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by

Natt Hongdilokkul, Archawa Paweenawat, Krislert Samphantharak, and Suparit Suwanik

Eliminating the Black Market:

Evidence from a Lottery Gambling Policy in Thailand[*]

Natt Hongdilokkul[†]   Archawa Paweenawat[‡]

Krislert Samphantharak[§]   Suparit Suwanik[¶]

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Abstract

This paper investigates the impacts and implications of a supply-side intervention of black market transactions using a natural experiment from lottery markets in Thailand. Between June 2003 and November 2006, the Thai government imposed a crackdown on the black-market lottery while introducing a new lottery with similar characteristics as a substitute. Using panel data of Thai households, we find that the intervention was effective in eliminating the black-market lottery. Household spending on the black-market lottery dropped sharply after June 2003 and increased again after November 2006. The substitution from the black-market lottery to the government lottery in 2003 was small, while the reverse substitution in 2006 was large. We also find that gambling was habitual and the intervention that breaks the habit had a long-term impact on gambling behavior, i.e., a persistent decrease in expenditures on both illegal and legal lotteries.

Keywords: Household finance, Gambling, Black market, Addiction

JEL Classification: D14, G51, O17

1   Introduction

Transactions in black markets are widespread in many countries, especially in developing economies with ineffective legal enforcement. Many studies have documented the adverse impacts of these illegal activities on the economy. For example, they negatively affect the collection of taxes to support public sectors, implying a low ability to provide public services. This, in turn, can lead more economic agents to move into the non-observed sector, often associated with criminal and corrupt activities that undermine social capital and cohesion.[1] Consequently, several governments worldwide have attempted to eliminate these activities. One approach is to crack down on these activities by enforcing the laws that prohibit them more intensively, i.e., supply reduction strategies. Another approach is to legalize the activities and implement demand reduction strategies, for instance, restricting advertising, introducing education, limiting access to cash, or providing gambling venue employee training.[2]

This paper contributes to the literature on public policies toward illegal economic activities by analyzing a government intervention in the lottery markets in Thailand in 2003. Lottery gambling has become a big business and has grown in popularity across nations. In Thailand, lotteries have become the most popular form of gambling (Piriyarangsan, 2003). Before the intervention, the country had two forms of lotteries: the government-sponsored six-digit lottery and the illegal black-market lottery (BML). In May 2003, the Thai government announced an intensive crackdown to eradicate the latter, and in July 2003 a new government-sponsored two- and three-digit lottery (TTL) was introduced as a close substitute. However, the TTL as well as the harsh crackdown on BML were abandoned in 2006, leaving the six-digit lottery as the only legitimate form while the BML resurfaced.

The 2003–2006 Thai lottery market intervention—the crackdown on BML and the launch of TTL sponsored by the government—provides a unique setting to analyze the short-term and long-term impacts of government policies on illegal economic activities, especially on the gambling behavior of households. Specifically, for the short-term impacts, we investigate (i) the substitution effect of BML to the government's newly introduced TTL and the incumbent six-digit lottery, and (ii) the substitution effect to BML after

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[1]See Valentini (2009) for a review of this literature.

[2]See Velasco et al. (2021) for more details on the effectiveness of gambling supply, demand, risk, and harm reduction strategies.

TTL was terminated. We also estimate the persistent effects of the BML crackdown on household gambling behavior by assessing the change in lottery spending pattern when the BML crackdown was no longer intensively enforced.

The analyses in this paper utilize household-level panel data from the Townsend Thai Monthly Survey, with a focus on the period between June 2000 and December 2009, covering the periods before, during, and after the existence of TTL. To estimate the effects of each intervention, we employ the difference-in-differences method with continuous treatment, specifically, a "dose-response" relationship between the intensity of expenditure on lotteries before the intervention and outcomes (Callaway and Sant'Anna, 2021).

Our findings show that the supply-side intervention was effective, as evidenced by a considerable fall in household spending on BML after June 2003 and a subsequent increase once the intervention ended in November 2006. Based on the difference-in-differences analysis, the substitution from the illegal BML to the legal government lotteries was small, albeit statistically significant. However, after the 2006 discontinuation of the intervention, the substitution from the government lotteries, including the terminated TTL, to BML was statistically significant and large. This result suggests that the supply reduction seems effective, especially when the enforcement is intensive, while the legalization has a limited impact, especially when the legitimate product is not a good substitute.

In addition, we find that, after the 2006 discontinuation, households significantly decreased their expenditures on all types of gambling, i.e., BML, government lotteries, and other gambling. This result implies that the 2003–2006 supply-side intervention had a persistent impact on the gambling behavior of households. This paper thus provides a broader policy implication: a supply-side intervention has a potential to reduce gambling demand through the interruption of habitual behavior.[3]

This study contributes to the literature on the interventions of illegal economic activities in two folds. First, it considers two approaches the government uses to cope with illegal activities: supply reduction and legalization. Second, it shows how households react to the implementation of such policy, both the immediate response in the short run

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[3]Empirical research has found that gambling is found to be habitual. For example, Guryan and Kearney (2010) find that the weekly pattern of lottery tickets sold across stores in Texas is consistent with the economic definition of addiction.

and the persistence in the long run.

The remainder of this paper is as follows. Section 2 provides background information on lottery markets in Thailand. Section 3 describes the data used in this paper and stylized facts. Section 4 reports the empirical strategy and results. Section 5 concludes.

2 Background on Lottery Markets in Thailand

Lottery gambling has been popular among the Thai population. Its history dates back to at least the 19th century when a gambling product called "Huay-Gor-Kor" was introduced. This product was a 36-alphabet lottery ticket adapted from the Chinese and brought into the Thai society by Chinese traders and migrants. However, it was later prohibited in 1916 when all forms of gambling were banned (Chotchakornpant, 2010).

After the 1932 Revolution that ended the absolute monarchy regime, the Thai government introduced a new gambling product, which was issued by the government and was the only legitimate form of lottery in Thailand. It was introduced as a ticket with a pre-printed unique six-digit number and was first sold to the public in November 1935, with the first draw conducted in April 1936 (Government Lottery Office, n.d.-a). With minor adjustments over time, this form of government lottery continues the present day and is operated by the Government Lottery Office. Currently, the draws of this lottery take place twice a month, on the 1st and the 16th of each month, except in December, when the draws are held on the 1st and the 30th. This state-sponsored lottery generates a large sum of revenue for the Thai government, accounting for about 46.6 billion Thai baht (THB) or 1.5 billion USD for the state income in 2020 (Government Lottery Office, n.d.-b).[4]

An alternative to the government lottery is the illegal black-market lottery (BML). Evolving from Huay-Gor-Kor, BML initially used Thai alphabets before switching to numeric, allowing it to use the last two and the last three digits of the winning numbers from the government lottery draws. BML has been popular among Thai households due to its flexible amount, lower prices, prize variety, and higher prize ratios (Voi You, 2004; Wannathepsakul, 2011). It is estimated that in 2001 around 23.7 million Thais, or approximately 51% of total adults in Thailand, take part in this illegal market (Piriyarangsan, 2003). In addition, this underground lottery business is argued to be worth

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[4]An exchange rate was approximately 31 THB/USD during the period of the intervention.

80–98 billion THB (2.6–3.2 billion USD) per year (Bowornwathana, 2004).

To eliminate the illegal BML, the Thai government declared an intensive crackdown on BML in late May 2003, followed by the announcement of an introduction of two- and three-digit lottery (TTL), also known as "Huay-Bon-Din" (literally translated as "Above-Ground Lottery"), in July 2003 with its first round launched in August 2003. TTL was designed to be a close substitute for BML: The buyers were able to freely pick their own numbers. The winning numbers were also based on the traditional government six-digit lottery, i.e., the last two and three digits of the lottery ticket winning the first prize as well as stand-alone two- and three-digit prizes. Since its introduction, TTL had become more popular due to its simple, yet flexible, betting options that enhanced the gamblers' chances of winning (Chotchakornpant, 2010). Due to its increasing popularity, TTL generated around 135 billion THB (4.4 billion USD) in government revenue during the three-and-a-half-year period of its existence. Aside from being the government's lucrative business, a study also finds that TTL partly reduced the demand for BML during the time of operation (Thairungroj, Pothong, and Ruktham, 2006).

Following the 2006 military coup, however, many of the previous government's policies were repealed, including TTL and the harsh crackdown on BML. As a result, the only legitimate form of lottery in Thailand since 2007 has been the six-digit lottery. Meanwhile, the BML business reemerged (Wannathepsakul, 2011). The Center for Gambling Studies (2015) estimates that in 2015, over 16.5 million Thais, or almost 31.6% of all adults in Thailand, participated in the BML, involving cash flow of nearly 130 billion THB (4.2 billion USD).[5]

3   Data and Stylized Facts

3.1   Data

This paper uses household-level panel data from the Townsend Thai Monthly Survey. The survey has a reasonably high frequency over several years, providing a relatively long time series on consumption fluctuations, including lottery and other gambling expenditures. The data also cover the periods long before, during, and long after the intervention. In this study we focus on the months between June 2000 and December 2009.

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[5]This study was conducted at the time closest to the termination of BML in 2007.

The Townsend Thai Monthly Survey is an intense monthly household survey that began its baseline interview in August 1998 in four Thai provinces. Chachoengsao and Lopburi are semi-urban provinces located in the more developed central region close to Bangkok. The provinces of Buriram and Sisaket, on the other hand, are rural and situated in a less developed section of Thailand's northeastern border with Cambodia. In each of the four provinces, the survey is conducted in four villages. This survey began with an initial village-wide census. Every structure and every household was enumerated, and the defined "household" units were created based on sleeping and eating patterns. All individuals, households, and residential structures in each of the 16 villages can be identified in subsequent monthly responses from September 1998 and onwards. From the village-wide census, approximately 45 households in each village were randomly sampled to become survey respondents, resulting in a total of 710 households in the survey. The monthly updates track activities and changing conditions of the same households over time.

In addition, since household total expenditures, income, assets, liabilities, and cash must be carefully computed, we use these data from the Townsend Thai Household Financial Accounts, which is constructed based on the data from the survey. The detailed description of this dataset can be found in Samphantharak and Townsend (2009).[6]

3.2 Descriptive Statistics

Table 1 reports the characteristics of households in our data. Most households have a male head. The average age of household heads is 55.9 years old with 4.5 years of education. On the other hand, most household members are female. Household members are, on average, 39.8 years old with 5.4 years of education. The average values of assets and liabilities per household member at the beginning of the intervention are 496,762 THB (approx. 12,000 USD) and 33,158 THB (800 USD), respectively. The average monthly income from production per household member is 2,421 THB (60 USD) prior to the intervention. Approximately 40% of the households primarily derived their income from agricultural activities, including crop cultivation, livestock, and fish or shrimp farming. Conversely, another 40% mainly earned their income through employment salaries.

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[6]The data from the Townsend Thai Monthly Survey and the Household Financial Accounts are publicly provided by the Research Institute for Policy Evaluation and Design (RIPED) at the University of the Thai Chamber of Commerce upon request.

Table 1: Household characteristics

Characteristics	Mean	Standard error
Demographics of heads of households		
Ages [years]	55.9	13.5
Education levels [years]	4.5	2.7
Female [%]	29.3	
Demographics of household members		
Ages [years]	39.8	13.8
Education levels [years]	5.4	2.2
Female [%]	53.7	
Wealth		
Assets [Baht per person]	496,762	1,343,924
Liabilities [Baht per person]	33,158	80,407
Income		
Monthly income from production [Baht per person]	2,421	12,267
Households with the main source of income from:		
[% of all households]		
Cultivations	26.5	
Livestock	11.8	
Fish or shrimp farms	2.2	
Non-agricultural businesses	10.3	
Employment salaries	40.7	
Number of households	660	

Note: The data consist of households engaging in at least one interview between June 2000 and May 2003. We include only households which have fully answered the questions related to expenditures. Therefore, the number of households is less than 710. Demographics of heads of households, demographics of household members, and household wealth are in May 2003. Household income and its components are cumulative values between June 2002 and May 2003. Unit conversion: 1 US dollar = 41.48 Thai Baht on average in 2003. There are 8.5% of the surveyed households of which the main sources of income are activities other than the five categories reported.

Source: Townsend Thai Monthly Survey and Townsend Thai Household Financial Accounts; Authors' calculations.

Figure 1 reports the change in gambling activities among the households in our sample over time. Panel A shows the fraction of households that gambled at least once in each month, while Panel B shows the share of gambling expenditure. Prior to the crackdown in June 2003, approximately 40–50% of the households reported buying BML at least once. The unconditional average of the share of BML spending out of total

Figure 1: Gambling activities of households in the Townsend Thai data

(a) Fraction of gambling households   (b) Share of gambling expenditure
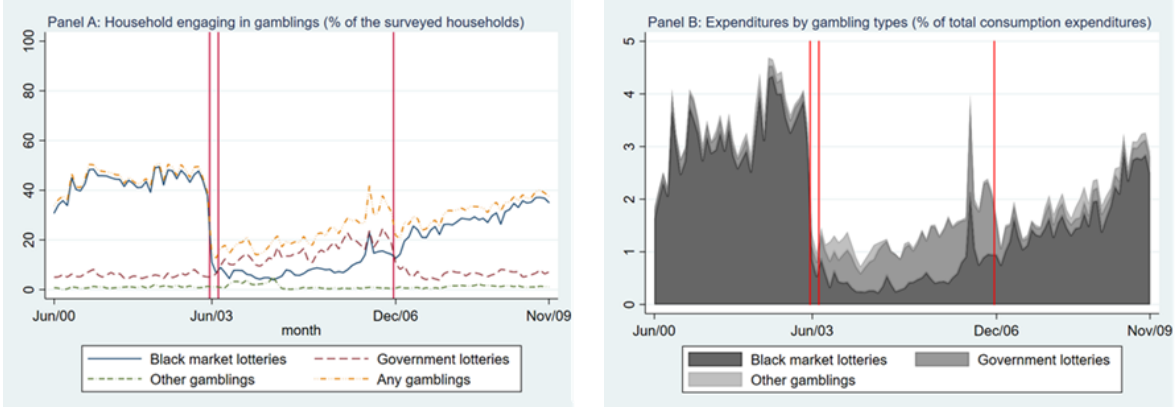
Note: The sample consists of 710 households with at least one interview between June 2000 and November 2009.
Source: Townsend Thai Monthly Survey.

consumption expenditures ranged around 3–4%. The numbers of households involving in gambling are consistent with the estimates from the Socio-Economic Survey (SES) reported in Miller and Paulson (2007).

Immediately after the crackdown in June 2003, only 5% of the households bought BML, and the average expenditure share on BML dropped from 4% to less than 1%. Before TTL was launched, approximately 10% of the households had spending on government lottery, with the average expenditure share less than 1% of total consumption expenditures. After TTL was launched, the fraction of households that bought government lottery (including TTL)[7] had increased to around 20% with the average expenditure share above 1% in 2006.

After the discontinuation of TTL in 2006, the surveyed households spent less on the government lottery and more on BML. In November 2009—three years after the discontinuation—around 40% of the households reported spending on BML, almost back to the pre-intervention level. Meanwhile, the average expenditure share resumed to almost 3%, on par with the levels before the 2003 crackdown. We also observed similar patterns at both provincial and village levels.

We consider the households' participation in lottery gambling in three sub-periods: Period A (June 2000–May 2003) is the period before the crackdown on BML and the introduction of TTL; Period B (June 2003–November 2006) is the period when the crackdown

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[7]We cannot distinguish between the spending on the six-digit government lottery and the spending on TTL.

and TTL were in effect; and Period C (December 2006–November 2009) is the period after TTL were eliminated.

Table 2 reports the gambling patterns of households in our data. The table reveals several patterns suggesting that lottery gambling is persistent or habitual. The unconditional probability that a household would not buy any lottery, either government or black-market, in period C is 33%. On the other hand, for households that did not buy any lottery in periods A and B, the conditional probability that they would not buy any lottery in period C is 83%. Furthermore, the probability of not buying any lottery in period C, conditioned on not buying in period A or period B alone, is 60% and 76%, respectively.

Next, we consider the effect of the crackdown on BML and the availability of TTL on households' participation in the black-market lottery. For households that bought BML in period A and bought the government lottery in period B, 80% of them bought BML in period C. On the other hand, for those who bought BML in period A but did not buy any government lottery in period B, only 39% of them bought BML in period C. Moreover, if we focus only on households that bought BML in period A but bought neither the government lottery nor BML in period B, the likelihood of buying BML in period C dropped to 30%. These findings further confirm that gambling is habitual. Once households "break the habit", they are less likely to return to gambling in later periods.

4   Empirical Results

To estimate the effects of the intervention, we employ the difference-in-differences method with continuous treatment, specifically, a "dose-response" relationship between the intensity of expenditure on lotteries before the intervention and outcomes (Callaway and Sant'Anna, 2021). Difference-in-differences with continuous treatment has been used for the setting in which binary difference-in-differences is not feasible or not appropriate, for example, in Card (1992) or Gruber, Hendren, and Townsend (2014). We argue that, compared to a binary difference-in-differences analysis, the dose-response difference-in-differences design is more appropriate to our settings because (i) almost 90% of the sampled households participated in the BML before the BML crackdown, and (ii) we

Table 2: Number of households participated in lotteries

Period A: Jun 2000–May 2003	Period B: Jun 2003–Nov 2006	Period C: Dec 2006–Nov 2009			
		Govt = 0 & Black = 1	Govt = 1 & Black = 1	Govt = 0 & Black = 0	Govt = 1 & Black = 0
Govt = 0 & Black = 0	Govt = 0 & Black = 0	5	1	39	2
Govt = 0 & Black = 0	Govt = 1 & Black = 0	2	5	6	1
Govt = 0 & Black = 0	Govt = 0 & Black = 1	5	0	0	0
Govt = 0 & Black = 0	Govt = 1 & Black = 1	4	2	0	3
Govt = 1 & Black = 0	Govt = 0 & Black = 0	0	0	3	0
Govt = 1 & Black = 0	Govt = 1 & Black = 0	1	1	0	0
Govt = 1 & Black = 0	Govt = 0 & Black = 1	0	0	0	0
Govt = 1 & Black = 0	Govt = 1 & Black = 1	0	0	0	0
Govt = 0 & Black = 1	Govt = 0 & Black = 0	15	5	39	0
Govt = 0 & Black = 1	Govt = 1 & Black = 0	31	14	29	2
Govt = 0 & Black = 1	Govt = 0 & Black = 1	13	1	7	0
Govt = 0 & Black = 1	Govt = 1 & Black = 1	43	29	8	0
Govt = 1 & Black = 1	Govt = 0 & Black = 0	0	1	10	0
Govt = 1 & Black = 1	Govt = 1 & Black = 0	4	18	7	3
Govt = 1 & Black = 1	Govt = 0 & Black = 1	2	0	1	0
Govt = 1 & Black = 1	Govt = 1 & Black = 1	28	64	6	3
Total		153	141	155	14

Note: Each period contains $Govt$ and $Black$: $Govt = 0$ means zero household's spending on government lotteries; $Govt = 1$ means positive household's spending on government lotteries; $Black = 0$ means zero household's spending on black-market lotteries; $Black = 1$ means positive household's spending on black-market lotteries.

Source: Authors' calculation based on the data from the Townsend Thai Monthly Survey. Only households completing answers regarding expenditure on lotteries in all three periods are included.

observed a high variation in the intensity of expenditure on BML before the BML crackdown.

This paper studies the effects of two major policy changes regarding lotteries: (i) the crackdown of BML dealers; and (ii) the discontinuation of TTL in 2006. The study interval for each policy change spanned over 36 months before and after the month of the change.

4.1 The Effects of the 2003 Crackdown

We estimate the effects of the 2003 crackdown by exploiting the variation in the intensity of BML expenditures within 36 months prior to the crackdown. We estimate the effect of the crackdown using data between June 2000 and May 2006 and the following specification:

$$Y_{im} = \beta Post_m^{2003} \times Treat_i^I + \mathbf{X}_{im} \cdot \mathbf{\Gamma} + \alpha_i + \eta_m + \epsilon_{im}. \tag{1}$$

The outcome variable of household i in month m, Y_{im}, is selected measures of household i's spending or investment behaviors. $Post_m^{2003}$ is a binary variable for the month on or after June 2003. $Treat_i^I$ is the continuous treatment variable measured by the expenditure share on BML, i.e., the ratio between the expenditure on BML and the total expenditure on consumption goods and services of household i between June 2000 and May 2003. The higher ratio implies that the household was more exposed to the intervention. $\mathbf{X}_{im}$ is a vector of control variables that include (i) the number of household members, (ii) the average age of household members, (iii) the average education level of household members, and (iv) the household's net operating income. Lastly, α_i is the household i's fixed effect, and η_m is the month m fixed effect. We report the estimated crackdown effect, $\hat{\beta}$, under the assumption that the effect from the 2003 crackdown is linear in the expenditure share of BML prior to the crackdown, on top of the standard parallel trend assumption.

Table 3 reports the estimation results. First, the crackdown in 2003 had a large effect on households' expenditure share on BML. For each percentage point higher in the households' expenditure share of BML prior to 2003, the crackdown led to a decrease of 0.81 percentage point in the expenditure share of BML after 2003. In other words, the crackdown eliminated 81% of households' spending on BML. In addition, the test for the parallel trend assumption suggests that our result underestimates the magnitude of the

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decrease in BML expenditure share and that the crackdown in 2003 had an even bigger effect.[8]

Second, the substitution from BML to TTL after the crackdown was small in magnitude but statistically significant. For each percentage point higher in the expenditure share on BML prior to 2003, the expenditure share on TTL increased by only 0.08 percentage point after 2003.

4.2 The Effects of the TTL Discontinuation in 2006

Next, we turn to the discontinuation of TTL in 2006. As in the previous section, we use the difference-in-differences specification. To identify the effects of TTL discontinuation, we take advantage of the variation in households' exposure to TTL between December 2003 and November 2006. Using the data from December 2003 to November 2009, we estimate the following specification:

$$Y_{im} = \beta Post_m^{2006} \times Treat_i^{II} + \mathbf{X}_{im} \cdot \mathbf{\Gamma} + \alpha_i + \eta_m + \epsilon_{im}, \tag{2}$$

where $Post_m^{2006}$ is a binary variable taking the value of one for the month on or after December 2006, and zero otherwise. The continuous treatment variable, $Treat_i^{II}$, is defined as the ratio between the expenditure on government lotteries and the total expenditure on consumption goods and services of household i between December 2003 and November 2006.

Table 4 reports the estimation results. We find that, for each percentage point higher in the expenditure share of government lottery between 2003 and 2006, the TTL discontinuation led to a decrease of 0.81 percentage point in the expenditure share of government lottery after 2006. This result might not come as a surprise because, after 2006, TTL was no longer available and the only form of government lottery was the six-digit lottery. It is also worth mentioning that the substitution away from the government lottery back to BML after 2006 was very similar in magnitude to the substitution away from BML to the government lottery after 2003.

We also find that, for each percentage point higher in the expenditure share of

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[8]We test the parallel trend assumption using an event study further explained in Section 4.4. We find that, for BML expenditures, the policy leads are increasing over time, although statistically insignificant, implying our estimate might be underestimated, i.e., the expenditures on BML may decrease by more than 0.81 percentage point after the 2003 crackdown.

Table 3: Effects of the 2003 crackdown on selected households' expenditure and savings

	Estimate	Standard Error	Parallel Trend Assumption
Expenditure			
On government lotteries	0.08***	0.01	✓
On black market lotteries	-0.81***	0.02	Underestimated magnitude
On other types of gambling	0.01***	0.00	✓
On alcohol, tobacco, and eating out	0.00	0.01	✓
Other food consumption	0.23***	0.02	X
Other non-food consumption	0.49***	0.03	X
On education	0.14***	0.01	X
On training	0.002***	0.0006	✓
On health	0.01	0.02	✓
Savings/Investment			
Cash flow from production	1.68*	1.11	✓
Change in inventory	0.79	1.03	✓
Capital expenditures on fixed assets	1.28	1.11	✓
Capital expenditures on livestock	-1.15***	0.36	✓
Deposits at financial institution	-0.27	0.62	✓
Lending	0.50	0.34	✓
Borrowing	0.61	0.77	✓
Net gifts and transfer	1.77	1.13	✓
Household durable goods	-1.43**	0.63	✓
Production assets	-0.31	0.56	✓
Cash	3.83**	1.57	✓

Note: All of the outcomes are measured as percentages of the household's total expenditure on consumption goods and services, including both food and non-food items (e.g., gasoline, utilities, rent, clothes, transportation). The pre-crackdown period is June 2000–May 2003. The post-crackdown period is June 2003–May 2006. The effects are estimated with a fixed-effects model using the within regression estimator with household fixed effects, adjusting for month fixed effects. Standard errors are clustered at the household level. ***, **, and * denote significance at 0.1%, 1%, and 5% levels, respectively.
Source: Townsend Thai Monthly Survey and Townsend Thai Household Financial Accounts; Authors' calculations.

government lottery between 2003 and 2006, the TTL discontinuation led to an increase of 0.56 percentage point in the expenditure share of BML after 2006. More importantly, the

Table 4: The effects of the TTL discontinuation on households' expenditure and savings

	Estimate	Standard Error	Parallel Trend Assumption
Expenditure			
On government lotteries	-0.81***	0.04	✓
On black market lotteries	0.56***	0.03	✓
On other types of gambling	-0.01	0.01	✓
On alcohol, tobacco, and eating out	0.07**	0.04	X
Other food consumption	0.06	0.07	✓
Other non-food consumption	0.14*	0.08	✓
On education	0.09**	0.04	X
On training	0.002	0.004	✓
On health	-0.07	0.09	✓
Savings/Investment			
Cash flow from production	4.17	5.16	✓
Change in inventory	-4.03	3.01	✓
Capital expenditures on fixed assets	-0.14	5.11	✓
Capital expenditures on livestock	0.45	0.69	✓
Deposits at financial institution	12.50*	6.64	✓
Lending	0.33	0.82	✓
Borrowing	-3.48	3.40	✓
Net gifts and transfer	-5.25	3.41	✓
Household durable goods	3.49	2.56	X
Production assets	4.53	2.95	✓
Cash	-15.6**	6.38	X

Note: All of the outcomes are measured as percentages of the household's total expenditure on consumption goods and services, including both food and non-food items (e.g., gasoline, utilities, rent, clothes, transportation). The pre-discontinuation period is December 2003–November 2006. The post-discontinuation period is December 2006–November 2009. The effects are estimated with a fixed-effects model using the within regression estimator with household fixed effects, adjusting for month fixed effects. Standard errors are clustered at the household level. ***, **, and * denote significance at 0.1%, 1%, and 5% levels, respectively.
Source: Townsend Thai Monthly Survey and Townsend Thai Household Financial Accounts; Authors' calculations.

substitution from government lottery to BML after 2006 was much larger in magnitude that the substitution from BML to government lottery after the 2003 crackdown.

4.3 The Long-Term Effects of the 2003 Intervention

Motivated by the findings in Table 2, we further analyze the long-term behavioral effects of the intervention in 2003, especially the crackdown on BML, on households' expenditure after the intervention ended. More specifically, we compare households' behaviors in period A (before the intervention) with the behaviors in period C (after the intervention had ended). In other words, we compare households' behaviors in two periods that had similar regulatory environments, i.e., TTL was unavailable and there was little or no crackdown on BML. Thus, the results in this section could be interpreted as the persistent impact of the intervention in the absence of the direct intervention itself.

We estimate the long-term effects of the intervention in 2003 using the data from June 2000 to May 2003 (period A, prior to the crackdown and the introduction of TTL) and from December 2006 to November 2009 (period C, after the discontinuation of TTL and the harsh crackdown) and the following specification:

$$Y_{im} = \beta Post_m^{2006} \times Treat_i^I + \mathbf{X}_{im} \cdot \mathbf{\Gamma} + \alpha_i + \eta_m + \epsilon_{im}, \tag{3}$$

where $Post_m^{2006}$ is an indicator variable for the month on or after December 2006. $Treat_i^I$ is the expenditure share on BML between June 2000 and May 2003, i.e., the same treatment variable we used in the study of the 2003 crackdown earlier.

Table 5 reports the estimation results. First, the coefficient on BML is large and statistically significant. For each percentage point higher in the expenditure share of BML prior to 2003, the 2003–2006 intervention leads to a decrease of 0.78 percentage point in expenditure share of BML after 2006. In other words, since the serious crackdown was abandoned in 2006, our result suggests that the intervention had a long-term impact on households' participation in BML. This finding also implies that gambling activities are habitual and that the current demand for gambling might depend on the previous level of gambling activities.

4.4 Event Studies

Finally, we conduct event studies to verify whether the parallel trend assumptions are valid during the pre-policy change periods. The difference-in-differences specification for

Table 5: The long-run effects of the intervention in 2003

	Estimate	Standard Error	Parallel Trend Assumption
Expenditure			
On black market lotteries	-0.78***	0.02	Underestimated magnitude
On other types of gambling	-0.02***	0.00	✓
On alcohol, tobacco, and eating out	0.01	0.01	✓
Other food consumption	0.40***	0.03	X
Other non-food consumption	0.40***	0.03	✓
On education	0.178***	0.016	X
On training	0.0008	0.0008	✓
On health	-0.006	0.009	✓
Savings/Investment			
Cash flow from production	2.33	1.43	✓
Change in inventory	-0.30	1.02	✓
Capital expenditures on fixed assets	1.37	1.04	✓
Capital expenditures on livestock	-1.60***	0.39	✓
Deposits at financial institution	0.85	1.14	✓
Lending	0.37	0.29	✓
Borrowing	1.14	0.76	✓
Net gifts and transfer	1.58**	0.66	✓
Household durable goods	-0.57	0.65	✓
Production assets	0.25	0.60	✓
Cash	3.99***	1.47	✓

Note: All of the outcomes are measured as percentages of the household's total expenditure on consumption goods and services, including both food and non-food items (e.g., gasoline, utilities, rent, clothes, transportation). The pre-crackdown period is June 2000–May 2003. The post-discontinuation period is December 2006–November 2009. The effects are estimated with a fixed-effects model using the within regression estimator with household fixed effects, adjusting for month fixed effects. Standard errors are clustered at the household level. The coefficient on the government lottery is not shown in this table since it is irrelevant as TTL was not available in both period A and C. ***, **, and * denote significance at 0.1%, 1%, and 5% levels, respectively.
Source: Townsend Thai Monthly Survey and Townsend Thai Household Financial Accounts; Authors' calculations.

our event studies is

$$Y_{it} = \beta_t \times Treat_i^j + \mathbf{X}_{it} \cdot \mathbf{\Gamma} + \alpha_i + \eta_t + \epsilon_{it}, \tag{4}$$

where $j \in \{I, II\}$. In this analysis, all variables are indexed by household i and trimester t, normalized to 0 at the trimester immediately prior to the policy change, i.e., March–May 2003 for the 2003 crackdown and September–November 2006 for the 2006 discontinuation. The variables of interest are the full set of β_t estimates, excluding the trimester immediately before the policy changes. These estimates identified the differences in the outcomes across the surveyed households with higher and lower pre-policy intensity of expenditures on the black-market lotteries (or the government lotteries) during 12 months before and after the policy changes. If the differences did not occur prior to the policy changes, the estimates for the policy leads, i.e., $\beta_t \times Treat_i^j$, $\forall t \in [-4, -1]$, should be close to zero and not be statistically significant. Furthermore, we may also observe the dynamic of the policy effects whether if the estimates for the policy lags, i.e., $\beta_t \times Treat_i^j$, $\forall t \in [1, 4]$, were statistically significant and if their trends were stable, increasing, or decreasing over time.

Our event-study results support the validity of the parallel trend assumption and confirm our difference-in-differences estimates presented earlier in this paper. Figure 2 presents the estimates of the event-study specification for expenditures on the BML and on the government lotteries. The two graphs in the left column of Figure 2 visualized the estimated effects of the 2003 crackdown. For the expenditures on government lotteries, the policy leads are close to zero and statistically insignificant in almost every trimester, indicating no differences in pre-crackdown trends in the outcome across households with high and low spending on the BML prior to the crackdown. We also observe that the policy lags are statistically significant and growing over time. For the expenditures on BML, we observe that the policy leads are increasing over time, although statistically insignificant, implying that our estimate might be overestimated, i.e., the expenditures on the black-market lotteries may decrease by more than 0.81 percentage point after the 2003 crackdown.

The two graphs in the middle column of Figure 2 visualize the estimated effects of the 2006 discontinuation, exploiting variations in the expenditure on BML between June 2000 and May 2003. The policy leads in both graphs are not statistically significant. The policy lags are negative, stable, and statistically significant for the expenditures on the government lotteries, but not statistically significant for the expenditure on BML.

Finally, the two graphs in the right column of Figure 2 visualize the estimated

Figure 2: Event studies on selected variables
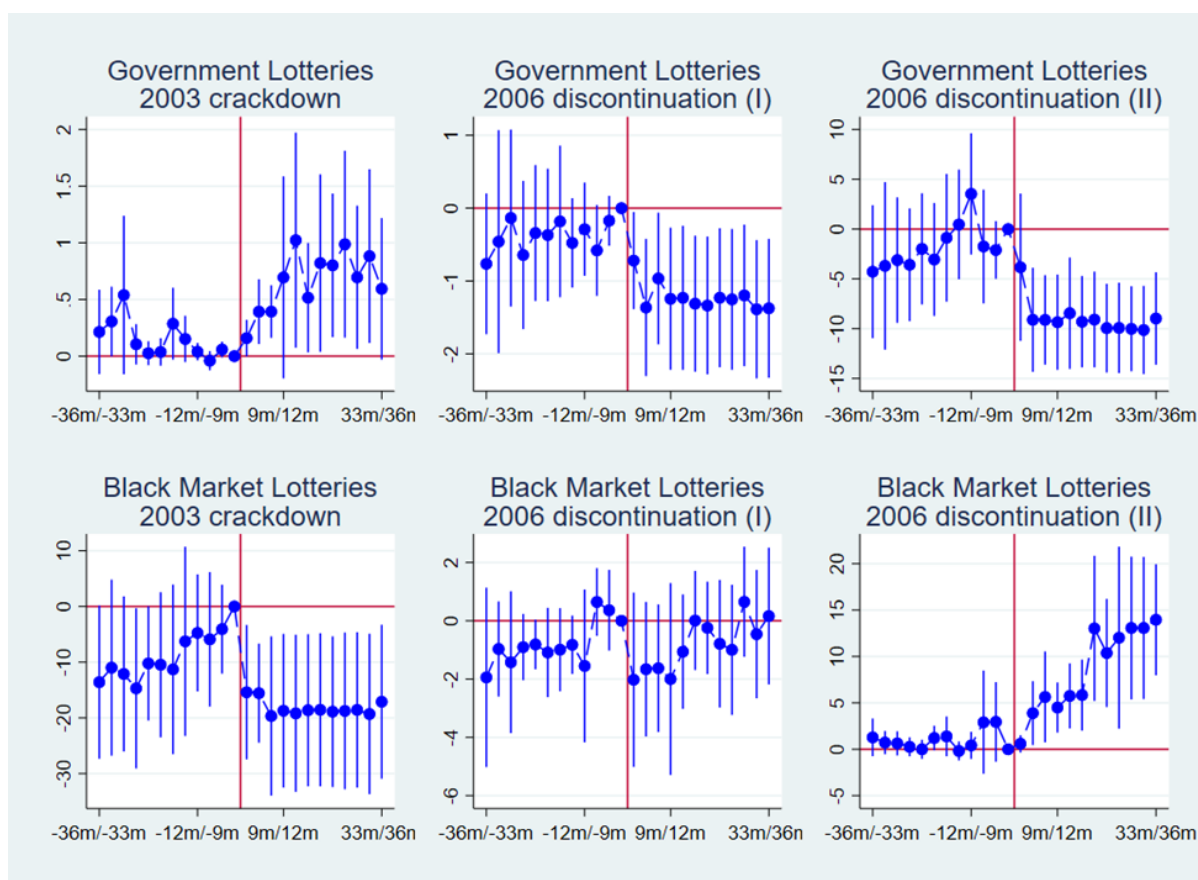
Note: Dots represent point estimates of the coefficients of the policy leads and policy lags and spikes represent 95% confidence intervals that account for household clustering. The vertical red lines in the figures in the left column represent June 2003. The vertical red lines in the middle and in the right columns represent December 2006. The coefficients of the policy leads and policy lags are estimated with a fixed-effects model using the within regression estimator with household fixed effects, adjusting for quarter fixed effects. The treatment variable for the estimates in the left and in the middle column is the expenditure on black market lotteries measured as a percentage of expenditures on all consumption goods between June 2000 and May 2003. The treatment variable for the estimates in the right column is expenditures on government lotteries measured as a percentage of the expenditure on all consumption goods between December 2003 and November 2006.
Source: Townsend Thai Monthly Survey; Authors' calculations.

effects of the 2006 discontinuation, exploiting variations of the expenditure on government lotteries between December 2003 and November 2006. The policy leads in both graphs are also not statistically significant. The policy lags are negative, stable, and statistically significant for the expenditures on the government lotteries, but positive, growing over time, and statistically significant for the expenditures on the BML.

5 Conclusion

This paper shows that the supply-side intervention in the Thai lottery market from June 2003 to November 2006—the severe crackdown on BML and the operation of the TTL system—was effective in eliminating BML, as evident by a significant fall in household expenditure on BML after June 2003 and a rise after November 2006.

Our study also finds that the substitution from BML to government lotteries (including TTL) was small, although statistically significant. However, following the termination of TTL and the end of the intensive crackdown in 2006, the substitution away from TTL and other government lotteries back to the BML was statistically significant and much larger in magnitude. We believe that this is due in part to BML being more appealing than TTL and other government lotteries in terms of amount flexibility, prize variety, and higher prize ratios, as well as additional features such as the ability to purchase on credit. These factors imply that TTL was not a close substitute to BML as the government had hoped when it was designed.

In addition, compared to the substitution from BML to TTL and other government lotteries, the reverse substitution from TTL to BML took longer time, approximately 1–3 years, to reach the pre-crackdown level. This lag in substitution from public to private lotteries could be because illegal BML dealers reemerged only gradually once the crackdown was no longer intensive.

Finally, our finding suggests that the 2003–2006 supply-side intervention of the underground lottery market, particularly the crackdown of BML dealers, had a persistent impact on gambling behavior of the households, as reflected by a significant decrease in the expenditure on all kinds of gambling, i.e., BML, government lotteries, and other types of gambling. This finding has a significant and broader policy implication: a supply-side intervention has the potential to reduce gambling demand through the interruption of a habitual behavior, in addition to providing the government with a source of revenue and the benefits of eliminating the illegal economy.[9]

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[9]However, the final finding should not be broadly applied to other forms of illegal and addictive behaviors, particularly those related to substance use. The contextual dynamics and consequences associated with interventions in gambling and substance abuse are markedly distinct. For instance, withdrawal from certain substances can lead to life-threatening conditions, a severe outcome not applicable to gambling. This differentiation underlines the necessity of tailored approaches in addressing varied types of addictive activities within the intervention framework.

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