Has gambling changed after major amendments of gambling regulations in Germany? A propensity score analysis

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Aims: This study examined changes in general population gambling in the light of two major amendments of the German gambling regulation, the Fifth Amendment of the German Gambling Ordinance (AGO) for commercial amusement machines with prizes (AWP) and the State Treaty on Gambling (STG) for gambling activities subject to the state monopoly. Methods: Applying cross-sectional data from the 2006 and 2009 Epidemiological Survey of Substance Abuse (SOAS), propensity-score-matched samples of 7,970 subjects and 3,624 12-month gamblers aged 18–64 years were used for analyses. Logistic regression was employed to examine changes in gambling controlling for possible confounding variables. Results: Overall participation in state gambling activities, participation in lottery as well as TV lottery decreased and gambling on Internet card games increased. No changes were found for any other gambling activity, 12-month prevalence of any gambling and pathological gambling. While weekly gambling declined, overall multiple gambling increased. Effects were similar in the total sample and among current gamblers. Conclusions: Prohibiting specific gambling activities, e.g., Internet gambling, seem to be insufficient approaches to change gambling behavior. Supply reduction might need to be enhanced by changes in game characteristics and implementation of early intervention measures. However, long-term consequences are uncertain and further monitoring is needed.

Keywords: gambling policy, impact of gambling regulations, gambling behavior, pathological gambling, changes in gambling over time

INTRODUCTION

In the international context, a great variety of different gambling legislation systems can be found which might influence gambling behavior differently. In Germany, two separate legislation systems for gambling exist. On the one hand, provision of any gambling activity is illegal and only possible with state approval (§§284–286 German Criminal Code). With a few exceptions such as horserace betting, gambling activities are subject to the public monopoly comprising (a) casinos (Spielbanken) which provide gambling on slot machines and table games such as poker, roulette and black jack, (b) the German lottery association offering, amongst others, lotto tickets (e.g., six out of 49; drawing of numbers is biweekly), different kinds of lottery or sports betting, (c) TV lottery (a lottery with strong focus on charity; winning numbers are announced on TV) as well as (d) class lottery (lottery tickets with pre-assigned seven-digit numbers).

On the other hand, so-called “amusement machines with prizes” (AWP; technically a specific type of slot machine) are not considered gambling and therefore principally legal. That is, regulation of AWP is not subject to the public monopoly, but to the German Industrial Code. In contrast to regular state slot machines, AWP are operated by commercial providers and openly accessible in restaurants, pubs, and gaming arcades without personal identification. Also, stakes, wins, and losses on AWP are limited and regulated (by the German Gambling Ordinance) contrary to being mainly unlimited for slot machines. However, similar to slot machines, AWP do give cash wins. In general, gambling participation is subject to an age limit of 18 years and older.

In the past years, the German gambling legislation underwent two key changes. In 2006, the Fifth Amendment of the German Gambling Ordinance (AGO) for AWP was implemented with two major, potentially contradictory aims: (a) to ameliorate the implementation of measures for the protection of minors and consumers and (b) to improve the economic conditions for providers of AWP. To this end, setup conditions were made stricter, e.g., only two AWP were permitted to be arranged next to each other and cover panels had to be installed, but game characteristics were liberalized, e.g., shorter duration of a game (five seconds) and higher maximum win (500€) and loss (80€) per hour. In 2008, new regulations concerning state-owned gambling activities (State Treaty on Gambling, STG) were enacted after the German Federal Constitutional Court had decided the state monopoly could only be justified and maintained if it focused on consumer protection, especially the prevention of pathological gambling (PG). In detail, the STG aimed (a) to prevent the development of gambling disorder, (b) to limit the provision of gambling services, (c) to steer the natural

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trolling for possible confounding factors, i.e. aiming at unbi-
changes in gambling behavior after the amendments con-
the AGO and the STG, this study focused on short-term
gamblers differently than the entire population.

Up to now, changes in gambling behavior and PG as re-
response to the AGO and the STG are not well assessed. Sales
figures reveal a 42.0% increase in turnover of AWP from
2005 to 2009 (Meyer, 2011). In contrast, overall annual
gambling turnover of state gambling activities decreased by
22.9% from 2008 to 2009, i.e. after the STG (Meyer, 2011).
A study on the effects of the AGO on current AWP gamblers
points to an increase in potentially hazardous gambling, con-
sidering time spent and amount of money at stake (Bühringer, Kraus, Höhne, Küfner & Künel, 2010). Also, the
risk of losing greater amounts of money, chasing losses, and losing control over gambling was found to be elevated.

Concerning changes associated with the STG, cross-sec-
tional studies conducted before (in 2007) and after the STG
(in 2009) (Bundeszentrale für gesundheitliche Aufklärung
[BZgA], 2010) reported a substantial increase in participa-
tion on AWP and lotto in the past 12 months prior to the sur-
vey. In contrast, a decreased participation in class lottery
was observed. Results indicate no changes in the prevalence
of any 12-month gambling and PG (BZgA, 2010). These
findings, however, are subject to fundamental limitations.
First, analyses were only controlled for possible confound-
ing of gender and age, not considering other factors well
known to influence gambling behavior and PG (for a review
see Johansson, Grant, Kim, Odlaug & Götestam, 2009).
Second, at the time of the first data collection in 2007, judi-
cial demands had been adhered to beforehand and an in-
creased number of prevention measures had already been
implemented even though the STG was not yet officially in
power. Third, there was no discrimination between effects
on the total population and effects on current gamblers. This
is highly relevant as the amendments could affect current
gamblers differently than the entire population.

In order to allow for sound conclusions on the impact of
the AGO and the STG, this study focused on short-term
changes in gambling behavior after the amendments con-
trolling for possible confounding factors, i.e. aiming at unbi-
ased intervention effects. Based on the available evidence, it
was expected that (1) overall gambling behavior within the
past year declined due to the restriction of the most common
gambling activities, in particular through personalized ac-


weekly and assessed overall in both samples and differenti-
ated for gambling, AWP and Internet gambling in the
SCG. Multiple gambling was defined as participation in
more than one vs. a single gambling activity (differentiation
for gambling activities not possible).

Pathological gambling. If respondents had gambled
on average more than 50€ per month (about US 65$) in the past
12 months, they were screened for PG using a 19-item ques-
tionnaire (Stinchfield, 2002) mapping onto the ten DSM-IV
criteria of PG (American Psychiatric Association, 1994).
Meeting five or more criteria indicated PG.

Covariates
To control for possible confounding, gender, age, national-
ity, region, marital status, educational attainment, inflation
adjusted equivalence income, and mode of data collection
were used as covariates in all analyses. Age was stratified
into three groups of 18 to 29, 30 to 49 and 50 to 64 years. Na-
tionality differed between German and other nationalities;
region between West and East Germany. Marital status cov-
ered being single, married, widowed, and divorced. Educa-
tional attainment was assessed by years of school (intended
to be) completed and classified participants with less, equal,
and more than ten years of education. Household income
was adjusted for differences in household needs due to its
size by dividing it by the square root of household size, thus
assuming an equivalence parameter of 0.5 (Kawachi & Ken-
nedy, 1997; Organisation for Economic Co-operation and
Development [OECD], 2008). Equalized household net in-
come per month was categorized into <$1,000€, 1,000–
2,000€ and >2,000€.

In order to assess changes in gambling behavior and PG
from 2006 to 2009, survey year was used as an indicator
with 2006 coded 0 “before the amendments” and 2009
coded 1 “after the amendments”.

Statistical analyses
The complex sampling design was adjusted by using survey
procedures of Stata 10.0 SE software package (StataCorp
LP, 2007) in all analyses. Missing values in covariates were
addressed by multiple imputation employing chained equa-
tions (Royston, 2005) generating five samples. Out of these,
one sample was randomly drawn resulting in valid outcome
data of 15,817 participants.

Propensity score matching
Observational data were used to assess changes before
(2006) and after (2009) the implementation of the AGO and
the STG. Thus, random assignment of participants to the
control (survey year 2006: not exposed to amendments) or
the intervention group (survey year 2009: exposed to
amendments) as in randomized control trials was not possi-
able. Consequently, covariates may differ between individu-
als surveyed in 2006 and those surveyed in 2009 potentially
leading to biased intervention effect estimates (D’Agostino,
1998). In order to minimize this bias, propensity score
matching can be applied. Propensity scores, defined as the
conditional probability of being exposed given a vector of
observed covariates, balance differences in the distribution
of each covariate between two groups. A subset of compari-
sion units (from 2006) similar to “exposed” units (from
2009) is selected on the basis of similar propensity scores re-
ducing the risk of biased intervention effect estimates.

By means of logistic regression with survey year as crite-
ron and covariates as predictors a one-dimensional propen-
sity score was estimated. The covariates comprised socio-
demographic characteristics described above. In addition,
number of children at home (households without children,
one to two children, three or more children), profession
(blue collar, white collar, self-employed, student, miscella-
neous), employment (full time, part time, not employed,
miscellaneous), and federal state were included. Various
chronic diseases, physical and mental health status varying
from very good to very bad on a five-point scale, number of
cigarettes smoked daily as well as nicotine dependence were
also employed. Furthermore, prevalence of using prescrip-
tion drugs (a) at least weekly within the past 30 days or (b)
problematically within the past 12 months (measured by the
Kurzfragenbogen zum Medikamentengebrauch [KFM – med-
ication use questionnaire], Watzl, Rist, Höcker & Miehle,
1991) as well as 30-day prevalence of alcohol consumption
in terms of frequency, quantity (in grams of ethanol), and ep-
isodic heavy drinking were used. Moreover, prevalence and
frequency of cannabis use within the past 30 days, 12-month
prevalence of problematic cannabis use as indicated by the
severity of dependence scale (SDS, Gossop & Darke, 1995),
and 30-day prevalence of illegal drug use (other than canna-ris) were included. In the sample of current gamblers,
12-month prevalence of any gambling was also used.

Exposed (survey year 2009) and control subjects (survey
year 2006) were matched one-to-one using Mahalanobis
metric matching technique including the propensity score
within propensity score calipers (Rosenbaum & Rubin,
1985) with a caliper width of 0.2 of a linear propensity score
standard deviation (Rubin, 2001). Apart from propensity
score, age, gender, education, inflation adjusted equivalence
income, marital status, nationality, and region were included
in the metric of the TS and the SCG, respectively.

After matching, 7,970 subjects (50.4%) could be in-
cluded in the analyses in the TS; 3,624 subjects (49.9%) in
the SCG. Pearson $\chi^2$ tests with Rao/Scott correction were
conducted to compare descriptive statistics between survey
years. Distribution of essential socio-demographic charac-
teristics in the original unmatched and matched TS as well as
SCG are presented in Table 1 (full table available on re-
quest). Indicated by changes in effect size, conformance be-
tween subjects surveyed in 2006 and 2009 on these charac-
teristics is higher in the matched samples, apart from ad-
justed equivalence income which still differed between sur-
vey years. Balance of covariates in the matched samples is
also improved between 2006 and 2009 as supported by
smaller standardized differences (Austin, 2009) in all but
one covariate (region) which differences were small.

Changes in outcome measures
In order to assess differences in outcome measures between
survey years, the propensity score matched samples were
used. Logistic regression was employed in all analyses.
Models included all socioeconomic variables and mode of
data collection. The resulting odds ratios (OR) indicate the
difference between survey years in the likelihood for gam-
bling behavior and PG.

Table 1. Comparison of selected socio-demographic characteristics in the original unmatched and matched samples before (2006) and after (2009) the amendments

<table>
<thead>
<tr>
<th>Socio-demographic characteristics</th>
<th>Total sample</th>
<th>Subset of current gamblers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Original unmatched</td>
<td>Matched</td>
</tr>
<tr>
<td>Gender (Male)</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>Stand. diff.</td>
</tr>
<tr>
<td>Gender (Male)</td>
<td>50.8</td>
<td>50.7</td>
</tr>
<tr>
<td></td>
<td>.669</td>
<td>0.00</td>
</tr>
<tr>
<td>Age</td>
<td>&lt;.001</td>
<td>0.06</td>
</tr>
<tr>
<td>Age</td>
<td>18–29</td>
<td>21.0</td>
</tr>
<tr>
<td>Age</td>
<td>30–49</td>
<td>49.1</td>
</tr>
<tr>
<td>Age</td>
<td>50–64</td>
<td>29.9</td>
</tr>
<tr>
<td>Education</td>
<td>&lt;.001</td>
<td>0.09</td>
</tr>
<tr>
<td>Education</td>
<td>&lt;10</td>
<td>26.8</td>
</tr>
<tr>
<td>Education</td>
<td>=10</td>
<td>33.7</td>
</tr>
<tr>
<td>Education</td>
<td>&gt;10</td>
<td>39.5</td>
</tr>
<tr>
<td>Equivalence income (adjusted to inflation)</td>
<td>&lt;.001</td>
<td>0.20</td>
</tr>
<tr>
<td>Equivalence income (adjusted to inflation)</td>
<td>&lt;1000</td>
<td>32.7</td>
</tr>
<tr>
<td>Equivalence income (adjusted to inflation)</td>
<td>1000-2000</td>
<td>56.8</td>
</tr>
<tr>
<td>Equivalence income (adjusted to inflation)</td>
<td>&gt;2000</td>
<td>10.5</td>
</tr>
<tr>
<td>Marital status</td>
<td>&lt;.001</td>
<td>0.05</td>
</tr>
<tr>
<td>Marital status</td>
<td>Single</td>
<td>32.0</td>
</tr>
<tr>
<td>Marital status</td>
<td>Married</td>
<td>58.1</td>
</tr>
<tr>
<td>Marital status</td>
<td>Widowed</td>
<td>1.8</td>
</tr>
<tr>
<td>Marital status</td>
<td>Divorced</td>
<td>8.1</td>
</tr>
<tr>
<td>Nationality (German)</td>
<td>93.7</td>
<td>94.3</td>
</tr>
<tr>
<td>Region (West)</td>
<td>83.2</td>
<td>84.6</td>
</tr>
<tr>
<td>Notes: Stand. diff.: Standardized differences. Test: $\chi^2$.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Has gambling behavior changed in Germany?

Table 2. Comparison of outcome variables in the original unmatched and matched total sample before (2006) and after (2009) the amendments

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>12-month prevalence</td>
<td>7,811</td>
<td>49.4</td>
<td>8,006</td>
<td>48.0</td>
<td>.918</td>
<td>0.00</td>
<td>3,985</td>
<td>51.1</td>
<td>3,985</td>
</tr>
<tr>
<td>Overall state gambling</td>
<td>7,811</td>
<td>47.4</td>
<td>8,006</td>
<td>43.5</td>
<td>&lt;.001</td>
<td>0.03</td>
<td>3,985</td>
<td>48.7</td>
<td>3,985</td>
</tr>
<tr>
<td>Lotto</td>
<td>7,715</td>
<td>38.9</td>
<td>7,981</td>
<td>36.1</td>
<td>.001</td>
<td>0.03</td>
<td>3,936</td>
<td>39.8</td>
<td>3,974</td>
</tr>
<tr>
<td>TV lottery</td>
<td>7,511</td>
<td>10.9</td>
<td>7,868</td>
<td>10.0</td>
<td>.070</td>
<td>0.01</td>
<td>3,832</td>
<td>11.2</td>
<td>3,913</td>
</tr>
<tr>
<td>Class lottery</td>
<td>7,434</td>
<td>6.0</td>
<td>7,837</td>
<td>4.8</td>
<td>.003</td>
<td>0.02</td>
<td>3,794</td>
<td>5.8</td>
<td>3,902</td>
</tr>
<tr>
<td>Tables games</td>
<td>7,417</td>
<td>2.2</td>
<td>7,844</td>
<td>2.9</td>
<td>&lt;.001</td>
<td>0.03</td>
<td>3,797</td>
<td>2.4</td>
<td>3,904</td>
</tr>
<tr>
<td>Slot machines</td>
<td>7,415</td>
<td>1.0</td>
<td>7,839</td>
<td>1.4</td>
<td>.016</td>
<td>0.02</td>
<td>3,795</td>
<td>1.0</td>
<td>3,910</td>
</tr>
<tr>
<td>Sports betting</td>
<td>7,421</td>
<td>3.0</td>
<td>7,837</td>
<td>2.4</td>
<td>.025</td>
<td>0.02</td>
<td>3,800</td>
<td>3.3</td>
<td>3,899</td>
</tr>
<tr>
<td>AWP</td>
<td>7,424</td>
<td>2.9</td>
<td>7,845</td>
<td>2.6</td>
<td>.860</td>
<td>0.00</td>
<td>3,800</td>
<td>2.9</td>
<td>3,903</td>
</tr>
<tr>
<td>Overall Internet gambling</td>
<td>7,811</td>
<td>2.1</td>
<td>8,006</td>
<td>2.4</td>
<td>.163</td>
<td>0.01</td>
<td>3,985</td>
<td>2.4</td>
<td>3,985</td>
</tr>
<tr>
<td>Internet sports betting</td>
<td>7,409</td>
<td>1.8</td>
<td>7,842</td>
<td>1.0</td>
<td>&lt;.001</td>
<td>0.04</td>
<td>3,794</td>
<td>2.0</td>
<td>3,902</td>
</tr>
<tr>
<td>Internet casino</td>
<td>7,412</td>
<td>0.3</td>
<td>7,837</td>
<td>0.3</td>
<td>.363</td>
<td>0.01</td>
<td>3,795</td>
<td>0.2</td>
<td>3,900</td>
</tr>
<tr>
<td>Internet card games</td>
<td>7,410</td>
<td>0.4</td>
<td>7,837</td>
<td>1.6</td>
<td>&lt;.001</td>
<td>0.07</td>
<td>3,795</td>
<td>0.5</td>
<td>3,900</td>
</tr>
<tr>
<td>Horse racing betting</td>
<td>7,410</td>
<td>0.8</td>
<td>7,840</td>
<td>0.8</td>
<td>.821</td>
<td>0.00</td>
<td>3,795</td>
<td>0.9</td>
<td>3,899</td>
</tr>
<tr>
<td>Illegal table games</td>
<td>7,411</td>
<td>0.4</td>
<td>7,836</td>
<td>0.5</td>
<td>.139</td>
<td>0.01</td>
<td>3,794</td>
<td>0.3</td>
<td>3,900</td>
</tr>
<tr>
<td>Weekly gambling</td>
<td>7,811</td>
<td>17.2</td>
<td>8,006</td>
<td>13.7</td>
<td>&lt;.001</td>
<td>0.05</td>
<td>3,985</td>
<td>17.5</td>
<td>3,985</td>
</tr>
<tr>
<td>Multiple gambling</td>
<td>7,811</td>
<td>13.5</td>
<td>8,006</td>
<td>17.2</td>
<td>&lt;.001</td>
<td>0.06</td>
<td>3,985</td>
<td>14.1</td>
<td>3,985</td>
</tr>
<tr>
<td>Pathological gambling</td>
<td>7,811</td>
<td>0.2</td>
<td>8,006</td>
<td>0.3</td>
<td>.092</td>
<td>0.01</td>
<td>3,985</td>
<td>0.1</td>
<td>3,985</td>
</tr>
</tbody>
</table>

Notes: Total N varies due to item non-response. * Provision was illegal in Germany at time of data collection in 2009. AWP: amusement machines with prizes. Stand. diff.: Standardized differences. Test: $\chi^2$. 
Table 3. Comparison of outcome variables in the original unmatched and matched subset of current gamblers before (2006) and after (2009) the amendments

<table>
<thead>
<tr>
<th>Outcome variables</th>
<th>Original unmatched</th>
<th>Matched</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before amendments</td>
<td>After amendments</td>
<td>Before amendments</td>
<td>After amendments</td>
<td>Before amendments</td>
<td>After amendments</td>
</tr>
<tr>
<td>N %</td>
<td>N %</td>
<td>p</td>
<td>N %</td>
<td>N %</td>
<td>p</td>
<td>N %</td>
</tr>
<tr>
<td>Overall state gambling</td>
<td>3,583 95.9</td>
<td>3,679 90.6</td>
<td>&lt;.001 0.12</td>
<td>1,812 95.2</td>
<td>1,812 90.3</td>
<td>&lt;.001 0.10</td>
</tr>
<tr>
<td>TV lottery</td>
<td>3,494 79.6</td>
<td>3,656 75.4</td>
<td>&lt;.001 0.07</td>
<td>1,767 78.2</td>
<td>1,797 75.4</td>
<td>.003 0.05</td>
</tr>
<tr>
<td>Class lottery</td>
<td>3,289 23.0</td>
<td>3,542 21.2</td>
<td>&lt;.001 0.03</td>
<td>1,684 23.0</td>
<td>1,737 20.4</td>
<td>.036 0.04</td>
</tr>
<tr>
<td>Tables games</td>
<td>3,218 12.8</td>
<td>3,511 10.4</td>
<td>&lt;.001 0.04</td>
<td>1,647 11.3</td>
<td>1,727 9.6</td>
<td>.039 0.02</td>
</tr>
<tr>
<td>Slot machines</td>
<td>3,201 4.6</td>
<td>3,521 6.1</td>
<td>&lt;.001 0.05</td>
<td>1,637 4.8</td>
<td>1,726 5.7</td>
<td>.059 0.03</td>
</tr>
<tr>
<td>Sports betting</td>
<td>3,199 2.2</td>
<td>3,516 3.0</td>
<td>&lt;.001 0.03</td>
<td>1,638 2.1</td>
<td>1,725 2.7</td>
<td>.045 0.01</td>
</tr>
<tr>
<td>Overall Internet gambling*</td>
<td>3,207 6.3</td>
<td>3,522 5.6</td>
<td>&lt;.001 0.01</td>
<td>1,642 6.5</td>
<td>1,729 5.6</td>
<td>.252 0.02</td>
</tr>
<tr>
<td>Internet sports betting</td>
<td>3,193 3.8</td>
<td>3,519 2.1</td>
<td>&lt;.001 0.07</td>
<td>1,634 3.8</td>
<td>1,725 2.1</td>
<td>&lt;.001 0.07</td>
</tr>
<tr>
<td>Internet casino</td>
<td>3,196 0.5</td>
<td>3,514 0.6</td>
<td>&lt;.001 0.01</td>
<td>1,636 0.7</td>
<td>1,723 0.6</td>
<td>.554 0.01</td>
</tr>
<tr>
<td>Internet card games</td>
<td>3,194 1.0</td>
<td>3,517 3.4</td>
<td>&lt;.001 0.10</td>
<td>1,636 1.0</td>
<td>1,723 2.7</td>
<td>&lt;.001 0.08</td>
</tr>
<tr>
<td>Horserace betting</td>
<td>3,194 1.7</td>
<td>3,517 1.7</td>
<td>.650 0.01</td>
<td>1,636 1.8</td>
<td>1,725 2.1</td>
<td>.616 0.01</td>
</tr>
<tr>
<td>Illegal table games</td>
<td>3,195 28.1</td>
<td>3,513 11.1</td>
<td>.196 0.02</td>
<td>1,636 1.8</td>
<td>1,723 1.0</td>
<td>.711 0.01</td>
</tr>
<tr>
<td>Weekly gambling</td>
<td>3,583 34.8</td>
<td>3,679 28.5</td>
<td>&lt;.001 0.09</td>
<td>1,812 34.0</td>
<td>1,812 28.8</td>
<td>&lt;.001 0.07</td>
</tr>
<tr>
<td>Weekly state gambling</td>
<td>3,590 35.8</td>
<td>3,231 30.6</td>
<td>&lt;.001 0.07</td>
<td>1,701 35.0</td>
<td>1,594 31.0</td>
<td>.003 0.05</td>
</tr>
<tr>
<td>Weekly gaming machines</td>
<td>247 28.1</td>
<td>257 29.1</td>
<td>.328 0.04</td>
<td>133 22.1</td>
<td>122 31.0</td>
<td>.030 0.14</td>
</tr>
<tr>
<td>Weekly Internet gambling</td>
<td>189 40.9</td>
<td>222 44.3</td>
<td>.561 0.03</td>
<td>100 36.6</td>
<td>98 49.4</td>
<td>.224 0.09</td>
</tr>
<tr>
<td>Multiple gambling</td>
<td>3,583 27.4</td>
<td>3,679 35.8</td>
<td>&lt;.001 0.09</td>
<td>1,812 27.7</td>
<td>1,812 34.4</td>
<td>&lt;.001 0.07</td>
</tr>
<tr>
<td>Pathological gambling</td>
<td>3,583 0.4</td>
<td>3,679 0.5</td>
<td>&lt;.001 0.02</td>
<td>1,812 0.3</td>
<td>1,812 0.7</td>
<td>.038 0.03</td>
</tr>
</tbody>
</table>

Notes: Total N varies due to item non-response. *Provision was illegal in Germany at time of data collection in 2009. AWP: amusement machines with prizes. Stand. diff.: Standardized differences. Test: \( \chi^2 \).
RESULTS

Descriptive results

Descriptive statistics for the original unmatched and the matched TS and SCG in 2006 and 2009 are presented in Table 2 and Table 3, respectively, demonstrating the effects of matching on outcome measures. Descriptive results point to significant changes in gambling behavior between survey years: In the unmatched TS, participation in any state gambling activity, lottery, class lottery, sports betting, and Internet sports betting was lower, whereas wagering on table games, slot machines and Internet card games were higher in 2009 compared to 2006 (see Table 2). After matching, similar results were found with the exception of gambling on TV lottery gambling which was significantly lower and class lottery, table games, and slot machines which did not differ between survey years. Results were also similar in the SCG except for TV and class lottery gambling which were lower in both the unmatched and the matched SCG (see Table 3). Any gambling within the past 12 months, gambling on AWP, on any Internet gambling activity, horserace betting, and illegal table games did not vary between conditions.

In 2009, significant lower weekly gambling participation and a higher percentage of multiple gambling was found compared to 2006 in both the unmatched and the matched samples. Weekly participation in state gambling activities was lower, whereas weekly Internet gambling remained stable in both the unmatched and the matched SCG. Higher weekly gambling on AWP was found in the SCG after matching. With regard to PG, no change between survey years was found in the unmatched samples and the matched TS, but a higher prevalence was noted in the SCG after matching.

Changes in outcome measures

Results for changes between 2006 and 2009 in gambling behavior in the matched samples are presented in Table 4, controlling for confounding variables. In the observed period, participation in state gambling activities decreased (TS: OR = 0.84, p = .002; SCG: OR = 0.45, p < .001), in particular participation in lotto (TS: OR = 0.89, p = .045) and TV lottery (TS: OR = 0.79, p = .015; SCG: OR = 0.82, p = .041). Whereas overall Internet gambling remained stable, the odds of participating in Internet card games increased (TS: OR = 3.41, p < .001; SCG: OR = 2.86, p = .001) and Internet sports betting declined among current gamblers (SCG: OR = 0.58, p = .049). No significant changes were found for 12-month prevalence of any gambling, class lottery, table games, slot machines, sports betting, AWP, Internet casino, horserace betting, and illegal table games in either matched sample.

With regard to the extent of gambling involvement, weekly gambling decreased (TS: OR = 0.74, p < .001; SCG: OR = 0.77, p = .003; see Table 5). In particular, a decline was noted for weekly participation in state gambling activities (SCG: OR = 0.81, p = .018) and an increase of weekly gambling on AWP (SCG: OR = 2.44, p = .031). No effects were

Table 4. Results of regression analysis for changes in gambling behavior before (2006) and after (2009) the amendments

<table>
<thead>
<tr>
<th>OR (95%-CI)</th>
<th>Matched total sample</th>
<th>Matched subset of current gamblers</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR (95%-CI)</td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>12-month prevalence</td>
<td>n = 7,970</td>
<td>0.93 (0.83–1.03)</td>
</tr>
<tr>
<td>Overall state gambling</td>
<td>n = 7,970</td>
<td>0.84 (0.75–0.94)</td>
</tr>
<tr>
<td>Lottery</td>
<td>n = 7,910</td>
<td>0.89 (0.79–1.00)</td>
</tr>
<tr>
<td>TV lottery</td>
<td>n = 7,745</td>
<td>0.79 (0.66–0.96)</td>
</tr>
<tr>
<td>Class lottery</td>
<td>n = 7,696</td>
<td>0.83 (0.64–1.06)</td>
</tr>
<tr>
<td>Tables games</td>
<td>n = 7,563</td>
<td>1.18 (0.86–1.62)</td>
</tr>
<tr>
<td>Slot machines</td>
<td>n = 7,559</td>
<td>1.34 (0.85–2.12)</td>
</tr>
<tr>
<td>Sports betting</td>
<td>n = 7,561</td>
<td>0.71 (0.50–1.01)</td>
</tr>
<tr>
<td>AWP</td>
<td>n = 7,703</td>
<td>0.91 (0.65–1.26)</td>
</tr>
<tr>
<td>Overall Internet gambling</td>
<td>n = 7,824</td>
<td>1.08 (0.76–1.53)</td>
</tr>
<tr>
<td>Internet sports betting</td>
<td>n = 7,558</td>
<td>0.74 (0.46–1.19)</td>
</tr>
<tr>
<td>Internet casino</td>
<td>n = 7,557</td>
<td>0.87 (0.38–1.98)</td>
</tr>
<tr>
<td>Internet card games</td>
<td>n = 7,557</td>
<td>3.41 (1.89–6.15)</td>
</tr>
<tr>
<td>Horserace betting</td>
<td>n = 7,556</td>
<td>0.77 (0.40–1.48)</td>
</tr>
<tr>
<td>Illegal table games</td>
<td>n = 7,556</td>
<td>1.95 (0.96–3.94)</td>
</tr>
</tbody>
</table>

Notes: * Provision was illegal in Germany at time of data collection in 2009. AWP: amusement machines with prizes. OR: odds ratio, CI: confidence interval.

Sensitivity analysis

Different specifications of the propensity score lead to different matched samples. In the present study, different specifications were selected according to predetermined t values using a method adapted from Hirano and Imbens (2001). In a first step, those t values critical for including a covariate in the logistic regression were selected, namely t = 0, t = 1, t = 2, t = 4, t = 8, and t = ∞. Subsequently, a simple logistic regression analysis was conducted for each of the 24 covariates producing a particular t value. In a third step, six different models were specified according to the predetermined t value, i.e. the model with a specification of e.g. t > 2 only included covariates meeting the requirement of a t value greater than 2. Consequently, whereas all 24 covariates were included in the original model (t = 0), no covariates were included in the last specification (t = ∞) leading to a propensity score indicating the chance to be exposed. Finally, using the described matching technique for each of the propensity score specifications, six matched samples (the original matched sample and five additional ones) were generated (each for the TS and the SCG). The original statistical analyses were executed in each sample. Significance of the coefficients for survey year relative to the coefficients resulting for the original matched samples was used to assess whether results were sensitive to different propensity score specifications (Guo & Fraser, 2009).
found for weekly Internet gambling. An increase was noted for multiple gambling (TS: OR = 1.23, \( p = .001 \); SCG: OR = 1.35, \( p < .001 \)). Concerning PG, prevalence did not change between survey years in either matched sample.

Table 5. Results of regression analysis for changes in gambling behavior and pathological gambling before (2006) and after (2009) the amendments

<table>
<thead>
<tr>
<th></th>
<th>Matched total sample</th>
<th>Matched subset of current gamblers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR (95%-CI) ( p )</td>
<td>OR (95%-CI) ( p )</td>
</tr>
<tr>
<td>Weekly AWP</td>
<td>0.74 (0.63–0.87)</td>
<td>(&lt; .001 )</td>
</tr>
<tr>
<td>Weekly state gambling</td>
<td>n = 3,295</td>
<td></td>
</tr>
<tr>
<td>Weekly Internet gambling</td>
<td>1.82 (0.84–3.93)</td>
<td>( p = .129 )</td>
</tr>
</tbody>
</table>

**Notes:** Provision was illegal in Germany at time of data collection in 2009. AWP: amusement machines with prizes. OR: odds ratio, CI: confidence interval.

**Sensitivity analysis**

Results for 12-month prevalence of any gambling could be replicated in all analyses in the TS. Original findings on table games, sports betting, overall Internet gambling, Internet casino, Internet card games, and horserace betting could be replicated in all five additional specifications in the TS as well as in the SCG. Results were also perfectly stable for illegal gambling in the TS (replicated in three specifications in the SCG) and quite robust for AWP (replicated in four specifications in the TS and SCG). In the SCG, results of overall state gambling as well as lotto were perfectly stable. In the TS, however, result on overall state gambling was only replicated in two specifications and findings on lotto were not confirmed in any other specification. In both populations, results were less stable regarding TV lottery, class lottery, and slot machines (each replicated in three (TS) and two (SCG) specifications) and Internet sports betting (replicated in three specifications in both samples).

Results for overall weekly gambling were replicated in four specifications in the TS and in three specifications in the SCG. In the SCG, weekly Internet gambling was confirmed in all specifications, whereas weekly gambling on state gambling and on AWP was less stable (replicated in three specifications and one specification, respectively). Findings for multiple gambling were replicated in three specifications in the TS and were perfectly robust in the SCG. Furthermore, results on PG were replicated in two specifications in both matched samples.

**DISCUSSION**

This study examined potential changes in gambling behavior and the prevalence of PG in a sample of the German adult population and a subsample of current gamblers between 2006 and 2009 while controlling for possible confounding variables. Changes were evaluated in light of two major amendments of the German gambling legislation undertaken within this time interval, the Fifth Amendment of the German Gambling Ordinance (AGO; implemented in 2006) for AWP and the State Treaty on Gambling (STG; implemented in 2008) for gambling under the state monopoly.

**Gambling behavior**

A major finding of our study is that overall gambling prevalence within the past year did not differ between survey years. This result is contrary to our expectation, but in line with other findings reporting a stable 12-month prevalence of any gambling (BZgA, 2010). Thus, reduction in the overall amount of money wagered between 2006 and 2009 as indicated by annual turnover figures (Meyer, 2011) is not due to fewer individuals participating in gambling. Instead, gambling on different gambling activities and frequency of gambling must have changed. However, changes in gambling might also be related to the global recession and substantial changes in the world economy since the beginning of 2008. Yet, the effect of the economic crisis was not as pronounced in Germany as in other countries, and the economic impact on gambling behavior might have been small.

In line with our hypothesis, overall participation in most state gambling activities that are subject to access or advertisement restrictions declined. In particular, fewer subjects gambled on lotto and TV lottery in 2009 than in 2006. However, caution is warranted when interpreting the decline in gambling on lotto as sensitivity analyses revealed stable participation in lotto in all other specifications of the propensity score. Furthermore, though statistically not significant, a tendency towards a decrease of participation in class lottery and sports betting in 2009 was found. Contrary to expectations, no reductions in gambling on table games and slot machines were found. Reasons for this could be that preceding regulations on accessibility and advertisements for these gambling activities were already quite strict compared to, for example, those of lotto.

Despite sales figures indicating a substantial increase in turnover of AWP from 2006 to 2009 (Meyer, 2011) and a strong tendency of increased AWP participation among current gamblers, prevalence of gambling on AWP was not found to be significantly higher in 2009. These findings are not necessarily contradictory as participation rate, i.e. the total number of gamblers, does not need to increase in order to result in higher turnover. This might rather be the result of individuals gambling with higher stakes, longer or more frequently. The latter is supported by the observed increase from 2006 to 2009 in number of AWP gamblers that gamble on a weekly basis. This finding questions the two-sided approach of the AGO and its true effectiveness in consumer protection as spending more time and money on gambling is linked to a higher risk for PG (Currie et al., 2006; Ferris & Wynne, 2001).

With regard to Internet gambling, overall gambling did not decline, although provision was prohibited by the STG. When assessing different kinds of Internet gambling activities, however, substantial differences were found. As expected, participation in Internet sports betting was lower among current gamblers in 2009 than in 2006. The decline might result from the strict ban of previously state Internet sports betting in Germany. Yet, this trend was not significant in the total population. While Internet casino gambling re-
Has gambling behavior changed in Germany?

mained stable in both matched samples, Internet card games even increased. Based on the observed increase in Internet card games, restricting Internet gambling seems of limited effectiveness. However, there is also reason to believe that an increase in Internet gambling in recent years follows a global trend (LaBrie, Kaplan, LaPlante, Nelson & Shaffer, 2008; Wood, Williams & Lawton, 2007). For instance, the prevalence of past-year Internet gambling in Canada was found to have increased since 2004 (Wood & Williams, 2009). Furthermore, the number of Internet gambling websites increased from 2,069 online casinos and gambling sites owned by 436 different companies in July 2007 (Williams & Wood, 2007) to 2,849 sites of 788 companies in July 2012 (Casino City, 2012).

As hypothesized, gambling on horserace betting and illegal table games was unaffected by the amendments shown in the lack of change in gambling on these activities. This result also indicates that the amendments did not fuel a shift to illegal gambling, i.e. resulted in an immoderate protectionism. Also in line with expectations, weekly gambling declined. As findings indicate an association between frequent participation and PG (Currie et al., 2006; Sassen et al., 2011; Welte, Barnes, Wieczorek, Tidwell & Parker, 2004), the decline is in accordance with the objectives of the amendments. However, as the decline is due to the decrease of weekly gambling on state gambling activities, it is questionable whether this effect was intended. This is particularly the case as weekly participation in AWP increased and Internet gambling activities did not decline, i.e. activities with an increased risk potential for gambling disorder (Meyer, Häfeli, Mörsen & Fiebig, 2010).

In contrast, multiple gambling increased, i.e. participation in more than one gambling activity. This could have resulted from the increased popularity and availability of Internet gambling activities, especially Internet poker, which might have triggered interest to test these activities in addition to usual gambling behavior. However, up to now, no reliable data exist concerning the background and reasons for this development.

Pathological gambling

Taking the short time between the amendments and the second survey into account, no change in the prevalence of PG was expected. This result is corroborated by international studies reporting stable 12-month prevalence rates of PG after changes in legal obligations and preventive measures (Bondolfi, Jermann, Ferrero, Zullino & Osiek, 2008) or qualitative and quantitative accessibility of gambling activities (Bondolfi et al., 2008; Govoni, Frisch, Rupcich & Getty, 1998; Jacques & Ladouceur, 2006). Yet, it has to be kept in mind that this result is not very stable to different propensity score specifications (replicated in two specifications while three other specifications indicate an increase).

Overall, preventive efforts are still challenged by changes towards multiple gambling and gambling activities associated with greater risk potential. As indicated by results on gambling behavior, gambling on high risk Internet card games increased (Meyer et al., 2010; Welte et al., 2004), while participation in activities with smaller risk potential, such as TV lottery, decreased. Also, the aforementioned rise in the number of weekly AWP gamblers is of great concern due to the higher risk associated with frequent as well as AWP gambling (Currie et al., 2006; Ferris & Wynne, 2001). However, conclusions on the effectiveness of the amendments concerning the prevention of PG are premature and possible effects might only be observed after some more years.

Effects in the total samples and among current gamblers

An important finding of this study is that the impact of the AGO and the STG is not greatly different between current gamblers and the total population. Significant differences were only found for participation in lotto and Internet sports betting. The odds ratios, however, point in the same direction indicating similar tendencies of reduced participation in both samples. Moreover, effects might be different for different groups of gamblers. For instance, occasional moderate gamblers might respond more to changes in accessibility of gambling activities than regular heavy gamblers. The former might have refrained from Internet sports betting after the prohibition and blocking of these offers. In contrast, the latter might have shifted to international providers instead of abandoning or cutting down on gambling.

Limitations

Our study is not without limitations. First, comparisons of matched and unmatched samples indicate that the results may not be generalized to the German general population aged 18 to 64 years. However, this paper did not aim at generalizability of results but at unbiased intervention effects. Second, a causal impact of the AGO and the STG on gambling behavior and PG can only be inferred with great caution. When assessing the impact of the amendments using observational data, intervention effect estimates may be biased due to variation in covariates. After propensity score matching, conformance in covariates was substantially improved rendering biases of observed covariates unlikely. Yet, differences in unobserved covariates may still exist and associated biases cannot be precluded. Due to the cross-sectional nature of our data and the lack of controls, that were not exposed to the changes in gambling regulations, other factors might be associated with the reported changes in gambling behavior. For instance, the Soccer World Championship took place in Germany in 2006 and might have triggered increased gambling participation, in particular on (Internet) sports betting. Also, new smoke-free laws were implemented in Germany in 2007 and 2008 prohibiting indoor smoking, including smoking in gambling facilities in most Federal States. As smoking is associated with gambling ( McGrath & Barrett, 2009) and smoking bans require gamblers to smoke outside and to interrupt their gambling, these bans might have preventive impact on gambling behavior. Indeed, introducing smoking bans in gambling facilities has led to a substantial reduction in gambling participation in Australia (Hirschberg & Lye, 2010). Although a significant reduction in 12-month prevalence of any gambling was found in our study, no changes in activities such as table games, slot machines and AWP, all of which are subject to these new smoke-free laws, were noted. Third, changes could be part of a natural trend. This may be the case for the rise in Internet card gambling and declining lotto turnover rates in Germany since 2004 (Meyer, 2010) derogating the possible influence of the amendments. The influence of external variables is the greatest challenge to this analysis and requests longer periods of observation.
CONCLUSIONS

Changes in gambling regulations to prevent PG seem to have had short-term impacts on gambling behavior in the population and among current gamblers. Whether the observed changes will indeed lead to a long-term reduction in the prevalence of PG remains to be seen. In light of the limited effectiveness of the prohibition of Internet gambling activities, the question arises whether qualitative supply reduction through prohibition or restriction of certain gambling activities are effective strategies to prevent PG. Qualitative changes in game characteristics such as in stakes, wins and losses, the implementation of early detection and intervention measures or a combination of restrictions of activities and monitoring of individual gambling behavior might be equally or even more effective. To learn more about the impact of either approach, long-term monitoring of gambling behavior and experimental studies are needed. This is even more crucial as it remains unclear why some indicators of gambling behavior were found to be associated with the amendments and others not.

ACKNOWLEDGEMENTS

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DECLARATION OF CONFLICTS OF INTEREST

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