase the probability of not defaulting by 24.5%. However, other factors have negative effects on maturity repayment without delay: the primary education level, crafts and proceeding activities, for example.

3.1.2 Effects on the number of delays with Poisson regression

The Poisson model estimate highlights the frequency of delays made by borrowers who have defaulted at least once. The deviance test that indicates the adequacy of the Poisson model, provides a deviance probability about 0.0444<0.05, suitable for reading the results. The results in Table 2 indicate that sponsorship positively reduces the frequency of maturity delayed payment: Coef = -1.1094. we've compute the estimated marginal effect that indicates 33.0% drop in the frequency of defaults from non-sponsored borrowers to sponsored ones.

Other factors are beneficial in reducing the frequency of maturity delayed payment. Rewards are powerful factors that reduce the frequency of maturity delayed payment. In Table 2, incentives in the form of gifts received by borrowers significantly reduce the frequency of delays. The estimated marginal effect indicates 83.2% drop in the frequency of defaults from borrowers who did not receive a gift to those who did. Similarly, the possibility of credit renewal, the work in agriculture and livestock are significantly leading to the reduction in the frequency of delays in maturity repayments.

3.2 Effects of supervisory practices in credit' life-time analysis

3.2.1 Effects on the failure and survival functions with Kaplan-Meier

The Figure 1 shows the non-parametric failure and survival estimates with the predictor sponsorship. It describes the trend in borrowers' default and survival according to the sponsorship status. The basic idea is that, when a borrower incurs defaults, he or she gets closer to the end of the credit' life-time. For the Kaplan-Meier non parametric estimator, when a borrower survives a default at maturity time t, it means the borrower is alive just before t, and he does not die at t time (Note 3). Kaplan-Meier failure and survival estimates are very different while comparing non-sponsored borrowers to those who are sponsored. Non-sponsored borrowers have significantly higher failure rates and are more likely to die faster than sponsored borrowers. Table 3 presents the failure function, which is an estimate of the probability of default by borrowers over time. Time represents the number of maturities.

The failure function evolves less quickly for borrowers who are sponsored. Table 3 shows that, for sponsored borrowers, the average default rate (50%) is reached at the 84th to 96th maturity dates, i.e. 7th to 8th loan. However, for non-sponsored borrowers, the average default rate is quickly reached before the end of the 4th loan. A completely opposite analysis must be done for Table 4 concerning the survival function.

Table 3 and Table 4 provide an important characteristic about right censored observations. An observation is right censored if the person was alive at study termination or was lost to follow-up at any time during the study. Right censoring means that the survival time is only known to exceed a certain value. In this study, survival times are presented to be 12, 24, ..., 132.

3.2.2 Effects on the instant risk of failure with Cox regression

To ascertain whether the results of our Cox model are significantly relevant, we performed the following three tests: the proportional risk test, the Wald test and the likelihood ratio test. The results in Table 5 show that each explanatory variable is affected by a hazard ratio, regardless the time period. This ratio indicates the risk of borrowers defaulting at maturity. When borrowers are sponsored, the risk of default given by *Haz. Ratio* is decreasing and quite low (0.296). When there is no material collateral proposed by the borrowers, i.e. when supervisors exist within the lending contract, the risk of failure becomes significant and decreasing with *Haz. Ratio* =0.699. Conversely, borrowers who offer a vehicle as collateral, those with a primary level of education, those whose main activity is agriculture or livestock, crafts, service activities; are highly vulnerable to maturity defaulting.

4. Concluding remarks

The credit repayment behavior of borrowers has always been a key issue for financial institutions. Indeed, this problem is linked to moral hazard, which is made possible by the non-observability of the agent's (borrower's) behavior by the principal (the lending institution). This is reflected in the fact that at maturity, some borrowers do not respect their commitment and gradually drift towards non-payment, which definitively degrades the quality of the credit portfolio. As a result, incentive mechanisms based on the role of supervisors become effective means of encouraging some borrowers to positively change their repayment behavior and reduce their risk of default. These effects are rather significant on the behavior of borrowers who are incentive-sensitive and therefore adopt maturity compliance behavior, while borrowers who are not attracted by such incentives will continue to be highly exposed to default risk.

In this study, we proceeded in different steps to analyze the credit repayment behavior of borrowers. The first two steps, the Logit model and the Poisson model, allowed us to check whether the incentive mechanisms proposed by the supervisors contributed positively and significantly to the borrowers' compliance behavior. Subsequently, we used the Kaplan-Meier and Cox models to analyze the influence of incentive mechanisms on the credit' life-time.

The findings of this research lead to the following management and business policies for contractual relationships involving a principal and an agent with asymmetric information. 1-The types of incentive mechanisms should be diversified in order to better assess the distinct effects of each incentive mechanism on the change in agents' behaviour. 2-Supervisory incentives are significantly powerful mechanisms for agents' behavior analysis and also appear as dynamic incentives that structurally affect the medium to long-term performance of contracts.

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Notes

Note 1. PADME was considered to be one of the best microfinance institutions in West Africa with higher repayment rate of borrowers. That lending institution was selected because of the opportunities given to learn about the non-market institutions such as endorsement and sponsorship practices involved in lending contracts.

Note 2. For each maturity, we check if the borrower has repaid the loan before the maturity date. Otherwise, a late payment penalty is imposed. It is therefore the number of penalties that determines the number of delays according to the number of maturities.

Note 3. Death refers to the end of the credit cycle. This means that no longer the lender decides to extend any more credit to the borrower and thus eject him from the loan portfolio.