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The social value of gambling: surplus estimates by gambling types for France

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Abstract: We estimate the social surplus of gambling in France by adding three components: consumer surplus, producer surplus and taxation revenue. To estimate consumer surplus, we use the rational benchmark approach, which attributes a loss of welfare (i.e. a negative surplus) to problem gamblers depending on their level of excess spending compared with recreational gamblers. Using data for the year 2019 and considering only legal gambling, we find that the consumer surplus is negative for the gambling activity as a whole. When we add the producer surplus and the taxation revenue to the consumer surplus, we find that the social surplus is more likely to be negative, ranging from -45 billion euros in the pessimistic scenario to +6 billion euros in the optimistic scenario. There are, however, important differences between gambling types. The social surplus is negative in all scenarios for poker and sports betting. Conversely, it is positive in all scenarios for draw lotteries and scratch cards.

Keywords: gambling; consumer surplus; rational benchmark; producer surplus; taxation revenue; social surplus.

1. Introduction

Gambling is a leisure activity with a risk of excess. The Diagnostic and Statistical Manual of Mental Disorders (DSM) indeed recognizes the existence of a gambling disorder. Negative impacts of problem gambling include job loss, depression and anxiety, poor health, relationship breakdown, and financial hardship (see e.g. Productivity Commission, 1999). The existence of these damages is a concern for the public authorities in charge of regulating this activity in

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many countries. If they are to maximize social welfare, they indeed face a trade-off between the benefits derived from the enjoyment of gambling, the profits of gambling companies and the government revenues from taxation, and the costs of problem gambling.

In this article, we provide an analytical framework for estimating the social surplus of gambling. It relies on the addition of three components: consumer surplus, producer surplus and taxation revenue. The most challenging part is estimating the consumer surplus for gamblers who suffer damages because of a gambling disorder. We adhere to theories that addictive behaviours, such as compulsive gambling, are deviations from the framework of perfect rationality (e.g. Gruber and Köszegi, 2001; Bernheim and Rangel, 2004). This implies that we must include "internalities", i.e. self-imposed costs incorrectly taken into account during the decision-making process, when estimating the consumer surplus.

The value of internalities can be measured by ad hoc studies. Pioneers of such studies were Lesieur and Anderson (1995) in Illinois and Thompson et al. (1996) in Wisconsin. More ambitious and large-scale studies were then conducted by Gerstein et al. (1999) in the United States and the Productivity Commission (1999) in Australia. They implemented dedicated surveys to estimate the monetary value of various "internal costs" attributed to gambling, such as depression, job loss and divorce. More recent pieces of work (e.g. Thorley et al., 2016 for Britain and Fielder, 2016 for Germany) combine various data sources—typically national prevalence surveys and national or international academic publications—to provide cost estimates.

This approach to consumer surplus estimate is rich but difficult to implement rigorously, as it requires that (i) it is exhaustive, i.e. investigate all possible negative impacts of problem gambling on gamblers' welfare, (ii) it is designed to measure causal effects, and (iii) its results are expressed in monetary terms. Another possible approach, that we adopt in this article, is to measure the consumer surplus of gamblers relying on the rational benchmark approach. It consists of computing a net consumer surplus integrating a welfare loss from excess spending. The advantage of this approach is that it requires only a parsimonious set of data.

We describe the analytical framework we use to measure the social surplus in greater detail in section 2. We then apply it to the French gambling sector for the year 2019. We describe the data in section 3. Section 4 shows the estimates, disaggregated by type of gambling, for the baseline scenario as well as for a series of alternative scenarios providing a sensitivity analysis. We discuss our results in section 5. In short, we find that the social surplus for the entire gambling sector ranges between -45 and +6 billion euros. However, there are significant differences between gambling types. For poker and sports betting, the social surplus is negative in all scenarios. It means that the producer surplus and the taxation revenue are never sufficient to compensate for the negative consumer surplus. Conversely, the social surplus is positive in all scenarios for draw lotteries and scratch cards. In these cases, either the consumer surplus is positive, or the producer surplus and the taxation revenue exceed the losses.

2. Analytical Framework

In our framework, the social surplus (SS) is measured by:

$$SS = CS + PS + TR \quad (1)$$

with CS the consumer surplus, PS the producer surplus and TR the taxation revenue.

Importantly, consumers are split into two groups: a group of rational consumers and a group of addicted consumers. Hence the global consumer surplus is defined by:

$$CS = RCS + ACS \quad (2)$$

with RCS the surplus of rational consumers and ACS the surplus of addicted consumers. The method used to estimate each of these elements is described below.

The rational consumer surplus

The surplus of rational consumers is measured using the traditional approach to measure consumer surplus, i.e. by calculating the surface area RCS in Figure 1, where P^* represents the equilibrium price, $Q^*$the quantity consumed and line D the demand schedule of rational consumers.[1]

It can be obtained by applying the following formula:

$$RCS = \frac{S}{2|\eta_R^*|} \quad (3)$$

with $S = P^*Q^*$, the spending of rational consumers, and η_R^*, the price elasticity of rational demand (see Massin and Miéra, 2020, Appendix A, for the computation details of this equation).

[1] The concepts of price and quantity are a bit peculiar in the gambling sector. We will explain in more detail what they mean and how we measure them in subsection 3.1.

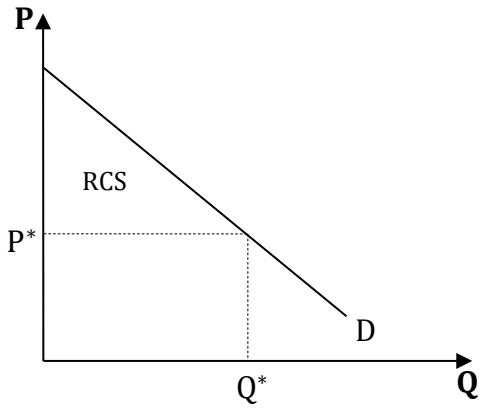

Figure 1. Graphical representation of the rational consumer surplus

The addicted consumer surplus

The measure of ACS is taken from Massin and Miéra (2020), who propose a revised version of the Productivity Commission's (1999) formula. This measure has been developed to assess the surplus of a group of addicted consumers, defined as agents assumed to overconsume a commodity compared to what would maximize their welfare. The net consumer surplus for this group is computed by considering a counterfactual where its unbiased, or "true", preferences would be the same as those of a benchmark group of rational consumers. This approach thus distinguishes a "reasonable" part of spending (corresponding to what consumers would have spent if they had been rational), providing a welfare gain, and an "excessive" part of spending, providing a welfare loss. The welfare loss, or negative surplus, can be seen as a way of measuring "internalities", i.e. the costs that consumers involuntarily impose on themselves because of bounded rationality (see e.g., Gruber, 2002).

In Figure 2, P^* represents the equilibrium price, line D_A the demand schedule of addicted consumers for which the optimal consumption is Q_A^*, line D_R the hypothetical demand schedule of rational consumers, which is associated with the optimal consumption Q_R^* and the satiation point Q_R^S. The net consumer surplus is obtained by subtracting area L from area G: $ACS = G - L$.

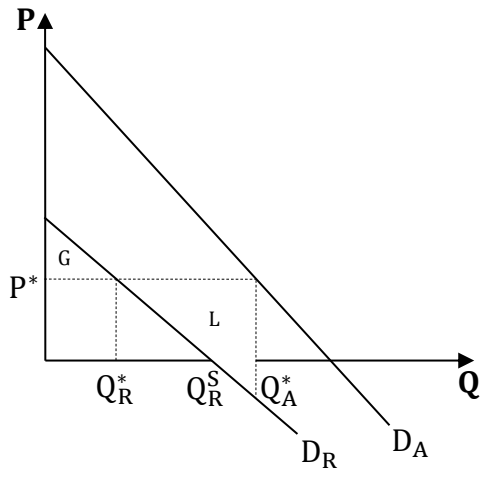

Figure 2. Graphical representation of the addicted consumer surplus

Massin and Miéra (2020) show that the following formulas are appropriate:

$$G = \frac{R^2}{2R|\eta_R^*|} \tag{4}$$

$$L = \frac{E^2}{2R|\eta_R^*|} \tag{5}$$

$$ACS = \frac{R^2 - E^2}{2R|\eta_R^*|} \tag{6}$$

with $R = P^*Q_R^*$, the rational spending, $E = P^*(Q_A^* - Q_R^*)$, the excess spending, and η_R^*, the price elasticity of the rational demand at equilibrium.

The producer surplus

The textbook microeconomic approach to measuring producer surplus under the assumption of linearity of the supply function is to apply the following formula:

$$PS = \frac{NR}{2\varepsilon^*} \tag{7}$$

where NR is the net revenue (i.e. revenue excluding taxes), and ε^* is the price elasticity of supply.

Taxation revenue

The taxation revenue (TR) requires no computation. The data collected can be used directly.

3. Data and methods

3.1 Gambling spending and revenue at the aggregate level

The implementation of our analytical framework requires data on gambling spending and revenue. They fundamentally rely on the notions of price and quantity, which have quite specific definitions in the gambling sector context: price can be defined as the expected loss per stake[2] and quantity as the number of stakes. Our numerical application does not require separate price and quantity data. The product of the two, which is more readily available, is sufficient. More precisely, we first use the gross gambling revenue (GGR), defined as the difference between the amount wagered and the amount paid out in winnings, as the measure of spending necessary to calculate the consumer surplus. Then, the difference between GGR and TR provides the net gambling revenue (NGR), necessary to compute the producer surplus.

Both GGR and TR are provided by the French Monitoring Centre for Gambling, combining two primary sources of data: data provided by the gambling operators (GGR) and data provided by public institutions (TR). Table 1 summarizes these data.

Table 1. Gambling activity (in million €; year 2019)

	Gross gambling revenue (GRR)	**Taxation revenue (TR)**	**Net gambling revenue (NGR)**
Draw lotteries	2 285	1 656	629
Scratch cards	2 410	1 512	898
Sports betting	1 659	768	891
Horse racing	2 050	711	1 339
Slot machines	2 027	1 115	912
Poker	333	119	214
Table games (w/o poker)	332	183	149
All gambling	11 095	6 063	5 032

Sources: The data on gross gambling revenue comes from the gambling operators, and the data on taxation revenue comes from the Ministry of Finance, the Ministry of the Interior, and the Online Gambling Regulatory Authority. Both are collected by the French Monitoring Centre for Gambling.

Only legal gambling is considered here. Note that for casinos the breakdown of taxation revenue between slot machines, poker and other table games is not available. We assume that the distribution of taxes between these three categories is identical to the distribution of GGR, i.e. that the tax rate is homogeneous.

[2] The price uniqueness implicitly requires that the expected loss rate is identical for all gamblers and homogeneous within each gambling type, which is a simplifying working assumption.

3.2 Identification of gamblers categories

The analytical framework requires that rational and addicted consumers be distinguished for measuring the consumer surplus. In our application to gambling, we use a distinction between recreational gamblers and problem gamblers, based on the overall score on the Problem Gambling Severity Index (PGSI), a quantitative sub-section of the Canadian Problem Gambling Index (Ferris & Wynne, 2001). It should be noted that this tool was designed to identify those who are very likely to be experiencing harm from gambling and who may have lost control of their gambling, not to capture individuals who may or may not be addicted in a clinical sense. This limitation in our approach is unavoidable given the available data and is mitigated by the sensitivity analysis that we will perform. We discuss this in more detail below.

PGSI scores were collected in France on a representative sample of the population for the first time in 2014 and for the second time in 2019, as part of the Health Barometer, a national survey carried out by the French national public health agency (Santé publique France).[3] In this study, we use data from the 2019 survey. 10,352 persons aged 18 to 85 years were interviewed using a computer-assisted telephone interviewing (CATI) system from January 2019 to June 2019.

The PGSI consists of 9 items with answers reported on a 4-point Likert scale ('never'; 'sometimes'; 'most of the time'; 'almost always'). Respondents were categorized as non-problem gamblers (PGSI score = 0); low-risk gamblers (score = 1–2); moderate-risk gamblers (score = 3–7); and problem gamblers (score = 8−27). Since our analytical framework requires only two categories (recreational and problem gamblers), a reclassification is needed. The reclassification is straightforward for gamblers with a PGSI score of 0 (non-problem gamblers according to the PGSI classification and recreational gamblers in our framework) and 8-27 (problem gamblers according to the PGSI classification and in our framework). It is trickier to reclassify gamblers with a PGSI score of 1-2 (low-risk gamblers) and 3-7 (moderate-risk gamblers)–see, e.g., Currie et al. (2013) and Stone et al. (2015). Many gamblers with a low or intermediate PGSI score self-report gambling-related harms (Li et al., 2016; Browne et al., 2017; Browne and Rockloff, 2018). It follows that, collectively, most of the damage can occur at this score level, given the number of players involved, in line with the prevention paradox (Browne and Rockloff, 2018). However, gamblers with a low or intermediate PGSI score do not systematically experience harm and do not necessarily have a gambling disorder from a clinical perspective (Ladouceur et al., 2005; Williams and Volberg, 2014; Samuelsson et al., 2019). It is then questionable to treat them all as problem gamblers whose gambling behaviour would result from some form of irrational decision-making rather than consumption

[3] See Soullier et al. (2021) for a presentation of the Health Barometer.

preferences.[4] Accordingly, there is no one best way to characterize problem gambling. Following Currie et al. (2009), we adopt a compromise position for baseline estimates by classifying low-risk gamblers (PGSI score 1-2) as recreational gamblers and moderate-risk gamblers (PGSI score 3-7) as problem gamblers. To limit the bias related to the aggregation of problem gamblers (PGSI score 3-27), we compute the surpluses of problem gamblers with a PGSI score of 3-7 and 8-27 separately.[5] We also perform a sensitivity analysis with alternative thresholds of problem gambling by considering problem gambling at a PGSI score of 1+ and 8+ (rather than 3+).

3.3 Spending by gamblers categories

The measure of consumer surplus requires splitting the overall spending (measured by the GGR, see subsection 3.1) in recreational and excess spending among the different categories of gamblers. The necessary data comes, like the PGSI scores, from the 2019 Health Barometer. The participants were indeed also asked to report their spending on each gambling activity either per occasion or on a weekly, monthly, or annual basis by answering the question (translated from French): "How much money do you usually spend per session when you play these games? We want to know the amount of money you take out of your pockets when you gamble. This does not include money won and put back into gambling." [6] Total spending was calculated on an annual basis for each gambling type and was then used to derive the distribution of spending among gamblers. In parallel, we estimate the recreational spending of problem gamblers using the median spending of regular (i.e., playing weekly or more) recreational gamblers.[7] The method used is identical to that of the Productivity Commission (1999, vol. 3, p. C19). The main steps are the following: (i) we establish the median spending of regular recreational gamblers; (ii) we set the recreational spending of problem gamblers

[4] This issue substantially reflects the distinct nature of a public health approach and a clinical one. The matter is rather complex, and the overview is quite schematic. See Delfabbro and King (2017) and Browne and Rockloff (2018) on the relevance of the prevention paradox for gambling, and Browne and Rockloff (2017) and Delfabbro and King (2020), on the difference between gambling-related harms and gambling disorders.

[5] The measure of problem gambler surplus (eq. 6) is non-linear. Thus, the measurement obtained in a group with a PGSI score of 3-27 is different from that obtained by summing the surplus of subgroups with a PGSI score of 3-7 and 8-27. It then seems reasonable to separate the two groups in the calculation to preserve their characteristics rather than assigning them those of an aggregate group.

[6] This way of defining gambling spending is equivalent to that of the GGR (which removes winnings from bets). The issues of proper understanding of the question and reliability of self-reported data are addressed in the discussion.

[7] Note that this method is not usable for slot machines, poker, and other table games because of the small number of regular recreational gamblers. As pointed out by the Productivity Commission (1999, vol. 3, p. C19) for the casino table game category: "even 'enthusiastic' recreational players, appear not to play weekly". We then use the median spending of all recreational gamblers rather than regular recreational gamblers for these games.

individually by comparison with this median (we retain the actual spending as recreational spending when it is inferior to this median); (iii) we estimate the overall share of recreational spending of problem gamblers using the data on individual recreational spending. Table 2 summarizes the distribution of gamblers, the distribution of spending, and the recreational spending share, per PGSI score.

The measure of consumer surplus involves the spending of recreational gamblers (S), the rational spending of problem gamblers (R), and the excess spending of problem gamblers (E), which are easily derivable from Tables 1 and 2. The distribution of overall spending (Table 2) allows us to derive total spending for each group directly from overall spending (GGR in Table 1). The share of recreational spending within each group (Table 2) then allows us to divide total spending into recreational and excessive spending for each group. The different amounts of spending are listed in Table 3.

3.4 Price elasticity of recreational demand

The measure of consumer surpluses involves the price elasticity of recreational demand. A proper estimation of this elasticity requires time series data on the specific demand of recreational gamblers for the different types of gambling as well as a robust identification strategy, which are not available. There exist estimates of the price elasticity of demand for different gambling types in the literature, such as those compiled by Gallet (2015) and summarized in the Appendix (Table A.1). However, beyond the issue of the reliability of such estimates, these data are not appropriate here for various reasons: (i) the estimates are not available for all gambling types; (ii) the estimates are not specific to France and do not account for national particularities; (iii) the estimates of the price elasticity of recreational demand (η_R^*) are surely different from that of overall demand (η_D^*). It then seems relevant to make an ad hoc calibration for all gambling and to perform a sensitivity analysis with alternative calibrations. Simple microeconomic reasoning can help to carry out this calibration by observing that the majority of operators are in a monopoly situation in the French gambling market.[8] It is well-known that monopolies theoretically set prices in a region where the demand is not inelastic ($|\eta_D^*| \geq 1$).[9] It is also well known that firms maximize their revenue when the price elasticity of demand is unitary ($|\eta_D^*| = 1$). Thus, a unitary price elasticity seems to be a reasonable assumption for the overall demand.

[8] The Française des Jeux (FDJ) has a monopoly on offline and online lottery games and offline sports betting. The Pari Mutuel Urbain (PMU) has a monopoly on offline horse racing betting. Slot machines and table games are authorized only in land-based casinos, which are subject to an operating licence from the Ministry of the Interior. Online sports and horse racing betting and poker are the only games officially open to competition.

[9] See Tirole (1988, p. 66 et seq.) on monopoly pricing behaviour.

Table 2. Gamblers and spending per PGSI score (in percent; year 2019)

	Distribution of gamblers			Distribution of overall spending			Share of recreational spending		
	PGSI 0-2	**PGSI 3-7**	**PGSI 8-27**	**PGSI 0-2**	**PGSI 3-7**	**PGSI 8-27**	**PGSI 0-2**	**PGSI 3-7**	**PGSI 8-27**
Draw lotteries	93.77	4.43	1.80	74.66	14.99	10.35	100.00	14.87	13.91
Scratch cards	92.21	5.73	2.05	60.50	20.17	19.33	100.00	29.12	17.24
Sports betting	80.91	12.88	6.21	37.27	23.77	38.96	100.00	11.60	5.42
Horse racing	82.56	10.53	6.92	78.64	9.08	12.27	100.00	21.28	9.85
Slot machines	86.25	8.20	5.55	65.65	19.83	14.52	100.00	8.49	8.65
Poker	81.75	9.85	8.40	42.30	31.88	25.82	100.00	1.26	1.30
Table games (w/o poker)	85.52	10.40	4.08	48.16	42.94	8.89	100.00	4.81	7.69

Sources: All data are secondary data based on the French Health Barometer. Both data on gamblers and spending distributions come from the French Monitoring Centre for Gambling. The data on recreational spending of problem gamblers was computed by the authors using the median spending of regular recreational gamblers (PGSI 0-2), except for slot machines, poker, and table games (recreational spending based on the median spending of all recreational gamblers, regular or not).

Note: The distribution of gamblers is expressed as a percentage of the number of gamblers for the considered gambling. The distribution of overall spending is expressed as a percentage of the overall spending for the considered gambling. The share of recreational spending is expressed as a percentage of the spending for the considered gamblers.

Table 3. Total, recreational, and excess spending by category of gamblers (in million €; year 2019)

	Overall spending (GGR)	**Recreational gamblers**			**Problem gamblers**					
		PGSI 0-2			**PGSI 3-7**			**PGSI 8-27**		
		Total spending (S)	Recreational spending	Excess spending	Total spending	Recreational spending (R)	Excess spending (E)	Total spending	Recreational spending (R)	Excess spending (E)
Draw lotteries	2 285	1 706	1 706	0	342	51	292	236	33	204
Scratch cards	2 410	1 458	1 458	0	486	142	345	466	80	386
Sports betting	1 659	618	618	0	394	46	348	646	35	611
Horse racing	2 050	1 612	1 612	0	186	40	147	252	25	227
Slot machines	2 027	1 331	1 331	0	402	34	368	294	25	269
Poker	333	141	141	0	106	1	105	86	1	85
Table games (w/o poker)	332	160	160	0	142	7	136	29	2	27

Note: The total spending for each group is computed by applying the distribution of overall spending (Table 2) to the overall spending (GGR, Table 1). The recreational spending is computed by applying the share of recreational spending (Table 2) to the total spending of the considered group. Excess spending is the difference between total spending and recreational spending.

Nevertheless, the overall demand aggregates the demand of recreational gamblers and problem gamblers, and recreational gamblers certainly have a more elastic demand than problem gamblers (Productivity Commission, 1999). Considering this, we compute the baseline consumer surplus by assuming that the price elasticity of recreational demand is equal to 1.25 in absolute value ($|\eta_R^*|$ = 1.25). Given the relatively arbitrary nature of this calibration, we also perform a sensitivity analysis with alternative calibrations of 0.75 and 1.75.

3.5 Price elasticity of supply

The measure of producer surplus involves the price elasticity of supply. A proper estimation of this elasticity requires both accurate data on the production process of the gambling industry and a robust statistical identification strategy, which are not at our disposal. There is also no estimate of the price elasticity of supply available for gambling. This leads us to propose an ad hoc calibration for all gambling combined with a sensitivity analysis, as is the case for the price elasticity of recreational demand. For this purpose, we use the producer surplus estimates performed by the Allen consulting group (2011) for Tasmania using an accounting approach.[13] The estimates obtained lead to a gross surplus rate—defined as the surplus in relation to GGR—of between 19% and 26% depending on the type of gambling (26% for casinos, 25% for Keno and slot machines, 19% for sport and horse racing betting). The centre of the range (22.5%) has a remarkable property when applied to French data: it corresponds approximately to a unitary price elasticity of supply (ε^* = 1).[14] It then seems reasonable to compute the producer surplus using a unitary price elasticity in the baseline scenario. If we extend the range from 19%- 26% to 15%-30%, to account for structural differences between the gambling sector in the two countries, we obtain price elasticities of supply corresponding approximately to 0.75 and 1.50 (Table A.2 in the Appendix). We then use alternative calibrations of 0.75 and 1.50 in the sensitivity analysis.

4. Results

4.1 Baseline estimates

In the baseline scenario, we estimate social surplus by setting problem gambling at a threshold of 3+ (problem gamblers = PGSI 3+) and by using a price elasticity of recreational demand of

[13] I.e. an approach where the producer surplus is measured as: $PS = NGR - VC = \Pi + FC$, where VC is the variable costs, Π is the economic profit, and FC is the fixed costs. To our knowledge, there is no other available estimate of producer surplus in the literature.

[14] See Table A.2 in the Appendix for details of the correspondence.

1.25 (in absolute value) and a unitary price elasticity of supply—calculation details are provided in the results tables.

Table 4 summarizes estimates for the consumer surplus. The estimates for recreational gamblers are obviously strictly positive. The surplus of problem gamblers is negative for gambling as a whole and for all gambling types.[15] The gain from recreational gamblers does not offset the loss of problem gamblers for any gambling type. As a result, the overall consumer surplus is negative for each gambling type and for the whole gambling sector. The overall loss on consumption is about 15 billion euros for the gambling activity as a whole. Sports betting and poker make the largest contribution to this loss (about 5 billion euros each).

Table 4. Consumer surplus estimates (in million €; year 2019)

	Recreational gamblers surplus PGSI 0-2 (RCS)	**Problem gamblers surplus**			**Overall gamblers surplus (CS=RCS+PGS)**
		PGSI 3-7	**PGSI 8-27**	**Total (PGS)**	
Draw lotteries	682	-647	-491	-1 138	-456
Scratch cards	583	-279	-708	-987	-404
Sports betting	247	-1 044	-4 256	-5 300	-5 052
Horse racing	645	-201	-821	-1 022	-377
Slot machines	532	-1 572	-1 125	-2 697	-2 165
Poker	56	-3 280	-2 572	-5 852	-5 796
Table games (w/o poker)	64	-1 070	-130	-1 200	-1 136
All gambling	2 810	-8 094	-10 102	-18 196	-15 386

Note: The surpluses of recreational and problem gamblers are computed using formulas (3) and (6), respectively, the spending data from Table 2, and a price elasticity of recreational demand of 1.25 in absolute value ($|\eta_R^*| = 1.25$).

Table 5 provides estimates for the producer surplus. The producer surplus is about 2.5 billion euros for the whole gambling sector. The contribution of each type of gambling to the overall producer surplus trivially depends on its NGR. Thus, the highest contribution to the overall producer surplus comes from horse racing (669 million euros) and the lowest from table games (75 million euros).

Table 6 summarizes estimates of consumer and producer surplus and adds the taxation revenue to obtain the social surplus. The social surplus is negative when all types of gambling are considered together, with a loss of about 6 billion euros. Three gambling types out of seven have a positive social surplus, draw lotteries and scratch cards showing the largest amounts. Four gambling types out of seven have a negative social surplus. For these games, the producer

[15] Details of gains and losses for each category of problem gamblers are provided in the Appendix (Table A.3). The loss on excess spending exceeds the gain on recreational spending for each category of problem gamblers and each type of gambling. As a result, the surplus is negative for each type of gambling and each category of problem gamblers.

surplus and the taxation revenue are not sufficient to compensate for the negative consumer surplus. Poker and sports betting exhibit the largest negative amount. Nevertheless, the magnitude of the surplus has a trivial link with the popularity of the game under consideration and the corresponding level of spending. It is then relevant to relate the social surplus to the GGR to assess the harmfulness of gambling types with a negative surplus. It then appears that the loss per unit of spending is very high for poker (-16.748), distantly followed by other table games (-2.649) and sports betting (-2.315).

Table 5. Producer surplus estimates (in million €; year 2019)

	Net gambling revenue (NGR)	**Producer surplus (PS)**
Draw lotteries	629	314
Scratch cards	898	449
Sports betting	891	445
Horse racing	1 339	669
Slot machines	912	456
Poker	214	107
Table games (w/o poker)	149	75
All gambling	5 032	2 516

Note: The net gambling revenue comes from Table 1. The producer surplus is computed by applying formula (7) with a price elasticity of supply of 1.

4.2 Alternative thresholds for problem gambling

In the baseline scenario, we characterize problem gambling using a threshold of 3+ (problem gamblers = PGSI 3+). This compromise position seems reasonable, but, as discussed in subsection 3.2, it is also arguable to set the threshold at 1+ (problem gamblers = PGSI 1+) or 8+ (problem gamblers = PGSI 8+).

Table 7 provides the estimates with these alternative thresholds.[16] The shift in the problem gambling threshold impacts both the magnitude and the sign of the social surplus. On the one hand, lowering the threshold to 1+ increases the loss in consumer surplus (about 32 billion euros) and, therefore, the loss in social surplus (about 23 billion euros). On the other hand, raising the threshold to 8+ sufficiently reduces the loss in consumer surplus (about 5 billion euros) to make the social surplus positive (about 4 billion euros). The shift in the problem gambling threshold also impacts each gambling type.

[16] The shift in the threshold trivially changes the categories of recreational and problem gamblers. It also modifies the median spending of recreational gamblers (regular or not) and the share of recreational spending for problem gamblers. Note further that we compute the surpluses of problem gamblers with PGSI scores of 1-2, 3-7, and 8-27 separately before adding them when the threshold is set at 1+.

Table 6. Social surplus estimates (in million €; year 2019)

	Gross gambling revenue (GGR)	**Consumer surplus (CS)**	**Producer surplus (PS)**	**Taxation revenue (TR)**	**Social surplus (SS)**	**Ratio SS/GGR**
Draw lotteries	2 285	-456	314	1 656	1 515	0.663
Scratch cards	2 410	-404	449	1 512	1 557	0.646
Sports betting	1 659	-5 052	445	768	-3 839	-2.315
Horse racing	2 050	-377	669	711	1 004	0.490
Slot machines	2 027	-2 165	456	1 115	-594	-0.293
Poker	333	-5 796	107	119	-5 570	-16.748
Table games (w/o poker)	332	-1 136	75	183	-878	-2.649
All gambling	11 095	-15 386	2 516	6 063	-6 806	-0.613

Note: The social surplus is computed by adding the consumer surplus (Table 4), the producer surplus (Table 5), and the taxation revenue (Table 1).

Table 7. Alternative thresholds for problem gambling (in million €; year 2019)

	Low threshold (Problem gamblers = PGSI 1+)		**Baseline threshold (Problem gamblers = PGSI 3+)**		**High threshold (Problem gamblers = PGSI 8+)**	
	Consumer surplus	Social surplus	Consumer surplus	Social surplus	Consumer surplus	Social surplus
Draw lotteries	-534	1 436	-456	1 515	411	2 381
Scratch cards	-933	1 028	-404	1 557	69	2 030
Sports betting	-9 971	-8 757	-5 052	-3 839	-3 851	-2 638
Horse racing	-3 778	-2 397	-377	1 004	-101	1 279
Slot machines	-6 488	-4 917	-2 165	-594	811	2 382
Poker	-8 418	-8 192	-5 796	-5 570	-2 242	-2 016
Table games (w/o poker)	-1 513	-1 256	-1 136	-878	3	260
All gambling	-31 634	-23 055	-15 386	-6 806	-4 900	3 678

Note: The producer surplus and the taxation revenue are identical to the baseline scenario. The social surplus is computed by adding the consumer surplus from this Table, the baseline producer surplus (Table 6), and the taxation revenue (Table 6).

Beyond changes in the magnitude of the measurements, shifting the threshold may change the signs of the consumer surplus and the social surplus for some gambling types. It then appears that draw lotteries, scratch cards, slot machines, and table games have a positive consumer surplus with a high threshold. This positive consumer surplus changes the sign of the social surplus for slot machines and table games, which becomes positive. Inversely, the social surplus becomes negative for horse racing with a low threshold. Finally, our most robust results are that draw lotteries and scratch cards have a positive social surplus for any threshold, while sports betting and poker have a negative one.

4.3 Alternative calibrations of price elasticities

In the baseline scenario, we compute the consumer surplus and the producer surplus using ad hoc calibrations for the price elasticity of recreational demand ($|\eta_R^*| = 1.25$) and the price elasticity of supply ($\boldsymbol{\varepsilon}^* = 1$), respectively. It is advisable to perform a sensitivity analysis to assess the robustness of the estimates to alternative calibrations of price elasticities. On the one hand, we recompute the consumer surplus and the social surplus using alternative calibrations of 0.75 and 1.75 for the price elasticity of recreational demand (Table 8). On the other hand, we recompute the producer and social surplus using alternative calibrations of 0.75 and 1.50 for the price elasticity of supply (Table 9). Beyond the changes in the magnitude of the measurements, there is no change in the signs of both consumer and social surplus for the whole gambling sector and for each gambling type. It follows that estimates are robust to the calibration of price elasticities.[17]

4.4 Alternative scenarios

In the two previous subsections, we have performed sensitivity analyses using (i) alternative thresholds for problem gambling, (ii) alternative calibrations for the price elasticity of recreational demand, and (iii) alternative calibrations for the price elasticity of supply, separately. We have observed that raising the problem gambling threshold and the price elasticity of recreational demand increases the social surplus while raising the price elasticity of supply reduces it. It is then appropriate to combine these variations to see if significant changes in the results emerge. For this purpose, we create two polar scenarios: a pessimistic scenario defined by a low problem gambling threshold, a low elasticity of recreational demand, and a high elasticity of supply, and an optimistic scenario defined by a high problem gambling threshold, a high elasticity of recreational demand, and a low elasticity of supply.

[17] Note that the loss in consumer surplus exceeds the GGR for the gambling type with a negative social surplus in the baseline scenario (Table 6). It follows that the estimate of producer surplus does not impact the sign of the social surplus in the baseline scenario since the taxation revenue plus the producer surplus is necessarily inferior to the GGR.

Table 8. Alternative calibrations for the price elasticity of recreational demand (in million €; year 2019)

	Low elasticity ($\|\eta_R^*\| = 0.75$)		**Baseline elasticity ($\|\eta_R^*\| = 1.25$)**		**High elasticity ($\|\eta_R^*\| = 1.75$)**	
	Consumer surplus	Social surplus	Consumer surplus	Social surplus	Consumer surplus	Social surplus
Draw lotteries	-760	1 211	-456	1 515	-326	1 645
Scratch cards	-673	1 288	-404	1 557	-288	1 673
Sports betting	-8 421	-7 208	-5 052	-3 839	-3 609	-2 396
Horse racing	-628	752	-377	1 004	-269	1 111
Slot machines	-3 608	-2 037	-2 165	-594	-1 546	25
Poker	-9 660	-9 434	-5 796	-5 570	-4 140	-3 914
Table games (w/o poker)	-1 893	-1 636	-1 136	-878	-811	-554
All gambling	-25 643	-17 064	-15 386	-6 806	-10 990	-2 411

Note: The consumer surplus is computed using the baseline threshold for problem gambling (PGSI 3+). The producer surplus and the taxation revenue are identical to the baseline scenario. The social surplus is computed by adding the consumer surplus from this Table, the baseline producer surplus (Table 6), and the taxation revenue (Table 6).

Table 9. Alternative calibrations for the price elasticity of supply (in million €; year 2019)

	Low elasticity ($\varepsilon^* = 0.75$)		**Baseline elasticity ($\varepsilon^* = 1.00$)**		**High elasticity ($\varepsilon^* = 1.50$)**	
	Producer surplus	Social surplus	Producer surplus	Social surplus	Producer surplus	Social surplus
Draw lotteries	419	1 620	314	1 515	210	1 410
Scratch cards	599	1 707	449	1 557	299	1 407
Sports betting	594	-3 691	445	-3 839	297	-3 988
Horse racing	892	1 227	669	1 004	446	780
Slot machines	608	-442	456	-594	304	-746
Poker	143	-5 535	107	-5 570	71	-5 606
Table games (w/o poker)	99	-854	75	-878	50	-904
All gambling	3 354	-5 968	2 516	-6 806	1 677	-7 645

Note: The consumer surplus and the taxation revenue are identical to the baseline scenario. The social surplus is computed by adding the producer surplus from this Table, the baseline consumer surplus (Table 6), and the taxation revenue (Table 6).

Table 10. Polar scenarios (in million €; year 2019)

	Pessimistic scenario			**Baseline scenario**			**Optimistic scenario**		
	Problem gamblers = PGSI 1+ $\lvert\eta_R^*\rvert = 0.75$ $\varepsilon^* = 1.50$			Problem gamblers = PGSI 3+ $\lvert\eta_R^*\rvert = 1.25$ $\varepsilon^* = 1.00$			Problem gamblers = PGSI 8+ $\lvert\eta_R^*\rvert = 1.75$ $\varepsilon^* = 0.75$		
	Consumer surplus	Producer surplus	Social surplus	Consumer surplus	Producer surplus	Social surplus	Consumer surplus	Producer surplus	Social surplus
Draw lotteries	-890	210	976	-456	314	1 515	293	419	2 369
Scratch cards	-1 554	299	257	-404	449	1 557	50	599	2 160
Sports betting	-16 618	297	-15 553	-5 052	445	-3 839	-2 751	594	-1 389
Horse racing	-6 296	446	-5 139	-377	669	1 004	-72	892	1 531
Slot machines	-10 813	304	-9 394	-2 165	456	-594	579	608	2 302
Poker	-14 029	71	-13 839	-5 796	107	-5 570	-1 601	143	-1 340
Table games (w/o poker)	-2 522	50	-2 290	-1 136	75	-878	2	99	284
All gambling	-52 723	1 677	-44 983	-15 386	2 516	-6 806	-3 500	3 354	5 917

Note: The taxation revenue is identical to the baseline scenario. The social surplus is computed by adding the consumer surplus from this Table, the producer surplus from this Table, and the taxation revenue (Table 6).

Table 10 summarizes the estimates in these scenarios. Beyond the expected changes in the magnitude of the measurements, there is no change in the signs of both consumer and social surplus with respect to the estimates obtained by changing only the problem gambling threshold (Table 7). This result confirms that the problem gambling threshold is the most decisive factor in the estimation process.

5. Discussion

Gambling is an almost universally regulated economic activity, although the form and intensity of the regulation vary over time and space (Chambers, 2017). Public authorities need indicators to optimize this regulation. The share of revenue derived from problem gamblers has been reported as a useful indicator in the literature. As pointed out by Fiedler et al. (2019, p.82): "The share of revenue derived from problem gamblers can be an important indicator of whether a game is beneficial or harmful to society". We agree with this view and extend it by converting this indicator into a measure of consumer surplus and adding to it a measure of producer surplus and taxation revenue. Thus, we assess the social contribution of gambling through the social surplus concept using limited data.

Our approach obviously has limitations. First, for a fully comprehensive approach, we would need to include public expenditures and externalities in the social surplus equation. Public expenditures would include costs of regulation, prevention and health treatment (to the extent that these are covered by a public system, which is the case in France). We lack data on these different items. Externalities refer to costs that gamblers impose on other people without financial compensation. Possible examples are the reduced productivity that a problem gambler could impose on his or her employer, or the violence suffered by a victim of a robbery perpetrated by a gambler seeking to illegally finance his or her gambling activity. It is also established that problem gamblers impose substantial harms on their families (Li et al., 2017). Again, we lack data on these items to include them in our estimates. Since lacking data relate only to costs, our results should be seen as a high estimate, which could only be revised downwards with additional data.

Second, our approach to estimate the consumer surplus relies on a binary conception of gambling behaviour (recreational/problem) while it is widely accepted that gambling-related problems exist on a continuum (Toce-Gerstein et al., 2003; Slutske, 2007). The definition of a threshold is nevertheless unavoidable from a practical point of view and also makes sense from a clinical and public health perspective. We have justified our approach in section 3.2. Because of the debates that this specific point may generate, our best argument lies in the sensitivity analysis, which allows for several assumptions. Its disadvantage is that it leads to rather wide estimation intervals. Nevertheless, several results are stable whatever the assumptions used, which makes them extremely robust.

Third, our measure of consumer surplus depends on retrospective self-report data regarding gambling spending (see subsection 3.3), which has been widely described as subject to bias. On the one hand, questions such as "how much money did you spend" are frequently misunderstood (Wood and Williams, 2007). On the other hand, even if the question is well understood, self-reported data on spending are notoriously unreliable in the case of gambling (see e.g. Heirene et al., 2022). There is obviously a significant correlation between reported and actual spending (Braverman et al., 2014; Auer and Griffiths, 2017). However, the biases are not homogeneous among gamblers, which distorts the estimate of the spending distribution (Braverman et al., 2014; Auer and Griffiths, 2017; Heirene et al., 2022). Although we assume that the distortion is acceptable and does not undermine our findings, it is tricky to assess its direction, magnitude and impact on the results.

Fourth, our approach to consumer surplus does not specify what is included in the "internalities", i.e. the negative part of surplus. Contrary to other studies, such as Gerstein et al. (1999) and Productivity Commission (1999), our estimates do not rely on a list of harms. This can be seen both as a limitation—it lacks an explicit tangible basis and does not allow for an assessment of the relative importance of each type of harm—and an advantage—there is no need to establish a list of causal harms, which is a very difficult task.

Our results can be compared with the results of existing studies, especially those of the Productivity Commission (1999; 2010), which uses the most similar approach. Two important differences in methods should nevertheless be mentioned. First, our formula to compute the loss of welfare is slightly different from that used by the Productivity Commission since it was shown that the latter is biased and likely to significantly underestimate welfare loss (Massin and Miéra, 2020). Second, the Productivity Commission simultaneously includes in its overall impact estimate a measure of welfare loss related to consumer surplus calculation and a measure of the costs of problem gambling, containing a significant part of internalities, from an ad hoc study. We believe that this approach is inappropriate as it leads to a double counting of internalities.

With these differences in mind, the Productivity Commission's estimates of the social net impact of gambling in Australia amount to a range of minus 1 billion dollars to 4 billion dollars for the year 1997-98 (Productivity Commission, 1999) and a range of 2 billion dollars to 11 billion dollars for the year 2008-09 (Productivity Commission, 2010). For Germany, using a different method, Fiedler (2016) finds a net cost ranging from 3 to 10 billion euros. This is of similar magnitude as our baseline estimate.

If we turn to the results by type of gambling, we find that draw lotteries and scratch cards are the most socially beneficial games in France (providing a positive social surplus in all scenarios). This result can be explained by the fact that they are widespread games (with a large GGR, see Table 1), with a low prevalence of problem gamblers and a relatively low share of spending attributable to problem gamblers (see Table 2). In contrast, the two most socially

detrimental gambling types are poker and sports betting (providing a negative social surplus in all scenarios). This is explained by a high prevalence of problem gambling and a large share of spending attributable to problem gamblers (see Table 2). In such cases, the large costs incurred are not compensated by benefits from the producer surplus or the taxation revenue since the GGR is limited (especially for poker, see Table 1). The results for the other categories of gambling are somewhat less clear, as they may be socially beneficial or detrimental depending on the assumptions made. Such a result for slot machines could seem surprising since it is proven that high-frequency slot machines have a strong addictive potential (James et al., 2016). The harmful impact of slot machines at the population level is however influenced by their accessibility. When they are allowed outside casinos, slot machines are shown to have a high share of spending derived from problem gamblers (e.g. 76% in Quebec according to Fiedler et al., 2019) and to generate very large problem gambling costs (e.g. more than 75% of all problem gambling costs in Australia according to the Productivity Commission, 2010). Our mitigated results for slot machines must be interpreted in light of the French context, which only allows slot machines inside casinos.

In conclusion, the approach we develop in this article provides fairly comprehensive estimates of the social surplus induced by gambling from relatively few data. It can therefore easily be applied in other countries, or replicated over time for monitoring purposes. Avenues for future research include efforts to adapt this method to measure the marginal impact of specific regulatory interventions on the social surplus and its components in order to inform the public decision in a more precise way.

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Appendix

Table A.1. Available estimates for the price elasticity of demand
(international meta-analysis; Gallet, 2015)

Draw lotteries	-1.07 ; -1.11
Scratch cards	n/a
Sports betting	n/a
Horse racing betting	-1.01 ; -1.02
Slot machines	-0.68 ; -0.76
Poker	n/a
Table games (w/o poker)	-0.68 ; -0.76

Table A.2. Calibration of the price elasticity of supply using data at the sector level
(amounts in million €; year 2019)

	Low value	Baseline value	High value
Estimate of gross surplus rate (Tasmania)	19%	–	26%
Used gross surplus rate	15%	22,5%	30%
Gross gambling revenue	11 095	11 095	11 095
Producer surplus	1 664	2496	3 329
Net gambling revenue	5 032	5 032	5 032
Corresponding elasticity	1,512	1,008	0,756
Used elasticity	1,50	1,00	0,75

Sources: The estimates of the gross surplus rate for Tasmania come from the Allen consulting group (2011). The gross gambling revenue and the net gambling revenue come from Table 1.

Note: All elements relate to France except the estimates of the gross surplus rate, which relate to Tasmania. We extend the range of gross surplus rates of Tasmania to account for structural differences between the gambling sector in the two countries. We compute the producer surplus at the sector level by applying estimates of the gross surplus rate to the gross gambling revenue. We use formula (7) to derive the corresponding price elasticities of supply given this producer surplus and the net gambling revenue.

Table A.3. Components of surplus for problem gamblers (amounts in million €; year 2019)

	PGSI 3-7			**PGSI 8-27**		
	Gain	Loss	Surplus	Gain	Loss	Surplus
Draw lotteries	20	668	-647	13	504	-491
Scratch cards	57	335	-279	32	740	-708
Sports betting	18	1 062	-1 044	14	4 270	-4 256
Horse racing	16	217	-201	10	830	-821
Slot machines	14	1 586	-1 572	10	1 135	-1 125
Poker	1	3 281	-3 280	0	2 572	-2 572
Table games (w/o poker)	3	1 073	-1 070	1	131	-130
All gambling	128	8 222	-8 094	81	10 183	-10 102

Note: Gain, loss, and surplus are computed using formulas (4), (5), and (6), respectively, the spending data from Table 2, and a price elasticity of recreational demand of -1.25 ($|\eta_R^*| = 1.25$).