PREDICTION MARKETS AND CONTRACT DESIGN

Ole Jakob Bergfjord[*]

ABSTRACT

Traditionally, the main function of prediction markets (PMs) has been to provide information about probabilities for various events. Good information requires a well-functioning market, which in turn depends on sufficient liquidity and a sufficient number of market participants. While many of the early PMs have been of a more experimental nature, with students or other test groups as market participants, a natural assumption is that future PMs must be able to attract market participants to be successful.

We assume that four main groups of stakeholders face potential gains from a well-functioning PM contract: The exchange launching the contract; hedgers; gamblers; and users of the market information, whether this is a corporation or society as a whole.

In this paper, we analyze different design characteristics of PM contracts, mainly in light of previous studies of futures markets. A relatively extensive literature exists on the design of futures contracts, and a number of criteria have been established to predict whether a contract is likely to be successful. We use this to provide some recommendations for contract design, in order to develop contracts that maximize the gain for the four groups of stakeholders.

INTRODUCTION

Although some of the potential benefits from PMs are still debated, such markets have gained importance over the past decade. This includes both corporate and public markets, covering a wide spectrum of uncertain events. Academics have responded to – and maybe progressed – this development by producing a substantial branch of empirical and theoretical literature on PMs[2]. However, an important question, both theoretically and for practitioners, has received little attention in the literature, and will be the focus of this paper. The question at hand is whether it matters how PM contracts are designed,

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[*] Bergen University College, Dept of Economics, Pb 7030, N-5030 Bergen, Norway. ojb@hib.no
[2] Tziralis and Tatsiopoulos, 2007 provide an overview of related contributions, whereas Wolfers and Zitzewitz, 2004 provide a useful presentation of concepts, applications and research problems.

and if yes, how they should be designed to maximize benefits for all stakeholders, including exchanges, contract buyers/sellers, and society.

At this point, it is worth stating a fundamental assumption for the analysis. We assume four main groups of stakeholders with interest in a PM contract: *The exchange*, (potential) *gamblers*, (potential) *hedgers*, and finally the *organization or society* at large.

Traditionally, the *organization or society* has been considered the most important stakeholder, in the sense that the main purpose of a PM has been to extract information. In corporate PMs, this remains the purpose of a PM – the contract is launched in order to get better information and better support for business decisions. For public PMs, much the same argument has been used – PM contracts are useful because they provide information about probabilities, and again serve as decision support for individuals, governments, and businesses. In this paper, we are primarily interested in public markets. Whereas corporate PMs can be subsidized because they provide the organization with valuable information, is it not clear how this could be done for public markets. In the long term, and on larger scale, it seems reasonable to assume that information should be treated as a positive externality, and that the contract must be able to survive without artificial subsidies. This leads us to the second stakeholder – *the exchange*. If a PM contract is to survive, this means that the exchange launching the contract must be able to make a profit from it. Different exchanges have different business models. Some charge membership fees; some charge commissions on trade; some make money from selling information. However, no matter what the business model looks like, it is obvious that there is a link between trade and profit. In other words, for a contract to be profitable for the exchange, it must at least attract a minimum amount of trade, and often, it will be more profitable the larger the trading volume is. This brings us the two last groups of stakeholders; *hedgers* and *gamblers.* Although people can participate in PMs – and other financial and betting markets – for a variety of reasons, we will argue that the division between hedgers and gamblers is useful. Trading motivated by other reasons, such as an "altruistic" wish to provide one's company with useful information in a corporate PM is not considered here – we are concerned with public PMs, and assume that traders have selfish motives for (considering) trading.

Traditionally, the gambling motive has been most important for PMs. This includes any trading activity where the primary motivation *not* is to hedge some underlying exposure. Examples include trading for entertainment purposes, technical arbitrage trading, and finally, trading where one considers the price to be wrong, and hence has an (subjective) positive expected value from the trade. Hedging, on the other hand, is done to hedge an underlying exposure, even if the expected monetary value of the stand-alone trade is negative. Most PMs have been – and still are – too small to serve as useful

hedging vehicles. However, in the future, this use could become important, just as is currently is in most other financial markets.

By definition, we have now assumed that any trade in the markets we study is either motivated by hedging or gambling. Another reason for using this division is that this eases the comparison between PMs and futures markets, where this distinction traditionally has been common (see e.g., Black, 1986 and Bergfjord, 2007).

Of course, there are several important differences between PM contracts and futures contracts – not least the fact that futures contracts are based on a physical underlying good, whereas a PM contract only is based on some future event. Nevertheless, PM contracts are conceptually similar to futures contracts. A contract is traded where the payoff is decided by some uncertain future event. For futures contracts this could be the oil price in Jan 2013, whereas a PM contract could be concerned with the American presidential election in 2012. This price will change over time, and, depending on how the contract is designed, it can also be interpreted as some kind of probability.

Much is written about how futures contracts should be designed; see e.g. Black, 1986 for an early, but thorough review. A new futures contract is usually launched by an exchange, and the objective is of course to generate profit for the exchange. Profit is typically achieved by high trading volumes over time, and of course, a vicious (or virtuous) circle exists: Low liquidity makes a contract less attractive, which in turn reduces activity and liquidity, whereas high liquidity reduces transaction costs and potentially attracts speculators, which increases activity and liquidity. Hence, it is reasonable to say that the main objective when introducing a futures contract is to design the contract to maximize – or at least ensure a certain level of – interest from users.

This should obviously be an important consideration for PM contracts too. If no one is interested in trading the contract, there will be no benefits for users, no profit for the exchange, and no information benefits for society (or the corporation). Nevertheless, a PM usually has several objectives. The contract design that *per se* maximizes interest from participants might not necessarily be optimal if it generates insufficient profits to the exchange, causes workers to spend too much working time with corporate markets instead of their real jobs, or provides insufficient information. Hence, when designing PM contracts, it is worth considering whether there is a conflict between different objectives, and if so, to balance these possibly conflicting objectives and design contracts that both provide useful information, are attractive to traders, and profitable to the exchange if the contract is run by a for-profit exchange.

The rest of the paper is organized as follows: Different characteristics, mainly those considered important for futures contracts, are discussed in a PM

setting. This is followed by a brief discussion of various types of PM contracts, and then a conclusion, with design recommendations and ideas for future research.

IMPORTANT CHARACTERISTICS FOR FUTURES CONTRACTS

Following Bergfjord (2007) and references therein, the characteristics determining whether a futures contract becomes a «success», i.e., attracts enough trade to stay liquid over time, can be divided into four groups:

1. Factors related to the underlying event
2. Factors related to the actual contract
3. Factors related to other contracts
4. Factors related to the exchange/market place

This division is useful for this purpose too, although the objective for this study is slightly different. Our objective is not (only) to point out which PMs contracts will attract liquidity, but also how different types of contract can provide different benefits to market participants as well as informational benefits to society as a whole.

Starting with factors related to the underlying event, many of the factors listed by Bergfjord (2007) will prove relevant in a PM setting as well.

Price variation and uncertainty

Needless to say, a PM will not be started to predict a (pretty) certain event. There are several reasons for this. First, if the event is (pretty) certain, society has little interest in the extra information gathered by a PM. Second, market participants will neither be interested in hedging the event, nor be interested in betting on it – as the potential gains from either is minimal. Finally and related: PM exchanges will typically have fee structures that either makes contracts trading at a level indicating «almost certainty» relatively unprofitable for the exchange, or guarantee a loss for all participants, thus removing any market interest in such a contract. The same argument goes for price variation too: If the contract is expected to stay at the same price during the whole contract period and also expire at that price, the contract is not very useful neither for hedgers nor gamblers.

Size and activity of spot market

The PM equivalent of a large and active spot market would be an underlying event that both is (financially) important for a large group of people, as well as dynamic, in the sense that new information is published or some other kind of development happens relatively frequently. Again, the reasoning is similar: If the event is unimportant, there is no need to hedge the outcome, and little interest in the information collected from a PM contract. The event might still be interesting for gamblers, and hence profitable for exchanges, but would more accurately be described as a betting contract than a PM contract.

The dynamic factor is also important. A steady flow of information prolongs the period of active trade, increasing the profit potential for the exchange. Furthermore, it encourages short-term speculation, which improves the informational value of the market, and also makes it easier to close contracts before the outcome is known.

Free flow of information

In a futures contract setting, this is related to information regarding spot market prices. For instance, in some industries prices are typically determined in secret negotiations between (large) buyers and sellers. Such markets are not suited for futures contracts, as outsiders lack complete information of spot prices. Much the same goes for PMs. Free flow of information will make it more attractive for both gamblers and hedgers to use a contract. The less transparent the process leading to an outcome is, the more difficult it will be for «outsiders» to assess the price; the less attractive a PM will be for all participants, and the less useful any resulting information will be for society.

The factors in the second group are related to the contract itself.

Attractiveness to hedgers

Traditionally, hedging has not been an important consideration when discussing PMs, whereas hedging has been the driving force behind the launch of most futures contracts. Legal obstacles exist in many countries, but hedging should still be considered when launching new contracts. An American weapon producer would probably be affected by the outcome of an American presidential election. If legislation and market liquidity allows it, this company could use a presidential election PM contract to hedge their position. For a presidential election contract, it is easy to see many affected parties with positions to hedge, whereas for other contracts, such hedging potential is less obvious. Everything else being equal, a large potential for hedging is good. Hedgers provide liquidity, and also attract more opportunistic speculators. Furthermore, (potential) hedgers often have good

knowledge about the underlying event, and their participation should thus
improve the informational value of the contract.

Attractiveness to speculators

Although they have a bad reputation, speculators are important for futures
markets, and continue to be the driving force behind most PM contracts.
Whether the speculation is motivated by potential financial gains or
entertainment; enough interest from speculators is vital for any PM contract,
as speculators continue to provide the lion's share of both exchange fees and
market liquidity. One might assume that if PMs are more used by hedgers,
speculators will no longer be necessary. While this might be true in some
cases, it is worth pointing out that active hedgers often will be concentrated on
one side of a contract. In such cases, an increased demand from hedgers will
increase the need for speculators too, as a larger number of speculators would
be needed to balance the market and provide good forecasts.

Vulnerability to manipulation

For futures contracts, vulnerability to manipulation is a question of
specifying the physical good to be delivered. Consider a salmon futures
contract. Important specifications here are for instance size, quality and
location. (Not all tons of salmon are equally good!). If these specifications are
too strict, physical delivery will be impossible for many producers. On the
other hand, without specifications, deliveries will be manipulated, and the
contract will gradually evolve towards a contract on the worst possible
underlying good. This will be bad both for producers of better underlying
goods, who now get a worse hedge of their goods, and also for the market, as
futures prices no longer are representative of the average commodity, but
rather the "worst" quality allowed by the contract. For PMs, the «underlying
good» is the event. Along the same line of reasoning, a contract should ideally
not be based on an event that easily could be manipulated. Based on
experiences from sports betting, this seems obvious, and needs no further
explanation – such manipulation reduces the trust in the market, and makes it
less attractive for both hedgers and speculators, which in turn reduces the
liquidity and the potential information value from the contract.

The third group of factors – related to cross-hedging – might at first seem
less relevant for PMs. For futures markets, the point is that if the relevant risk
can be hedged by using existing contracts, the need for – and potential success
of – a new contract is less. For instance, if the price of pork bellies were
heavily correlated with the price of, say, soy beans, and a futures contract for
soy beans already exists, there would be little need for a specific futures

1 contract in pork bellies, as both speculators and hedgers could use the existing
2 and presumably more liquid soy bean contract to get a good – although not
3 perfect – hedge or exposure.
4   Although the differences are easy to see, the link to PMs is again clear. A
5 contract is more useful for all stakeholders if the competition from existing
6 contracts is low. Such a contracts makes the hedging potential larger for
7 hedgers. A contract in a new "domain" without competitors also provides
8 public information in a new domain, and enables speculators to take
9 advantage of knowledge in a new domain. Finally, a new contract with high
10 (potential) liquidity means high (potential) profit for the exchange, without
11 cannibalizing existing contracts.
12   The last group of important factors are related to the exchange and its
13 users. Again, much of the insight from futures markets is transferable to PMs.
14   One important issue is the *size* of the exchange launching a contract.
15 Empirically, a futures contract offered by a large exchange is more likely to
16 succeed (Silber, 1981). This is reasonable, as a larger exchange both has an
17 established customer base and typically larger resources to market a new
18 contract.
19   The geographical location of the exchange has typically been considered
20 important for futures contracts. Although electronic trading has decreased the
21 importance of this, it is still not completely irrelevant. Legislation varies
22 between countries, so some geographical locations would simply be illegal for
23 many exchanges, whereas others would be inconvenient. Although customers
24 are no longer concerned with opening hours or geographical proximity to the
25 exchange, a web site in their native language and the opportunity to keep
26 accounts in their own currency would typically be considered an advantage.
27   Finally, the level of risk aversion among users is important. For PMs,
28 transactions motivated by hedging have traditionally been less important.
29 Related to the discussion above about attractiveness to hedgers, it could still
30 be argued that a contract everything else equal is more attractive to (potential)
31 hedgers if these are very risk averse. Risk aversion increases their utility
32 surplus from hedging, thus making the PM contact more attractive. Even more
33 important for PMs is probably the risk attitude among potential gamblers: The
34 more risk loving these stakeholders are, the more eager they will be to trade.
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36 **DIFFERENT TYPES OF CONTRACTS**
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38   In the previous section, we applied various criteria from futures markets to
39 say something about how a PM contract should be designed.
40   In this section, we will look at some existing types of contracts. Wolfers
41 and Zitzewitz (2004) defined three main types of contracts: "Winner-take-
42 all", index, and spread contracts. These three contract types are defined and

discussed in detail in that paper. For our purpose, the interesting part is how
each contract type benefits the four types of stakeholders.

"Winner-take-all" contracts are probably the most used ones, and for good
reasons. First of all, such contracts are very easy to understand and interpret.
This increases the informational value for society – an immediate
interpretation of price as probability is usually more informative than an
interpretation as mean or median. Much the same goes for estimation of
uncertainty. Whereas (complex families of) all three contract types also can be
used to interpret the uncertainty related to the market estimates of probability,
we will argue that the interpretation is usually easier with "winner-take-all"
contracts. However, unless someone subsidizes the contract, it must be
attractive to hedgers and speculators to remain liquid and subsequently be
profitable for the exchange. We will argue that this is often the case for
"winner-take-all" contracts. First of all, the easy interpretation is good for
gambler interest. It is tempting to argue that easily understandable contracts
attract unsophisticated gamblers, which in turn attract more sophisticated
gamblers – often on the other side of the contract. Also hedgers would often
be more interested in these contracts, though rather because of the underlying
event rather than the contract itself. For a "winner-take-all" contract to be
useful, the underlying event must be easy to define and only have two
possible outcomes. Public votes about joining the European Union or the Euro
currency area are good examples, and, given the American political system,
American presidential elections are for practical purposes quite similar. In
such binary events, the risk faced by individuals and corporations is
significant and easy to see, thus making hedging attractive.[3]

The downsides of "winner-take-all" contracts mainly relate to points
already mentioned. Events with continuous outcomes (e.g., the 2015
maximum marginal tax rate, MMTR) are less suitable for such contracts.
Although a contract paying out $10 if this rate is at or above 50% could be
established, this contract would be less useful for hedgers. Agents exposed to
a high MMTR could of course buy this contract, but the figure below
illustrates how the hedge provided by any one such contract would be of little
use.

For simplicity, it is here assumed that the contract is trading at $5,
indicating a 50% chance of a MMTR above 50%. The net effect of the
contract is thus -50 if the MMTR ends up below 50%, and 50 if it ends up
above 50%. This agent is assumed to have wealth (or income) of 200 not
affected by the MTR, and a wealth (income) of 100 taxed at the MMTR. As
we can see, the "hedge" changes the wealth function, but does not eliminate

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[3]The money spent lobbying in such situations serve as a reminder of the large stakes
for various interest groups.

1   the variance – the agent is still very much exposed to the MMTR. If a family
2   of such contracts exists (e.g., one contract paying out if the MMTR is above
3   50%, one if the MTR is above 45% etc), a better hedge could be achieved by
4   using all these contracts. However, with a clear, binary event (e.g., joining the
5   EU or not), all exposure could be removed by using just one contract.
6   To summarize, the problem with a "winner-take-all" contract is more
7   related to the underlying event not always being suitable for such contracts
8   than to the contract type itself. If the underlying event permits a good
9   "winner-take-all" contract, the simplicity and transparency will usually make
10   this contract attractive.
11

Example, hedge on marginal tax rate
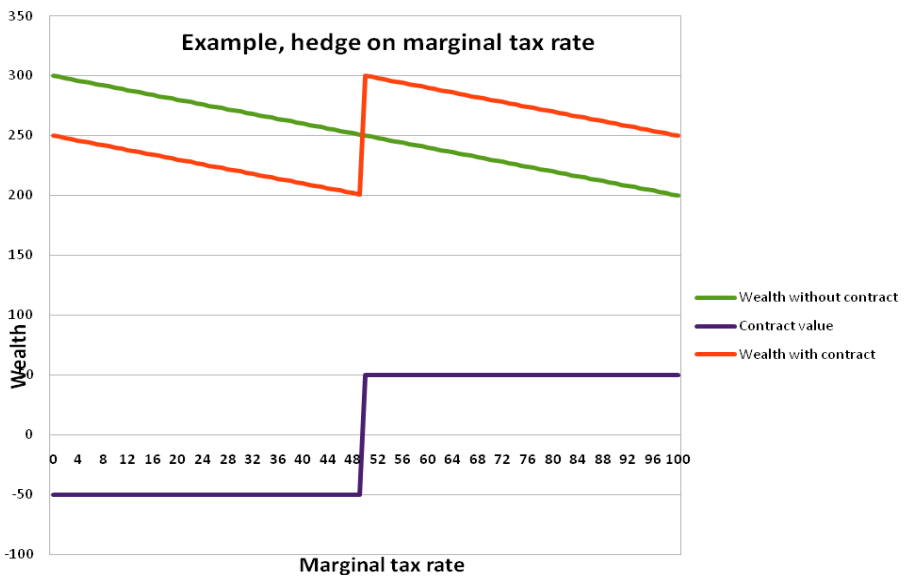
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14 **OTHER CONSIDERATIONS**

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16   We have argued that "winner-take-all" contracts often are beneficial to all
17   groups of stakeholders. However, not all such contracts are equally good. We
18   will now discuss two other contracts properties – time frame and, for lack of a
19   better expression, expected price.
20   Much of the discussion above is based on futures contracts. However, in
21   this section, experience from futures markets is of little help. With regards to
22   time frames, futures markets typically offer contracts with different expiry
23   dates. (E.g., different contracts on crude oil with expiry dates in Q1-2012, Q2-
24   2012, Q3-2012 and Q4-2012 will be traded simultaneously. As one contract
25   expires, a new one is launched.) Many typical PM events are exceptional

events, where this contract structure is impossible. A contract can be launched on the 2012 American presidential election, but this will be the only 2012 presidential election, so launching many identical contracts with different expiry dates is not possible. Also the discussion of "expected price" is difficult to relate to futures markets. The key issue here is whether it matters for contract quality (liquidity) if the price (and implied probability of the underlying event) is high or low. Of course, in futures markets, the contract is based on an underlying physical good, not an uncertain event. Hence, there is no similar link between prices and probabilities.

First, consider the time frame of a contract, e.g., how long the period is between launch and expiry date. Most contracts generate most of the trade close to the expiry date. For instance, the Intrade contract on John McCain to win the American 2008 presidential election was first traded on 14th Jul, 2006. However, the election was on 4th Nov, 2008, and more than 50% of all trades were made in the last 5 months of the contract lifespan.[4] In addition to low(er) liquidity, contracts far away from their expiry date face another problem. Whereas prices easily can be interpreted as probabilities for very short term contracts, the interest effect makes this more difficult for contracts with potential pay-offs far into the future. The extreme example would be a contract paying $10 if humans had visited Mars by 2050. Even if one estimated this probability to be .50, one would of course not pay $5 for this contract, because even a risk-free investment would make the $5 increase to more than $10 over this time horizon. This effect gains importance as the time horizon increases, and reduces informational value of prices for society. For hedgers and gamblers alike, this effect can relatively easily be incorporated in prices. However, when this is done, the contract is no longer a pure bet/hedge on the underlying event, but also a hedge/bet on for instance future interest and inflation rates.

However, even with low liquidity and potentially misleading prices, there are a few good arguments in favor of introducing a contract as soon as it becomes sufficiently likely that it at some point in the future becomes liquid and commercially interesting.[5] First, existing contracts create publicity, thus improving the liquidity of the contracts. In lack of better information, probabilities derived from contracts expiring far into the future are often published by media, thus increasing the interest in the underlying event. Hence, launching the contract earlier will not only add a period of trade (although typically little trade); the contract will also serve as marketing for

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[4]Source: Intrade trading records

[5]In relation to the earlier discussion on the benefits of a larger exchange launching the contract, one would usually think that just this judgement is easier to make for a large and experienced exchange.

1   itself in this period, by increasing interest in the underlying event and
2   subsequently increasing contract liquidity in the most important trading period
3   closer to expiry.
4   Second, and related: A contract with a longer lifespan generates better data
5   series and more useful information about probabilities of the underlying
6   event. Although not necessarily directly profitable for the exchange, one could
7   argue that this positive externality at least should make exchanges launch
8   contracts early unless they see clear financial reasons not to do so. Some
9   exchanges profit from sales of data series, and if this is the case, a longer
10   trading period should be directly profitable, as a longer time series of data
11   should have higher market value.
12   Finally, it is worth pointing out that many contracts by their nature not can
13   be launched years before expiry. Many important events suitable for PM
14   contracts would be unimaginable years in advance; the possibility of the event
15   is caused by some unexpected development.[6] In some of these situations,
16   simultaneous trade in related contracts with different expiry dates could be an
17   option, e.g., contracts on whether Gadaffi will be the leader of Libya by Jun
18   1st, Aug 1st, Oct 1st, etc. This would provide more precise opportunities for
19   hedgers and gamblers, as well as more complex data sets for interested
20   parties. However, the downside is that spreading a limited interest in the
21   underlying event out on several competing contracts is likely to decrease
22   liquidity in any one of these contracts, possibly offsetting gains to hedgers,
23   gamblers and society.
24   The option to launch several related contracts is interesting also in relation
25   to the question of whether the price (and implied probability) of a contract
26   matters. The main determinant here is transaction costs. The exchange could
27   get its revenues from monthly fees independent on trading activity; fees on all
28   trades; fees on winning contracts, or some combination of these. Different fee
29   structures would have different effects, but typically, most structures would
30   make transaction costs a smaller problem for contracts with prices implying
31   underlying probabilities around 50/50[7]. For instance, a fee on wins would
32   typically be very damaging to buyers of high-probability contracts, thus
33   significantly reducing liquidity in such contracts. If the underlying event is of
34   a type that makes it possible, this could be considered when launching a
35   contract. E.g., if a Gadaffi-contract as outlined above could be launched with

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[6]For instance, a contract with pay-out based on whether Gadaffi would be the leader
of Libya on 31st Dec, 2011 was one of the most liquid InTrade contracts during
Spring 2011. Launching such a contract would not have made much sense before the
dramatic events in the Middle East during the Winter 2010/2011.
[7] This is also briefly covered in the discussion about the importance of price variation
and uncertainty on p. 6.

expiry date Jun 1st, Aug 1st, and Oct 1st, but the market is considered too small to support all three contracts, the exchange should launch the contract where it expects the underlying probability to be the closest to 50/50.

CONCLUSIONS

We have discussed PM contracts, mainly in light of results from the literature on futures markets, and analyzed how differently designed contracts benefit the various groups of stakeholders. A «good» PM contract is a contract that is (highly) beneficial to (a large number of) stakeholders. This also typically implies that the contract will be relatively liquid. In short, we believe a good PM contract has the following characteristics:

- It is based on a clear, well-defined event, with only two possible outcomes.
- The underlying event is uncertain, financially and socially important, difficult to manipulate, yet influenced by a stream of publicly available information, so that the probability can be expected to fluctuate over time.
- The contract is of the "winner-take-all" type, and is launched by a large exchange as early as possible.

Most PM contracts fail to attract high liquidity, but when looking at these characteristics, it is not hard to see how well the criteria fit the most successful PM contracts so far; the contracts related to the American presidential elections. These contracts typically match most, if not all, of these criteria, and thus provide some anecdotal support for the success criteria developed earlier in the paper. Obviously, this does not *per se* validate the developed success criteria, and an interesting subject for future analysis could be to empirically study how these and other factors influence liquidity in different PM contracts.
Finally, it is worth considering how benefits to different groups of stakeholders should be weighted. PM contracts have traditionally been designed mainly to provide useful information, and from this perspective, one could argue that what's important is mainly whether a contract generates useful information, and not whether, for instance, the exchange makes money from the contract. While the weighting of benefits for different groups could – and should – be discussed, the connection explained earlier in the paper is likely to hold in most situations: High informational value for society requires high liquidity. An exchange will only launch a contract if it expects to make money from it, which typically means that the contract must be liquid. The liquidity comes from hedgers and gamblers trading in the contracts, which

they won't do unless this benefits them. Hence, although one trader's gain is another trader's loss in the market, the situation is often the opposite when designing the contract: One stakeholder's gain leads to another stakeholder's gain.

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