Who are the non-separable voters?

Austin Horng-En Wang

Department of Political Science, University of Nevada, Las Vegas, USA

ABSTRACT

Non-separable preference is defined as an individual's preference on one issue being conditional to the outcome of another issue. Studies in political behavior suggest three theories explaining the non-separable preferences: (1) High cognitive capacity with strong policy preferences, (2) motivated partisan independence, and (3) non-attitude. This article exploits a new rank order question design implemented right before the 2021 Taiwan referendum, in which two power outages before the voting encouraged the formation of non-separable preferences on two referendums choosing between environmental protection and power supply. Results of a pre-registered survey (n = 910) show that the majority of the self-reported non-separable voters are driven by non-attitude instead of policy or partisan concerns, even though these non-separable voters can alter the referendum results at the aggregate level. Non-separable voters have, on average, lower education, lower political knowledge, and are non-partisan. Its implications for forming and measuring non-separable preferences are finally discussed.

1. Introduction

Non-separable preference is defined as an individual's preference on one issue conditional to the outcome of another. This unique attitudinal structure deviates from the independent and identical (i.i.d.) assumption implicitly assumed in many social choices, democratic, and statistical theories. Meanwhile, non-separable preference exists widely in the collective decision-making process, such as budget ceiling (Hinich and Munger 1997), roll-call voting (Binding and Stoetzer 2022), and policy preferences among the public (Lacy 2001a). The existence of non-separable preferences also articulates the importance of agenda-setting in democracies (Lacy and Niou 2000).

Given the importance and wide existence of non-separable preferences, previous studies rarely discuss why people hold (or at least self-report) the non-separable preferences in the first place. Existing literature on non-separable preferences can be roughly categorized into two categories: (1) An individual-level independent variable explaining vote choices and survey answers, and (2) measuring the group-level tendency reflected by existing voting patterns. The first group of the literature shows that non-separable preference may explain the split voting across different branches or levels of elections (Lacy and Paolino 1998; Lacy and Niou 1998; Lewis-Beck and Nadeau 2004). This school of literature argues that moderate voters are motivated to split their votes, so the election outcome may be closer to their ideal point on the policy spectrum. In addition, non-separable preference could explain the ordering effect in the survey (Lacy 2001a) and the instability of sur-

vey responses across time (Lacy 2001b). For example, when an individual's preferences for two policies are related, and he just revealed his preference for one policy, his attitude toward the second policy will be conditional to the preference for the first one. As a result, a respondent may adjust his answer given different orders or the changing political context.

The second group of literature focuses on the measure of non-separable preferences itself. Following the spatial voting paradigm and the (weighted) Euclidean distance assumption, researchers use the aggregate-level distributions in roll-call votings or self-report policy stances to estimate the separability (Milyo 2000) between multiple policy issues or (underlying) ideological constructs (Finke 2009; Stoetzer and Zittlau 2015, 2020; Binding and Stoetzer 2022). In these studies, researchers usually apply factor analysis to identify the latent constructs from all respondents or politicians' voting patterns or policy stances and then estimate how likely the two or more constructs are separable. Finke (2009) further examines the institutional factor behind country-level separability.

This article aims to contribute to the literature by identifying the non-separable voters at the individual level and explaining their attitudinal formation. To successfully identify the non-separable voters, this article suggests a new rank order question in the context of the 2021 Taiwan referendum. The rank order question can capture how people rank their preference toward multiple election or referendum outcomes at the same time; this feature enables researchers to identify the non-separable preference without relying on the overall distribution of all

other voters or politicians. The method section will further explain the details of this question design and its difference from the Euclidean distance measure (after Table 2).

Interestingly, literature on public opinion and political psychology offers three competing theories explaining the formation of non-separable preferences: (1) high political knowledge/education with strong policy preferences, (2) motivated partisan independence, and (3) low political knowledge and indifference. In other words, the non-separable preference may be driven by a clear perception of the trade-off between policies, self-reported independence from existing parties, or simply a lack of attitude.

With the help of the new rank order measure, this article aims at falsifying these three competing theories through a unique case in Taiwan. Taiwan encountered two consecutive large-scale power outages in May 2021, followed by two referendums about the trade-off between the power supply and environmental protection in December 2021. Even though the majority of Taiwanese people ranked environmental protection as the top priority in governance,[1] the two power outages made the power supply one of the most salient policy issues in Taiwan in 2021. Hence, Taiwanese voters may be motivated to have non-separable preferences – support either of the two referendums to strike a balance between power supply and environmental protection, but not both. Meanwhile, given the increasing political polarization and the increasing number of independent voters in Taiwan (Wang 2019), non-partisans may be motivated to have non-separable voting to distance themselves from either of the two major parties (Klar and Krupnikov 2016) in Taiwan, both of which offered clear voting guidance to their supporters before the referendum. Hence, the 2021 Taiwan referendums serve as a proper case to examine the three theories explaining the formation of non-separable preferences.

After the introduction, this article is organized as follows. The second section juxtaposes three competing theories explaining the formation of non-separable preferences. The third section briefly introduces the political context in Taiwan in the 2021 referendums. The fourth and fifth sections are about data collection and analysis, followed by the discussion at the end.

2. Competing theories in explaining non-separable preferences

Why do people have non-separable preferences? The definition of non-separable preferences implicitly requires a high level of cognitive capacity. First, individuals need to have a clear preference for multiple policies. Second, they need to observe or imagine the outcomes (and the changes of outcomes) of different policies. Third, they need to calculate how different outcomes from one policy will influence their utility from the outcome of another (the definition of non-separable preference in this article, similar to Binding and Stoetzer 2022). Fourth, they need to connect these synchronic changes and form non-separable preferences. And in the end, they need to be able to reflect their non-separable preferences in the survey.

Hence, the first theory explaining the non-separable preference is that *the non-separable "preference" does not exist*: some people accidently show their non-separable answers in the survey simply because they do not have policy preferences and randomly pick up options in the questionnaire. Classic literature in the studies of public opinion doubts whether people really hold a public opinion (Zaller 1992), especially when people do not hold a strong ideology to help their attitude formation (Converse 1964). Given the limited cognitive capacity with a lower level of political knowledge, when people also do not rely on political

Table 2
Preference ranking and non-separable preference in pollcracylab (n = 910).

Preference	Non-separable preference	Theoretical origin of Non-separable preference	Theoretical origin of Separable preference	N in survey
ABCD			Pro-Environment	14
ABDC	O			3
ACBD			Pro-Environment	60
ACDB	O			17
ADBC	O	Motivated Independence		3
ADCB	O	Motivated Independence		5
BACD	O			1
BADC			Pro- KMT	64
BCAD	O	High cognitive		1
BCDA	O	High cognitive		4
BDAC			Pro- KMT	227
BDCA	O			23
CABD	O			16
CADB			Pro- DPP	240
CBAD	O	High cognitive		3
CBDA	O	High cognitive		1
CDAB			Pro- DPP	36
CDBA	O			1
DABC	O	Motivated Independence		20
DACB	O	Motivated Independence		0
DBAC	O			24
DBCA			Pro- Power supply	41
DCAB	O			1
DCBA			Pro- Power supply	21
Overall	16 O			826

Note.

B = [Restarting No.4 Nuclear Power Plant & Relocating No.3 Natural Gas Station].

D = [Restarting No.4 Nuclear Power Plant & Not Relocating No.3 Natural Gas Station].

A = [Not Restarting No.4 Nuclear Power Plant & Relocating No.3 Natural Gas Station].

C = [Not Restarting No.4 Nuclear Power Plant & Not Relocating No.3 Natural Gas Station].

ideology or group identity as a heuristic cue, "*context dependence of preferences is an unavoidable consequence of basic cognitive and evaluative process*" (Bartel 2003). If non-separable preference does not exist and researchers accidently categorize people with randomly-picked answers as non-separable voters, these non-separable voters would have a lower level of political knowledge, a lower level of education (Barabas et al., 2014), do not identify themselves with any party, and do not have a strong policy preference or ideology.

Oppositely, the second theory explaining the non-separable preference is that *voters form this preference with a high cognitive capacity*. These voters have clear policy preferences and vividly perceive the trade-off between policies under different scenarios, and they are able to elaborate their considerations in the survey. Therefore, they would strategically switch their vote choice given different expectations of referendum outcomes. Indeed, voters with high cognitive capacity do not necessarily mean they will always have non-separable preferences - it depends on the nature of the policies and the changing political contexts. In other words, high cognitive capacity is a sufficient but not necessary condition for non-separable preferences. However, suppose the political context encourages non-separable preferences, as in the 2021 Taiwan referendum. In that case, this theory expects that voters with high cognitive capacity would be systematically more likely to have non-separable preferences than those with a lower level of cognitive capacity. Indicators related to high cognitive ability may include a higher

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[1] In the 2019 World Value Survey, 63.2% of Taiwanese respondents chose environmental protection as the top priority "*even if it causes slower economic growth and some loss of jobs*," while 36.2% chose the opposite. Source: https://www.worldvaluessurvey.org/WVSDocumentationWV7.jsp Access: March 3, 2022.

level of political knowledge, a higher level of education, and a strong attitude toward multiple policies.

In the end, the third theory explaining the formation of non-separable preference is *motivated independence*. In a highly polarized political world, voters may perceive both major parties as uncivil and are unwilling to align with any party. Therefore, they are *motivated* to insist on their non-partisanship and distance themselves from all parties. Such a declaration is attractive on dating websites and after people read the news about political turmoil (Klar and Krupnikov 2016). Motivated independence suggests that people care more about their perceived closeness with any party than their policy stance. Therefore, when the motivated independent voters are asked about their policy preference, they would consciously draft the preference profile which is not consistent with the manifesto of any major parties. This psychological mechanism is called "self-monitoring" in Klar and Krupnikov's seminal work.

Motivated independent voters definitely self-identify as independent voters, but their political knowledge or education level may not be different from other voters. They still rely on partisan cues but choose the opposite, which does not require a high cognitive capacity. In Klar and Krupnikov's analysis (2016) in the United States, motivated independent voters share a similar socio-demographic background with partisans.

2.1. Examining the three competing theories and hypotheses

If non-attitude and motivated independent voters claim themselves as non-partisans, how do we distinguish them to explain the composition of voters with non-separable preferences? Similarly, how do we distinguish the two if motivated independent and high cognitive voters with strong policy preferences have similar socio-demographic backgrounds?

This article suggests that the *composition of the non-separable preferences* may help evaluate the three competing theories. Generally speaking, if motivated independent voters compose the majority with non-separable preferences, they will rank the options that do not align with major parties as their top choices. Similarly, if high cognitive voters composed of the majority of non-separable voters, they would rank their least preferred policy outcome as their last choice; meanwhile, if non-attitude voters are those apparently non-separable voters, we would not find any clear pattern in the ranking of preferences.

Let us formalize the theory above. Assuming there are two referendums in Taiwan, R1, and R2, both promote environmental protection at the expense of sufficient power supply. There are four possible referendum outcomes: (A) both passed, (B) R1 passed, R2 rejected, (C) R2 passed, R1 rejected, and (D) both rejected.

First, how would the high cognitive voters form their non-separable preferences on these four possible outcomes? The majority of Taiwanese respondents prioritize environmental protection, but they do not like the power shortage. Hence, high cognitive voters with non-separable preferences would be much more likely to pass at least one of the two referendums but not both (B > C > A or C > B > A). Meanwhile, whether they would support passing or rejecting both depend on their leaning toward the environment or power supply. If they care more about the environment, then A > D. If they care more about the power supply, then D > A. Overall, their voters are non-separable because they put B and C as their top two preferences. If one passes, the other needs to be rejected, and vice versa.

Second, how would the motivated independent voters form their non-separable preference? The two major parties consider public opinion and its impact on their preference (i.e., how the power supply may influence economic development), so one major party supports B and the other supports C. Given the polarized context, their partisan supporters undoubtedly rank their preferred party's preference as the top choice and rank the opposite party's preference as the bottom choice. Among these partisans, their preferences are always separable

(B > A > D > C, B > D > A > C, C > D > A > B, and C > A > D > B) since there is no "trade-off" in the preference ranking. They want the policy outcome closer to their preferred party as possible.

However, among the motivated independent voters, their top concern is to distance themselves from the two major parties. Hence, these non-partisan voters would rank the stance of the two major parties – B and C – as their least preferred options. They want either both referendums to pass (A) or fail (D) so that they can "punish" the two major parties. In other words, motivated independent voters are much more likely to have a ranking with higher A or D and lower B or C (A > D > B > C, A > D > C > B, D > A > B > C, and D > A > C > B). Since they put D and An as the first two preferences, their preferences are clearly non-separable – if one passes, the other must be passed, and vice versa.

Third, we can discuss non-attitude voters and their possible non-separable preferences. Overall, there are twenty-four different possible rankings given the four possible outcomes. Eight are separable (With either A/D or B/C as the top and the bottom), and sixteen are non-separable. Therefore, if the majority of non-separable voters are non-attitude and non-partisans, we should observe that the distribution of non-separable voters exists in all sixteen types of non-separable preferences without a clear pattern.

Table 1 summarizes the literature-driven research hypotheses and empirical strategies of juxtaposing the three competing theories to explain non-separable preferences. The socio-demographic background and partisanship of the non-separable voters provide preliminary evidence in supporting the theories, while the distribution in the preference rankings may offer further support for either of the three theories. Suppose we find that most non-separable voters ranked either B or C as their top two preferences because they care about both power supply and environmental protection and have a higher level of political knowledge and education. In that case, the high cognitive capacity may better explain the non-separable preference. If the majority of non-separable voters are non-partisan and disproportionally ranked A or D as their top choices but not the other type of rankings, their non-separable preferences may be better explained by the motivated independence; if no pattern in preference rankings can be found, and these non-separable voters also have a lower political knowledge and educational level, their apparent non-separable preference would just a misunderstood categorization from their non-attitude.

2.2. The 2021 Taiwan referendum

This article aims at examining the three theories in Table 1 through the 2021 Taiwan referendum, in which two power supply-related referendums were voted after two power outages in Taiwan.

On May 13 and May 17, 2021, respectively, Taiwan encountered two nationwide blackouts because of the combination of the increase in demand amid heatwave, drought, and power plant failures. The first

Table 1
Competing theories on non-separable preferences and empirical strategies.

Theory	Socio-demographic	Partisanship	Non-separable Preference Ranking
Non-attitude	Low political knowledge Low education	Non-partisan	All 16 types of non-separable preferences
High cognitive capacity (Dual policy concern)	High political knowledge High education	–	B > C > D > A C > B > D > A B > C > A > D C > B > A > D
Motivated Independent (non-partisan concern)	–	Non-partisan	A > D > B > C A > D > C > B D > A > B > C D > A > C > B

outages influenced 92% of the population (22 million in 24 million Taiwanese residents), while the second outages influenced about 50%.[2] The two blackouts seriously influenced public opinion in Taiwan. According to a nationally representative landline survey conducted one month after the two outages by Taiwan Institute for Sustainable Energy,[3] 77.6% of Taiwanese respondents worried that the power outage would happen again, which increased 22.3% from a year ago. Given the serious concern and vivid experience of power outrages, however, the same survey still shows that 85.3% of Taiwanese respondents support the zero-emission policy, 85.9% support renewable energy, and 68% believe that renewable energy is used for protecting the environment. The distribution of public opinion implies the potential non-separable preferences between environmental protection and power supply in 2021.

The two upcoming referendums deepened the motivation to form the non-separable preferences among Taiwanese respondents. There were four referendums on December 18, 2021, originally planned on August 28, 2021, but were postponed because of a COVID-19 outbreak in early June 2021. One referendum is to consider the activation of the Lungmen Nuclear Power Plant, while the other is to stop the construction of the Guantang LNG Terminal upon Taoyuan City's Datan Algal Reef. The remaining two topics are referendum dates and pork imports unrelated to power supply nor environmental protection.

The activation of the Nuclear Power Plant and the construction of the Guantang LNG Terminal can directly enhance the power supply in Taiwan. The Guantang LNG Terminal will be used to supply the Datan Power Plant in Northern Taiwan. Meanwhile, both proposals may damage the environment to some extent. Regarding the nuclear power plant, no county in Taiwan welcomes the radioactive waste generated by the nuclear power plants; all existing wastes are either restored inside the power plants or on Orchid Island, a small island nearby Taiwan where the residents have protested for forty years.[4] Regarding the LNG terminal, the terminal's construction was built upon Datan algal reef, which would directly influence its ecosystem. In February 2021, college students and activists in Taiwan collaborated to collect petitions for proposing the algal reef referendum, successfully received 300,000 petitions, and passed the threshold within one month for holding the referendum.[5]

The two referendums underwent the petition stage before the two power outages. Nevertheless, as mentioned above, the two power outages shifted public opinion and made the trade-off between power supply and environmental protection one of the most salient issues during the campaign. According to Google Trends, "power outage" and "reservoir" (related to power outage) are the fifth and tenth most searched terms in Taiwan in 2021 (others are related to COVID-19 and the Olympics Game).[6]

This unique context encouraged Taiwanese people to form non-separable preferences regarding the power supply and environmental protection: for those who prioritize environmental protection, they are also motivated to support either one of the two referendums so that they would not encounter the same terrible blackout again. If one referendum passes, which may harm the power supply, another referendum must fail to secure enough electricity. It is worth noticing that the nuclear power plant and the LNG terminal only account for a small proportion of the overall power supply in Taiwan. However, the two nationwide blackouts that happened months ago made Taiwanese people believe that these two options in the referendum were "pivotal" to the power supply -- another blackout may happen if neither of them passed. Combined this belief with the strong desire to protect the environment, this context encouraged Taiwanese people to form non-separable preferences.

The two major parties offered their clear stance on these two referendums. The ruling party Democratic Progressive Party (DPP) supported the status quo, which opposes the nuclear power plant and supports the LNG terminal. On the other hand, the opposition party Kuomintang (KMT) literally chose the opposite, supporting the nuclear power plant and opposing the LNG.[7] Clearly, both parties chose the portfolio that strikes a balance between environmental protection and power supply, and they believed that their stance could maximize their support, which is another evidence that the political context is prone to brew non-separable preferences.

Meanwhile, the level of political polarization in Taiwan has increased since 2014 (Wang 2019), and 40% of voters in Taiwan are self-identified as non-partisan. Since the two major parties provide clear heuristic cues for their supporters, motivated independent voters can also follow the cues to distance themselves from the two major parties.

This unique political context in the 2021 Taiwan referendum is a proper case to falsify the three theories explaining the formation of non-separable preferences. The intertwining of blackouts and referendums ensures a high level of issue salience, and the two referendums offer the direct opportunity for constructing non-separable preferences. Since there was no concurrent election in 2021, voters would pay full attention to the issues, not candidates or parties. In such a scenario, we would expect that the proportion of high cognitive voters and the proportion of motivated independent voters – if they exist – would be much higher than the number in previous studies. For example, Lacy (2001a) conducted a telephone survey in Ohio and asked people about their tax rates and budget preferences. Even though he found a considerable proportion of respondents with conditional preferences, we are unsure if the respondents really saw the trade-off between policies or consider the overall budget ceiling. Their non-separable preferences between a tax cut and budget may reflect partisan consideration, ideology, non-attitude, or a combination of all. This 2021 Taiwan referendum allows the researcher to distinguish between the three theories of non-separable preferences.

3. Research design

3.1. Data collection

This article designed and conducted a pre-registered survey capturing the non-separable preferences right before the 2021 Taiwan referendum. Overall, 910 respondents were recruited and completed the survey by Pollcracylab,[8] an online survey firm run by the National Chengchi University, between December 13 and 16, 2021. Pollcracylab compiles and maintains its sample pool through previous invitations in academic telephone and face-to-face surveys based on the house registration record from the Taiwanese government. Hence, the diversity in

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[2] Dou, Eva and Pei Lin Wu (2021), "Widespread blackouts hit Taiwan after power plant trips" https://www.washingtonpost.com/world/asia_pacific/taiwan-power-outage/2021/05/13/f1be2bc8-b3bf-11eb-bc96-fdf55de43bef_story.html, *Washington Post*, May 13, 2021. Access: March 10, 2022..

[3] Taiwan Institute for Sustainable Energy (2021), *2021 Public opinion on Electricity Use and Energy Transition in Taiwan*, https://taise.org.tw/news-view.php?ID=2174. Access: March 10, 2022..

[4] Aspinwall, Nick (2019), "Tao Indigenous Community Demands Removal of Nuclear Waste From Taiwan's Orchid Island," *The Diplomat*, December 6, 2019. https://thediplomat.com/2019/12/tao-indigenous-community-demands-removal-of-nuclear-waste-from-taiwans-orchid-island/Access: March 11, 2022.

[5] Cheng, Shu-ting, (2021), "Public urged to sign petition on algal reefs poll." *Taipei Times*, February 24, 2021. https://www.taipeitimes.com/News/taiwan/archives/2021/02/24/2003752769 Access: March 11, 2022.

[6] https://trends.google.com.tw/trends/yis/2021/TW/Access: March 11, 2022.

[7] Hoei, Brian (2021), "DPP Sweeps Taiwan's Latest Referendum Vote," *The Diplomat,* December 20, 2021. *Https*://thediplomat.com/2021/12/dpp-sweeps-taiwans-latest-referendum-vote/.

[8] We requested 900 in the research design, but we received 910 responses because some respondents filled the survey at the same time.

Pollcracylab's sample pool would be higher than in other opted-in surveys such as MTurk. Moreover, all Pollcracylab respondents in Taiwan had been verified as real people, mitigating the problem of bot infestation in other established platforms (e.g., Chmielewski and Kucker 2020). The survey experiment was implemented right before four referendums in Taiwan on December 18, 2021, which we believed would enhance citizens' attention and willingness to participate in this study; in other words, participants were not limited to those with extremely high political interest. The survey experiment has been approved by the IRB committee of the author's institution (#UNLV-2021-189) and has been pre-registered on Open Science Framework (https://osf.io/8pr4j/) before data collection.[9]

The socio-demographic background of the respondents is shown in Appendix Table B. Compared to the Taiwanese population, Pollcracylab respondents include more males, younger, and highly educated citizens. Nevertheless, the results of political variables such as national identity and partisanship are similar to those from other representative telephone and face-to-face surveys conducted during the same period.[9] In addition, it is worth mentioning that all socio-demographic variables, including party identification and national identity, were asked at the end of the whole survey experiment to avoid priming or even framing effects (Klar et al., 2020).

All respondents received an invitation email from Pollcracylab, indicating they were invited to participate in a survey titled "How do people discuss politics in daily life." They were informed that there were at most 40 items, the survey had passed IRB, and they could skip any item, but they must reach the last page to receive compensation (a gift card worth 2 dollars) distributed by Pollcracylab directly.

All respondents were first asked a series of questions about their information consumption across different information sources. They were then asked their preferences toward the two upcoming referendums that this article is interested in (which will be discussed in the next subsection). They were then asked about their attitude toward the environment, power supply, and national economy. In the survey, 55.2% of the respondents said that the power supply was worse than last year, 39.9% felt no change, and only 4.9% thought the power supply condition was better than last year. Meanwhile, when asked between economic development and environmental protection, 36.2% chose economic development, 40.2% chose environmental protection, and 23.6% chose neutral. Ultimately, all respondents were asked about their socio-demographic background before debriefing and compensation.

3.1.1. Measuring non-separable preferences

Operationalizing the non-separable preferences into measurements is challenging in telephone surveys. As Lacy argues (2001a, 2001b), for any two policies, surveyors need to ask respondents to rank all twenty-four combinations of outcome ((2*2)! = 24). Internet survey offers a better solution for respondents to rank their preference toward all possible outcomes. This article then follows the theoretical setup by Lacy and Niou (2000) and exploits the "rank order question" in modern online survey programs to capture the possible non-separable preferences among Taiwanese respondents in the 2021 referendums.

Before the rank order question, all respondents were asked two questions about whether they had ever heard the two referendums. Overall, 98.8% of the respondents said they knew the nuclear power plant referendum, and 93.6% knew the LNG referendum. Hence, almost all respondents in this survey had informed about the two referendums. Nevertheless, the description of these two questions includes a short summary of both the pros and cons of the two referendums, and both mentioned the power supply and environmental protection, which the full description can be found in Appendix A. These two questions fur-

ther informed the respondents about the referendums, framed them about the trade-off, and decreased the likelihood of non-attitude.

After the two information questions, the design of the rank order question is below (the four options were randomly ordered when this question appeared):

Q6. About these two "Restarting No.4 Nuclear Power Plant" and "Relocating No.3 Natural Gas Station" referendums, no matter how likely they will pass or not, which outcome do you prefer the most?

In the four possible outcomes below, please use your mouse or finger to drag and drop them, and rank the order of these four outcomes. Please move your most preferred outcome to the top, the second-best outcome at the second, the third-best outcome at the third, and the least preferred outcome at the bottom.

[Restarting No.4 Nuclear Power Plant & Relocating No.3 Natural Gas Station].

[Restarting No.4 Nuclear Power Plant & Not Relocating No.3 Natural Gas Station].

[Not Restarting No.4 Nuclear Power Plant & Relocating No.3 Natural Gas Station].

[Not Restarting No.4 Nuclear Power Plant & Not Relocating No.3 Natural Gas Station].

Respondents can use their mouse or finger on the screen (either PC or smartphone) to freely drag and drop the four options until the ranking of the four possible referendum outcomes reflects their preference. Compared with the telephone survey (Lacy 2001a) or internet survey with filled-in ranking (Lacy and Niou 2000), this rank order question can completely measure the separable and the non-separable preferences voters could possibly have. Moreover, one question is enough to capture the rankings instead of twenty-four.

Moreover, this rank order question design may overcome the question order effect which Lacy (2001a, 2001b) figured out in his seminal studies on non-separable preferences. Specifically, Lacy shows that respondents with non-separable preferences may answer differently given the order of the questions. After a respondent reveals his preference for the first question, how he or she answers the second question is anchored by the first answer and its relationship to the second answer. As a result, multiple questions are needed to detect the non-separable preference. This rank order question can circumvent this question ordering effect because all outcomes are presented simultaneously. In addition, the preference rankings collected from the rank order question may help distinguish between voters with different intentions, which may be more complex for the measure created by a series of binary questions.

One potential problem is that the respondents may find this rank order question too long and refuse to answer due to fatigue. However, this question is the sixth question in this survey, so it is not likely that the respondents already felt tired. Moreover, the twenty-fifth question (Q25) is an attention check item (Berinsky et al., 2014) and 98.1% (893 in 910) passed the attention check. Hence, this article believes that the respondents in this survey answered their preferences through this Q6 rank order question honestly. The design of the two information items (Q4, Q5) and this Q6 rank order question are for reducing the likelihood and motivation for expressing non-attitude.

After the respondents ranked their preferences of the four possible outcomes in the rank order question, researchers can then categorize them as non-separable voters or not. Following the discussion in the third section and Table 1, this article defines the two pro-environment policy outcomes as A (not restarting nuclear power plant and relocating gas station), the two pro-power supply outcomes as D (restarting nuclear power plant and not relocating gas station). At the same time, B is pro-nuclear and anti-LNG, and C is anti-nuclear and pro-LNG. Therefore, B is KMT's stance, while C is DPP's.

Following the discussion in Table 1, high cognitive non-separable voters who want to strike a balance between environment protection and power supply (both were supported by the majority of Taiwanese voters) would put B and C as the top two options and keep A and D as

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the least preferred options; they want either LNG (C) or nuclear power plant (B) to ensure the pivotal power supply (not A), but not both which may be harmful to the environment too much (not D). Hence, high cognitive respondents are defined as BCAD, BCDA, CBAD, and CBDA.

Similarly, motivated independent non-separable voters who want to tarnish their "independent" brand would try to put B and C as the two least preferred options since they want to distance themselves from the two major parties. They prefer both LNG and nuclear power plant (D) or to ban both (A) so that they can "punish" the two major parties (B and C). Therefore, the preferences for motivated independent voters will be ADBC, DABC, ADCB, and DACB.

In the end, non-attitude non-separable voters would randomly distribute across all types of non-separable (and separable) preferences, which includes the eight types above and eight others cannot be explained by the two abovementioned models. The other eight types are still defined as non-separable preferences because they followed the classic definition of non-separable preferences, which means one's preference on one issue is conditional on the outcome of the other one.

Overall, the preference rankings and their relationship to the three theories are summarized in Table 2. In this table, the first column indicates all 24 possible preference rankings. The second column labels the 16 non-separable preferences as O. The third column highlights the right categories of non-separable preferences predicted by the motivated independence theory and the four categories predicted by the double policy consideration. The fourth column shows how the eight separable preferences can be explained by either partisanship or the most valued policy. In the end, the fifth column is the number of respondents in each category. We deleted all respondents who did not answer this question or failed to pass the attention check item. Overall, 826 (90.8%) of the respondents offered a complete answer to this question and also passed the attention check item later. This procedure may further exclude some non-attitude voters.

The rank order question differs from the aggregate-level Euclidean distance measure in two salient ways. First, the rank order question can capture the non-separable preference at the individual level, so researchers may categorize the voters accordingly as is shown in Table 2. Researchers do not need to use the overall distribution to capture the averaged non-separable tendency across two ideological domains (e.g., Stoetzer and Zittlau 2015; Stoetzer and Zittlau 2020; Binding and Stoetzer 2022).

Second, the Euclidean distance measure mostly relies on the weighted quadratic Euclidean distance model (Hinich and Munger 1997) as the spatial utility function to estimate the level of separability. Specifically, this model implicitly includes the assumption of a single-peaked utility function: two non-separable domains may either positively or negatively link to each other. In Table 2, however, only the four motivated independence and four high cognitive non-separable orders fit this single-peaked utility assumption. The Euclidean distance measure cannot capture the other eight non-separable preferences (one policy preference is conditional to the outcome of the other policy but not the other way around). If we stick to the definition of non-separable preference as "how different outcomes from one policy will influence their utility from the outcome of another policy," the rank order measure may capture more non-separable preferences than the Euclidean distance measure.

4. Result

4.1. Descriptive analysis

Among all 826 respondents who provided complete ranking and passed the attention check, 123 (14.9%) had non-separable preferences, while 703 (85.1%) had separable preferences shown in Table 2. Clearly, people with separable preferences account for the majority of Pollcracylab respondents. The proportion of respondents with non-

separable preferences is low if we consider the measurement format. All respondents were given a random order of all four possible referendum outcomes, and sixteen of the twenty-four possible rankings were non-separable. If respondents did not understand the questions and arbitrarily ranked the four outcomes, two-thirds of the respondents would have be categorized as non-separable voters. Hence, this low number of non-separable voters implies that the majority of the respondents indeed understood the questions and expressed their separable preferences accordingly.

Most of the 703 separable voters can be explained by party polarization or single-issue preference. Overall, 291 (41.4%) ranked KMT's stance as the top preference and DPP as the bottom, and 276 (39.2%) did the opposite. Again, this distribution reflects the political polarization in Taiwan. The remaining separable voters either put both pro-environment outcomes as the top preference and both anti-environment outcomes as the bottom (74, 10.5%), and 62 (8.8%) did the opposite; policy-oriented voters account for a much smaller proportion of Taiwanese voters, which is consistent with previous findings in Taiwan politics (Achen and Wang 2017).

Among the 123 non-separable voters, 28 (22.8%) have the ranking explained by motivated independence, and 9 (7.3%) could be explained by high cognitive capacity and policy preference. In comparison, 86 (70.0%) non-separable voters are in the categories beyond the previous two explanations. This preliminary evidence may suggest that the majority of the non-separable voters may not be driven by motivated independence or policy considerations.

Even though the non-separable voters account for less than one-sixth of the respondents in the Pollcracylab survey, the proportion is big enough to alter the referendum results under different agenda settings. Table 3 shows the distribution of votes when the two referendums were held on the same day or when either of the referendums had been determined, given the preference ranking of all respondents. When all voters cast their top preference on the same day, both referendums will be passed, as is shown in the first left column in Table 3. However, if the Natural Gas Station was already relocated (the second left column), B and A are the remaining options. In this scenario, at least 16 respondents with non-separable preferences shifted their preferences from supporting the nuclear power plant to opposing it; as a result, the result of the Nuclear Power Plant referendum will be reversed (from 427: 399 to 411: 415, the gray-shadowed cell in Table 3). Similarly, the public

Table 3

Referendum results given different scenarios in Pollcracylab (n = 826 from Table 3).

	Concurrent referendums and sincere voting	If the Gas Station already relocated (B: A)	If the Gas Station already NOT relocated (D: C)	If the Nuclear Power Plant already restarted (B: D)	If the Nuclear Power Plant NOT restarted (A: C)
Restarting the Nuclear Power Plant (BD > AC)	427 : 399	411 : 415	422 : 394		
Relocating the Gas Station (AB > CD)	422 : 404			417 : 409	438 : 388

Note.

B = [Restarting No.4 Nuclear Power Plant & Relocating No.3 Natural Gas Station].

D = [Restarting No.4 Nuclear Power Plant & Not Relocating No.3 Natural Gas Station].

A = [Not Restarting No.4 Nuclear Power Plant & Relocating No.3 Natural Gas Station].

C = [Not Restarting No.4 Nuclear Power Plant & Not Relocating No.3 Natural Gas Station].

opinion toward relocating the natural gas station will be leaning toward approval if the nuclear power plant was not restarted (438: 388) and leaning toward near disapproval if the nuclear power plant was already restarted (417: 409).

Table 3 suggests that these non-separable voters may sometimes serve as the pivotal voters in the referendum results. However, the aggregate results also evidence the power of agenda-setting and the importance of non-separable preference. Admittedly, the non-separable voters are pivotal only if the majority of separable preference respondents are evenly divided on the issues. Nevertheless, the next question is: who are the non-separable voters and what is their motivation?

4.2. Testing the motivated independence hypothesis

In Table 2, the number of non-separable voters in the motivated independence categories is low, and some may also come from non-attitude voters' random answers. One possible falsification is to examine the relationship between non-partisans and motivated independence-driven non-separable voters. If non-partisans are more likely to choose the motivated independence-driven non-separable preference (e.g., ADBC), we may still argue that the motivated independence may drive these 28 voters.

To examine the motivated independence mechanism, the left side of Table 4 shows the cross-table between partisanship and the motivated independence-related non-separable preferences. Among the 123 non-separable voters, 51 are non-partisans. Among them, 11 (21.6%) showed the non-separable preference ranking predicted by the motivated independence theory. Among 83 non-separable voters with self-reported partisanship, 17 (20.5%) chose the motivated independence non-separable preference rankings. The chi-squared test with Yates' correction shows that partisanship has no relationship with the types of non-separable rankings ($p = 0.961$). Moreover, the insignificance result holds even if the partisans are replaced by the supporters of the two major parties and by separating supporters of small and large parties (see Appendix Table C).

In short, although the motivated independence theory suggests that non-partisans may be motivated to distance themselves from the major parties by choosing certain types of non-separable preferences (ranking A and D as the top two choices), this hypothesis is not supported by the empirical data.

4.3. Testing the high cognitive capacity hypothesis

In Table 2, only nine respondents chose the non-separable preference rankings predicted by the high cognitive capacity hypothesis (ranking B and C as the top two choices). The rationale behind this ranking is that respondents cared about both the power shortage and environmental protection, so they prefer either of the referendums to

have the pro-power supply result but not both. In the Pollcracylab survey, after the rank order question, respondents are asked (1) whether they think the power supply condition is worse than a year ago, and (2) to position themselves on a 0 to 10 scale, 0 means economic development and 10 means environmental protection. In the survey, 55.2% thought the power supply was worsening, 40.2% chose 6 or higher environmental protection, and 185 (20.3%) were concerned about both.

The right side of Table 4 shows the relationship between those who considered both policies or not and whether they chose the non-separable preference rankings which is predicted by the high cognitive capacity hypothesis. Among those concerned with both policies, when they chose the non-separable preferences, only 2 (6.3%) chose the ranking predicted by the high cognitive capacity hypothesis. Again, the distribution is skewed and indistinguishable from those not concerned with both policies (7 in 91, 7.69%). The chi-square test shows no significant difference, albeit the skewed distribution hampers the p-value. To summarize, even among the respondents with dual consideration, they are not much more likely to reflect this trade-off in their non-separable preferences.

4.4. Testing the socio-demographics

In the end, Table 5 presents four logit regression models explaining the non-separable voters. Respondents are coded 1 if they provided a non-separable preference ranking in Tables 2 and 0 for a separable preference ranking. Model 1 includes the level of education and political knowledge. Political knowledge is measured by the summation of three questions (Who is the US President, who is the Taiwan Premier, and who is responsible for interpreting the Constitution). Model 2 includes the previous section's dual consideration (care for the power shortage and environmental protection). Model 3 includes a dummy variable for non-partisans. Finally, model 4 includes all three groups of independent variables suggested by the three theories in Table 1, as well as two additional control variables (age and gender).

In both Model 1 and 4, the level of education and political knowledge are both negatively correlated with non-separable voters. In other words, people with a higher cognitive capacity are *less* likely to be non-separable voters in the 2021 Taiwan referendum. To further illustrate the effects, Fig. 1 shows the simulated effect of education and political knowledge on the likelihood of being a non-separable voter. The effect is simulated from Model 4 in Table 5, controlling all other variables at the mean value. Both simulations in Fig. 1 shows that people with a lower level of education and lower political knowledge are at least twice as likely to be a non-separable voter. Overall, this result supports

Table 4
The Effect of motivated independence and policy consideration.

	NSV - MI	NSV - Others			NSV - HC	NSV - Others	
Non-partisans	11	40	$\chi^2 = 0.002$ $p = 0.961$	Both policies	2	30	$\chi^2 < 0.001$ $p > 0.999$
Partisans	17	55		Others	7	84	

Note.
NSV – non-separable voting.
MI: Motivated Independence category in Table 3.
p-value calculated with Yates' continuity correction.
Note.
NSV – non-separable voting.
MI: Motivated Independence category in Table 3.
p-value calculated with Yates' continuity correction.
p-value imprecise because n < 5 in a cell.

Table 5
Logit regression on non-separable voters (n = 910).

	DV: Having Non-separable preference ranking (0–1)			
	Model 1	Model 2	Model 3	Model4
Edu (1–6)	−0.248* (0.111)			−0.263* (0.117)
Political Knowledge (0–3)	−0.777** (0.326)			−0.706** (0.333)
Both Policies Considered (0–1)		0.338 (0.226)		0.225 (0.231)
Non-partisans			0.455** (0.200)	0.399+ (0.205)
Age (1–5)				−0.086 (0.092)
Female (0–1)				0.214 (0.203)
Constant	1.799+ (1.070)	−1.821** (0.113)	−1.907** (0.126)	1.398 (1.252)
n	826	826	826	826
AIC	690.4	697.0	694.1	690.9

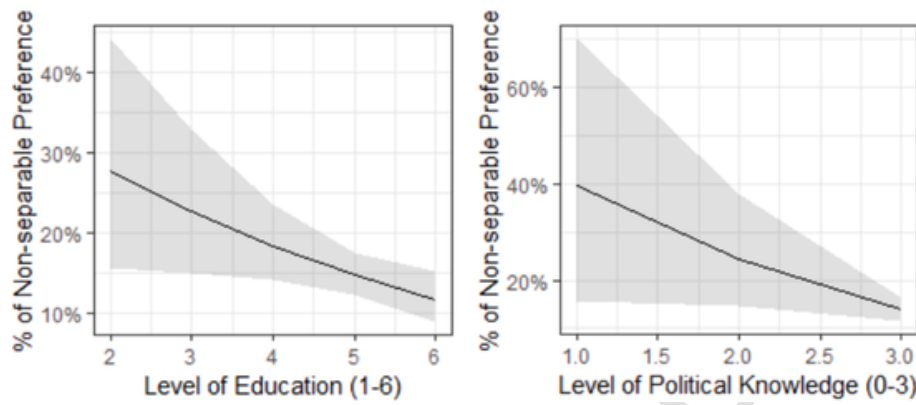+p < 0.1; *p < 0.05; **p < 0.01.

Fig. 1. Simulated effect of Education and Political Knowledge on non-separable preference. Effect estimated from Model 4, Table 5.

the non-attitude hypothesis and opposes the high cognitive capacity hypothesis in Table 1.

In Model 2 and Mode 4, Taiwanese respondents concerned with environmental protection and power shortage are not predictive of the formation of non-separable preferences. This article considers this variable a hard test for the high cognitive capacity hypothesis. Taiwanese respondents with this dual consideration should have been much more likely to form non-separable preferences following the theory of non-separable preferences. Unfortunately, this theory is not supported by empirical data.

In the end, non-partisan positively correlates with non-separable preference in both Model 3 and 4 in Table 5, at least at p < 0.1 level. Taiwanese respondents who are self-identified as not with any party are much more likely to have non-separable preferences toward the two referendums. Fig. 2 further simulates the effect of non-partisanship from Model 4 in Table 5, controlling all other variables at the mean value. Non-partisan respondents are 5% more likely to have non-separable preferences than the partisans in Fig. 2. This result supports both the non-attitude and the motivated independence hypothesis. However, the motivated independence hypothesis is not supported by other evidence discussed above.

5. Discussion

Who are the non-separable voters? This article reviews the literature and summarizes three potential theories explaining the formation of non-separable preferences. The 2021 Taiwan referendum was then used to examine the three theories. Table 6 summarizes the main findings of
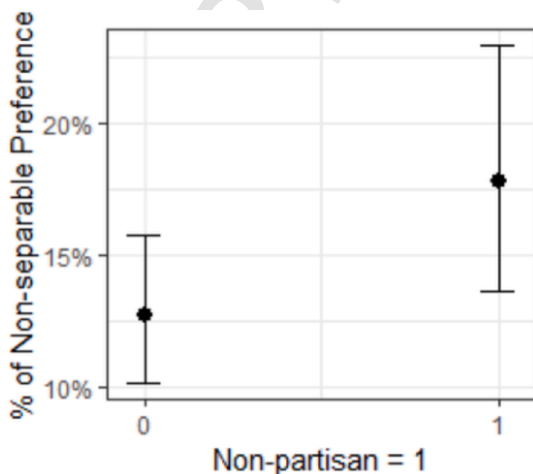

Fig. 2. Simulated effect of Non-partisanship on non-separable preference. Effect estimated from Model 4, Table 5.

Table 6

Competing theories on non-separable preferences – results.

Theory	Socio-demographic	Partisanship	Non-separable Preference Ranking
Non-attitude	Support – Table 5	Support – Table 5	Support – Table 2
High cognitive capacity (Dual policy concern)	No evidence – Table 5		No evidence – Tables 4 and 5
Motivated Independent (non-partisan concern)		Support – Table 5	No evidence – Table 4

this article. Generally speaking, Table 2 suggests that despite 15% of non-separable voters in the Pollcracylab survey, most of their preferences cannot be explained by either the high cognitive capacity or the motivated independence. Regression analysis in Table 6 further confirms that non-separable voters usually have a lower level of education, lower political knowledge, and are non-partisans. All results point out that most of the non-separable voters in the survey are mainly driven by non-attitude instead of rational consideration or psychological (dis)attachment.

This finding is surprising because this article tried many methods to boost the likelihood of the other two theories: (1) The 2021 Taiwan referendum was held right after two large-scale power outages which already shifted the public opinion; (2) the highly polarized political context and the considerable proportion of non-partisans in Taiwan; (3) the referendum does not have a concurrent election; (4) the survey was conducted right before the referendums; (5) the survey design includes to informative items before measuring the preference rankings; (6) the data-cleaning process already drops people who do not pay attention; (7) Pollcracylab sample is biased toward the highly educated population. Given all these potential efforts, the result still shows that the non-attitude theory dominates the explanation in forming (measurable) non-separable preferences.

Ultimately, it is worth noticing that the result does not rule out the existence of "meaningful" non-separable preference. In Tables 2 and 37 of 123 non-separable voters (30.0%) can be explained by either motivated independence or high cognition. Their preferences are closer to the Euclidean distance models in other works. In other words, the proportion of non-separable voters found in this article (14.7%) may serve as the maximum proportion of non-separable voters.

One limitation of this finding is to verify whether respondents are really non-attitude. It is harder to prove something that does not exist. In this article, all empirical evidence supports the implications derived from the non-attitude theory, as shown in Table 6. However, this article cannot rule out the likelihood that respondents form a non-separable

preference ranking beyond the knowledge of current literature. For example, in Tables 2, 17 and 24 respondents provided non-separable preferences ACDB and DBAC, respectively. This uneven distribution is not likely driven by randomness. One possible explanation is that these respondents only care about the nuclear power plant but have no attitude toward the natural gas station, so their preference rankings may be explained by combining three theories.[10]

To overcome this limitation and further explore how much the non-attitude influences the non-separable preference, one possible solution is to measure the preference ranking repeatedly. Repeated measure on non-separable preferences is nearly impractical in the telephone survey (Lacy 2001a), but it can be done by the rank order question used in this article. If respondents answered differently in the repeated rank order questions, it is likely that their preference ranking is driven by non-attitude.[10]

Another possible application of the current finding is to examine the relationship between non-separable preference and the Madisonian check-and-balance. Lewis-Beck and Nadeau (2004) suggest that people who support the constitutional check-and-balance are much more likely to split their votes in the general election. However, Yu et al. (2015) 's analysis of panel data shows that most people's check-and-balance attitude is conditional on whether their preferred party is in power (or will be) or not. In other words, many people may not hold the check-and-balance ideology as the Founding Fathers did. The rank order question used in this article may help examine the type and robustness of the Madisonian check-and-balance attitude.

In the end, this article only uses the simplest test (level of education and general political knowledge) on the effect of political sophistication. However, political sophistication itself should be treated as multi-dimensional (Luskin 1990) and the measure of political knowledge should be domain-specific and goal-oriented (Lupia 2016). It is possible that certain political knowledge (such as the stance of major parties) will be especially useful for the non-partisans but not the partisans, so the effect of political knowledge and sophistication is underestimated in this article. Unfortunately, given the small number of motivated independence and high cognition non-separable voters, the hypothesis of heterogenous effect cannot be further examined. This problem can be further verified by increasing the number of respondents which may have more non-separable voters with different types.

Statements and declarations

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Uncited references

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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[10] Nevertheless, the interaction of any pair of independent variables in Table 6 is insignificant.

Appendix.

A. The two information questions before the rank order measurement

Q4. One referendum is about "Whether the No.4 Nuclear Power Plant should be restarted." Supporters believe that the power plant can enrich and stabilize the power supply, while opponents argue that the No.4 Power Plant is unsafe and there is no place for nuclear waste. Have you ever heard of this "Restarting No.4 Nuclear Power Plant" referendum?

○ Yes ○ No

Q5. The referendum is about "Whether the No.3 Natural Gas Station should be relocated." Supporters believe that relocating the No.3 Station can further protect the algae reef, while the opponents argue relocating the station would cause temporal power outage and more coals would be burnt. Have you ever heard of this "Relocating No.3 Natural Gas Station" referendum?

○ Yes No

B. Background of the Pollcracylab respondents (n = 910)

Table B
Background of the Pollcracylab respondents (n = 910)

Gender	Male	553 (60.8%)
	Female	357 (39.2%)
Age	20~29	158 (17.4%)
	30~39	280 (30.8%)
	40~49	247 (27.1%)
	50~59	171 (18.8%)
	60 up	54 (5.9%)
Education	Middle School	4 (0.4%)
	Senior High	52 (5.7%)
	Junior College	118 (13.0%)
	College	380 (41.8%)
	Graduate School	356 (39.1%)
Taiwanese Identity	Taiwanese	547 (60.1%)
	Both	348 (38.2%)
	Chinese	9 (1.0%)
	Others	6 (0.7%)
Party Identification	KMT	158 (17.4%)
	DPP	223 (24.5%)
	New Power Party	38 (4.2%)
	Taiwan People's Party	124 (13.6%)
	Taiwan Statebuilding Party	38 (4.2%)
	Other parties (<4% each)	29 (3.2%)
	Non-Partisan	300 (33.0%)

C. Partisanship and Non-separable preference rankings

Appendix Table B. Partisanship and Non-separable preference rankings.

	NSV - MI	NSV -Others			NSV - MI	NSV -Others	
Non-partisans	11	40	$\chi^2 = 0.338$	Non-partisans	11	40	$\chi^2 = 4.435$
DPP/KMT	6	35	p = 0.561	DPP/KMT	6	35	p = 0.109
				Small parties	11	20	

Note.
NSV – non-separable voting.
MI: Motivated Independence category in Table 3.
p-value calculated with Yates' continuity correctionNote.
NSV – non-separable voting.
MI: Motivated Independence category in Table 3.
p-value calculated with Yates' continuity correction.

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