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Revolving cards: A financial analysis of the credit repayment and legal implications

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ABSTRACT

The framework of this paper is credit card holding by users and consumers, more specifically, the so-called revolving cards. In most cases, the true interest rate applied to a credit is much higher than its nominal interest rate. Usually, this is due to the existence of some additional fees to be paid by the card holder, and to the process of splitting the periods of interest. However, the contracted annual interest rate of revolving cards is very high which, together with their peculiar amortization system, gives rise to an excessive amount of interests. The objective of this paper is to describe and analyze, from a legal and financial point of view, the main characteristics of the credit repayment in revolving cards. We conclude that the complete amortization of the principal needs a very long duration and the payment of a high amount of interests.

Keywords: revolving card, usurious interest, repayment method, outstanding balance.

JEL classification: C02, G21, G40.

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1. Introduction

The framework of this paper is the sentence 149/2020, issued by the Supreme Court of Spain on March 4, 2020 (Tribunal Supremo, 2020). This institution considers as usurious an interest rate of 27.24% applied by a revolving credit card to its outstanding balances. The Plenary of the Chamber considers that, in case of a usurious remunerative interest, it is necessary to make reference to a "normal interest of money".

This sentence sets out three questions. The first one is to set the concept of "normal interest of money" in this context. The second issue is to decide if the interest rate applied by the involved revolving card is significantly greater than the so-called "normal interest of money". And the third question is the calculation of the amount to be returned by the bank to the borrower.

With respect to the first question, the Plenary of the Chamber considers that a "normal interest of money" must be the average interest applicable to the category of the corresponding operation. In effect, to determine the benchmark to be used as "normal interest of money", we have to use the average interest rate, at the time of this contract, corresponding to the category to which the questioned credit operation corresponds. And, if there were more specific categories within broader ones (as is currently the case of credit and revolving cards), it should be used the specific category with which the credit operation presents more coincidences (duration of the credit, amount, purpose, means by which the borrower can obtain the credit, guarantees, ease of claim in case of non-payment, etc.). In this way, the Supreme Court claims that this benchmark could be the average interest rate of loans and credits to households published by the Bank of Spain (namely, the category "Loans and credits to households and ISFLSH"). More specifically and referred to the credit cards in 2018, the Bank of Spain has published the data shown in Table 1.

Table 1. Average annual interest rate applied to credit cards with delayed payments. **Source**: Own elaboration.

Month (2008)	Average anual interest rate
January	20.831
February	20.716
March	20.728
April	20.662
May	20.694
June	20.621
July	20.593
August	20.530
September	20.198
October	20.214
November	19.996
December	19.980

With respect to the second issue, we are going to use the well-known Student *t*-test. This methodology could be justified by article 1 of the Law of July 23, 1908, on the Repression of Usury, which states that any loan contract stipulating an interest significantly higher than normal and manifestly disproportionate, will be null. Unlike other countries in our context, where the legislator has established several percentages or specific parameters to determine the value from which an interest rate should be considered as usurious, in Spain the regulation of usury contains indeterminate concepts such as "noticeably higher than normal money" or "grossly disproportionate to circumstances of the case". This indetermination forces the courts to choose a reference index. Moreover, this question is very important due to the risk derived from the high level of defaults in consumer credit operations, in occasions granted through aggressive marketing techniques and without checking adequately the borrower's solvency.

In this way, for the analysis of significance, some appropriate statistical methodologies could be applied. Specifically, in testing the null hypothesis that the population mean is less than a given value μ, one can use the statistic (Spiegel et al., 2010):

$$t = \frac{\bar{x} - \mu}{s}\sqrt{n-1},$$

where $\bar{x}$ is the sample mean, *s* is the sample standard deviation and *n* is the sample size. The degrees of freedom used in this test are $n-1$. The distribution of the population of sample means is assumed to be normal. In this case, $\bar{x} = 20.48025$ and $s = 0.29985$.

In order to decide if 26.82% is usurious interest rate, we have to set out the following null and alternative hypotheses:

$$\begin{cases} H_0 : \mu = 26.82 \\ H_1 : \mu < 26.82 \end{cases}$$

Under the hypothesis H_0, one has $t = \frac{20.48025 - 26.82}{0.29985}\sqrt{12-1} = -70.123$. At 99% significance level, $-t_{0.99,11} = -2.72$. As $-70.123 < -2.72$, the null hypothesis must be rejected in favor of the alternative hypothesis. Therefore, the intuition expressed by the Supreme Court is confirmed by using purely statistical tools.

With respect to the third question, the rest of this paper will be devoted to the calculation of the money amount that the bank has to return to the borrower. Therefore, the objective of this paper is to determine the excessive amount paid by the borrower in concept of interest quotas, motivated by the high nominal interest rate applied to the outstanding balance and the mechanism of amortization which takes a long time to repay the contracted principal. Thus, by following the doctrine contained in the article 1 of the Law of July 23, 1908, on the Repression of Usury, the money to be returned by the bank must be the total amount of interests paid by the borrower throughout the entire operation.

The methodology used in this paper is the analysis of legal legislation and the application of the usual methods of loan repayment within the field of financial mathematics.

The organization of this paper is as follows. This Introduction has analyzed the sentence 149/2020, issued by the Supreme Court of Spain on March 4, 2020. Section 2 includes a formal definition of revolving cards and their main characteristics. Moreover, it shows the main perspective under which revolving cards have been studied, specifically from the point of view of consumer's traits. On the other hand, Section 3 presents a financial analysis of the loans operations implicit in revolving cards by distinguishing between the case of a constant payment (Subsection 3.1) and the case of a percentage payment of the outstanding balance (Subsection 3.2). Finally, Section 4 summarizes and concludes.

2. Concept and characteristics of revolving cards

A *revolving card* is a card which is used as a tool to hold a consumer credit. A revolving card exhibits the following *characteristics*:

- The credit has a *limit* which is the maximum money amount available to do shops or to obtain cash.
- There are three possible *modalities to repay* the amount due:
  1. By means of a single payment at the beginning of the immediately subsequent month, without interests.

2. By paying for a constant monthly amount within certain (minimum and maximum) limits agreed in the contract. Usually, these limits are 3% and 25%, respectively.
3. By paying for a constant percentage of the outstanding balance at each moment, within certain (minimum and maximum) limits agreed in the contract. Usually, these limits are 20 € and 200 €, respectively.

- Usually, these cards are linked to certain insurances and discounts on purchases.
- The user may do shops, withdraw and refund money, and the interests will be calculated on each balance.
- As the principal is repaid, the client recovers the line of credit, hence its name as revolving.

It is well known that, in most credit transactions, the existence of additional fees to be paid by the borrower and other characteristics, such as the use of linear discount as the underlying discount function or splitting time when using a nominal interest rate, can lead to a true interest rate of the operation greater than the contracted nominal interest rate (Cruz Rambaud and Sánchez Pérez, 2016). In other circumstances, the nominal interest rate is known by the borrower and it is very similar to the effective interest rate but the repayment method involves the payment of a very high amount of interest. This is the case of revolving cards whose repayment system will be analyzed in depth in Section 3. But before, we are going to collect the main contributions on this issue mainly from the point of view of consumer's traits.

In effect, Hamilton and Khan (2001) point out the existence of three types of credit card holder: (i) non-active card holders; (ii) non-interest paying active card holders; and (iii) interest paying active card holders (this is the case of convenience holders and revolvers).

A research of noteworthy interest consists in identifying the (socio-demographic and behavioral) characteristics of active card holders with the greatest propensity to revolve (i.e., to pay interest). This will be of great relevance for main issuers (in Spain, Banco Santander and BBVA) in order to develop suitable methodologies of credit risk management or credit scoring.

Among the behavioral characteristics, Hamilton and Khan (2001) highlight cash advances, minimum payment due and interest paid in previous periods. Tan et al. (2011), starting from a study in Malaysia, indicate that age, household size, income, education, loan commitments, and current-account ownership play a role in card holding. Specifically, age, loan commitments, previous card holdings, current-account ownership, and bad debt history affect the probability and level of card debt. On the other hand, multi-card holders are more likely to be credit revolvers than convenience users.

In the same line, Till and Hand (2003) design models for transaction time distributions in order to predict likely future behavior. Andreeva et al. (2005), in a research conducted in Belgium, find that the characteristics of a first purchase and the remaining credit available for use enhance the explanatory and predictive power of remaining characteristics.

Kim and DeVaney (2001) point out that education, income, real assets, credit card interest rate, number of credit cards, the credit limit, a positive attitude to credit, and behind schedule payments were positively related to the outstanding credit card balance.

3. A financial-mathematical approach to revolving cards

Let us consider a revolving card with the following characteristics:

- Principal amount: C_0 (in €).
- Monthly interest rate: *i*.
- Repayment by the French method.

3.1. Constant monthly payment

Assume that lender and borrower have agreed the payment of a constant monthly amount, denoted by *a*. In order to guarantee the regularity in the repayment process, it is necessary to require that such a payment is greater than the interests corresponding to the first month, that is to say:

$$a > C_0 i \, .$$

In this case, a repayment table can be built with the following parameters (see Table 2):

- Quota of the interest due at time *r*, denoted by I_r .
- Principal repaid at time *r*, represented by A_r .
- Outstanding balance at time *r*, denoted as C_r .
- Total amount repaid at time *r*, represented as M_r .

Table 2. Repayment table in case of a constant monthly payment.
Source: Own elaboration.

r	*a*	I_r	A_r	C_r	M_r
0	-	-	-	C_0	0
1	*a*	$I_1 = C_0 i$	$A_1 = a - I_1$	$C_1 = C_0 - A_1$	$M_1 = A_1$
2	*a*	$I_2 = C_1 i$	$A_2 = a - I_2$	$C_2 = C_1 + A_2$	$M_2 = M_1 + A_2$
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
$s-1$	*a*	$I_{s-1} = C_{s-2} i$	$A_{s-1} = a - I_{s-1}$	$C_{s-1} = C_{s-2} - A_{s-1}$	$M_{s-1} = M_1 + A_2$
s	*a*	$I_s = C_{s-1} i$	$A_s = a - I_s$	$C_s = 0$	$M_s = C_0$

Example 1. Let us consider a revolving card with the following characteristics:

- Principal amount: 2,000 €.
- Monthly interest rate: 2%.
- Repayment by the French method.
- Constant payment: 50 €.

The repayment process is partially shown in Table 3.

Table 3. Amortization table corresponding to Example 1.
Source: Own elaboration.

r	*a*	I_r	A_r	C_r
0	-	-	-	2.000,00 €
1	50,00 €	40,00 €	10,00 €	1.990,00 €
2	50,00 €	39,80 €	10,20 €	1.979,80 €
3	50,00 €	39,60 €	10,40 €	1.969,40 €
4	50,00 €	39,39 €	10,61 €	1.958,78 €
5	50,00 €	39,18 €	10,82 €	1.947,96 €
6	50,00 €	38,96 €	11,04 €	1.936,92 €
7	50,00 €	38,74 €	11,26 €	1.925,66 €
8	50,00 €	38,51 €	11,49 €	1.914,17 €
9	50,00 €	38,28 €	11,72 €	1.902,45 €
10	50,00 €	38,05 €	11,95 €	1.890,50 €

⋮	⋮	⋮	⋮	⋮
75	50,00 €	6,71 €	43,29 €	292,08 €
76	50,00 €	5,84 €	44,16 €	247,92 €
77	50,00 €	4,96 €	45,04 €	202,88 €
78	50,00 €	4,06 €	45,94 €	156,94 €
79	50,00 €	3,14 €	46,86 €	110,08 €
80	50,00 €	2,20 €	47,80 €	62,28 €
81	50,00 €	1,25 €	48,75 €	13,53 €
82	13,80 €	0,27 €	13,53 €	0,00 €

3.1.1. Determining the time to repay the principal amount

The time at which the principal amount is completely repaid is the instant $s+1$ defined by:

$$s+1 := \min\{r : C_0 \leq a \cdot a_{\overline{r}|i}\},$$

where $a_{\overline{r}|i} = \frac{1-(1+i)^{-r}}{i}$. In order to determine *s*, we are going to solve the following equation in *t*:

$$C_0 = a\frac{1-(1+i)^{-t}}{i}.$$

Simple algebra leads to the following solution:

$$t = -\frac{\ln\left(1-\frac{C_0 i}{a}\right)}{\ln(1+i)}.$$

Consequently, $s = \text{int}(t)$, where “int” is the function “integer part”.

Example 2. Let us apply the former methodology to the revolving card defined in Example 1. In this case,

$$t = -\frac{\ln\left(1-\frac{40}{50}\right)}{\ln(1+0{,}02)} = 81.27.$$

Thus, $s = \text{int}(81.27) = 81$ months and then $s+1 = 82$ months.

Observe that *t* is decreasing with respect to *a* and increasing with respect to *i*, as shown, for several values of these two parameters, in Table 4 and Figure 1.

Table 4. Values of *t* according to different values of *a* and *i*.

Source: Own elaboration.

		Values of *i*			
		1.50%	**1.75%**	**2.00%**	**2.25%**
Values of *a*	**50**	62	70	**82**	104
	60	47	51	56	63
	70	38	40	43	47
	80	32	34	36	38

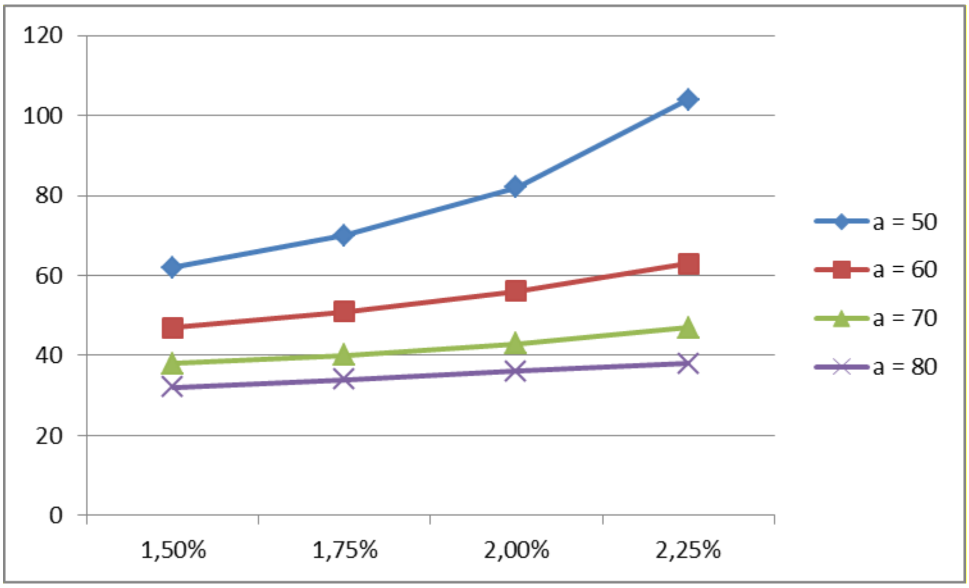

Figure 1. Values of *t* according to different values of *a* and *i*.

Source: Own elaboration.

3.1.2. Determining the total amount of interests

The verdict of the Court of First Instance number 8 of Santander (Spain), confirmed by the Provincial Court, sentenced the applicant to pay the amount exceeding the total of the principal loaned taking into account all amounts already paid by the borrower. Therefore, the objective of this subsection will be to determine the total amount of interests paid by the borrower. In general, the quota of interest due at time *r* is $I_r = a - A_r$, where A_r is the principal repaid at time *r*. It is well known that, in the French repayment method, the principal repaid is a geometric progression whose first term is $A_1 = a - C_0 i$ and whose common ratio is $1+i$, that is to say:

$$A_r = A_1(1+i)^{r-1} = (a - C_0 i)(1+i)^{r-1}.$$

Thus, the quota of interest corresponding to the *r*-th period is:

$$I_r = a - (a - C_0 i)(1+i)^{r-1}$$

and, consequently, the sum of the *s* first quotas of interest is:

$$\sum_{r=1}^{s} I_r = sa - (a - C_0 i)s_{\overline{s|}i},$$

where $s_{\overline{r|}i} = \dfrac{(1+i)^r - 1}{i}$. Moreover, the quota of interest corresponding to the last period is:

$$I_{s+1} = (C_0 - A_1 s_{\overline{s|}i})i = C_0 i - (a - C_0 i)s_{\overline{s|}i} i.$$

Therefore, the overall amount of interests is:

$$\sum_{r=1}^{s+1} I_r = (sa + C_0 i) - (a - C_0 i)s_{\overline{s|}i}(1+i).$$

Example 3. With the information of Example 1, one has $\sum_{r=1}^{82} I_r = 2{,}063.80$ €.

Observe that the overall amount of interests is decreasing with respect to *a* and increasing with respect to *i*, as shown, for several values of these two parameters, in Table 5 and Figure 2.

Table 5. Overall amount of interests according to different values of *a* and *i*.
Source: Own elaboration.

		Values of *i*			
		1.50%	**1.75%**	**2.00%**	**2.25%**
Values of *a*	**50**	1,077.25	1,470.04	**2,063.80**	3,174.35
	60	793.44	1,027.92	1,328.83	1,738.36
	70	631.20	796.81	995.22	1,239.32
	80	525.59	653.28	800.23	972.36

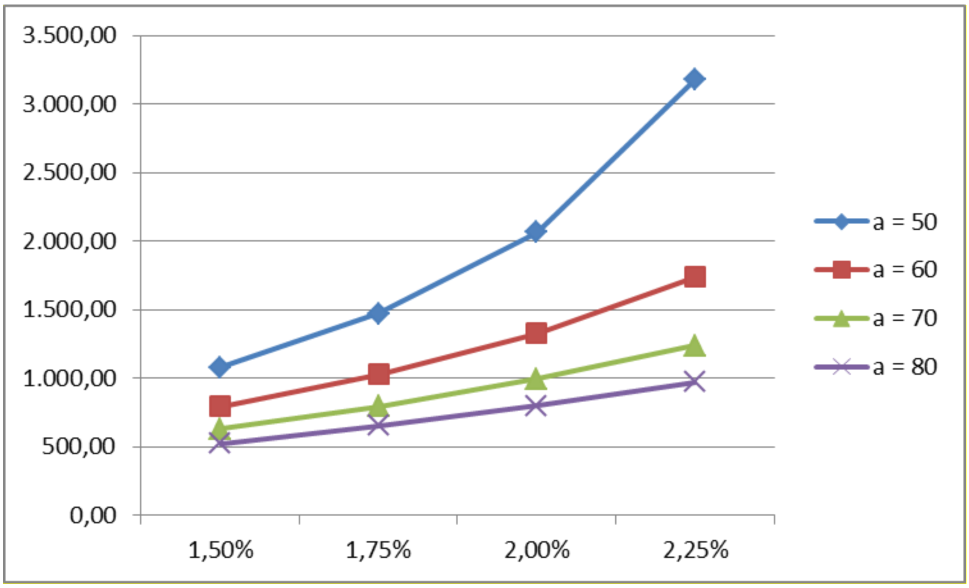

Figure 2. Overall amount of interests according to different values of *a* and *i*.
Source: Own elaboration.

3.2. Payment of a given percentage over the outstanding balance

Assume that lender and borrower have agreed the payment of a constant percentage over the outstanding balance, denoted by *p*. In order to guarantee the regularity of the repayment process, it is necessary to require that:

$$p > i.$$

In this case, a repayment table can be built showing the main parameters (see Table 6).

Table 6. Repayment table in case of a constant percentage over the outstanding balance. **Source**: Own elaboration.

r	a_r	I_r	A_r	C_r
0	-	-	-	C_0
1	$a_1 = pC_0$	$I_1 = C_0 i$	$A_1 = (p-i)C_0$	$C_1 = [1-(p-i)]C_0$
2	$a_2 = p[1-(p-i)]C_0$	$I_2 = [1-(p-i)]C_0 i$	$A_2 = (p-i)[1-(p-i)]C_0$	$C_2 = [1-(p-i)]^2 C_0$
3	$a_3 = p[1-(p-i)]^2 C_0$	$I_3 = [1-(p-i)]^2 C_0 i$	$A_3 = (p-i)[1-(p-i)]^2 C_0$	$C_3 = [1-(p-i)]^3 C_0$
$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
s	$a_s = p[1-(p-i)]^{s-1} C_0$	$I_s = [1-(p-i)]^{s-1} C_0 i$	$A_s = (p-i)[1-(p-i)]^{s-1} C_0$	$C_s = [1-(p-i)]^s C_0$

Observe that, in this case, all parameters in Table 6 are variable in geometric progression. This could be in contradiction with the result obtained by Cruz Rambaud and Del Pino (2018) which states that, when the repaid principal varies in geometric progression, then the payment is an arithmetic-geometric sequence. However, the two statements are compatible as shown by the following proposition.

Proposition 1. Table 6 is a particular case of Section 4 in Cruz Rambaud and Del Pino Álvarez (2018).

Proof. In effect, it suffices to take $A_1 = (p-i)C_0$ and $r = 1-(p-i)$ in the aforementioned referenced paper. ☐

Example 4. With the information of Example 1, if the percentage of constant payment is 5%, then the repayment process is partially shown in Table 7.

Table 7. Amortization table corresponding to Example 4.
Source: Own elaboration.

r	*a*	I_r	A_r	C_r
0	-	-	-	2.000,00 €
1	100,00 €	40,00 €	60,00 €	1.940,00 €
2	97,00 €	38,80 €	58,20 €	1.881,80 €
3	94,09 €	37,64 €	56,45 €	1.825,35 €
4	91,27 €	36,51 €	54,76 €	1.770,59 €
5	88,53 €	35,41 €	53,12 €	1.717,47 €
6	85,87 €	34,35 €	51,52 €	1.665,94 €
7	83,30 €	33,32 €	49,98 €	1.615,97 €
8	80,80 €	32,32 €	48,48 €	1.567,49 €
9	78,37 €	31,35 €	47,02 €	1.520,46 €
10	76,02 €	30,41 €	45,61 €	1.474,85 €
⋮	⋮	⋮	⋮	⋮
75	50,00 €	6,71 €	43,29 €	292,08 €
92	6,26 €	2,50 €	3,75 €	121,35 €
93	6,07 €	2,43 €	3,64 €	117,71 €
94	5,89 €	2,35 €	3,53 €	114,18 €
95	5,71 €	2,28 €	3,43 €	110,75 €
96	5,54 €	2,22 €	3,32 €	107,43 €
97	5,37 €	2,15 €	3,22 €	104,20 €
98	5,21 €	2,08 €	3,13 €	101,08 €
99	5,05 €	2,02 €	3,03 €	98,05 €

3.2.1. Determining the time to repay the principal amount

In this case, the repayment process is up to a given amount denoted by *K*. Thus, the time at which the principal amount is completely repaid is the instant $s+1$ defined by:

$$s+1 := \min\{r : C_r \geq K\}.$$

Therefore, we have to solve the following equation in *t*:

$$[1-(p-i)]^t C_0 = K.$$

Simple algebra leads to the following solution:

$$t = \frac{\ln K - \ln C_0}{\ln[1-(p-i)]}.$$

Consequently, $s = \text{int}(t)$, where "int" is the function "integer part".

Example 5. With the information of Example 1, *p* = 5% and *K* = 100 €, we can obtain *s* = 98 months and then $s+1=99$ months.

Observe that *t* is decreasing with respect to *p* and increasing with respect to *i*, as shown, for several values of these two parameters, in Table 8 and Figure 3.

Table 8. Values of *t* according to different values of *p* and *i*.
Source: Own elaboration.

		Values of *i*			
		1.50%	**1.75%**	**2.00%**	**2.25%**
Values of *p*	**4%**	119	132	149	170
	5%	85	91	**99**	108
	6%	66	69	74	79
	7%	53	56	59	62

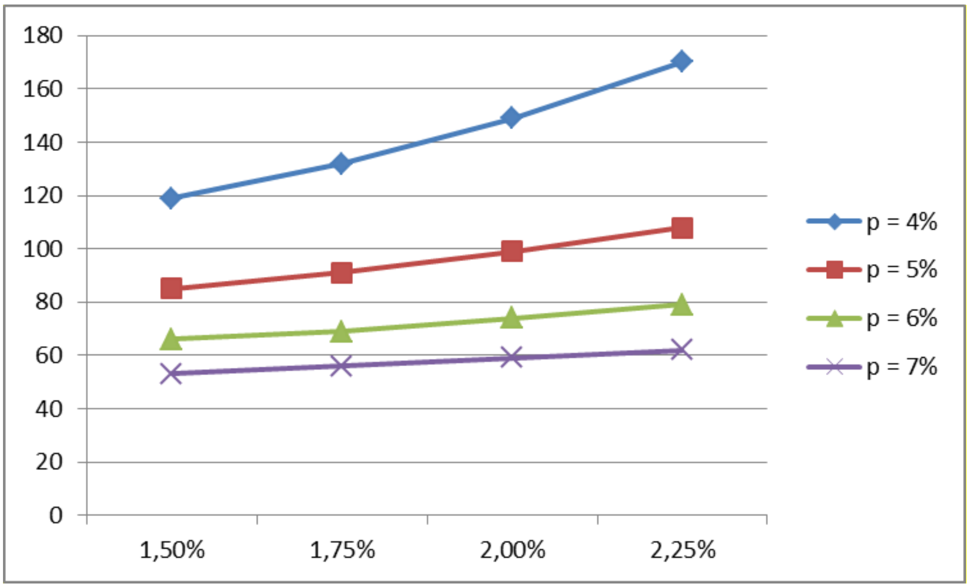

Figure 3. Values of *t* according to different values of *p* and *i*.
Source: Own elaboration.

3.2.2. Determining the total amount of interests

In this case, the quota of interest due at time *r*, $I_r = [1-(p-i)]^{r-1} C_0 i$, is a geometric progression whose first term is $C_0 i$ and whose common ratio is $1-(p-i)$. Consequently,

$$\sum_{r=1}^{s} I_r = C_0 i \frac{1-[1-(p-i)]^s}{p-i}.$$

However, for the last period the quota of interest is:

$$I_{s+1} = \left[C_0 - C_0(p-i)\frac{1-[1-(p-i)]^s}{p-i}\right] i = I_1 - (p-i)\sum_{r=1}^{s} I_r.$$

Therefore,

$$\sum_{r=1}^{s+1} I_r = C_0 i \left\{ 1 + [1-(p-i)] \frac{1-[1-(p-i)]^s}{p-i} \right\}.$$

Example 6. With the information of Example 1, one has $\sum_{r=1}^{99} I_r = 1{,}267.97$ €.

Observe that the overall amount of interests is decreasing with respect to *p* and increasing with respect to *i*, as shown, for several values of these two parameters, in Table 9 and Figure 4.

Table 9. Overall amount of interests according to different values of *p* and *i*.
Source: Own elaboration.

		Values of *i*			
		1.50%	**1.75%**	**2.00%**	**2.25%**
Values of *p*	**4%**	1,141.02	1,478.41	1,901.44	2,443.58
	5%	815.66	1,023.66	**1,267.97**	1,555.83
	6%	634.74	782.39	951.24	1,141.41
	7%	518.25	634.13	761.20	901.01

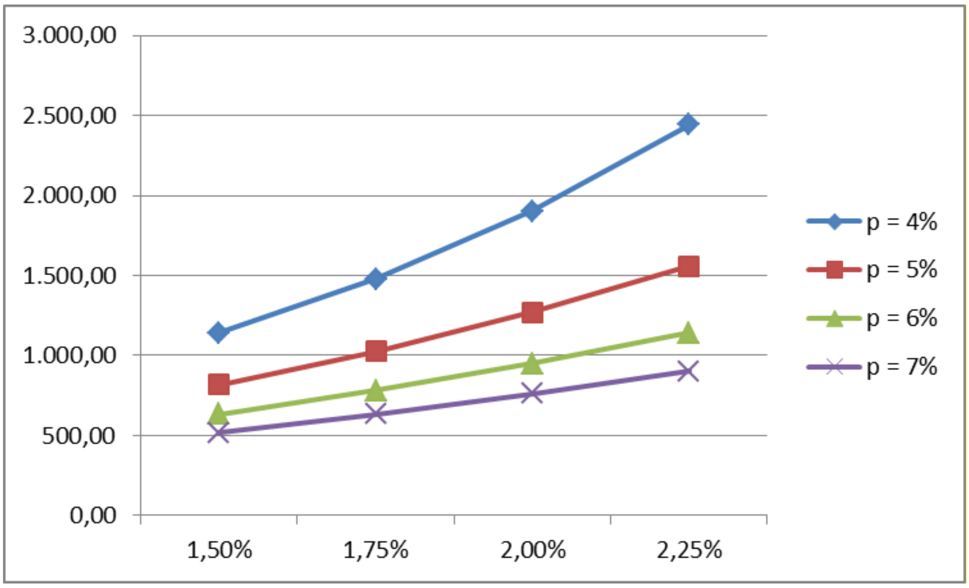

Figure 4. Overall amount of interests according to different values of *p* and *i*.
Source: Own elaboration.

4. Conclusion

In this paper, we have analyzed the main characteristics of the recent sentence 149/2020, issued by the Supreme Court of Spain on March 4, 2020. Firstly, we have set out the concept of "normal interest of money" in this context. Additionally, we have proposed a statistical methodology able to decide if a specific rate of interest can be considered or not as usurious. In our opinion, this could be an important tool to be applied by Spanish courts in other presented appeals on the same topic.

The third question is the calculation of the amount to be returned by the bank to the borrower. According to the article 1 of the Law of July 23, 1908, on the Repression of Usury, a loan contract in this context is null, whereby we have determined the total amount paid by the borrower in concept of interests. This calculation has been made in two cases: constant monthly payment and payment of a constant percentage of the outstanding balance. Both cases have been analyzed in detail, by determining the time which is necessary to repay the principal amount and by calculating the total amount of interests.

This paper aims to be a tool for academicians and practitioners when dealing with loan contracts issued through credit and revolving cards. Given the recentness of this sentence, further research will be needed when analyzing the future jurisprudence on this topic in Spanish courts.

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