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Abstract

This paper investigates the effect of economic policy uncertainty (EPU) on gambling activity in China. Based on a theoretical model, we hypothesize that EPU increases the demand for hope which raises the willingness to pay for lottery tickets, resulting in higher lottery sales. We estimate a Panel Autoregressive Distributed Lag model with an Error-Correction form using data on lottery sales in Chinese provinces to estimate the short- and long-run effect of EPU on gambling. Our results suggest that EPU has a significant positive effect on gambling in the short run. In addition, we find that this positive effect is less persistent if the EPU proxy is based on economic policy reports in national newspapers than when the EPU measure is derived from local newspaper reports. This may be explained by the different thematic focus and the different degrees of media censorship of national and local newspapers.

JEL-Codes: D120, D810, D910, G410, L830.

Keywords: economic policy uncertainty, household behaviour under uncertainty, gambling behaviour, welfare lottery, China.

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1 INTRODUCTION

The effect of macroeconomic uncertainty on gambling behavior is theoretically ambiguous. On the one hand, increased uncertainty induces anxiety and stress, which, according to psychological studies (Lightsey Jr and Hulsey, 2002; Muraven and Baumeister, 2000), is positively related to gambling behavior. According to this literature, uncertainty-induced emotional stress reduces individuals' self-control and encourages gambling. From this perspective, higher macroeconomic uncertainty may stimulate gambling. On the other hand, gambling can be regarded as a form of amusement consumption, which is expected to be reduced in times of uncertainty due to households' higher precautionary savings (Nam et al., 2021). This paper is the first to provide evidence of the effect of macroeconomic uncertainty on gambling.

We develop a theoretical framework in which uncertainty positively affects gambling by increasing the demand for hope in the short run. This positive effect decreases over time as agents learn to cope with uncertainty. In our empirical framework, we focus on China and use lottery sales per capita to proxy gambling preferences in each province in mainland China. This choice can be motivated as follows. First, a lottery ticket can be regarded as a risky financial asset with a negative expected outcome (Clotfelter and Cook, 1990). Lottery purchases are considered gambling because they violate the basic rationality hypothesis in economics. The extremely low probability of winning is common for lotteries in all countries. Second, gambling, such as casinos and lotteries, has been prohibited in mainland China since 1949 when the People's Republic of China was founded. This restriction was lifted in 1987 when the Ministry of Civil Affairs of China was authorized to sell lottery products to collect funds for social welfare. Since then, lotteries have become the only legalized gambling tool in mainland China.

Our research question is whether lottery sales rise or fall in response to economic policy uncertainty. To examine this question, we use a novel dataset of lottery sales and policy uncertainty in China. We collect monthly lottery sales data from 31 provinces of mainland China, covering the period from 2008 to 2021. We use Economic Policy Uncertainty (EPU) indexes constructed by different researchers using national or local newspapers to measure policy uncertainty. In our empirical framework, we employ a Panel Autoregressive Distributed Lag model with an Error-Correction form (Panel ARDL-EC) to disentangle the short- and long-run effect of EPU on gambling. Our results show that an increase in EPU has a significant positive impact on gambling in the short run, no matter whether EPU is measured using national or local newspapers. This result is consistent with our theoretical explanation that people gamble more during uncertain times due to a higher demand for hope. However, the persistence of this positive effect of EPU on gambling varies with the selection of newspapers used to construct the EPU index. The positive effect of EPU is less persistent if the EPU proxy is based on economic policy reports in national newspapers than when the EPU measure is derived from local newspaper reports.

Our study contributes to the literature in two ways. First, our empirical evidence contributes to the literature on the determinants of people's gambling behavior in China. Prior studies have examined the determinants of gambling behavior in advanced countries where in most cases lotteries are one of many forms of gambling (Capacci et al., 2017; Horváth and Paap, 2012; Mikesell, 1994). Yet, the literature on gambling behavior in emerging countries is scant. We focus on China where lotteries are the only legal form of gambling. Therefore, this study provides new insights into gambling behavior in an emerging country. Second, this paper adds to the literature on the implications of economic policy uncertainty on consumer behavior. Recent studies show that EPU has a pronounced impact on consumers' economic decision-making, particularly concerning consumption and saving (Nam et al., 2021), portfolio allocation (Lee et al., 2021), and life insurance (Canh et al., 2021). Our results suggest that EPU affects gambling activity as well.

The topic of this paper is also relevant for practitioners for two reasons. First, welfare lottery sales are important for the public budget and welfare spending. For example, one-third of welfare lottery sales in China are used to fund public welfare undertakings. In 2021, welfare lottery sales reached 142 billion RMB, of which approximately 44 billion RMB was allocated to welfare funds, accounting for around 10% of the expenditures of the Ministry of Civil Affairs in the same year.[1] Second, by showing that EPU significantly affects lottery sales, we provide a snapshot of human behavior under uncertainty that might also be relevant for other kinds of human decision-making.

The remainder of this paper is organized as follows. Section 2 summarizes related literature. Section 3 presents our

[1] Source: China Welfare Lottery Responsibility Lottery Report 2022.

theoretical model. Section 4 introduces our data and section 5 describes the empirical methods. Section 6 displays the results. Section 7 presents some robustness analyses. Finally, section 8 concludes.

2 LITERATURE REVIEW

Multiple studies show that gambling is not only driven by psychological factors, but also by economic considerations. A strand of economic literature related to this paper finds that gambling (proxied by lottery sales) is related to the business cycle. For example, using data from U.S. states, Mikesell (1994) reports that the effect of the business cycle on lottery sales is twofold. In recessions, people would buy fewer lotteries because of income loss. On the other hand, given the rising unemployment rate, people would find it more attractive to purchase lotteries because of the slight chance of winning a prize. Similarly, Horváth and Paap (2012) find that lottery sales in the U.S. grow a lot during recessions and are not affected by temporary income shocks. Capacci et al. (2017) use data from Italy and conclude that gambling expenditures increase as overall economic conditions worsen, implying that there is a higher tendency for people to resort to gambling during recessions. This relationship is confirmed in the case of Iceland by Olason et al. (2015) who report that gambling participation increased during the Icelandic economic recession starting in 2008.

This paper contributes to the literature on the implications of economic uncertainty on agents' economic behavior. Many studies find that economic uncertainty reduces consumption and encourages precautionary savings. For example, using U.S. household data, Nam et al. (2021) conclude that economic uncertainty depresses household consumption. Likewise, Coibion et al. (2021), who use data for European countries, find that economic uncertainty reduces households' consumption of non-durable goods and services in subsequent months. Other studies show that EPU affects people's borrowing and investment attitudes. For example, Nguyen et al. (2020) find that EPU negatively affects bank credit growth, implying that people borrow less in times of uncertainty. Lee et al. (2021) show that an increase in macroeconomic uncertainty decreases households' financial asset holdings, while Coibion et al. (2021) conclude that uncertainty reduces households' propensity to invest in mutual funds. Kalcheva et al. (2021) stress that EPU lowers individuals' impulse control and increases alcohol and cigarette consumption. To the best of our knowledge, no study has investigated the effect of EPU on gambling activities.

This paper is also related to studies on the gambling behavior of Chinese households, many of which use lottery sales as a proxy for gambling preference. For example, Ji et al. (2021) use provinces' per capita welfare lottery sales to measure local gambling preferences and find that a stronger gambling incentive causes higher stock price crash risk. Similarly, Qian and Wu (2021) use the ratio of provincial per capita lottery sales over provincial per capita disposable income as a measure of gambling tendency, finding that higher gambling preferences raise bank risk-taking. According to Chew et al. (2021), lottery sales reflect a demand for hope and may be considered as an indicator of subjective well-being. Using province-level data from China, they find that lottery sales increase at times of increasing air pollution confirming the idea that adversity increases the demand for hope. Using the wake of heavy snow and an earthquake in China in 2008, Li et al. (2011) report increased lottery demand after disasters. Yuan (2015) investigates Chinese gambling behavior using Chinese peer-to-peer online lottery gambling industry data. The author concludes that Chinese lottery gamblers are highly irrational when buying lotteries because their gambling behavior is influenced by others' gambling behavior.

3 THEORETICAL MODEL

3.1 Gambling in expected utility models

Gambling is difficult to reconcile with standard models of decision-making under uncertainty. First, in expected utility theory models as pioneered by von Neumann and Morgenstern (1944), the expected monetary value of gambling is usually negative. Rational agents should thus not participate in lotteries. Second, gambling incurs risk. Risk-averse individuals would thus require a risk premium as otherwise they would prefer not to participate in gambling. Third, it is difficult to construct utility functions that explain why people gamble (love risk) and buy insurance (avoid risk) at the same time.

To explain gambling, three approaches have been proposed: First, non-concave segments might be introduced to an otherwise concave utility function (Friedman and Savage, 1948). The reasoning here is that the opportunity to win a substantial amount of money offers the possibility to improve one's socioeconomic status. Agents are willing to pay a premium for this chance. By way of example, winning might enable parents to afford better education for their children. As a consequence, besides its monetary value, winning provides long-term benefits in terms of higher expected income.

The second approach to rationalizing gambling is based on cumulative prospect theory (Tversky and Kahneman, 1992). This theory modifies standard prospect theory - a concave utility function over gains and convex over losses - by weighting the cumulative distribution function such that the tails of the distribution are over-weighted. In the case of lotteries, gamblers overweight their ability to win. Due to a sense of optimism, people uphold irrational beliefs regarding their chances of winning. There is an "availability bias" in the sense that players inflate their subjective odds compared to the objective chance of winning. The fact that only winners get media attention contributes to this misjudgment. This reasoning is related to the literature on a long shot bias where individuals overestimate prospects of winning (Griffith, 1949). Chark et al. (2020) show that for a given expected lottery value, individuals prefer a lottery with a high prize and a small winning probability to a lottery with a low prize and a high winning probability.

Third, people might derive a separate, non-monetary utility component from gambling (Conlisk, 1993; Fishburn, 1980; Le Menestrel, 2001). This utility of gambling is treated as a separate additive term outside the standard expected utility function. That is, the traditional expected utility function is extended by an additional argument, which measures the non-monetary utility from gambling. The traditional expected utility function and its properties can be preserved. In particular, the expected utility function is restricted to consequences defined as probability distributions over outcomes. If agents value the outcome only, the utility is consequential in the sense that only the consequences are assessed. There is, however, a separate utility related to the conditions, institutions, and procedures that lead to these outcomes, the so-called procedural utility (Frey et al., 2004) or experienced utility (Kahneman et al., 1997). According to this approach, different procedures can produce different effects (procedural goods) relevant to individual utility. By way of example, two lotteries with the same expected monetary payoff can involve different personal utilities depending on their design. Lotteries do not have to be analyzed solely in terms of their consequences for wealth; the activity of gambling itself provides utility.

While there is some empirical support for the Friedman-Savage theory (Brunk, 1981) and the prospect theory (Snowberg and Wolfers, 2010), they both have their shortcomings in explaining individuals' gambling behavior. The Friedman-Savage theory provides an explanation of why the lottery is mainly played by individuals of the low and middle social classes; however, it cannot motivate why people with high income also gamble. Cumulative prospect theory, in turn, is a modeling device that simply assumes irrational behavior but cannot motivate it. It cannot explain why people overweight their chances of winning a lottery but show rational behavior in most other daily decisions. We thus proceed with the utility-of-gambling model to examine how policy uncertainty affects lottery gambling.

There are several approaches to explain why gambling offers procedural utility besides its expected value in monetary terms. First, gambling can be considered an amusing pastime that provides fun and excitement (Lee and Qiu, 2009). Burger et al. (2020) find that participating in a lottery increases happiness. They conclude that part of this utility is consumed before the draw as a procedural utility, from the excitement of playing the game, to the hope of winning a large prize, as well as social bonding. After the draw, players may gain procedural utility from winning a prize. Players are willing to pay for this fun like for any other type of fun, e.g., a cinema ticket or the price for a ride on a roller coaster. According to a survey-based factor analysis presented in the British Gambling Prevalence Survey (Wardle et al., 2010), recreation (hobbies, pastimes, fun, relaxation) is the second most important reason to gamble after the hope of winning money. In a similar vein, Dorn and Sengmueller (2009) explain the excessive trading puzzle in financial instruments by the joy that traders may derive from buying and selling assets.

Second, by purchasing a lottery ticket, individuals buy hope.[2] According to Chew and Ho (1994), hope may be defined as the joy in delaying the resolution of uncertainty. People are risk-seeking, because this type of risk provides utility (Diecidue et al., 2004). In the case of lotteries, hope is coupled with positive emotions before the draw because of hope for a happier life (Bruyneel et al., 2006) and dream of becoming rich (Forrest et al., 2002).[3] During the waiting period between the purchase of a

[2] A book about American state lotteries by Clotfelter and Cook (1989) is entitled "Selling hope".

[3] Devereux (1980) (p. 781) states that "the possession of a lottery ticket gives a stamp of authenticity to the hope for escape".

ticket and the draw of the winning numbers, people enjoy positive anticipatory emotions (Kocher et al., 2014; Loewenstein, 1987; Wu, 1999). These theoretical considerations are supported by the empirical finding that lottery sales rise during adverse situations like recessions and disasters (Capacci et al., 2017; Horváth and Paap, 2012; Li et al., 2011; Mikesell, 1994; Olason et al., 2015).

Finally, in the special case of welfare lotteries that support charities or sports organizations, the bet is perceived as a donation. Altruism is an additional motive to buy tickets. In comparison to a pure donation, welfare lotteries benefit from a feeling of reciprocity, because charity is giving you something back in the form of a potential prize (Hassay and Peloza, 2005).

3.2 A model of "gambling for hope"

Assume that our lottery is characterized by the following two outcomes: With a probability p the individual receives a gain G measured net of the price of the lottery ticket L, and with a probability *(1-p)* the person loses L. In the case of lotteries, the game is usually not fair in the sense that the expected value $p\,G+(1-p)\,L$ is smaller than zero. The reason is that the state removes part of the revenues for purposes other than prizes, e,g, administrative costs and charities. Hence, the cost C of buying N lottery tickets equals

$$C = -(p\,G + (1-p)\,L)\,N > \ 0 \tag{1}$$

In the spirit of Conlisk (1993) and Fishburn (1980), we assume that there is a utility of gambling[4], which can be combined additively with the expected payoff or utility function.[5] Following our discussion in the previous section we distinguish three main determinants of procedural gambling utility:

1. Fun and excitement: These depend on the lottery design like the waiting period and the size of the gain (G) given an expected value of the lottery. Gambling activity is usually motivated by the prospect of substantial gains that change an individual's social position. Therefore, gamblers prefer lotteries that offer large gains at a low probability.[6]

2. Hope: Lotteries sell hope. Two types of hope may be distinguished: The first type of hope may be defined as a desire that something uncertain happens. People enjoy delaying the resolution of uncertainty as their desire might not come true. Therefore, the waiting period in lottery games creates hope. Second, the chance to win a large prize produces the hope to live a better life, to overcome economic and financial problems and to maintain one's lifestyle even in a recession or after a disaster. Hope might be addictive in the sense that gamblers feel the need to maintain a certain level of hope. Given that the "hope returns" of a lottery ticket are decreasing, gamblers have to increase their stake, a phenomenon known as problem gambling.

3. Positive feeling of altruism due to donation for charity: This utility component increases in the share of the ticket price that is donated.

Hence, the term for the utility of gambling denoted by σ can be written as

$$\sigma(N) = \sigma(fun(N),\, hope(N),\, donation(N)) \tag{2}$$

where each of its three components is a function of the number of lottery tickets purchased (N). The utility σ is expressed in monetary terms as a willingness to pay. We assume that σ is a linear function of its variables fun, hope, and donation. Each variable can be measured in units and transformed into a willingness to pay. We further assume that these three variables

[4] Diecidue et al. (2004) model this utility as a negative cost of gambling.

[5] Fishburn (1980) assumes that all lotteries with equal expected utility have the same utility of gambling. We deviate from this assumption and allow for different utilities of gambling depending on the design of the lottery and on the valuation of the by-products it offers like joy, excitement, and hope.

[6] In line with Conlisk (1993), *fun* and *hope* could be modeled as functions of p for a given expected value of the lottery. Conlisk (1993) discusses that there might be an ideal skewness in which utility initially rises with p and then decreases for larger values of p. For our purposes, however, we can abstract from the relationship between p and the utility of gambling and therefore do not make any assumptions how p affects the utility of gambling. Conlisk (1993) proposes to model the excitement in the utility of gambling term as a Cobb-Douglas function of G and L or as the standard deviation of the prospect *(G, p)*.

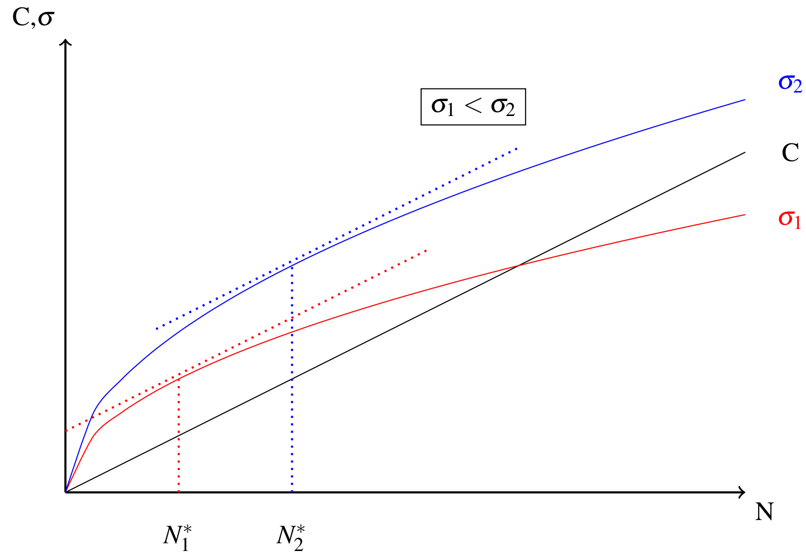

Figure 1. Costs and utility of gambling

Note: This figure compares the costs of gambling C with the utility of gambling for a low level of gambling utility σ_1 and a high level of gambling utility σ_2.

themselves are concave functions of N. By way of example, the fun linked to the first lottery ticket purchased is greater than that produced by the second ticket. As a result, σ is a concave function in N. Along a given utility function we consider changes in the amounts of fun, hope, and donation if we change the number of lottery tickets purchased.

These three variables may have prices, which depend on the demand for them. A higher demand translates into higher prices. Two agents might have differing demands for fun with the one showing a higher demand for fun willing to pay more for one unit of it. The demand for hope is a positive function of adversity. Adverse situations might be individual specific like unemployment or bad health or be caused by macro conditions like economic and political uncertainty or disasters. The willingness to pay for one unit of hope increases with the adversity of an agent's situation. Finally, the valuation of a donation depends on one's education, cultural habits, and the perceived need for it. Changes in the willingness to pay for one unit of fun, hope or donation shift our function $\sigma(N)$ up or down. If the demand for fun, hope or donation increases, the demand for lottery tickets rises. Given that the supply of tickets is totally price elastic, a higher demand leads to a larger amount of tickets sold in equilibrium.

Combining the expected payoff and the utility of gambling, our model reads as

$$Payoff = (p\,G + (1-p)\,L)\,N + \sigma(N) \tag{3}$$

For simplicity, we consider monetary payoffs and do not model an individual's preferences by a utility function.[7]

Figure 1 shows the amount $N*$ of lottery tickets that a profit-maximizing agent should purchase. Profits are maximized if the slope of the costs function equals the slope of the "utility of gambling" curve. If the utility of gambling increases for given N the function σ_1 is shifted to σ_2 and the optimum amount of lottery tickets rises from N_1^* to N_2^*.

So far, our model is static and does not consider repeated lottery games. If someone repeatedly buys lottery tickets, the utility of gambling might decrease over time. While it is likely that the utility due to fun and the donation aspect does not depend on the number of previous lottery games in which a player participated, hope might suffer from the negative experience that it did not materialize in previous draws. Over time, players learn that their hope is in vain. In the framework of our

[7] In line with prospect theory, one could assume a concave utility for gains and a convex function for the segment of losses (loss aversion). This, however, would render our model intractable as the utility of gains and losses depends on the specific design of the lottery characterized by *p, G* and *L*.

model, this means that the units of hope that a lottery ticket produces is a decreasing function of the number of preceding game participations T without a positive outcome. Hence, σ is a concave function of N and T.

Let us assume, without loss of generality, that each lottery ticket contains one unit of "raw" hope. That is, N lottery tickets enclose N units of hope. To measure the actual amount of hope perceived, however, we weigh the units of hope depending on the amount of tickets bought by an agent. First, we control for dynamic effects by assuming that perceived hope is a decreasing function of the number T of previous participations in the lottery game. We call this amount $hope^{real}$.

$$hope^{real}(N,T) = (T+1)^{\alpha} * N \tag{4}$$

where $-1 < \alpha < 0$.[8] In the second step, perceived hope is priced and transformed into a willingness to pay for hope. We assume that at each date at which an agent plays the lottery, the first perceived unit of hope has a constant price, which we normalize to one. As assumed above, the willingness to pay for one unit of perceived hope is decreasing in the number of tickets purchased N:

$$hope^{nominal}(N,T) = (hope^{real})^{\beta} \tag{5}$$

where $0 < \beta < 1$. This $hope^{nominal}$ linearly enters the utility of gambling function σ.

Figure 1 can be used to illustrate this dynamic lottery game. Assume that σ_2 represents the utility of gambling function for an agent who plays for the first time, that is, $T=0$. The next time the same agent purchases lottery tickets, the perceived real hope per ticket is lower. $T=1$ and the utility of the gambling function is depicted by σ_1. In this dynamic setting, the optimal number of tickets purchased decreases with each additional participation in the game, ceteris paribus.

In the long run of a dynamic model, there might be an additional demand-reducing effect at work: Agents learn to cope with uncertainty and lower their willingness to pay for hope. This might explain why the high demand for hope induced by increased uncertainty vanishes over time.

Based on the considerations above, this paper examines the following hypotheses:

Hypothesis 1 *By raising the demand for hope, uncertainty increases the amount of lottery tickets sold.*

Hypothesis 2 *By disappointing hope, the positive effect of uncertainty on the amount of lottery tickets sold decreases over time.*

4 DATA: DEFINITIONS AND ANALYSIS

4.1 Lottery sales

The lottery industry in China is operated by state-owned lottery companies that offer two categories of lotteries: sports lotteries, characterized by betting on sports matches, and welfare lotteries based on "number picking". The first ones involve betting on the outcomes of sports matches, the sales of which mainly depend on the popularity of the sports event. In addition, the chance of winning sports lotteries partly depends on gamblers' knowledge of the respective type of sport, making these lotteries more popular among sports lovers than ordinary consumers. The welfare lotteries, which are the main interest of this paper, consist of different kinds of lotteries based on pure speculation and chance, such as 3D, Double Color Balls, Big Lotto, etc. We use data on sales of welfare lotteries to represent gambling because the expected outcome is independent of any characteristics and knowledge of the player. In this regard, the techniques gamblers can use to increase their chances of winning are very limited. That is, the result is a random variable. By way of example: Players pay 2 Chinese Yuan (CNY) for a 3D lottery, a type of welfare lottery, and pick three integers from 0 to 9 with the purpose of guessing the winning three-digit number from 000 to 999. The player can choose three matching formats, from correctly guessing a single number to matching all three in the exact order. The winning amounts per bet range from 173 to 1040 CNY per bet. The 3D lottery and many other welfare lotteries

[8] Alternatively, instead of measuring the number of lottery game participations, T could measure the time since the last lottery purchase. In this case, it would be reasonable to assume that $hope^{real}$ is an increasing function in time $hope^{real}(N,T) = T^{\alpha} * N$ and $0 < \alpha < 1$. This would imply that perceived real hope is lower, the closer an unsuccessful ticket purchase in the past is.

are operated on a daily basis except for important national holidays. The winning numbers and the corresponding prizes are announced every other day through the leading newspapers and TV networks.

We collect monthly sales data for welfare lotteries in 31 mainland Chinese provinces from the China Welfare Lottery Issuing and Management Center and the Ministry of Finance of China.[9] The sample period is determined by data availability and ranges from January 2008 to December 2021. To remove the impact of population size and price level in each province, welfare lottery sales are divided by the total provincial population and deflated by the consumer price index with 2008 as the base year. Table 1 provides descriptive statistics. It shows that the average lottery sales per capita are 9.19 CNY, implying that on average each individual spends 9.19 CNY on buying welfare lotteries each month, which is around 0.45% of their monthly income.

Table 1. Descriptive statistics

Variable	Mean	SD	Min	Max	No. obs
Lottery sales per capita (CNY, constant price)	9.19	5.59	0.00	67.11	5176
Income per capita (CNY, constant price)	2052.87	760.35	876.96	5545.43	5208
Output gap (% of GDP)	-1.61	12.96	-51.46	31.44	5208
EPU (Baker et al., 2013)	319.84	246.50	26.00	971.00	5208
EPU (Davis et al., 2019)	212.51	245.84	0.00	1425.20	5208
EPU (Huang and Luk, 2020)	142.31	24.67	98.87	238.32	5208
EPU (Yu et al., 2021)	21.29	14.73	0.34	86.25	309

4.2 Control variables

We add two control variables that might affect lottery sales.[10] First, to capture the effect of income on lottery consumption, we add deflated income per capita as a control variable in our model. Second, we include the output gap as a percentage of provincial GDP as a control variable to consider the effect of the business cycle in each province. This prevents potential omitted variable bias as EPU is found to be associated with the business cycle (Duca and Saving, 2018). To construct the output gap variable, we use the approach of Hamilton (2018) to filter real GDP per capita and obtain the cyclical component. Data on income per capita and provincial GDP are collected from the National Bureau of Statistics of China.[11]

4.3 Economic policy uncertainty indexes for China

To the best of our knowledge, there are currently four publicly available measures of EPU in China. The authors of these indexes follow a similar methodology as proposed by Baker et al. (2016). In particular, the number of newspaper articles is counted that contain the three-term sets: Economic, Policy, and Uncertainty. To identify which keywords in newspaper articles are related to these terms, Baker et al. (2016) rely on human readings of 12,000 randomly sampled articles to populate a list of candidate English keywords. Based on the counts of these keywords, they construct the EPU index for English-speaking countries. However, in the case of China, the four EPU series are somewhat different from each other depending on the selection of newspapers. The following paragraphs describe in detail how each index is constructed and introduce its characteristics.

Baker et al. (2013) construct the first EPU index for China using information from South China Morning Post, Hong Kong's leading English-language newspaper, which makes it easier to apply Baker et al. (2016)'s method and keywords list which is designed for English-speaking countries. For a long time, this index was the only well-accepted measure for economic policy uncertainty in China. However, an obvious shortcoming of this index is that the chosen newspaper focuses on Hong Kong instead of mainland China, which implies that it may not fully reflect the level of uncertainty in the latter.

The second EPU index for China has been constructed by Davis et al. (2019) who, for the first time, use mainland Chinese-language newspapers as sources: the Renmin Daily and the Guangming Daily, which are the two leading newspapers

[9] The data are available from `http://www.cwl.gov.cn` and `http://www.mof.gov.cn`

[10] We opt not to add more control variables because our core estimations are at a high frequency (monthly) while most province-level economic variables are at a lower frequency (yearly). We provide analyses with more control variables in Section 6.2.

[11] The quarterly deflated income per capita and the output gap are interpolated into monthly data.

at the national level in mainland China. Using mainland Chinese-language newspapers allows a more precise measure of EPU, because these newspapers are more related to the Chinese economy than Hong Kong newspapers. This, however, entails the challenge of creating a new list of Chinese keywords related as closely as possible to the economic policy uncertainty terms used to identify uncertainty in the English version of the index. To solve this problem, Davis et al. (2019) use an advanced and less labor-intensive natural language processing tool to help select terms.

Besides these two EPU indexes that employ national newspapers, an alternative EPU index has been created by Huang and Luk (2020) who use 10 mainland Chinese-language local newspapers. In contrast to Davis et al. (2019) who rely on two national newspapers, Huang and Luk (2020) select 10 city-level newspapers from major mainland cities representative of the newspaper market in urban areas. They then use the average EPU index number computed from these ten newspapers as China's overall economic policy uncertainty measure. Compared with the previous two indexes, this new EPU index for China has the benefit that it is less affected by potential bias due to the editorial policy or preference of a single or few newspapers because it is based on a larger number of newspapers. The authors construct their EPU index for China at both monthly and daily frequencies.[12] Using local newspapers, however, implies that the index pays more attention to local economic policy instead of the overall policy-making environment in China.

One common feature of the above three EPU indexes for China is that they do not differ across provinces. However, Yu et al. (2021) have developed an EPU index by using the leading local newspaper from each of the 31 provinces of mainland China, thereby providing the first measure of China's provincial EPU that introduces regional heterogeneity. In addition, this provincial EPU takes into account the uncertainty from both central and local governments. The index by Yu et al. (2021) is at a lower frequency (yearly) and covers a shorter period (2000-2017) compared with the other EPU indexes. Figure 2 displays a scatterplot of the average provincial EPU index against welfare lotteries sales. The positive slope of the fitted line indicates that there might be a positive association between EPU and welfare lotteries sales.

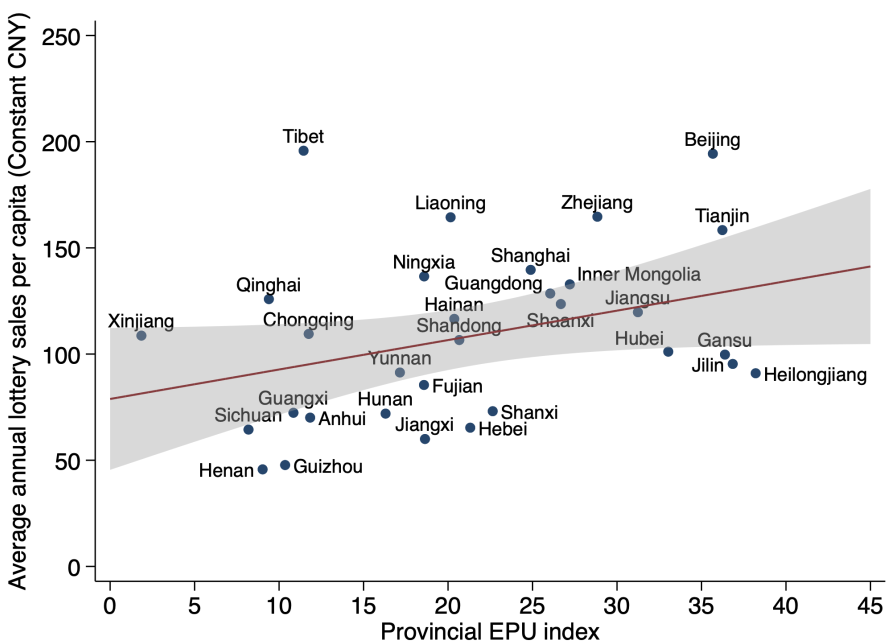

Figure 2. EPU index (Yu et al., 2021) and average lottery sales per capita by province (2008-2017)

Accordingly, the most notable difference among these four EPU series is with regard to the newspapers they use: Baker et al. (2013) and Davis et al. (2019) use national newspapers while Huang and Luk (2020) and Yu et al. (2021) use local newspapers. This difference is important because newspapers with different scopes have different focuses and suffer from different kinds of

[12] To construct daily EPU, the authors employ a more comprehensive range of local newspapers (144 instead of 10).

media censorship. National newspapers pay more attention to national policies and are supervised by the central government, and local newspapers focus on both national and local policies and are supervised by the local government.

Table 2 summarizes details of these EPU measures for China. Table 1 and Table 3 report the descriptive statistics and correlation coefficients of all variables, including the four EPU indexes, respectively. Figure 3 displays the evolution of average lottery sales per capita and the four EPU indexes. Most notably, the EPU indexes by Baker et al. (2013), Davis et al. (2019), and Yu et al. (2021) are positively related to lottery sales per capita, while the EPU index by Huang and Luk (2020) has a negative correlation with lottery sales per capita. In addition, we find that the two EPU indexes using national newspapers (Baker et al., 2013; Davis et al., 2019) have similar movements over time with a high and positive correlation coefficient of 0.7, whereas the EPU indexes constructed by Huang and Luk (2020) and Yu et al. (2021), who use local newspapers, have a low correlation with the previous two. Furthermore, these two local-level EPU indexes have a low and negative correlation (-0.21).

Table 2. Measures of EPU for China

Authors	Sample coverage	Source newspapers	Frequency	Notes
Baker et al. (2013)	January 1995 to present, national level (Time series)	National newspaper: South China Morning Post	Monthly	Use English-language newspapers
Davis et al. (2019)	October 1949 to present, national level (Time series)	National newspapers: Renmin Daily and the Guangming Daily	Monthly	Use natural language processing tools to analyze newspaper texts
Huang and Luk (2020)	January 2000 to present, national level (Time series)	City level newspapers: Beijing Youth Daily, Guangzhou Daily, Jiefang Daily, People's Daily Overseas Edition, Shanghai Morning Post, Southern Metropolis Daily, The Beijing News, Today Evening Post, Wen Hui Daily, and Yangcheng Evening News	Monthly, daily	Use 10 city-level newspapers to avoid idiosyncrasies in individual newspapers
Yu et al. (2021)	2000-2017, provincial level (Panel data)	Province level newspapers: Local newspapers from 31 provinces	Yearly	Use 31 provincial newspapers to introduce regional heterogeneity

Notes: EPU data compiled by Baker et al. (2013), Davis et al. (2019), Huang and Luk (2020), and Yu et al. (2021) are available at https://www.policyuncertainty.com/scmp_monthly.html, https://www.policyuncertainty.com/china_monthly.html, https://economicpolicyuncertaintyinchina.weebly.com, and https://doi.org/10.1016/j.eneco.2020.105071, respectively.

Table 3. Correlation matrix

		Lottery sales (1)	Income (2)	Output gap (3)	EPU 1 (4)	EPU 2 (5)	EPU 3 (6)	EPU 4 (7)
Lottery sales	(1)	1						
Income	(2)	0.50	1					
Output gap	(3)	0.06	-0.06	1				
EPU 1	(4)	0.16	0.53	0.02	1			
EPU 2	(5)	0.12	0.42	0.11	0.70	1		
EPU 3	(6)	0.06	-0.12	-0.09	0.12	-0.08	1	
EPU 4	(7)	0.28	0.26	0.03	0.02	-0.44	-0.21	1

Notes: All variables except the output gap are expressed in logs. EPU 1, EPU 2, EPU 3, and EPU 4 represent the EPU indexes compiled by Baker et al. (2013), Davis et al. (2019), Huang and Luk (2020), and Yu et al. (2021), respectively.

In order to examine the nature of our data and to choose an appropriate estimation approach, we first apply unit-root tests for all variables. We adopt two types of panel unit root tests for panel variables: the Augmented Dickey-Fuller (ADF) test and the Im-Pesaran-Shin (IPS) test, both of which assume stationarity under the null hypothesis.[13] Results reported in Table 4 show that the null hypotheses are not rejected for lottery sales per capita and income per capita in levels but are rejected in the case of their first-differences, implying that these two variables are I(1). With regard to the EPU and output gap, we find that the null hypotheses are rejected when we use variables in levels, suggesting that EPU variables and the output gap are stationary and contain no unit root. Hence, these results indicate a mixture of I(0) and I(1) variables.

[13] For EPU series, we only use the ADF test because the IPS test cannot be applied to time series.

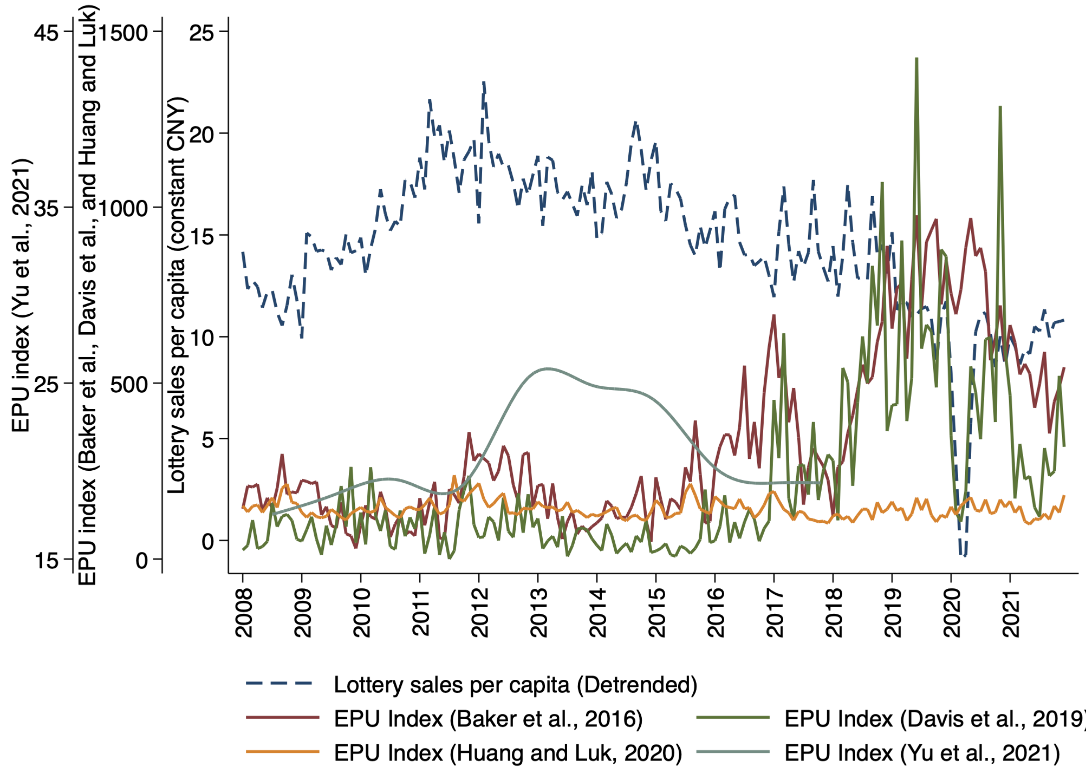

Figure 3. EPU index and averaged lottery sales per capita

Table 4. Panel unit root tests

Variable	ADF		IPS		Result
	In levels	First-difference	In levels	First-difference	
Lottery sales per capita	-3.009	156.185***	4.104	-49.067***	I(1)
Income per capita	-0.461	161.622***	-0.841	-38.880***	I(1)
Output gap	187.41***		-41.712***		I(0)
EPU (Baker et al., 2013)[a]	-4.229***				I(0)
EPU (Davis et al., 2019)[a]	-7.483***				I(0)
EPU (Huang and Luk, 2020)[a]	-6.998***				I(0)
EPU (Yu et al., 2021)	8.526***		-3.95***		I(0)

Notes: The logs of lottery sales, income, and EPU indexes are used. ADF means Augmented Dickey-Fuller unit-root test. IPS means the Im-Pesaran-Shin test. The null hypothesis for both tests is that the tested series contain a unit-root. *, **, *** represent the 10%, 5%, and 1% significance level, respectively. Superscription [a] means the time-series unit root test is used for this series.

5 EMPIRICAL METHOD

We proceed with a Panel Autoregressive Distributed Lag model with an Error-Correction form (Panel ARDL-EC) to estimate the effect of EPU on gambling behavior. We adopt this approach for three reasons. First, we are interested in distinguishing the short-run effect of EPU from its long-run impact on lottery sales because our theoretical model indicates a dynamic impact of uncertainty on gambling. This ARDL-EC approach has the advantage of simultaneously estimating the long- and short-run parameters. Second, we use a long panel (large T and small N), and our panel unit root tests suggest the existence of both I(0) and I(1) variables, which rationalizes the use of the error correction form of the ARDL model that can be applied irrespective of whether underlying regressors are purely I(0), purely I(1) or mutually cointegrated variables (Pesaran et al., 2001). Third, this Panel ARDL-EC approach provides two estimators (pooled mean group estimator and mean group estimator) that allow for heterogeneity in the units/provinces, which is more realistic because we cannot assume that the effect of EPU on gambling behavior is exactly the same in all provinces. The baseline specification is as follows:

$$\Delta Y_{i,t} = \alpha + \sum_{k=1}^{m} \beta_{1,k} \Delta Y_{i,t-k} + \sum_{k=0}^{n} \beta_{2,k} \Delta \mathbf{X}_{i,t-k} + \gamma_1 Y_{i,t-1} + \gamma_2 \mathbf{X}_{i,t-1} + M_t + \varepsilon_{i,t}, \tag{6}$$

where $Y_{i,t}$ is deflated lottery sales per capita in province i at time t. $\mathbf{X}_{i,t}$ is a vector of explanatory variables which include the EPU index and control variables. The lottery sales are expressed in logs as the original series are highly positively skewed. This logarithm transformation has the advantage of reducing the skewness as well as reducing the effect of extreme values. EPU series are standardized to have a mean of zero and a standard deviation of one. Accordingly, we estimate a semi-log model in which the coefficient of EPU shows the percentage ($\beta_{1,k} \times 100$ or $\gamma_2 \times 100$) of welfare lottery sales that is attributable to an increase in EPU by one-unit standard deviation. m and n are the lags of the first-differenced lottery sales and EPU, respectively. The optimal lag structure is determined using the Bayesian Information Criteria (BIC). M_t is a series of monthly dummy variables to capture any seasonal effects in lottery sales. In Equation 6, the short-run effects are captured by the estimated coefficients on first-differenced variables, and long-run effects are inferred by the estimates of γ_2. Note that cointegration is needed to ensure the validity of the long-run estimates, which is satisfied if the coefficient of the error correction term (γ_1) is significantly negative.

We estimate Equation 6 in a panel framework. In particular, we adopt three estimators that differ in their assumptions concerning the degree of homogeneity. The Dynamic Fixed Effects (DFE) estimator assumes both the long- and short-run coefficients to be homogeneous. Therefore, all units have the same long- and short-run coefficients. The Mean Group (MG) estimator assumes that both short- and long-run coefficients are heterogeneous. It calculates the estimated coefficients using the unweighted means of all heterogeneous coefficients. The third estimator is the Pooled Mean Group (PMG) estimator proposed by Pesaran et al. (1999), which compromises the DFE and MG estimators by allowing a combination of heterogeneous short-run effects and homogeneous long-run effects. The PMG estimator allows the short-run coefficients, the speed of adjustment, and error variances to be heterogeneous across units while the long-run slope coefficients are homogeneous. As suggested by Pesaran et al. (1999), we rely on the Hausman test and the likelihood ratio test to choose the most appropriate estimator.

6 RESULTS

6.1 Monthly-frequency estimation

We examine the effect of EPU on gambling by regressing each monthly EPU index on lottery sales per capita. We first estimate the standard panel ARDL-EC model with all three estimators and thereafter subject the results to Hausman and likelihood ratio tests. Results are reported in Table 5 in which we consider three monthly measures for EPU. Columns (1) to (3), (4) to (6), and (7) to (9) present results using the EPU indexes compiled by Baker et al. (2013), Davis et al. (2019), and Huang and Luk (2020), respectively. Non-rejection of the null hypothesis of the Hausman test implies a preference for the PMG or DFE estimators over the MG estimator while rejection indicates that the MG estimator should be adopted. It turns out that the null hypothesis is not rejected in all specifications, supporting the PMG or DFE estimators. We then choose between DFE and PMG estimators by using the likelihood ratio test that examines the null hypothesis that there is no heterogeneity in the short-run effects.[14] Rejection of the null hypothesis implies the adoption of the PMG estimator while non-rejection indicates the adoption of the DFE estimator. As depicted in Table 5, we reject the null hypothesis across all models, suggesting that PMG is the preferred estimator. Taken together, our results indicate that the PMG estimator is the most appropriate estimator, implying a heterogeneous short-run and a homogeneous long-run impact of EPU on gambling activity across provinces.

Table 5. Panel ARDL-EC estimation

	EPU Baker et al. (2013)			EPU Davis et al. (2019)			EPU Huang and Luk (2020)		
	PMG	DFE	MG	PMG	DFE	MG	PMG	DFE	MG
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Short-run effects									
Δ EPU	0.009*	0.012**	0.006	0.034***	0.034***	0.031***	0.009***	0.011***	0.010***
	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)	(0.001)	(0.002)	(0.002)
Δ EPU_{t-1}	0.045***	0.049***	0.052***	0.040***	0.042***	0.045***	0.008***	0.007***	0.007***
	(0.006)	(0.006)	(0.006)	(0.004)	(0.003)	(0.004)	(0.001)	(0.002)	(0.002)
Δ EPU_{t-2}	0.012***	0.014***	0.017***	0.040***	0.041***	0.043***	-0.001	-0.003*	-0.002
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.002)	(0.001)	(0.002)
Δ Income	0.994***	0.339***	1.029***	0.913***	0.319***	0.940***	1.073***	0.313***	1.091***
	(0.123)	(0.061)	(0.119)	(0.120)	(0.058)	(0.117)	(0.122)	(0.061)	(0.128)
Δ Output gap	0.002**	0.000	0.001**	0.002***	0.001	0.002***	0.002***	0.000	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Long-run effects									
EPU	-0.153***	-0.172***	-0.190***	-0.194***	-0.252***	-0.254***	0.012	0.043***	0.039***
	(0.012)	(0.018)	(0.020)	(0.013)	(0.024)	(0.019)	(0.013)	(0.013)	(0.010)
Income	1.143***	1.218***	1.266***	1.138***	1.258***	1.261***	0.784***	0.795***	0.753***
	(0.043)	(0.100)	(0.078)	(0.042)	(0.103)	(0.086)	(0.037)	(0.100)	(0.090)
Output gap	-0.005***	-0.005***	-0.007**	-0.003**	-0.003***	-0.003	-0.005***	-0.005***	-0.009**
	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.004)
Error correction term	-0.205***	-0.173***	-0.242***	-0.193***	-0.168***	-0.224***	-0.173***	-0.149***	-0.191***
	(0.024)	(0.029)	(0.027)	(0.021)	(0.027)	(0.025)	(0.022)	(0.025)	(0.024)
Constant	-1.277***	-1.156***	-1.587***	-1.154***	-1.134***	-1.357***	-0.591***	-0.504***	-0.574***
	(0.162)	(0.251)	(0.204)	(0.138)	(0.220)	(0.171)	(0.083)	(0.161)	(0.131)
	(0.134)	(0.215)	(0.168)	(0.125)	(0.223)	(0.166)	(0.089)	(0.164)	(0.136)
Hausman test [p-values]	10.45 [0.88][a]	0.02 [0.99][b]		8.54 [0.96][a]	0.01 [0.99][b]		3.81 [0.99][a]	0.03 [0.99][b]	
Likelihood ratio test		739.1892***			763.4745***			710.8287***	
Half-life period (month)	3.02	3.65	2.50	3.23	3.76	2.73	3.65	4.29	3.27
Observations		5049			4925			5080	

Notes: Sample period: January 2008 to December 2021. The dependent variable is the first difference of deflated welfare lottery sales per capita. Standard errors are in parentheses. *, **, *** represents the 10%, 5%, and 1% significance level, respectively. Likelihood ratio tests examine the null hypothesis of short-run homogeneity, which favors DFE, assuming that the short-run coefficients are homogeneous across provinces. Rejection of the null hypothesis indicates that PMG is preferred over DFE.
a: Tests the hypothesis that the difference between MG and PMG is not significant, which favors PMG because it is more efficient than MG.
b: Tests the hypothesis that the difference between MG and DFE is not significant, which favors DFE because it is more efficient than MG.

Looking at the short-run effects, we find that the coefficients of different EPU indexes are all significantly positive, and this result is robust across different estimators and different EPU measures, which indicates that an increase in EPU stimulates gambling activity in the short run. According to the coefficients, a one-unit standard deviation increase in different EPU indexes (Baker et al., 2013; Davis et al., 2019; Huang and Luk, 2020) is associated with a short-run increase in lottery sales by 0.9%, 3.4%, and 0.9%, respectively. This result provides support for our first hypothesis that uncertainty increases the amount of lottery tickets sold.

The estimated long-run effects show that policy uncertainty affects gambling activity differently depending on the EPU measure applied, providing mixed support for our second hypothesis that the effect of uncertainty on the amount of lottery tickets sold decreases over time. The EPU indexes by Baker et al. (2013) and Davis et al. (2019) who use national newspapers have significant negative coefficients, while Huang and Luk (2020)'s EPU that relies on local newspapers has a positive but insignificant coefficient. The negative long-run effects of EPU suggest that agents learn to cope with uncertainty over time such that they reduce their demand for lottery tickets per unit of uncertainty. To sum up, our results from the panel ARDL-EC model reveal that the effect of EPU on gambling activity is significantly positive in the short run, which reconciles with the theoretical

[14] This is because the PMG and DFE estimators are restricted versions of the set of individual group equations (Pesaran et al., 1999). Under the null hypothesis that short-run heterogeneity is insignificant, this likelihood ratio test statistic has an asymptotic $\chi^2(n)$ distribution where the degrees of freedom n equal the number of restrictions imposed which, in our case, is the difference in the number of estimated parameters in the PMG and DFE estimators.

hypothesis in the previous section. On the other hand, we find that, in the long run, the effects are negative if significant at all. In the long-run equilibrium, agents seem to purchase fewer lottery tickets than in the period characterized by high uncertainty.

In ARDL models, the long-run effect is defined as the long-run equilibrium effect of independent variables on the dependent variable, while the short-run effect accounts for fluctuations due to deviations from the long-run equilibrium. We are able to compute how long it takes for disequilibrium to be reduced by 50% (half-life period) using the error correction coefficient γ_1.[15] The results for the half-life periods are reported at the bottom of Table 5. It is shown that the half-life period ranges between 3 to 3.7, indicating that it takes approximately three to four months for a disequilibrium in lottery sales caused by a change in EPU to be reduced by 50%. A closer inspection reveals that columns (7) to (9) have the longest half-life periods compared with the other columns. This indicates that the short-run positive effect of the EPU index constructed by Huang and Luk (2020) on gambling is more persistent than that of the other two EPU indexes.

We find that the coefficients of the control variables (income and the output gap) are statistically significant in most cases. Income has significant positive short- and long-run coefficients in all specifications. This indicates that an increase in income positively affects lottery sales, whether in the short or long run. This is reasonable because increased income may encourage people to raise general consumption, including their gambling expenditures. This result is consistent with the earlier finding by DeBoer (1986), who documents a significant positive association between income and lottery sales. The coefficient of the output gap is significantly positive in the short run while it becomes significantly negative in the long run, signaling a positive short-run and a negative long-run effect of the business cycle on lottery sales. In other words, an economic boom is positively related to gambling behavior in the short run, implying that people would gamble more in good times. However, the effect of an economic boom turns negative, meaning that in the long run people gamble less in an economic expansion. This long-run counter-cyclicality is consistent with studies of Horváth and Paap (2012) and Mikesell (1994) who find that people gamble more during recessions.

6.2 Yearly-frequency estimation

So far, our EPU indexes are calculated at the national level, which means that they are the same for all provinces at a given point in time. In this subsection, we use EPU data compiled by Yu et al. (2021), which allows us to account for different levels of economic policy uncertainty across provinces. This index is available at an annual frequency only and covers a relatively short period. However, the use of annual data allows us to include a larger set of control variables available at a yearly but not monthly frequency, which may reduce potential endogeneity concerns caused by omitted variables.

The results of these regressions are reported in Table 6. For control variables, we only consider long-run effects in order to avoid increasing the complexity of the estimated models. Column (1) presents the results without any control variables, in which EPU has positive short- and long-run coefficients, suggesting that a rise in EPU is related to a rise in gambling activities. In columns (2) and (3), we control for the effects of income measured by the logarithm of GDP per capita and the business cycle proxied by the output gap, respectively. Income has a significantly positive coefficient, implying that income growth could stipulate gambling, while the effect of the output gap (business cycle) is negative and insignificant. In column (4), we include education as a control variable measured by the ratio of the population with high school education or above to the total population. In column (5), we control for the urbanization rate measured by the ratio of the urban population to the total population. The urbanization rate has a positive effect at the 1% significance level, suggesting that gambling is more popular in provinces where more people live in urban areas. In column (6), we include the dependency ratio to capture the effect of the demographic structure, which turns out to be negative and insignificant. Finally, in column (7) we include all control variables, where the coefficient of income has a significant positive sign and those of education and dependency ratio have significant negative signs.

We find that, regardless of the controls, the province-specific EPU is positive and significant at the 1% level in both the short and long run in almost all specifications of Table 6. This result is consistent with the findings obtained for the EPU computed by Huang and Luk (2020) that also employ local newspapers and validates the robustness of the positive short-run association

[15] The half-life period can be approximated as $-\ln 2/\ln(1+\gamma_1)$.

between EPU and gambling found in the previous sections. This result is robust to the inclusion of alternative control variables and the consideration of regional heterogeneity in EPU.

Table 6. Panel ARDL-EC estimation using EPU index by Yu et al. (2021)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Short-run effects							
Δ EPU	0.011	0.018**	0.014***	0.014**	0.016***	0.007	0.012***
	(0.008)	(0.009)	(0.005)	(0.006)	(0.005)	(0.005)	(0.001)
Long-run effects							
EPU	0.066**	0.075**	0.072**	0.076**	0.062**	0.101*	0.096***
	(0.029)	(0.031)	(0.029)	(0.031)	(0.024)	(0.057)	(0.028)
Income		1.288***					2.107***
		(0.220)					(0.582)
Output gap			-0.006				-0.000
			(0.004)				(0.004)
Education				0.004			-0.076**
				(0.040)			(0.030)
Urbanization					0.020***		-0.047
					(0.005)		(0.039)
Dependency ratio						-0.003	-0.033**
						(0.007)	(0.014)
Error correction term	-0.533***	-0.548***	-0.529***	-0.518***	-0.608***	-0.348**	-0.440***
	(0.181)	(0.202)	(0.187)	(0.182)	(0.217)	(0.138)	(0.153)
Constant	2.570***	-4.821***	2.573***	2.348	2.277***	1.740**	-2.823
	(0.855)	(1.235)	(0.888)	(1.968)	(0.723)	(0.686)	(2.215)
Half-life period (month)	10.92	10.48	11.05	11.39	8.88	19.45	14.35
Observations	176	176	176	178	176	176	178

Notes: Sample period: 2008 to 2017. The dependent variable is deflated annual welfare lottery sales per capita. Estimations are based on the DFE estimator because PMG is not applicable due to the limited number of observations. Standard errors are in parentheses. *, **, *** represents the 10%, 5%, and 1% significance level, respectively.

6.3 Discussion

Overall, our results using four EPU indexes indicate a significant positive effect of EPU on lottery sales per capita in the short run. This result supports the first hypothesis that uncertainty increases the amount of lottery tickets sold by raising the demand for hope. However, our results are mixed regarding the second hypothesis that the positive effect of uncertainty on the amount of lottery tickets sold decreases over time because of disappointed hope and individuals' improvements to cope with uncertainty. Results using EPU indexes computed using national newspapers (Baker et al., 2013; Davis et al., 2019) imply a negative long-run effect on lottery sales, which supports the second hypothesis. However, we do not find a significant decrease in the positive effect of EPU on lottery sales in the long run when we use EPU indexes computed using city- or province-level newspapers (Huang and Luk, 2020; Yu et al., 2021), which provides limited support for our second hypothesis. In addition, we find that the positive short-run effect of the EPU based on national newspapers is less persistent than that of the other two EPU series. This is evidenced by the comparison of the half-life period between models with different EPU measures. For example, column (7) in Table 6 shows that the half-life period is around 14 months, which, together with the half-life period (3.65 months) for the model with EPU by Huang and Luk (2020), are longer than those (3 and 3.23 months) for models with EPU by Baker et al. (2013) and Davis et al. (2019).

A possible explanation for this disparity in the long-run effects is that, compared to national newspapers, city- or province-level newspapers may contain more information that relates to residents' daily life, thus exerting a more pronounced and persistent positive effect on lottery consumption, which strengthens and prolongs the short-run positive effect. Another explanation is related to selective censorship in Chinese national and local newspapers. As suggested by Kuang (2018); Qin et al. (2017), national authorities are more lenient than their local counterparts when it comes to allowing the media to cover unfavorable social news that has a harmful impact on the local government. Local authorities, on the other hand, extensively control the local media and repress negative news that is harmful to either central or local governments. By implication, national newspapers report relatively more negative news and generally display a higher level of uncertainty. Accordingly, an individual might better learn to cope with EPU over time when reading national newspapers. Given the higher frequency of negative news in national newspapers, readers are less surprised and sooner forget any news related to uncertainty. On the other hand, the same individual might react more to increased EPU from local newspapers as it is less usual to receive negative news from local newspapers. Therefore, the positive effect on gambling of EPU indexes that use local newspapers is more pronounced and persistent than the effect of EPU indexes that rely on national newspapers.

7 ROBUSTNESS CHECKS

7.1 Dynamic Models

As a first robustness check, we use a more straightforward and intuitive method to examine the effect of EPU on gambling. To do so, we consider a dynamic panel model that contains lagged lottery sales as one explanatory variable in order to allow for the modeling of a partial adjustment mechanism. However, adding a lagged dependent variable may create the Nickell Bias (Nickell, 1981), which can be solved by employing the Arellano and Bond two-step generalized method of moments (GMM) estimator (Arellano and Bond, 1991). This estimator may have the additional benefit of solving the potential endogeneity problem.

Table 7 presents the estimation results. Columns (1) to (4) display the estimated coefficients using four types of EPU indexes. Panel A shows the results without adding lags of EPU and Panel B presents the results after adding lags of EPU to capture the effect of past EPU.[16] The results show that *EPU* has a significant positive coefficient across all specifications. This finding confirms our previous argument that EPU has a significant positive effect on gambling in the short run.

7.2 Daily-frequency estimation

So far, we have used monthly and yearly data to investigate the impact of policy uncertainty on gambling activity. This is because the most widely publicly available data for both EPU and aggregate welfare lottery sales are at a monthly frequency. As a robustness check, we use two other sets of daily data: daily 3D lottery sales (a specific welfare lottery) from Chew et al. (2021), which compared with monthly lottery sales data covers a shorter period from 2013 to 2017 and the EPU index from Huang and Luk (2020) who construct a daily EPU using 144 local newspapers. Though not as representative as our monthly data due to its shorter sample period, this daily data can be used for a complementary analysis.

We use daily data and estimate a Panel ARDL model. To control for time-fixed effects in the daily data, we include a series of time controls: month-of-year dummies, day-of-week dummies, and a public holiday dummy to capture systematic sale shifts within a year, within a week, and because of public holidays, respectively. Table 8 provides the results obtained from the parsimonious analysis of regressing 3D lottery sales per person on the daily EPU index. What stands out is that EPU has a significant positive short- and long-run effect on lottery sales. This result is consistent with previous results generated using the EPU indexes created by Huang and Luk (2020) and Yu et al. (2021) who both also use local newspapers only to construct their indexes. Therefore, our results confirm that EPU indexes based on local newspapers have a positive effect on gambling, which is more persistent compared to the effect based on national newspapers. This can be explained by the fact that local newspapers are more frequently censored and, therefore, their readers are less capable of coping with uncertainty, which prolongs the positive effect of increased EPU on lottery sales.

8 CONCLUSION

This paper explores the implications of economic policy uncertainty on gambling behavior. Our theoretical model extends an expected utility model by incorporating an utility of gambling. Besides the monetary payoff agents derive utility from lotteries because they provide fun, hope and altruistic feelings due to their charitable character. Optimization implies that an increase in the level of uncertainty positively affects gambling activity in the short run because uncertainty raises agents' demand for hope.

[16] The lag structure of EPU is determined by the estimated half-life period. We also test other lag structures, and the results are not substantially different.

Table 7. Robustness check: Dynamic panel estimation

	EPU Baker et al. (2016) (1)	EPUDavis et al. (2019) (2)	EPU Huang and Luk (2020) (3)	EPU Yu et al. (2021) (4)
Panel A: without lags of EPU				
EPU_t	0.167***	0.062***	0.021*	0.041***
	(0.055)	(0.017)	(0.011)	(0.010)
Lottery $sales_{t-1}$	0.035	0.203***	0.257***	0.823***
	(0.037)	(0.043)	(0.040)	(0.012)
Controls	YES	YES	YES	YES
AR(1) p-value	0.00	0.00	0.00	0.00
AR(2) p-value	0.47	0.06	0.29	0.11
Hansen statistic [p-value]	29.64 [0.76]	28.94 [0.57]	29.47 [0.99]	26.19 [0.39]
Number of IV	52	47	72	33
Observations	5,111	5,111	5,111	248
Panel B: with lags of EPU				
EPU_t	0.067***	0.105***	0.037**	0.031***
	(0.026)	(0.032)	(0.019)	(0.008)
EPU_{t-1}	-0.053	-0.072***	0.009	0.016
	(0.036)	(0.019)	(0.010)	(0.014)
EPU_{t-2}	0.022	0.020	-0.002	
	(0.036)	(0.015)	(0.014)	
EPU_{t-3}	-0.039	-0.044*	-0.004	
	(0.036)	(0.025)	(0.014)	
Lottery $sales_{t-1}$	0.187**	0.175**	-0.080	0.812***
	(0.087)	(0.071)	(0.073)	(0.012)
Controls	YES	YES	YES	YES
AR(1) p-value	0.00	0.00	0.00	0.00
AR(2) p-value	0.20	0.49	0.25	0.12
Hansen statistic [p-value]	27.98 [0.99]	28.07 [0.46]	28.92 [0.99]	25.61 [0.37]
Number of IV	73	47	52	33
Observations	5,049	5,049	5,049	247

Notes: Sample period: January 2008 to December 2021 for columns (1) to (3) and 2008 to 2017 for column (4). Estimation by the Arellano-Bond Difference GMM estimator. The dependent variable is deflated welfare lottery sales per capita. Robust standard errors are in parentheses. *, **, *** represents the 10%, 5%, and 1% significance level, respectively. We collapse the possibly large instrument set. Columns (1), (2), and (3) control for income, the output gap, and month dummies. Column (4) controls for income, output gap, education, urbanization, and dependency ratio.

Table 8. Robustness check: Daily data

	Short-run effects	*Long-run effects*
Daily EPU	0.003***	0.068***
	(0.000)	(0.023)
Error correction term	0.045***	
	(0.005)	
Observations	49724	

Notes: Sample period: January 1st 2013 to December 31st 2017. The dependent variable is the first difference of daily deflated 3D lottery sales per capita. Estimation is based on the PMG estimator. Standard errors are in parentheses. *, **, *** represent the 10%, 5%, and 1% significance level, respectively. A series of time controls are included: month-of-year dummies, day-of-week dummies, and a public holiday dummy to capture systematic sale shifts within a year, within a week, and on public holidays.

The dynamic version of the theoretical model indicates that the positive effect of uncertainty on gambling decreases over time as agents learn to cope with uncertainty and lower their willingness to pay for hope.

Our empirical analysis tests these hypotheses: We measure gambling activity by welfare lottery sales per capita in China and proxy uncertainty by several versions of the EPU index. We use the Panel ARDL-EC model to estimate the short- and long-run effects of uncertainty on gambling. The empirical evidence shows that EPU has a robust significant positive impact on gambling activity in the short run, which is robust across different specifications and measures for EPU. Our findings for the long-run effects depend on the version of EPU we use. While EPU series that employ national newspapers have a shorter positive effect on gambling, EPU series that employ local newspapers have a more persistent positive effect. This is rationalized by the selection of newspapers by different EPU indexes and their focus on local versus national uncertainty.

STATEMENTS AND DECLARATIONS

The authors declare that there is no conflict of interest associated with this publication and that there has been no financial support for this work that could have influenced its outcome.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon request.

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