Impacts of Third-Party Entry to a Polarized Two-Party Political System: A Structural Analysis of Taiwan General Elections*

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Abstract

Using both vote and poll data and employing the micro-BLP framework, we estimate a discrete choice model to examine the impacts of third-party entry in the 2024 Taiwan presidential election. We find that such entry exacerbated political polarization because it strengthened the two major parties' incentives to further polarize. First, a stronger competitor (third party) for central voters makes each major party's effort to gain such voters less effective; second, central voters leaving a major party due to its further polarization now will not all switch to the other major party because they will be split by the third party. Welfare analyses show that the potential white-blue alliance would generate the highest social welfare because it retains the most centrist perceived ideological position and a large proportion of the third-party leader's political valence.

Keywords: Entry, Political Duopoly, Third Party, Political Polarization, Vote, Alliance, Endorsement, Two-Party System

JEL Codes: D72, D74, L1, L2, P16

"The time is basically ripe for a third-party challenge, and, largely, the reason is because of the level of polarization in American politics."

— Bernard Tamas, author of *The Demise and Rebirth of American Third Parties*

* The result in this paper is generated from econometric models fed with publicly available data. It does not necessarily represent the author's stance.

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1. Introduction

Many countries with a two-party political system have recently experienced a trend of increasingly intense partisan polarization. Political polarization within a country usually results in a divided society, isolated groups, an inefficiently squabbling congress, and a restrained government. In this context, whether the entry of a third party can be a cure for political polarization is an open question of great importance.

In this study, we examine an impactful third-party entry in the 2024 Taiwan presidential election. Before 2024, the presidential elections in Taiwan were dominated by two parties: Kuomintang (KMT) and Democratic Progressive Party (DPP). In 2024, Taiwan People's Party (TPP, founded in 2019) entered the presidential election for the first time and obtained 26.46% of the popular votes, compared to 40.05% for DPP and 33.49% for KMT.

Studying politics in Taiwan itself is also important because Taiwan plays the most crucial role in the relationship between the U.S. and China, the two largest economies in the world. KMT advocated that the 2024 Taiwan general election is the choice between war and peace because DPP's "pro-independence" moves would dramatically elevate the risk of war, while DPP advocated that the election is the choice between democracy and autocracy because KMT's "pro-Mainland-China" path would be a threat to Taiwan's democracy. Meanwhile, as the home of Taiwan Semiconductor Manufacturing Co., Ltd., Taiwan serves as the most important link in the supply chain of the semiconductor and AI industries (core industries in the new science and technology revolution).

The major controversy between the two major parties in Taiwan is how to address the relationship with China, which is referred to as "the green-blue ideological split." DPP (with green as its party color) unequivocally advocates Taiwanese nationalism, firmly opposes the notion of "One China," and actively promotes the increase in military expenditures to prevent military intimidation from the People's Republic of China (PRC). In contrast, KMT (with blue as its party color) opposes irritating the PRC government and favors strategically maintaining a peaceful relationship with China to promote economic growth in Taiwan.

As an emerging third force, TPP' ideological position stands in between the two major parties'. TPP argues that under the previous two-party political system, regardless of which of DPP and KMT was in office, the two dominant parties were keen on manipulating the green-blue ideologies, dividing the society, and stirring up hatred, which essentially sacrificed Taiwan people's interest in their own parties' interest. TPP asserts that Taiwan ought to step out of the

mud of the green-blue ideological split and have a rational, pragmatic, and scientific government. The founder and nominated presidential candidate of TPP, Wen-je Ko, is a nontypical politician with great personal charisma.[1] He worked as a professor and physician for 30 years before entering politics.

While a plausible hope is that an impactful third-party entry would mitigate political polarization, we find that such entry in fact can exacerbate political polarization by increasing the two major parties' incentives to further polarize. First, a stronger competitor (third party) for central voters makes a major party's effort to gain such voters less effective. Second, third-party entry can reduce the importance of central voters relative to extreme voters for a major party. Without the third party in the middle, central voters leaving a major party due to its further polarization will switch to the other major party (doubling the effect on the vote share difference between the two major parties), whereas extreme voters on a major party's side leaving it due to its movement toward the center will merely not turn out. However, with the third party, central voters leaving a major party due to its further polarization now will not all switch to the other major party because they will be split by the third party.

We first estimate a discrete choice model of voters' voting decisions to recover parties' ideological positions in the 2020 and 2024 presidential elections. We leverage both voting and polling (survey) data and employ methods similar to those of Petrin (2002) and Berry et al. (2004, micro-BLP) for the structural estimation. We find that the ideological gap between the two major parties was greater in 2024 with the third-party entry compared to that in 2020 without the entry. Noting that the widened gap may be caused by other differences between 2020 and 2024 instead of the third-party entry, based on the structural estimates obtained from the 2024 data, we conduct counterfactual analyses for the scenario of no third-party entry in 2024. We find that third-party entry can increase the two major parties' incentives to further polarize, which can at least partially explain the widened ideological gap in 2024.

Conditional on not being able to win the election by itself, one possible channel through which the third party can mitigate political polarization is forming an alliance with a major party. Our counterfactual analyses indicate that if either a blue-white alliance or a white-blue alliance was successfully formed, the ideological position of the alliance perceived by voters would be somewhat centrist (as a weighted average of each of the two parties' positions), and

[1] At least before and in the 2024 election.

the alliance would win.[2]

We conduct welfare analyses for the actual 2024 election with three candidates and for three counterfactual scenarios in which the third party did not enter (the blue party would marginally win), the blue-white alliance was formed, or the white-blue alliance was formed. The results show that the social welfare and the vote share of the winning candidate in the last scenario are the highest. First, the white-blue alliance has the most centrist perceived ideological position and hence eligible voters' average ideological distance to it is the shortest. Second, the white-blue alliance retains a greater proportion of Ko's political valence than the blue-white alliance does.

Another possible action for the third-party candidate in the 2024 election was to endorse a major-party candidate.[3] Our counterfactual analyses show that Ko's endorsement of the green candidate could have had little effect on the green candidate's ideological position as perceived by voters, whereas Ko's endorsement of the blue candidate could have substantially altered voters' perception of the blue candidate's ideological position. In contrast, through his endorsement, Ko's valence in the nonideological dimension could be substantially transmitted to the green candidate but could not be transmitted to the blue candidate.

Additional counterfactual analyses show that strategically adjusting its ideological position is not quite helpful for the third party to increase its vote share. If TPP moves toward the green (blue) side, then gaining green (blue) voters and losing blue (green) voters will offset each other, thereby limiting the total change to its vote share. Therefore, an appropriate strategy for the third party to win an election in the future may be to focus on enhancing the nonideological dimension, which fundamentally distinguishes it from the two major parties. The analyses also show that although the third party cannot make itself win the election through adjusting its ideological position, it can "determine" which of the two dominant parties will win the election. The reason is that TPP can absorb green voters from DPP (blue voters from KMT) and return blue voters to KMT (green voters to DPP) by moving toward the green (blue)

[2] The blue-white alliance means that the blue party nominates a presidential candidate and the white party nominates a vice-presidential candidate, and they jointly participate in the election; the white-blue alliance means vice versa. The blue and white parties negotiated to form an alliance two months before the election date but the negotiation ultimately broke down. The major controversy was which party's candidate should be nominated as the presidential candidate.

[3] After the negotiation to form an alliance broke down, KMT continued to seek Ko's endorsement before the election. KMT publicly announced that if elected, it would set up a coalition government and appoint officials jointly with TPP. However, by election day, the TPP candidate had not publicly announced that he would endorse the KMT candidate.

side in the ideological dimension.

Our study links two distinct strands of literature. One end of the link is the political economy literature on voting. Existing studies have conducted structural estimations to examine voters' voting behavior either in two-party political systems (e.g., Kawai et al., 2021; Kawai and Sunada, 2022; Cox, 2024; Shachar and Nalebuff, 1999; Gordon and Hartmann, 2013; Degan and Merlo, 2011; Waldfogel, 2023) or in multiparty political systems (e.g., Rekkas, 2007; Montero, 2016; Merlo and de Paula, 2017; Ujhelyi et al., 2021; Iaryczower et al., 2022). However, little research has structurally analyzed the impacts of the entry by an emerging third party to a two-party political system. There is reduced-form research on the influence of the existence of a third candidate in an election on voters' decisions, election outcomes (turnout rates and vote shares), and local economic development (Pons and Tricaud, 2018; Hillygus, 2007; Chatterjee et al., 2024). In contrast, we examine the impact of a viable third-party entry on incumbent major parties' choices of ideological positions using structural estimations.

The other end of the link is the industrial organization literature on entry, competition, and product differentiation. Many studies examined entries by firms into a market, a product line, an industry, or a country.[4] However, little research has examined entries by a third political party to a two-party political system (political duopoly). Examining whether third-party entry into a political duopoly would mitigate political polarization is, in some sense, an analog of analyzing whether a firm entry would reduce product differentiation, but the involved mechanisms are different.

Whether firm entry or increases in market competitiveness will increase product differentiation remains an open question in the industrial organization literature. Both

[4] For example, Jia (2008), Goolsbee and Syverson (2008), Prince and Simon (2015), Ma (2019), and Sweeting et al. (2020).

theoretical and empirical studies provided mixed results.[5] [6]

This study also contributes to the literature on political polarization. Existing research in political science and economics has explored a variety of causes driving political polarization, such as party control (Canen et al., 2020 & 2023), social media (Gentzkow and Shapiro, 2011), individual donors (Barber, 2016; Waldfogel, 2023), political action committees (Bonica, 2013), gerrymandering (McCarty et al., 2009), primary voters (Kujala, 2020; McGhee et al., 2014), and college experience (Strother et al., 2021). In contrast, we examine whether third-party entry can mitigate political polarization in a two-party system.

2. Background

2.1. Democratic Progressive Party and Pan-Green Coalition

DPP won the 2000 presidential election of Taiwan, ending 91 years of KMT rule in the Republic of China (ROC). Thereafter, DPP was the ruling party in Taiwan from 2000-2008 and from 2016 to the present. The party unequivocally advocates Taiwanese nationalism, firmly opposes the notion of "One China," and actively promotes the increase in military expenditures to prevent military intimidation from the PRC. DPP is considered to represent the interests of Island Taiwanese more than those of Mainland Taiwanese.[7] The party is frequently accused by

[5] Theoretically, firms' product differentiation is determined by two competing forces: the market-share effect and the market-power effect. The former effect induces firms to move closer to their competitors to capture more consumers (Hotelling, 1929), leading to minimum differentiation. The second effect prompts firms to move away from their competitors to soften price competition (d'Aspremont et al., 1979; Economides, 1986), thereby causing maximum differentiation. Theoretical studies have not reached consensus on which effect dominates. Such domination depends crucially on the particular assumptions of the model. For example, the first effect can dominate if consumers are sufficiently heterogeneous in terms of their taste parameter (de Palma et al., 1985) or have a nonuniform distribution (Eaton and Lipsey, 1975); in contrast, Smithies (1941) and Eaton (1972) showed that the assumption of inelastic demand can make the second effect dominant. Several theoretical studies examined differentiation in multiple dimensions and found that firms maximally differentiate on one dimension (that from which customers derive the most utility) while minimally differentiating on the others (e.g., Ben-Akiva et al., 1989; Irmen and Thisse, 1998; Tabuchi, 1994; Ansari, 1998).

[6] Empirical research also provided mixed results. Some empirical studies found that entries or increases in competitiveness lead to greater product differentiation (e.g., Prince and Simon (2015) on airline on-time performance; Netz and Taylor (2002) on the spatial differentiation of gasoline stations; Kerkhof (2024) on content differentiation among YouTube channels). Other empirical studies found that entries or increases in competition reduce product differentiation (e.g., Borenstein and Netz (1999) and Salvanes et al. (1997) on the departure-time differentiation of airlines; Pinske and Slade (1998) on the spatial differentiation of gasoline stations; Stavins (1995) on personal computers; Goolsbee and Petrin (2004) on cable television).

[7] Mainland Taiwanese include people who migrated to Taiwan in 1949 with the failing of the KMT government in Mainland China and their later generations. In contrast, Island Taiwanese include people who had been living in Taiwan before 1949 and their later generations. Mainland Taiwanese and Island

the PRC government of being a primary force in Taiwan that aims to “prevent the Chinese nation from achieving complete reunification" and "halt the process of national rejuvenation.” As the party color of DPP is green, DPP and other parties sharing similar ideologies and political positions (e.g., Taiwan Solidarity Union) are referred to as the Pan-Green Coalition, with DPP as the dominant party.

2.2. Kuomintang and Pan-Blue Coalition

KMT was the ruling party in Taiwan before 2000 and from 2008-2016. While supporting the maintenance of the present status quo and rejecting immediate unification with Mainland China, KMT opposes irritating the PRC government and favors strategically maintaining a peaceful relationship with Mainland China to promote economic growth in Taiwan. KMT was considered to represent the interests of Mainland Taiwanese more than those of Island Taiwanese. KMT is frequently accused by DPP of “selling out Taiwan to the PRC.” As the party color of KMT is blue, KMT and other parties that share similar ideologies and political positions (e.g., People First Party and New Party) are referred to as the Pan-Blue Coalition, with KMT as the dominant party.

2.3. Taiwan People's Party and its founder Wen-je Ko

Taiwan People's Party is currently the third largest party in Taiwan and is considered a rising third force in Taiwan’s political system. The party was founded by Wen-je Ko in 2019 and seeks to "become an alternative" to both the Pan-Green Coalition headed by DPP and the Pan-Blue Coalition headed by KMT. The party colors are cyan and white: the color cyan signifies an end to the longstanding green-blue political divide in Taiwan, and the color white represents calling for an open and transparent government.

TPP’s founder, Wen-je Ko, is a nontypical politician, unlike many political figures within the Pan-Green and Pan-Blue Coalitions. Before 2014, Ko was a physician at National Taiwan University Hospital and a professor at National Taiwan University College of Medicine. In both the 2014 and 2018 Taipei (capital of Taiwan) Mayoral Elections, Ko ran as an independent candidate and won the election.

In 2019, Ko established the Taiwan People's Party and was elected as the party

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Taiwanese are becoming less divided among the younger generations.

chairperson at the founding assembly. In the 2024 Taiwan presidential election, Ko ran the campaign as the candidate nominated by TPP. As a newly established party, TPP does not possess local faction networks or mainstream media. However, given his distinct policy orientations and presentation of great personal charisma to younger generations, Ko eventually obtained 26.46% of the popular votes, compared to 40.05% for the DPP candidate and 33.49% for the KMT candidate. This election marked the first time since the 2000 election that the winning candidate obtained less than 50% of the votes. After the 2024 election, Ko stated that the popular vote achieved by TPP shows that Taiwan is no longer dominated by the Pan-Blue or Pan-Green coalitions.

In the early stages of his political career, Ko espoused positions closer to those of the Pan-Green coalition. He endorsed Tsai Ing-wen (the DPP candidate) in both the 2012 and 2016 presidential elections. In the 2014 Taipei Mayoral Election, DPP agreed not to put forward a candidate for the election and to support Ko as the representative of the Pan-Green Coalition, without forcing Ko to join any political party. After 2016, Ko's political stance started shifting toward the Pan-Blue coalition. Regarding Taiwan's political status, Ko is generally seen as favoring the status quo but does not explicitly accept the 1992 Consensus as KMT does.[8] Since his term as Taipei mayor, Ko has used the wording "two sides of the Strait, one family" to express his opinion about Cross-Strait relations. Regarding economic policies, Ko supports enhancing economic and trade relationships with Mainland China. In the 2018 Taipei Mayoral Election, DPP nominated its own candidate and did not endorse Ko as it had in 2014. However, Ko still narrowly won the election as an independent candidate.

Ko argues that under the previous two-party political system, regardless of which of DPP and KMT was in office, the two dominant parties were keen on manipulating the green-blue ideologies, dividing the society, and stirring up hatred, which essentially sacrificed Taiwan people's interest in their own parties' interest. Ko advocates that Taiwan ought to step out of the mud of the green-blue ideological split and turn toward a solidary and harmonious society, and Taiwan's government ought to be rational, pragmatic, and scientific. Ko claims that, unlike the green and blue candidates, he is free of coercion by factions and constraint by consortiums, which enables him to appoint government officials according to their abilities instead of their

[8] The 1992 Consensus is "one China, different interpretations." The meaning is that while both the ROC and the PRC agree that there is one China, they disagree about who is the sole legitimate representative of China (i.e., the ROC vs. the PRC).

green-blue ideologies. Ko argues that Taiwan ought to play a role as the bridge of communication between the U.S. and China instead of a chess piece in their confrontation.

To summarize, the entry by TPP in the 2024 presidential election has two main characteristics: centrist party ideology and high candidate valence. These two characteristics could be an equilibrium outcome for a viable third-party entry to a polarized two-party system, although the time of the emergence of such a party or politician may be random and exogenous. This type of entry came to the stage in 2024 for the first time in Taiwan's history of direct presidential elections since 1996. On the one hand, although there are small extremist parties in Taiwan that are either bluer than KMT (such as New Party) or greener than DPP (such as Taiwan Solidarity Union), their influences are limited and have been marginalized. A viable third party needs to be ideologically centrist to fill the substantial gap between the two polarized major parties. On the other hand, compared to the two major parties, one crucial disadvantage of a new party is that it usually lacks a strong local party branch system at the grassroots level. Consequently, it has to rely on the high valence of a star candidate to effectively penetrate the two major parties' voter bases.[9]

3. Data

We obtain the district/township-level vote data from the Central Election Commission (CEC) in Taiwan. For each district in a city or each township in a county, the data include the number of votes for each candidate and the number of eligible voters. We divide the votes by the eligible voters to obtain the district/township-level vote shares for each candidate.[10] There are 368 districts/townships in Taiwan and approximately 14 million eligible voters for the 2024 election.

We also download statistical tables based on the Population and Housing Census from the Statistical Bureau of Taiwan and the Statistical Yearbook from the Ministry of the Interior. Based on these data, we construct empirical distributions of eligible voters' demographic characteristics for each district in a city and each township in a county.[11]

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[9] Kawai and Sunada (2022) studied how candidates' valences influence voters' voting decisions in a two-party system with each party horizontally differentiated in the ideological dimension.

[10] In estimation, we calculate a candidate's vote share as the ratio between the number of votes obtained by the candidate and the number of eligible voters instead of as the ratio between the number of votes obtained by the candidate and the number of total votes. The reason is that this ratio will be directly used in the estimation of the BLP-style model. The typical BLP models in the industrial organization literature require the market shares of each product and the outside option, which add up to one. The percentage of eligible voters who do not turn out is analogous to the market share of the outside option.

[11] Eligible voters in Taiwan need to be at least 20 years old.

In addition, we collect the polling data from my-formosa.com, which is one of the major polls in Taiwan and is widely cited by many media. It is operated by Formosa Publishing Co., Ltd. The sample size of each wave is above 1,000, similar to the sample size of the survey data of the American National Election Studies (970) used by Degan and Merlo (2011) examining the U.S. presidential election. Given that the population of Taiwan (approximately 23 million) is significantly smaller than that of the U.S. (approximately 330 million), the sample used should be sufficiently representative.[12] We use the data from the last wave before the election voting date.[13] Formosa's estimated popular vote intervals based on its last wave are 38.9%~41.3%, 33.0%~36.0%, and 24.5%~27.0%, respectively, for the green, blue, and white candidates (the votes for a candidate divided by the total votes), very close to the actual outcomes on the election date (January 13, 2024), i.e., 40.05%, 33.49%, and 26.46%, respectively.

Table 1 provides descriptive statistics.

4. Structural model

In Section 4.1, we build a discrete choice model for voters' voting decisions. Next, we propose moment conditions that leverage both the voting and polling data in Section 4.2 and discuss the identification of the structural parameters in Section 4.3. We address concerns about the methodology in Appendix B.

4.1. A discrete choice model for voting

Suppose that the ideological positions of DPP (green), KMT (blue), and TPP (white) are x_g, x_b, and $x_w \in R$, respectively. We normalize x_g to zero because only the distance between a

[12] Also note that in Petrin (2002), which examined the vehicle purchase choice problem of the U.S. consumers, the data from Consumer Expenditure Survey were used to construct micro moment conditions in addition to macro-BLP moment conditions. There were 2,660 observations of consumers purchasing new vehicles, of which 337 observations were of principal interest to the author's research questions (including purchasers of minivans, station wagons, sport-utility vehicles, and full-size vans).

[13] There are long- and short-version questionnaires. The poll with long-version questionnaires was conducted every month before the election, whereas the poll with short-version questionnaires was conducted every three days in 2023 and every two days in 2024 before the election. With January 13, 2024 as the 2024 election date, the last wave of the short version was conducted during January 11-12, 2024, and the last wave of the long version was conducted during December 20-21, 2023. For survey questions that appear in both the long and short versions, we use the last wave of the short version because it is closer to the election date. For other survey questions, we use the last wave of the long version.

pair of positions matters. Given that DPP is more liberal than KMT and that TPP's supporters are mainly central voters, we assume that $0 = x_g < x_w < x_b$.

Assume that the ideological position of a voter i is $\mu(D_i) + \eta_i$. $\mu(D_i)$ captures how a voter's ideological position in the green-blue ideological dimension varies as a function of observed individual demographic characteristics D_i, while η_i captures the effect of voter i's unobserved demographic characteristics on her green-blue ideological position. We assume that η_i follows a normal distribution $N(0, \sigma_1^2)$.[14]

The utility of having the green candidate in office for voter i at district/township k is as follows:

$$u_{ig} = -|\mu(D_i) + \eta_i| + \varsigma_{kg} = \bar{u}_{ig} + \varsigma_{kg} \quad (4.1)$$

The term ς_{kg} is the location-level unobserved random preference shock. The utility of having the blue candidate in office for voter i at location k is as follows:

$$u_{ib} = -|\mu(D_i) + \eta_i - x_b| + \varsigma_{kb} = \bar{u}_{ib} + \varsigma_{kb} \quad (4.2)$$

The utility of having the white candidate in office for voter i at location k is as follows:

$$u_{iw} = -|\mu(D_i) + \eta_i - x_w| + \lambda(D_i) + \zeta_i + \varsigma_{kw} = \bar{u}_{iw} + \varsigma_{kw} \quad (4.3)$$

$\lambda(D_i)$ in equation (4.3) captures how a voter's preference toward the third-party candidate in the nonideological dimension varies as a function of observed individual demographic characteristics D_i, while ζ_i captures the effect of unobserved demographic characteristics in the dimension. This dimension is mainly driven by Ko's political valence. We assume that (η_i, ζ_i) follow the bivariate normal distribution $N(0,0, \sigma_1^2, \sigma_2^2, \rho)$.

In typical consumers' product-choice problems, choosing the outside option results in the outcome of not obtaining any product in the choice set. In contrast, in voting choice problems, choosing the outside option (not to vote) still results in a certain candidate winning the election. Therefore, for a voter, the utility of having a certain candidate in office is different from the utility of voting for the candidate. Following the calculus of the voting framework (originally formulated by Downs (1957) and later developed by Tullock (1967) and Riker and Ordeshook (1968)),[15] voter i's utilities of voting for the green, blue, and white candidates and the utility of not turning out, V_{ig}, V_{ib}, V_{iw}, V_{i0}, respectively, can be expressed as follows:

[14] The empirical results are robust to changes in the distribution assumption for η_i. Alternatively, we assume that η_i follows a uniform distribution or a bimodal distribution. The results are similar and are available upon request.

[15] The calculus of voting model has been applied by multiple empirical studies on voting, such as Kawai et al. (2021).

$$V_{ig} = p(2u_{ig} - u_{ib} - u_{iw}) + \epsilon_{ig}$$
$$V_{ib} = p(2u_{ib} - u_{ig} - u_{iw}) + \epsilon_{ib}$$
$$V_{iw} = p(2u_{iw} - u_{ig} - u_{ib}) + \epsilon_{iw}$$
$$V_{i0} = \varphi + \varrho_k + \epsilon_{i0}$$

The derivation of the equations above linking the utility of voting for a candidate to the utility of having the candidate in office can be found in Appendix A. φ captures the mean cost of turning out to vote (e.g., traveling to a polling place and waiting in line) net the mean utility that a voter derives from fulfilling her civic duty of voting. ϱ_k and ϵ_{i0} represent unobserved random shocks to φ, respectively, at the location level and the individual level.[16] If voter i chooses not to vote, she will save the net voting cost. ϵ_{ig}, ϵ_{ib}, ϵ_{iw}, and ϵ_{i0} are idiosyncratic shocks to voter i's preferences for the four voting choices; they are assumed to follow the type-I extreme value distribution to generate the logit vote probabilities. Because only the difference between the utilities of two choices matters, we can normalize V_{i0} to ϵ_{i0}, and hence we have:

$$V_{ig} = p(2u_{ig} - u_{ib} - u_{iw}) - \varphi - \varrho_k + \epsilon_{ig} \quad (4.4)$$
$$V_{ib} = p(2u_{ib} - u_{ig} - u_{iw}) - \varphi - \varrho_k + \epsilon_{ib} \quad (4.5)$$
$$V_{iw} = p(2u_{iw} - u_{ig} - u_{ib}) - \varphi - \varrho_k + \epsilon_{iw} \quad (4.6)$$
$$V_{i0} = \epsilon_{i0} \quad (4.7)$$

In equations (4.4) through (4.6), p is the probability in the voter's belief that she is pivotal. It can also be broadly interpreted as the voter's perception of voting efficacy. Unlike some studies on the U.S. presidential elections in the literature (e.g., Kawai et al. 2021), we do not assume that the pivotal probability p differs across different locations within Taiwan. The reason is that the winner of the Taiwan presidential election is determined directly by the popular votes of the entire Taiwan, in contrast to the Electoral College system used in the U.S.[17]

[16] The heterogeneity of voting costs across individuals should be small in Taiwan. Unlike the U.S. with a population density of only 96 people per square mile, Taiwan is a small area with a high population density (1,680 per square mile). It is convenient for voters to travel to their polling places. The density of polling places for the 2024 presidential election in Taiwan was 1.28 per square mile (17,795 polling places in total), compared to 0.03 per square mile for the 2016 presidential election in the U.S. Moreover, during election day, candidates' campaign teams solicit votes door to door. The voter turnout in Taiwan (74.9% for 2020 and 71.9% for 2024) is substantially higher than that in the U.S. (60.1% for 2016). Note that we do not compare Taiwan's turnout rates to the statistics for the 2020 U.S. presidential election because it was conducted during the COVID-19 pandemic.

[17] Under the Electoral College system, in each state of the U.S. (except for Maine and Nebraska), the winner of the plurality of its constituent statewide popular vote receives all of that state's electors ("winner-takes-all"). The candidate who receives an absolute majority of electoral votes is then elected to office. Consequently, a voter's pivotal probability in swing states should be much higher than that in

If the pivotal probability is only a constant, it cannot be separately identified but can be implicitly captured by the structural parameters in u_{ig}, u_{ib}, and u_{iw}. Given that this research does not need to identify and estimate p separately from other structural parameters, we rewrite equations (4.4), (4.5), and (4.6) as follows, with the awareness that the effect of p on voters' choices is completely embedded in the structural parameters in u_{ig}, u_{ib}, and u_{iw}:[18]

$$V_{ig} = 2u_{ig} - u_{ib} - u_{iw} - \varphi - \varrho_k + \epsilon_{ig} \quad (4.8)$$
$$V_{ib} = 2u_{ib} - u_{ig} - u_{iw} - \varphi - \varrho_k + \epsilon_{ib} \quad (4.9)$$
$$V_{iw} = 2u_{iw} - u_{ig} - u_{ib} - \varphi - \varrho_k + \epsilon_{iw} \quad (4.10)$$

Equations (4.8) through (4.10) can be further written as follows:[19]

$$V_{ig} = 2\bar{u}_{ig} - \bar{u}_{ib} - \bar{u}_{iw} - \varphi + 2\varsigma_{kg} - \varsigma_{kb} - \varsigma_{kw} - \varrho_k + \epsilon_{ig}$$
$$V_{ib} = 2\bar{u}_{ib} - \bar{u}_{ig} - \bar{u}_{iw} - \varphi + 2\varsigma_{kb} - \varsigma_{kg} - \varsigma_{kw} - \varrho_k + \epsilon_{ib}$$
$$V_{iw} = 2\bar{u}_{iw} - \bar{u}_{ig} - \bar{u}_{ig} - \varphi + 2\varsigma_{kw} - \varsigma_{kb} - \varsigma_{kg} - \varrho_k + \epsilon_{iw}$$

We denote the following:

$$\xi_{kg} = 2\varsigma_{kg} - \varsigma_{kb} - \varsigma_{kw} - \varrho_k \quad (4.11)$$
$$\xi_{kb} = 2\varsigma_{kb} - \varsigma_{kg} - \varsigma_{kw} - \varrho_k \quad (4.12)$$
$$\xi_{kw} = 2\varsigma_{kw} - \varsigma_{kb} - \varsigma_{kg} - \varrho_k \quad (4.13)$$

Then, we have: [20] [21]

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other states.

[18] Unlike Kawai et al. (2021), we do not explicitly assume that the pivotal probability p varies according to individual voters' demographic characteristics D_i. The reason is that $p(D_i)$ cannot be separately identified from $\mu(D_i)$ and $\lambda(D_i)$. Our research does not need to identify $p(D_i)$, as the effect of D_i on $p(D_i)$ can be captured by the parameters in $\mu(D_i)$ and $\lambda(D_i)$. Moreover, accurately estimating the pivotal probability does not necessarily lead to precisely capturing voters' voting behavior. The reason is that people can derive utility from expressing their political preferences while voting even if they know that their vote does not count (Riker and Ordeshook, 1968; Blais and Young, 1999; Frey and Stutzer, 2001). Citizens feel a moral obligation to vote because using their vote to self-express their preference is essential to the survival of democracy (Downs, 1957).

[19] For the counterfactual scenarios in which KMT and TPP form a blue-white or white-blue alliance or TPP does not enter the election, we need to explicitly reincorporate p into the equations. The reason is that these counterfactual experiments reduce the number of candidates from three to two and hence should substantially alter voters' perceived pivotal probabilities. We need to rescale the structural parameters obtained from the baseline estimation by p_1/p_0, where p_0 is the unidentified pivotal probability in the actual voting that scales the structural parameters in equations (4.8) through (4.10) and p_1 is the new pivotal probability in those counterfactual scenarios. See Sections 8 and 9 for detailed discussions. Note that allowing the pivotal probability to vary across states in the U.S., Kawai et al. (2021) normalized the pivotal probability in one state and estimated pivotal probabilities in other states.

[20] The reason why we can allow that the cost of turning out to vote net the utility of fulfilling one's civic duty of voting differs across locations (i.e., allow the existence of ϱ_k) in the model is that ξ_{kg}, ξ_{kb}, and ξ_{kw} only have two degrees of freedom if without ϱ_k (without ϱ_k, $\xi_{kg} + \xi_{kb} + \xi_{kw} = 0$). However, there are three available choices besides the outside option.

[21] Our model can be extended to a nested logit distribution for the individual-level unobserved random preference shocks in equations (4.14) through (4.16). Voter i's utilities of voting for the green, blue, and white candidates and the utility of not turning out, V_{ig}, V_{ib}, V_{iw}, V_{i0}, respectively, can be expressed as follows

$$V_{ig} = 2\bar{u}_{ig} - \bar{u}_{ib} - \bar{u}_{iw} - \varphi + \xi_{kg} + \epsilon_{ig} = \bar{V}_{ig} + \xi_{kg} + \epsilon_{ig} \quad (4.14)$$
$$V_{ib} = 2\bar{u}_{ib} - \bar{u}_{ig} - \bar{u}_{iw} - \varphi + \xi_{kb} + \epsilon_{ib} = \bar{V}_{ib} + \xi_{kb} + \epsilon_{ib} \quad (4.15)$$
$$V_{iw} = 2\bar{u}_{iw} - \bar{u}_{ig} - \bar{u}_{ig} - \varphi + \xi_{kw} + \epsilon_{iw} = \bar{V}_{iw} + \xi_{kw} + \epsilon_{iw} \quad (4.16)$$

Each eligible voter in 2024 faces four available choices: votes for the green, blue, or white candidate or does not turn out to vote (the outside option), denoted as g, b, w, and o, respectively. Denote the choice of voter i at location k as y_{ik}. For $j \in \{g, b, w\}$,

$$Prob\{y_{ik} = j\} = \frac{exp(\bar{V}_{ij} + \xi_{kj})}{1 + exp(\bar{V}_{ig} + \xi_{kg}) + exp(\bar{V}_{ib} + \xi_{kb}) + exp(\bar{V}_{iw} + \xi_{kw})} \quad (4.17)$$

The probability of not turning out to vote is:

$$Prob\{y_{ik} = o\} = \frac{1}{1 + exp(\bar{V}_{ig} + \xi_{kg}) + exp(\bar{V}_{ib} + \xi_{kb}) + exp(\bar{V}_{iw} + \xi_{kw})}$$

The two equations above yield individual choice probabilities.[22] The vote share for candidate j at location k is given by the following:

$$s_{jk} = \int Prob\{y_{ik} = j\}\, dF_k(D_i, \eta_i, \zeta_i) \quad (4.18)$$

$$V_{ig} = 2\bar{u}_{ig} - \bar{u}_{ib} - \bar{u}_{iw} + \varphi + \xi_{kg} + \nu_i(\vartheta) + \vartheta\epsilon_{ig}$$
$$V_{ib} = 2\bar{u}_{ib} - \bar{u}_{ig} - \bar{u}_{iw} + \varphi + \xi_{kb} + \nu_i(\vartheta) + \vartheta\epsilon_{ib}$$
$$V_{iw} = 2\bar{u}_{iw} - \bar{u}_{ig} - \bar{u}_{ig} + \varphi + \xi_{kw} + \nu_i(\vartheta) + \vartheta\epsilon_{iw}$$
$$V_{i0} = \epsilon_{i0}$$

ν_i is a "nested logit" random variable that is constant across voting choices and differentiates voting from the outside option (not vote). ϵ_{ij}, $j \in \{g, b, w, 0\}$ is an independently and identically distributed (across choices and individuals) "logit error." ϑ is the nested logit parameter that varies between 0 and 1. If $\vartheta = 1$, then $\nu_i(\vartheta) \equiv 0$, and the vote choice probability of a voter takes the simple multinomial logit form. If $\vartheta = 0$, then the independently and identically distributed ϵ_{ij}s have no effect. Under the nested logit assumption, we obtain similar results, which are available upon request. The estimation procedure follows Berry and Jia (2010).

[22] Unlike Kawai et al. (2021) that used a pivotal-voter model and assumed that voters compare utilities of voting for a candidate (V_{ij}), another group of studies used ethical-voter models and assumed that voters directly compare utilities of having a candidate in office (u_{ij}) when making discrete voting choices. This group of studies includes Rekkas (2007), Gordon and Hartmann (2013), Montero (2016), Ujhelyi et al. (2021), Iaryczower et al. (2022), and Waldfogel (2023). The probability of being pivotal was abstracted from their models. We also follow this alternative model specification and the corresponding choice probability of voting for $j \in \{g, b, w\}$ is

$$Prob\{y_{ik} = j\} = \frac{exp(u_{ij})}{1 + exp(u_{ig}) + exp(u_{ib}) + exp(u_{iw})}$$

and the choice probability of not voting is

$$Prob\{y_{ik} = o\} = \frac{1}{1 + exp(u_{ig}) + exp(u_{ib}) + exp(u_{iw})}$$

The empirical results are similar and are available upon request. Appendix B.3 provides more discussion on the validity of employing a pivotal-voter framework for a large-scale election.

where $F_k(D_i, \eta_i, \zeta_i)$ represents the cumulative density function for the joint distribution of (D_i, η_i, ζ_i).

With abuse of notation, we parametrize function $\mu(D_i)$ as a linear function in D_i with parameters μ and parametrize function $\lambda(D_i)$ as a linear function in D_i with parameters λ. Given the location-level unobserved random preference shocks $\xi_k = \{\xi_{kg}, \xi_{kb}, \xi_{kw}\}$ and the numerical values for the structural parameters $\theta = \{\mu, \lambda, \sigma_1, \sigma_2, \rho, x_b, x_w, \varphi\}$, we can simulate vote shares as follows:

$$s_{jk}(\xi_k; \theta) = \frac{1}{ns} \sum_{i=1}^{ns} \frac{exp(\bar{V}_{ij} + \xi_{kj})}{1 + \sum_{j' \in \{g,b,w\}} exp(\bar{V}_{ij'} + \xi_{kj'})} \tag{4.19}$$

To simulate $s_{jk}(\xi_k; \theta)$ in equation (4.19), we first randomly draw D_i, $i = 1, \dots, ns$ from the empirical distribution of observed demographic characteristics at location k, $F_{D,k}(D)$. Next, we randomly draw e_{i1} and e_{i2}, $i = 1, \dots, ns$ from the standard normal distribution $N(0,1)$. Then, let

$$\eta_i = e_{i1}\sigma_1 \tag{4.20}$$

$$\zeta_i = \left(\rho e_{i1} + \sqrt{1-\rho^2} e_{i2}\right) \sigma_2 \tag{4.21}$$

Consequently, (η_i, ζ_i) follows the bivariate normal distribution $N(0,0,\sigma_1^2, \sigma_2^2, \rho)$.

Let $s_k(\xi_k; \theta) = \{s_{jk}(\xi_k; \theta)\}_{j \in \{g,b,w\}}$ (simulated market shares) and $S_k = \{S_{jk}\}_{j \in \{g,b,w\}}$ (observed market shares in the data). Given a set of values for the structural parameters θ, the unobserved random preference shocks at the location level ξ_k can be solved from the following implicit system of equations:

$$s_k(\xi_k; \theta) = S_k \tag{4.22}$$

Based on the contraction mapping suggested by BLP, ξ_k can be numerically solved by the following iteration:

$$\xi_k^{h+1} = \xi_k^h + lnS_k - lns_k(\xi_k; \theta) \tag{4.23}$$

4.2. Moment conditions and estimation methods

Leveraging both polling (survey) and actual voting data, we construct three types of moment conditions: BLP moments, micro moments based on voters' choices, and micro moments based on voters' political positions.

Given that voting is anonymous, in actual voting date, we cannot observe voters' demographic characteristics other than their locations. Thus, actual voting data, although

accurate, are essentially aggregate-level market share data. Accordingly, we construct BLP moments based on the actual voting data. The Formosa poll asks about both voters' voting choices and their demographic characteristics and political positions. Accordingly, we construct micro moments based on the polling data. The estimation methods are similar to those Petrin (2002) and Berry et al. (2004).

BLP moments

We use only one BLP moment as follows:

$$E\xi_{kj} = 0 \tag{4.24}$$

Typically, the BLP framework is employed for product markets with price as an endogenous variable. In contrast, the voting context does not have a price variable. Therefore, we do not need to find instrumental variables (IVs) for endogenous prices and construct moment conditions like $E\xi_{kj}IV_{kj} = 0$. One may argue that x_b and x_w are endogenous because candidates endogenously choose their political stances to gain more votes. However, x_b and x_w are parameters to be estimated instead of variables constructed from data.[23] [24]

Although we use only one BLP moment, the BLP procedure is important because ξ_{kj} recovered from the contraction mapping will be used to calculate micro moments, which will be discussed below.

Micro moments based on choices

Micro moments match the predictions of the structural model to their counterparts in the polling data. The first set of moments of this type matches the average probability of voting for a candidate conditional on that the lth dimension of demographic characteristics D_{il} equals a certain value $\overline{D}_{ls}$. The moments are given by the following:

$$Prob[y_i = j | D_{il} = \overline{D}_{ls}], \qquad j \in \{g, b, w\} \tag{4.25}$$

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[23] This treatment is similar in spirit to Waldfogel (2023), which fully controlled for the endogeneity of ideology by including candidate-election fixed effects. Other studies constructed ideology scores for candidates based on campaign data (Iaryczower et al., 2022) or roll call vote data (Degan and Merlo, 2011; Merlo and de Paula, 2017). Iaryczower et al. (2022) further found instrumental variables for candidates' ideology scores.

[24] One potential omitted variable is the location-level efforts made by candidates' campaign teams, including calls, visits, advertisement expenditure, etc. The efforts are generally not observable at the location level. They will be captured by ξ_{kj}s (unobserved random shocks to voters' preferences). Many studies in the literature did not explicitly model candidates' efforts. Shachar and Nalebuff (1999) employed the state-level calls and visits as a proxy for the U.S. presidential candidates' efforts in campaigns. Gordon and Hartmann (2013) analyzed the effect of market-level advertising on county-level vote shares in the U.S. presidential elections. Huang and He (2021) studied candidates' spending in the U.S. House of Representatives elections instead of presidential elections.

The demographic characteristics have three dimensions, including age, gender, and education, denoted as $l = 1,2,3$, respectively. For the age dimension, $\bar{D}_{1s}$ has six possible values: 20~29, 30~39, 40~49, 50~59, 60~69, and 70+. For the gender dimension, $\bar{D}_{2s}$ has two possible values: female and male. For the education dimension, $\bar{D}_{3s}$ has four possible values: elementary, junior high, senior high, and college and above.

The second and third sets of moments of this type leverage one Formosa poll question: "Which of the three candidates do you dislike most and would definitely not vote for?"[25] The second set of moments matches the average probability of having the least inclination to vote for candidate j' conditional on voting for j. The moments are given by:

$$Prob\left[\underset{\sim}{y_i} = j' \,\&\, y_i = j\right], j \in \{g,b,w\}, j' \in \{g,b,w\} \backslash j \tag{4.26}$$

The probability predicted by the structural model can be calculated as follows:

$$\begin{aligned} &Prob\left[\underset{\sim}{y_i} = j' \,\&\, y_i = j\right] \\ &= \frac{exp\left(\bar{V}_{ij} + \xi_{kj}\right)}{1 + \sum_{j'' \in \{g,b,w\}} exp\left(\bar{V}_{ij''} + \xi_{kj''}\right)} \\ &\times \frac{exp\left(\bar{V}_{i,\{g,b,w\}\backslash\{j,j'\}} + \xi_{k,\{g,b,w\}\backslash\{j,j'\}}\right)}{\sum_{j'' \in \{g,b,w\}\backslash j} exp\left(\bar{V}_{ij''} + \xi_{kj''}\right)} \end{aligned} \tag{4.27}$$

The third set of moments matches the average probability of having the least inclination to vote for candidate j' conditional on turning out and the lth dimension of demographic characteristics D_{il} being equal to a certain value $\bar{D}_{ls}$. The moments are given by the following:

$$\begin{aligned} &Prob\left[\underset{\sim}{y_i} = j' | y_i \neq o \,\&\, D_{il} = \bar{D}_{ls}\right] \\ &= \sum_{j'' \in \{g,b,w\}\backslash j'} Prob[\underset{\sim}{y_i} = j' \,\&\, y_i = j'' |\, y_i \neq o \,\&\, D_{il} = \bar{D}_{ls}] \end{aligned} \tag{4.28}$$

Micro moments based on political positions

The Formosa poll classifies respondents into nine grades representing their green-blue ideological positions based on their answers to the questions of how much they like or dislike DPP or KMT, with "grade one" representing the greenest and "grade nine" representing the bluest.[26] The Formosa poll reports the percentage of each grade in its sample. For each of these

[25] This question is essentially similar to the survey question on consumers' second choices in Berry et al. (2024).

[26] Actually, the raw data of the Formosa poll code the greenest as "grade nine" and the bluest as "grade one." We recode the grades to be consistent with the direction of the green-blue ideological dimension

percentages, we can calculate the corresponding percentile of the distribution of $\mu(D_i) + \eta_i$, given a set of values for the structural parameters $\{\mu, \sigma_1\}$. Consequently, we can assign an ideological grade to each simulated voter i according to her $\mu(D_i) + \eta_i$. Then, conditional on the lth dimension of demographic characteristics D_{il} equal to a certain value $\bar{D}_{ls}$, we can match the percentage of voters falling into grade $\mathbb{g}_{gb}$ predicted by the structural model to its counterpart in the poll.[27] The moments are given by the following:

$$Prob\left[grade_{gbi} = \mathbb{g}_{gb} | D_{il} = \bar{D}_{ls}\right],\ \mathbb{g}_{gb} \in \{1, 2, \dots, 9\} \tag{4.29}$$

Another set of moments matches the average probability of voting for a candidate conditional on that the voter falls into grade $\mathbb{g}_{gb}$. The moments are given by the following:

$$Prob\left[y_i = j \middle| grade_{gbi} = \mathbb{g}_{gb}\right], \qquad j \in \{g, b, w\}, \mathbb{g}_{gb} \in \{1, 2, \dots, 9\} \tag{4.30}$$

Similarly, the Formosa poll classifies respondents into five grades representing their favoritism for TPP based on their answers to the questions of how much they like or dislike TPP, with "grade one" representing "strongly favor" and "grade five" representing "strongly dislike." Voters' favoritism for TPP is mainly driven by Ko, the charismatic founder and spiritual leader of this young party.[28] The Formosa poll reports the percentage of each grade in its sample. For each of these percentages, we can calculate the corresponding percentile of the distribution of $\lambda(D_i) + \zeta_i$, given a set of values for the structural parameters $\{\lambda, \sigma_2\}$. Consequently, we can assign a grade to each simulated voter i according to her $\lambda(D_i) + \zeta_i$. Then, conditional on the lth dimension of demographic characteristics D_{il} equal to a certain value $\bar{D}_{ls}$, we can match the percentage of voters falling into grade $\mathbb{g}_w$ predicted by the structural model to its counterpart in the poll. The moments are given by the following:

$$Prob[grade_{wi} = \mathbb{g}_w | D_{il} = \bar{D}_{ls}],\ \mathbb{g}_w \in \{1, 2, 3, 4, 5\} \tag{4.31}$$

Another set of moments matches the average probability of voting for a candidate

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in our model.

[27] In addition to the three dimensions of the demographic characteristics (age, gender, and education) used in choice-based micro moments (e.g., equation (4.25)), herein, we employ the location group as the fourth dimension, denoted as $\bar{D}_{4s}$. The Formosa poll groups cities and counties in Taiwan into 7 regions and provides region-level statistics for their polling data. Therefore, $\bar{D}_{4s}$ has 7 possible values. Cities and counties included in each region are listed in Table S.2 in Appendix S. The reason why we do not match the location-level vote shares predicted by the structural model to their counterparts in the Formosa poll for equation (4.25) is that the contraction mapping in the BLP procedure has already exactly matched the predicted ones to their counterparts in the actual voting data.

[28] Because of its heavy reliance on its founder Ko, many political observers claim that TPP is a "one-person party."

conditional on that the voter falls into grade $\mathbb{g}_w$. The moments are given by the following:

$$Prob[y_i = j|grade_{wi} = \mathbb{g}_w], \quad j \in \{g, b, w\}, \mathbb{g}_w \in \{1, 2, 3, 4, 5\} \tag{4.32}$$

The final set of moments matches the model-predicted percentage of voters falling into grade $\mathbb{g}_w$ in the dimension of the effect of Ko's valence conditional on they falling into grade $\mathbb{g}_{gb}$ in the ideological dimension to its counterpart in the poll. The moments are given by the following:

$$Prob\left[grade_{wi} = \mathbb{g}_w \middle| grade_{gbi} = \mathbb{g}_{gb}\right], \ \mathbb{g}_w \in \{1, 2, 3, 4, 5\}, \mathbb{g}_{gb} \in \{1, 2, \dots, 9\} \tag{4.33}$$

GMM

Denote the BLP and micro moments as $G_1(\theta)$ and $G_2(\theta)$, respectively. Let $G(\theta) = \begin{bmatrix} G_1(\theta) \\ G_2(\theta) \end{bmatrix}$. The structural parameters are estimated by solving the following minimization problem:

$$\min_{\theta} G(\theta)' W G(\theta) \tag{4.34}$$

4.3. Identification

If x_b and x_w are fixed, in the aggregate-level data, the variation in the empirical distributions of demographic characteristics across locations and the variation in location-level vote shares of the candidates can identify μ, λ, and φ; meanwhile, in the individual survey data, the variation in individual demographic characteristics and the variation in individual voting choice probabilities can also identify μ, λ, and φ.

Given D_{il}, the shape of $Prob\left[grade_{gbi} = \mathbb{g}_{gb} | D_{il} = \overline{D}_{ls}\right]$ in $\mathbb{g}_{gb}$ helps identify σ_1; the reason is that in the green-blue ideological dimension, conditional on observed demographic characteristics, more voters will fall into grades at the two ends if the variance of unobservable characteristics is greater. Given $\mathbb{g}_{gb}$, the variation of $Prob\left[grade_{gbi} = \mathbb{g}_{gb} | D_{il} = \overline{D}_{ls}\right]$ across different D_{il} helps identify the relative magnitude of each parameter within μ. Similarly, given D_{il}, the shape of $Prob[grade_{wi} = \mathbb{g}_w | D_{il} = \overline{D}_{ls}]$ in $\mathbb{g}_w$ helps identify σ_2. Given $\mathbb{g}_w$, the variation of $Prob[grade_{wi} = \mathbb{g}_w | D_{il} = \overline{D}_{ls}]$ across different D_{il} helps identify the relative magnitude of each parameter within λ.

The moments represented by equation (4.30) can help identify x_b and x_w. The moments represented by equations (4.26) and (4.33) can help identify ρ. Given that a voter

votes for the white candidate, she will be more likely to most dislike the green candidate instead of the blue candidate if ρ is greater.[29]

In Appendix B, we address several concerns about the methodology, including the possibility of strategic voting, other dimensions in voters' preferences, and the validity of employing a pivotal-voter framework for a large-scale election.

5. Estimation Results

Panels A and B of Table 2 report the estimation results using the data on the 2024 and 2020 presidential elections, respectively.[30] Comparing the two panels reveals that the gap between the two major parties' ideological stances ($x_b - x_g$) became wider in the 2024 election with TPP's entry than in the 2020 election without TPP's entry.[31] [32]

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[29] Our rich set of moment conditions can identify more complicated models that capture additional aspects. For example, they can identify each candidate's valence. Nonetheless, given that Ko has substantially more prominent valence than the two major parties' candidates, to estimate a parsimonious model that can capture the major concerns in reality, we assume that the two major parties' candidates have the same level of valence (normalized to zero because only differences matter). In a political system dominated by two parties, a third party usually has neither a strong local branch system to closely contact voters in each location nor many party members serving as local mayors or council members to gain political resources. Correspondingly, whether the third party can obtain an essential vote share in the presidential election heavily relies on a star candidate.

[30] In fact, the 2020 presidential election also had three candidates: Kuo-yu Han (KMT nominee), Ing-wen Tsai (DPP nominee), and Chu-yu Soong (People First Party [PFP] nominee). For the 2020 election, first, we do not treat Soong as a third-party candidate because he and his party originated from KMT and his ideological stance is similar to that of KMT. Second, we aggregate the votes for Han and Soong together as the votes for one blue candidate and estimate a pivotal-voter model for a two-candidate case (see the model in Appendix A.1) because Soong only obtained 4.26% of the popular vote and PFP did not win any legislative seats. Born to a KMT military family, Soong was originally a member of KMT and began his political career as a secretary to Ching-kuo Chiang. After failing to gain KMT's nomination for the 2000 presidential election, Soong ran as an independent candidate and hence was expelled from KMT. Even though he obtained 36.84% of the popular vote, his candidacy split the pan-Blue vote between himself and the KMT candidate, leading to the victory of DPP candidate Shui-bian Chen (39.30% of the popular vote). Immediately after the election, Soong founded PFP, a party in the Pan-Blue Coalition. In 2004, Soong ran as vice-presidential candidate jointly with the KMT candidate (presidential candidate) and lost to Shui-bian Chen by a narrow margin of 0.22%. Afterward, as the PFP candidate unallied with KMT, he ran in multiple Taiwan presidential elections and Taipei Mayoral Elections. However, because most blue voters voted strategically to concentrate their votes on KMT candidates, the vote shares Soong obtained were ignorable and could not affect the election outcomes.

[31] The estimate of x_b itself is not comparable across 2024 and 2020. The reason is that x_g in 2024 and that in 2020 are both normalized to zero, although the green party's actual ideological positions could be different in the two years. Only the gap between the two major parties ($x_b - x_g$) is comparable across 2024 and 2020.

[32] TPP's ideological position (x_w) is between DPP's (x_g) and KMT's (x_b), and it is closer to KMT's than to DPP's. The estimates on demographic characteristics are consistent with the well-known facts that TPP is favored by younger generations, that DPP is favored by less-educated people, and that KMT is favored by older generations. The estimate of φ is positive, indicating that the mean cost of turning

However, we cannot indiscreetly conclude that the third-party entry exacerbated political polarization merely based on the enlarged $x_b - x_g$. One possible reason for the wider gap between the two major parties' ideological stances is that voters' ideological positions became more dispersed in 2024 (see Figure 1) than in 2020 (see Figure 2). The standard deviation of $\mu(D_i) + \eta_i$ in 2024 is 1.0623, greater than that in 2020 (0.5761). This result is consistent with the pattern of the Formosa poll: the standard deviation of the green-blue ideological grades of respondents in the 2024 poll is 9.89, greater than that in the 2020 poll (7.96).

Multiple forces may play substantial roles in diverging voters' ideological positions. First, Beijing made increasingly stringent policies regarding Cross-Strait relations, such as more intensive military exercises surrounding Taiwan. On the one hand, these policy changes may make some blue voters more aware of the importance of strategically maintaining a peaceful relationship with China and hence become bluer. On the other hand, such policy changes may trigger some green voters' reverse psychology and hence make them become greener. Second, the increasingly fierce conflicts between China and the U.S. may strengthen some green voters' belief that the U.S. would help defend Taiwan if the Cross-Strait war occurs and hence make these voters become greener. Third, the increasingly stronger control over Hong Kong may make voters in Taiwan become greener.[33] [34]

Given the possible changes in the distribution of voters' ideological positions, we also

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out to vote (e.g., traveling to a polling place and waiting in line) surpasses the mean utility that a voter derives from fulfilling her civic duty of voting. This result is consistent with the literature on voting turnouts (e.g., Kawai et al., 2021).

[33] One may argue that the widening of the gap between the two major parties' ideological stances ($x_b - x_g$) was mainly driven by the polarization of the green party because some signs indicated that the blue party was trying to be less polarized to gain more central voters. For example, unlike what had occurred previously, KMT nominated an Island Taiwanese instead of a Mainland Taiwanese as the presidential candidate for the 2024 election. However, first, many political observers believed that, due to his status in KMT, the presidential candidate Hou did not have sufficient power to determine policies regarding Cross-Strait affairs after being in office. Ying-jeou Ma, the former Taiwan president from 2008-2016 and the former Chairperson of KMT from 2005-2007 and from 2009-2014, and Shaw-kong Jaw, the vice-presidential candidate nominated by KMT for the 2024 election, are influential on policies regarding Cross-Strait affairs. During an interview by Deutsche Welle three days before the 2024 election date, Ying-jeou Ma stated that regarding Cross-Strait relations, we must trust the Chinese government. Many political observers believed that this statement substantially altered voters' perception of the blue party's green-blue ideological position. Second, as KMT was frequently labeled by DPP as "the agent of the Chinese Communist Party (CCP) in Taiwan," Taiwanese voters' perception of the blue party's ideological position could also be influenced by Beijing's political stance. If Beijing becomes more stringent regarding Cross-Strait relations, the blue party's ideological position perceived by voters will become more polarized even if KMT does not intentionally further polarize.

[34] Many factors can affect people's ideological positions, such as social media (Gentzkow and Shapiro, 2011) and even college roommates (Strother et al., 2021).

examine the gap between the two major parties' ideological positions based on a relative measure. In 2020, 52.95% of eligible voters with their ideological positions ($\mu(D_i) + \eta_i$) fell between x_g and x_b, whereas in 2024, this percentage increased to 56.40%. This 3.45% increase is nontrivial, given a 4.7% winning margin (in terms of votes divided by eligible voters) in 2024. [35]

To further discreetly analyze the effect of the third-party entry on political polarization, we conduct counterfactual experiments in which TPP did not enter the 2024 election and examine changes in the two major parties' incentives to polarize in the next section (Section 6).

6. Third-party entry increased the two dominant parties' incentives to polarize

Based on the structural estimates reported in panel A of Table 2, we conduct counterfactual experiments in which we make one of the two major parties in the election further polarized than their actual ideological positions. We examine the effect of this deviation in both the scenario in which TPP entered the 2024 election and the scenario in which TPP did not. The results show that the third-party entry can strengthen the two major parties' incentives to further polarize.

As shown in Table 3, in the 2024 election, if the green party went further polarized by 0.1 (x_g decreased by 0.1), it would lose only 0.55%; if the blue party went further polarized by 0.1 (x_b increased by 0.1), it would lose only 0.65%. In contrast, in the counterfactual scenario of the 2024 election without the third-party entry, if the green party went further polarized by 0.1, it would lose more votes (1.02%>0.55%); if the blue party went further polarized by 0.1, it would also lose more votes (1.28%>0.65%).[36] The third-party entry can

[35] As the structural parameter estimates $\{\mu, \lambda, \sigma_1, \sigma_2, \rho, x_b, x_w\}$ are scaled by p, one possible concern is that the different gaps between the two major parties' ideological positions and different dispersions of voters' ideological positions across 2024 and 2020 could be due to different p across the two elections. However, p in 2020 should be greater than p in 2024. As shown in Table A.1 in Appendix A, in a two-candidate election, the pivotal events are categorized into three mutually exclusive cases and p is the probability of each of the three cases; in contrast, as shown in Table A.2, in a three-candidate election, the pivotal events are categorized into nine mutually exclusive cases and p is the probability of each of the nine cases. Consequently, the 2020 election should tend to have a wider gap between x_b and x_g and a more dispersed $\mu(D_i) + \eta_i$ than the 2024 election. The relative measure of the two major parties' ideological gap is unaffected by p. In fact, based on either the Formosa polls or our structural estimates, voters' ideological positions are found to be more dispersed in 2024 than in 2020.

[36] Another pattern shown in Table 3 is that a 0.1 further polarization by KMT would cause a greater drop in its own votes (0.65% in panel A and 1.28% in panel B) than that by DPP (0.55% in panel A and 1.02% in panel B), regardless of whether the third party entered. The reason is that, as shown in Figure

lessen the magnitude of reduction in a major party's vote share caused by its polarization and hence should alter a major party's decision on its ideological position.

The third-party entry alters the two major parties' polarization incentives through three channels. First, a stronger competitor (the third party) for central voters makes a major party's effort to gain these voters less effective. As shown in Table 4 (which decomposes the overall effect across left, central, and right voters), in the 2024 election, if the green party went further polarized by 0.1 (x_g decreased by 0.1), it would lose only 1.23% in central voters; if the blue party went further polarized by 0.1 (x_b increased by 0.1), it would lose only 1.29% in central voters. In contrast, in the counterfactual scenario of the 2024 election without the third-party entry, if the green party went further polarized by 0.1, it would lose more central voters (1.48%>1.23%); if the blue party went further polarized by 0.1, it would also lose more central voters (1.55%>1.29%). With the third-party entry in the middle, given that a major party has already lost many central voters to the third party, additional drains of central voters caused by the major party's further polarization should be moderate.

Second, without the third party, central voters are much more important than extreme voters for a major party. If one major party's polarization causes it to lose 1% of central voters, these voters will probably all switch to the other major party, and hence the resulting difference is approximately 2%. If one major party's moving toward the center causes it to lose 1% of extreme voters on its side, these voters will probably merely not turn out instead of switching to the other major party, and hence the resulting difference is only 1%. However, with the third-party entry, if one major party's polarization causes it to lose 1% of central voters, these voters will be split by the other major party and the third party instead of all switching to the other major party. Therefore, the third-party entry reduces the importance of gaining central voters relative to gaining extreme voters.

As shown in Table 4, in the 2024 election, if the green party went further polarized by 0.1, the blue party and the third party, respectively, would gain 0.57% and 0.75% in central voters; if the blue party went further polarized by 0.1, the green party and the third party, respectively, would gain 0.59% and 0.88% in central voters. In contrast, in the counterfactual scenario of the 2024 election without the third-party entry, if the green party went further

1, KMT's ideological position is more distant from the center of the distribution of voters' ideological positions than DPP's; accordingly, a further polarization by KMT would make more people disappointed (voters to the left of x_b) than that by DPP (voters to the right of x_g).

polarized by 0.1, the blue party would gain more in central voters (1.59%>0.57%); if the blue party went further polarized by 0.1, the green party would also gain more in central voters (1.53%>0.59%).

Third, without the third party, one major party's polarization would increase the turnout rate of extreme voters not only on its own side but also on the other major party's side. The reason is that one major party's polarization would not only make extreme voters on its own side favor the party more but would also make extreme voters on the other side dislike the party more. However, with the third-party entry, the increase in the turnout of extreme voters on the other side will be split by the other major party and the third party.

As shown in Table 4, in the counterfactual scenario of the 2024 election without the third-party entry, if the green party went further polarized by 0.1, it would gain 0.46% in extreme voters on the green side, but it would also make the blue party gain 0.33% in extreme voters on the blue side; if the blue party went further polarized by 0.1, it would gain 0.29% in extreme voters on the blue side, but it would also make the green party gain 0.53% in extreme voters on the green side. In contrast, in the actual 2024 election with the third-party entry, if the green party went further polarized by 0.1, it would make the blue part gain only 0.25% in extreme voters on the blue side because another 0.06% would be split away by the third party; if the blue party went further polarized by 0.1, it would make the green party gain only 0.32% in extreme voters on the green side because another 0.05% would be split away by the third party.

One natural question that could be raised by typical economists is why candidates did not optimally choose their ideological positions to maximize their vote shares in elections. The reason is that a candidate's objective function does not consider only the vote share. Although holding a polarized position would generally reduce a candidate's votes in a presidential election, a candidate may not essentially move toward the center. Incentives other than the votes obtained in the final election matter.

First, running campaigns requires donations and donors' political positions are usually more polarized than ordinary voters'. Candidates choose their political positions not only to gain voters but also to attract funds from donors. Barber (2016) and Waldfogel (2023) have documented donors' effects on political polarization. Waldfogel (2023) built a model in which a candidate's objective function to be maximized partially depends on her fundraising.

Second, candidates with central stances usually cannot win their parties' primaries and get nominated (Kujala, 2020). Moreover, the growing path for a presidential candidate in

Taiwan usually requires local executive experience in her early political career. A candidate with centrist stances usually cannot win city/county mayoral elections because the population in a city or a county is usually more biased toward one ideological color than the national average. For example, Hou has been the mayor of New Taipei City (a "deep blue" city), while Lai has been the mayor of Tainan City (a "deep green" city).[37]

Third, after a primary, a nominated candidate cannot effectively move to a centrist position to a large degree because voters' perception of a candidate's stance is based not only on her current speech but also on her past speech. For example, Lai's mild statements such as "support for 'the cross-strait status quo'" during his campaign after the primary did not substantially offset his label as a "pragmatic worker for Taiwan independence," which he called himself many years ago.

Fourth, to rule the country smoothly after winning the presidential election, a candidate must integrate factions within the party to form an executive team and gain the support of her party's members in the Legislative Yuan.

To summarize, shifting political positions is costly for a candidate regardless of whether it is toward the center or a pole.[38] However, a candidate from a young third party in the middle can have more flexibility, which will be discussed in the next section (Section 7).

7. Should the white party go green or blue?

An emerging third party may have dramatically greater freedom than the two dominant parties to adjust its ideological position for the purpose of increasing its vote share in the final election. The reason is that the emergence of a third party relies mainly on the founding person's personal charisma rather than the power of factions within the party. As Ko has claimed, unlike the green and blue candidates, he is free of coercion by factions and constraint by consortiums, which enables him to appoint government officials according to their abilities instead of their green-blue ideologies.[39]

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[37] One exception is Kuo-yu Han, a blue party member who won the 2018 mayoral election of Kaohsiung City, the largest green city in Taiwan. The main reason for his winning is that voters vented their disappointment over the two-year DPP rule in the central government. In 2020, Han was recalled by a Kaohsiung mayoral recall election. The number of votes agreeing to the recall even outnumbered the votes that favored Han two years before.

[38] It is not like that firms can freely adjust prices to maximize profits.

[39] The other side of the coin is that overreliance on the founder's personal charisma can also be a disadvantage for a third party because if the founder falls, the party will face an essential challenge.

In fact, Ko dramatically changed his ideological position during his political career before the 2024 election and was swinging his position shortly after the 2024 election.[40]

In Table 5, we report the results of counterfactual analyses regarding the white candidate's gains in the percentage of votes by deviating from his current ideological stance in different directions and by different magnitudes. The pattern indicates that, on the one hand, Ko will lose more votes as he moves toward the blue candidate's position; on the other hand, Ko's votes will first increase and then decrease as he moves toward the green candidate's position. While Ko can maximize his votes by deviating from his current position toward the green end by 0.3, the resulting increase in his votes is limited (only 0.70%).

Therefore, the help obtained from strategically adjusting its ideological position is limited for the third party, although it has considerable freedom to do so. Correspondingly, an appropriate strategy for the third party to win an election in the future may be to focus on enhancing Ko's (and/or other rising stars') political valence in eligible voters' preferences, which fundamentally distinguishes it from the two major parties, rather than strategically adjusting its ideological position. Figure 3 displays the distribution of voters' preferences for Ko's political valence in the 2024 election (the distribution of $\lambda(D_i) + \zeta_i$). The variation in responses to Ko's valence is large across eligible voters. Given that the overall variation is substantially driven by the variation across younger and older generations, a possible projection might be that voters who are currently 20-39 years old still maintain their positive responses four or eight years later while new voters at that time can also be attracted by Ko's valence; accordingly, the proportion of voters with positive responses to Ko's valence becomes larger.

One interesting phenomenon shown in Table 5 is that while the third party cannot effectively affect its own vote shares by strategically adjusting its ideological position, it can substantially alter the other two parties' vote shares. The reason is that when moving toward the green party's position, the third party can absorb many green voters from the green party and lose many blue voters to the blue party. However, the absorbed green voters and the lost blue voters offset each other, thereby limiting the change in the third party's own votes.

[40] As mentioned in Section 2, in the early stages of his political career, Ko espoused positions closer to the Pan-Green coalition; after 2016, Ko's political stance started shifting toward the Pan-Blue coalition. Shortly after the 2024 election, TPP members in the Legislative Yuan attempted to cooperate with KMT members on some issues and cooperate with DPP members on other issues. On March 14, 2024, Ko met Ing-wen Tsai (the outgoing president) in the Office of the President and had a two-hour talk, seeking potential white-green collaborations. Moreover, key members within the third party have different opinions regarding which direction it should move.

Another question is whether the third party has absorbed more blue voters from KMT than green voters from DPP at its current position. Given that the third party's actual position ($x_w = 1.0847$) is closer to the blue party's position ($x_b = 1.6585$) than to the green party's position ($x_g = 0$) (see structural estimates in Table 3), the third party should have absorbed more voters from KMT. One pattern shown in Table 5 can further confirm this answer. If the third party keeps moving toward the blue party's position from its current position, the green party's vote share will substantially increase, whereas the blue party's vote share will decrease by only a limited amount. In contrast, if the third party keeps moving toward the green party's position from its current position, the drop in the green party's vote share and the increase in the blue party's vote share will both be large.

8. What if there were no third party in the 2024 presidential election?

In this section, we discuss in more detail the analyses for the counterfactual scenario in which there was no third-party entry in the 2024 presidential election.

As mentioned in Section 4.1, the structural parameters generated by the baseline estimation for 2024 (reported in panel A of Table 2) are scaled by p_0, i.e., the unidentified perception of the pivotal probability or voting efficacy in the actual 2024 election. In the counterfactual scenario in which TPP did not enter the 2024 election, the corresponding pivotal probability (denoted as p_1) should be different from p_0. The reason is that this counterfactual experiment reduces the number of candidates from three to two and hence should substantially alter voters' perceived pivotal probabilities.

Correspondingly, given the estimates in panel A of Table 2, the resulting ξ, and a numerical value of p_1/p_0, we can construct the utilities of voting for DPP or KMT without TPP's entry as follows (see Appendix R.1 for derivations from the first line to the last line of equations (8.1) and (8.2)):

$$\begin{aligned} V_{ig} &= \frac{p_1}{p_0}\left(u_{ig} - u_{ib}\right) - \varphi - \varrho_k + \epsilon_{ig} \\ &= \frac{p_1}{p_0}\left(\bar{u}_{ig} - \bar{u}_{ib} + \varsigma_{kg} - \varsigma_{kb}\right) - \varrho_k - \varphi + \epsilon_{ig} \\ &= \frac{p_1}{p_0}\left(\bar{u}_{ig} - \bar{u}_{ib}\right) + \frac{1}{3}\left[\left(1 + \frac{p_1}{p_0}\right)\xi_{kg} + \left(1 - \frac{p_1}{p_0}\right)\xi_{kb} + \xi_{kw}\right] \\ &\quad - \varphi + \epsilon_{ig} \end{aligned} \tag{8.1}$$

$$
\begin{aligned}
V_{ib} &= \frac{p_1}{p_0}\left(u_{ib} - u_{ig}\right) - \varphi - \varrho_k + \epsilon_{ib} \\
&= \frac{p_1}{p_0}\left(\bar{u}_{ib} - \bar{u}_{ig} + \varsigma_{kb} - \varsigma_{kg}\right) - \varrho_k - \varphi + \epsilon_{ib} \\
&= \frac{p_1}{p_0}\left(\bar{u}_{ib} - \bar{u}_{ig}\right) + \frac{1}{3}\left[\left(1 - \frac{p_1}{p_0}\right)\xi_{kg} + \left(1 + \frac{p_1}{p_0}\right)\xi_{kb} + \xi_{kw}\right] \\
&\quad - \varphi + \epsilon_{ib}
\end{aligned}
\tag{8.2}
$$

Then, we can calculate individual-level choice probabilities and aggregate them up to the national level. Correspondingly, the aggregated national-level turnout rate is a function of p_1/p_0. If we do not make any adjustment to the pivotal probability in this counterfactual scenario (i.e., assuming $p_1/p_0 = 1$), as shown in the first row of Table 6, the resulting turnout rate is only 48.67%, dramatically lower than the actual turnout rates in the 2024 and 2020 elections (71.86% and 74.90%, respectively).[41]

Therefore, we first pin down p_1/p_0 such that the corresponding turnout rate can match a reasonable percentage. Given p_1/p_0, we then calculate the vote shares for DPP and KMT.

In Table 6, we match the turnout rate to multiple percentages ranging from 65% to 80%. The p_1/p_0 corresponding to the actual turnout rate in 2024 (72%) is equal to 2.1697.[42] While the two parties' vote shares substantially change across different adjustments to p_1/p_0, the relative order (voting outcome) is quite robust; i.e., KMT should have marginally won the 2024 election if TPP had not entered.

This result indicates that although TPP's ideological position is closer to KMT's than to DPP's and TPP also advocated ruling party alternation, TPP's entry actually helped the ruling party (DPP). This result, generated from counterfactual analyses based on structural estimates, is consistent with the reduced-form evidence provided by Pons and Tricaud (2018) on elections in France.

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[41] The lower turnout rate in this counterfactual scenario is not due to the fact that the multinomial logit assumption for the distribution of idiosyncratic shocks tends to generate a larger market share of the outside option when the number of available choices is smaller. The reason is that micro moments based on survey data employed in our estimation can mitigate this issue (see Petrin (2002)). Another method to mitigate this issue is using a nested multinomial logit assumption. Given the micro moments employed, if we do not adjust the pivotal probability in the counterfactual experiment but allow a nested multinomial logit assumption for the idiosyncratic shocks at the estimation stage (with ϵ_{ig}, ϵ_{ib}, and ϵ_{iw} as one nest and ϵ_{i0} as the other nest), the resulting turnout rate in this counterfactual scenario is only slightly above 50%.

[42] The intuition for $p_1/p_0 > 1$ is that the pivotal events under two parties are categorized into three mutually exclusive cases and p_1 is the probability of each of the three cases (see Table A.1 in Appendix A); in contrast, the pivotal events under three parties are categorized into nine mutually exclusive cases and p_0 is the probability of each of the nine cases (see Table A.2 in Appendix A).

Previously, when we conducted counterfactual experiments in which one of the two major parties go further polarized than their actual ideological positions in Section 6, we examined the effect in a scenario in which TPP did not enter the 2024 election (see panel B of Table 3). Those analyses are also based on the p_1/p_0 that makes the national turnout rate match 72% (see results in Panel B of Table 3). The results are robust to changes in the matched turnout rate (or the pivotal probability).

9. Alliance

In October and November 2023, KMT and TPP conducted intensive negotiations on forming an alliance against DPP for the 2024 election. They reached a six-point consensus in mid-November. The consensus included that the decision on whether to nominate Hou (in the blue party) as the "presidential candidate" and Ko (in the white party) as the "vice-presidential candidate" or vice versa would be determined according to polling results; if the alliance won the election, then officials in the Department of Defense, Ministry of Foreign Affairs, and Mainland Affairs Council would be nominated by the president, and officials in the other parts of the central government would be determined according to the two parties' seats in the Legislative Yuan.

However, after drawn-out negotiations, the potential alliance officially broke down at the deadline for presidential candidate registration. On November 24, KMT and TPP each had their own presidential and vice-presidential candidates registered at the CEC. The major controversy was which of Hou (blue) and Ko (white) within the potential alliance should be the "presidential candidate" versus the "vice-presidential candidate".

The long-version Formosa poll conducted from October 24-25 asked two relevant questions. The first question was as follows: "If KMT and TPP successfully form a blue-white alliance (Hou as the presidential candidate and Ko as the vice-presidential candidate) to compete against DPP, for whom will you vote?" The second question was as follows: "If a white-blue alliance (Ko as the presidential candidate and Hou as the vice-presidential candidate) is formed to compete against DPP, for whom will you vote?"

In this section, we examine how the potential blue-white alliance and the potential white-blue alliance would have altered voters' preferences over available choices.

9.1. Blue-white alliance and white-blue alliance

If Hou had run as the presidential candidate and Ko had run as the vice-presidential candidate, the utility of having the blue-white alliance in office for voter i at location k is assumed to be as follows:

$$\begin{aligned} u_{ibw} &= -|\mu(D_i) + \eta_i - [(1-\varpi_{bw1})x_b + \varpi_{bw1}x_w]| + \varpi_{bw2}[\lambda(D_i) + \zeta_i] \\ &\quad + (1-\varpi_{bw3})\varsigma_{kb} + \varpi_{bw3}\varsigma_{kw} \\ &= \bar{u}_{ibw} + (1-\varpi_{bw3})\varsigma_{kb} + \varpi_{bw3}\varsigma_{kw} \end{aligned} \tag{9.1}$$

In equation (9.1), $(1-\varpi_{bw1})x_b + \varpi_{bw1}x_w$ is the expected ideological stance of the blue-white alliance in the green-blue ideological dimension. It is a weighted average of the blue candidate's stance and the white candidate's stance. ϖ_{bw2} is the expected proportion of Ko's nonideological effect that will transmit to the blue-white alliance. $(1-\varpi_{bw3})\varsigma_{kb} + \varpi_{bw3}\varsigma_{kw}$ is the location-level unobserved random shock to voters' preferences for the blue-white alliance. It is a weighted average of the shock to voters' preference for the blue candidate and that for the white candidate. The weights ϖ_{bw1}, ϖ_{bw2}, and ϖ_{bw3} are parameters to be estimated. The utility of having the green candidate in office for voter i at location k remains unchanged (represented by equation (4.1)).

Voter i's utilities of voting for the green candidate and the blue-white alliance, respectively, are as follows:

$$\begin{aligned} V_{ig} &= \frac{p_2}{p_0}(u_{ig} - u_{ibw}) - \varphi - \varrho_k + \epsilon_{ig} \\ &= \frac{p_2}{p_0}(\bar{u}_{ig} - \bar{u}_{ibw}) \\ &\quad + \frac{1}{3}\left[\left(1 + \frac{p_2}{p_0}\right)\xi_{kg} + \left(1 - \frac{p_2}{p_0}(1-\varpi_{bw3})\right)\xi_{kb}\right. \\ &\quad \left. + \left(1 - \frac{p_2}{p_0}\varpi_{bw3}\right)\xi_{kw}\right] - \varphi + \epsilon_{ig} \end{aligned} \tag{9.2}$$

$$\begin{aligned} V_{ibw} &= \frac{p_2}{p_0}(u_{ibw} - u_{ig}) - \varphi - \varrho_k + \epsilon_{ibw} \\ &= \frac{p_2}{p_0}(\bar{u}_{ibw} - \bar{u}_{ig}) \\ &\quad + \frac{1}{3}\left[\left(1 - \frac{p_2}{p_0}\right)\xi_{kg} + \left(1 + \frac{p_2}{p_0}(1-\varpi_{bw3})\right)\xi_{kb}\right. \\ &\quad \left. + \left(1 + \frac{p_2}{p_0}\varpi_{bw3}\right)\xi_{kw}\right] - \varphi + \epsilon_{ibw} \end{aligned} \tag{9.3}$$

We assume that the idiosyncratic shocks ϵ_{ig}, ϵ_{ibw} and ϵ_{i0} follow the Type-I extreme value distribution. Derivations from the first line to the second line of equations (9.2) and (9.3) are presented in Appendix R.2.

Given the structural parameter estimates generated from the baseline estimation for 2024 (reported in panel A of Table 2) and the resulting ξ, the structural parameters $\theta_{bw_alliance} = \{\varpi_{bw1}, \varpi_{bw2}, \varpi_{bw3}\}$ can be estimated with the following two sets of moments that match the structural-model predictions to their empirical counterparts in the poll data. The first set of moments matches the average probability of voting for the green candidate (or the blue-white alliance) conditional on that the lth dimension of demographic characteristics D_{il} equals a certain value $\bar{D}_{ls}$. The moments are given by the following:

$$Prob[y_i' = j' | D_{il} = \bar{D}_{ls}], \qquad j' \in \{g, bw\} \tag{9.4}$$

The demographic characteristics have four dimensions, including age, gender, education, and region.

The second set of moments matches the average probability of voting for $j' \in \{g, bw\}$ in the situation with the blue-white alliance conditional on voting for $j \in \{g, b, w\}$ in the situation of no alliance. The moments are given by the following:

$$Prob[y_i' = j' | y_i = j\ ], j \in \{g, b, w\}, j' \in \{g, bw\} \tag{9.5}$$

The weight parameters ϖ_{bw1}, ϖ_{bw2}, and ϖ_{bw3} can be sufficiently identified by the first set of moments. The variation in voters' choices over $\{g, bw\}$ across age, gender, and education groups can identify ϖ_{bw1} and ϖ_{bw2} because the average ideological positions and the average favoritism toward Ko are different across these groups. The variation in voters' choices across regions can identify ϖ_{bw3} because ξ are different across regions.[43]

The structural parameters in this scenario $\{\varpi_{bw1}, \varpi_{bw2}, \varpi_{bw3}\}$ are estimated given the estimates of $\{\mu, \lambda, \sigma_1, \sigma_2, \rho, x_b, x_w, \varphi\}$ in panel A of Table 2. Because the errors in the estimates of $\{\mu, \lambda, \sigma_1, \sigma_2, \rho, x_b, x_w, \varphi\}$ will affect the efficiency of the estimators of $\{\varpi_{bw1}, \varpi_{bw2}, \varpi_{bw3}\}$, the standard errors of $\{\varpi_{bw1}, \varpi_{bw2}, \varpi_{bw3}\}$ are adjusted using the correction methods developed by Murphy and Topel (1985).

If Ko had run as the presidential candidate and Hou had run as the vice-presidential candidate, we simply need to replace the weight parameters $\{\varpi_{bw1}, \varpi_{bw2}, \varpi_{bw3}\}$ in equation (9.1) with $\{\varpi_{wb1}, \varpi_{wb2}, \varpi_{wb3}\}$ to construct voters' preferences for the white-blue alliance and reestimate the model.

[43] The voting efficacy parameter p_2/p_0 is set to be 2.1697, the same as p_1/p_0 for the case where the white party does not enter. Both cases have two voting choices. The empirical results are robust to changes in p_2/p_0.

9.2. Estimation results

Columns 1 and 2 in Table 7 report the estimation results for the blue-white alliance and the white-blue alliance, respectively. In voters' belief, Ko's influence weight in the alliance's ideological position is 0.4774 as the vice president and 0.6782 as the president.

As the vice president, 0.2407 of Ko's political valence can be transmitted to the alliance. In contrast, as the president, 0.3864 of Ko's political valence can be transmitted to the alliance.

As shown in the third row of Table 7, location-level shocks to voters' preference toward Ko would play no role in location-level shocks to voters' preference toward the alliance if Ko ran as the vice-presidential candidate and would play a limited role (0.2865) if Ko ran as the presidential candidate. The reason is that KMT has strong local factions. In contrast, TPP heavily relies on online propaganda (referred to as "air forces") and does not have many local organizations (referred to as "ground troops") to serve local voters. TPP currently has no electoral district legislators in the Legislative Yuan besides eight legislators-at-large. Meanwhile, TPP has only a small number of local administrative heads and councilors in some cities and counties.

From the KMT perspective, its weight on location-level shocks would have decreased slightly from 1 to 0.7135 (=1-0.2865) if Hou ran as the vice-presidential candidate instead of the presidential candidate. This result is consistent with the reality that KMT would have had less power in determining the assignment of officials to the central government, which would have hurt the interest of KMT's local factions and hence decreased their level of support.

9.3. A white-blue alliance would obtain a larger vote share than a blue-white alliance

Based on the parameter estimates, we calculate individual voters' choice probabilities and aggregate them into vote shares. In terms of the vote share defined as votes for a candidate divided by total votes for all the candidates, the blue-white alliance would obtain a smaller vote share than would the white-blue alliance (see the percentages in curly brackets in Table 8). The reason is that the perceived ideological position of the blue-white alliance is more extremist than that of the white-blue alliance ($\varpi_{bw1} < \varpi_{wb1}$). Compared to the white-blue alliance, the blue-white alliance loses an essential number of central voters and most of them will switch to the green party.[44] Compared to the blue-white alliance, the white-blue alliance loses right

[44] As shown in Table 8, in terms of the vote share defined as votes for a candidate divided by eligible voters, from the white-blue alliance to the blue-white alliance, the alliance loses 0.58% (from 21.58%

voters, but this loss will be offset by the green party's loss in left voters. The lost voters will mostly not turn out instead of switching to the opponent candidate.[45] The overall turnout rate drops because the difference between the alliance and the green party is smaller.

A second effect making the white-blue alliance gain a larger vote share is that it retains a greater proportion of Ko's political valence than the blue-white alliance does ($\varpi_{wb2} > \varpi_{bw2}$).

The vote shares of the blue-white alliance (54.76%) and the white-blue alliance (55.65%) are both smaller than the sum of the vote shares of the blue party and the white party when no alliance is formed (59.95%). The reason is that a proportion of central voters supporting the white party would switch to the green party if the white party allies with the blue party.

We also examine how Ko's endorsements of the two major parties would have altered voters' preferences over available choices in Appendix E.

10. Welfare analyses

The empirics-based evidence that the third-party entry strengthened the two major parties' incentives to further polarize can partially explain the widened ideological gap between the two major parties. However, a natural question is whether the third-party entry mitigated the polarization of the entire politics in Taiwan, given that central voters now have an alternative to better represent their political stance.

While it is difficult to construct a comprehensive measure of political polarization and provide a definite answer accordingly, we can at least propose the following two statements. First, the third party did not win the 2024 presidential election; therefore, in the short run, it will play almost no role in centralizing the policy orientation of the central government. Second, the third party won only eight seats in the Legislative Yuan, but legislative bills proposed to the Legislative Yuan need at least ten legislators to cosign. Therefore, TPP has to collaborate with a major party (most likely KMT) to propose a legislative bill. Accordingly, in the short run, it is highly likely that TPP will act as a small blue party in the Legislative Yuan instead of an

to 21.00%) and the green party gains 0.86% (from 11.71% to 12.57%) in central voters. The reason why the green party gains more than the alliance loses is that the turnout rate of central voters also increases, which strengthens the gain of the green party and offsets the loss of the alliance. Moreover, these additional voters turning out are more likely to vote for the green party than for the alliance.

[45] As shown in Table 8, in terms of the vote share defined as votes for a candidate divided by eligible voters, from the blue-white alliance to the white-blue alliance, the alliance loses 1.17% (from 16.58% to 15.41%) in right voters and the green party loses 0.75% (from 18.52% to 17.77%) in left voters, whereas the alliance's votes coming from left voters and the green party's votes coming from right voters are still close to zero.

independent centrist party.

As an alternative to constructing a comprehensive measure of polarization of the entire politics, we conduct welfare analyses for the actual 2024 election with three candidates and for three counterfactual scenarios in which the third party did not enter, the blue-white alliance was formed, or the white-blue alliance was formed. The results indicate that although unable to win the election, the third party still had the potential to mitigate political polarization of the winning candidate and improve social welfare by forming an alliance with the blue party, but the alliance formation was aborted before the election.

The social welfare in a scenario is calculated as the sum of all eligible voters' utilities associated with the election outcome in the scenario. See Appendix D for details about welfare calculation.

As shown in Table 9, the scenario in which the white-blue alliance was formed generates the largest welfare. First, the ideological position of the white-blue alliance is more centrist than that of the green party, the blue party, or the blue-white alliance. Therefore, the average ideological distance across all eligible voters to the white-blue alliance is the shortest. Second, the white-blue alliance retains the largest proportion of Ko's political valence.

11. Conclusion

The two-party political systems (political duopoly) present in many countries have recently experienced a trend of increasingly intense partisan polarization, leading to more divided societies. One open question is whether the entry of a third party could be a cue for political polarization.

In this study, we examine an impactful third-party entry to the 2024 presidential election in Taiwan, a society previously dominated by two parties being increasingly polarized in the green-blue ideological dimension.

While an aspiring hope is that a viable third-party entry would mitigate political polarization, we find that such entry in fact can exacerbate political polarization by increasing the two major parties' incentives to further polarize. First, a stronger competitor (the third party) for central voters makes a major party's effort to gain these voters become less effective. Second, third-party entry can reduce the importance of central voters relative to extreme voters for a major party. Without the third party in the middle, central voters leaving a major party due to its further polarization will switch to the other major party (doubling the effect on the

vote share difference between the two major parties), whereas extreme voters on a major party's side leaving it due to its movement toward the center will merely not turn out. However, with the third party, central voters leaving a major party due to its further polarization now will not all switch to the other major party because they will be split by the third party.

Additional counterfactual analyses show that strategically adjusting its ideological position is not quite helpful for the third party to increase its vote share. If TPP moves toward the green (blue) side, then the gain in green (blue) voters and the loss in blue (green) voters will offset each other, thereby limiting the total change in its vote share. Therefore, an appropriate strategy for the third party to win an election in the future may be to focus on enhancing dimensions other than the ideological dimension, which fundamentally distinguishes it from the two major parties.

At its current ideological position, the third party has absorbed more blue voters from KMT than green voters from DPP. Moving toward the green side can slightly increase the third party's vote share.

Conditional on not being able to win the election by itself, one possible channel through which the third party can mitigate political polarization is forming an alliance with a major party. Our counterfactual analyses indicate that if either the blue-white alliance or the white-blue alliance was successfully formed, the ideological position of the alliance perceived by voters would be somewhat centrist (as a weighted average of each of the two parties' positions), and the alliance would win.

Welfare analyses show that the white-blue alliance would generate a greater winning margin and higher social welfare than would the blue-white alliance, the scenario of no third-party entry (the blue party would marginally win), and the actual 2024 election with three candidates. First, the white-blue alliance has the most centrist ideological position and hence eligible voters' average ideological distance to it is the shortest. Second, the white-blue alliance retains a greater proportion of Ko's political valence than the blue-white alliance does.

Alternatively, Ko's endorsement of the green candidate would have had little effect on the green candidate's ideological position perceived by voters, whereas Ko's endorsement of the blue candidate could have substantially altered voters' perception of the blue candidate's ideological position. In contrast, through his endorsement, Ko's valence in the nonideological dimension could have been substantially transmitted to the green candidate but could not have been transmitted to the blue candidate.

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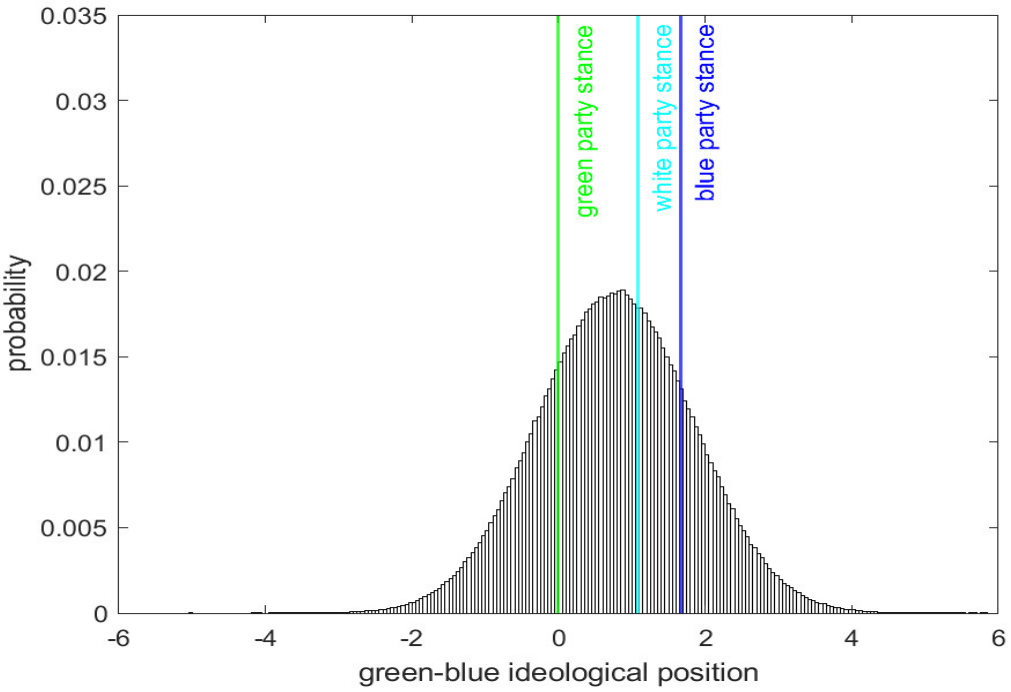


Figure 1. Distribution of eligible voters' ideological positions in 2024. The histogram shows the distribution of eligible voters' green-blue ideological positions ($\mu(D_i) + \eta_i$). The vertical green, cyan, and blue lines represent the positions of the DPP, TPP, and KMT candidates, respectively (x_g [normalized at zero], x_w, and x_b).

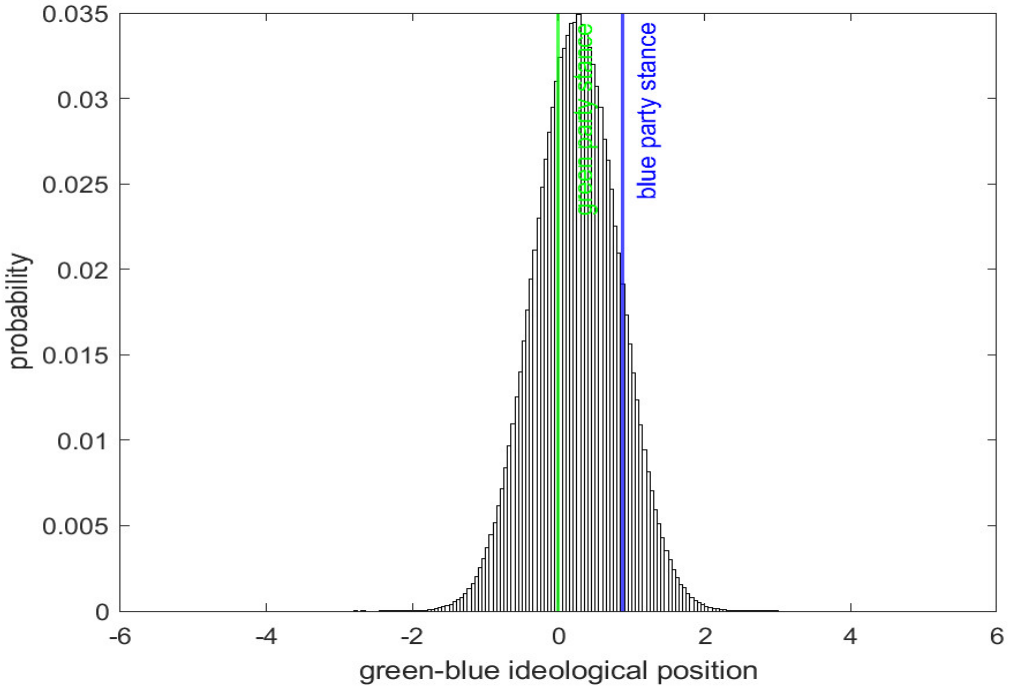


Figure 2. Distribution of eligible voters' ideological positions in 2020.

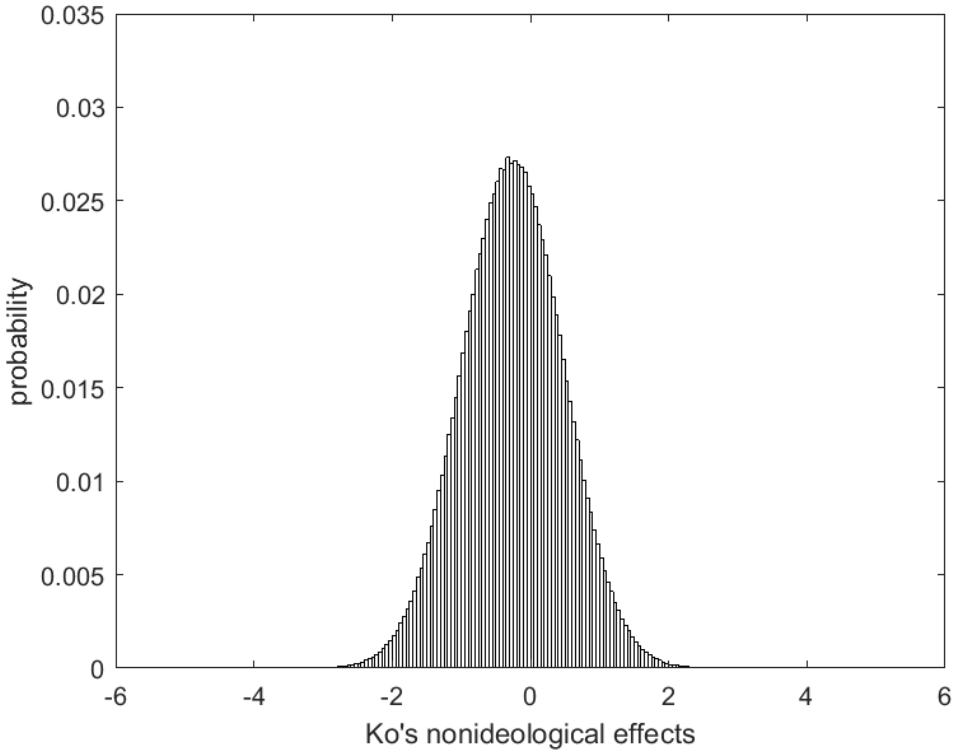


Figure 3. Distribution of the effect of Ko's valence on eligible voters' preferences in 2024. The histogram shows the distribution of $\lambda(D_i) + \zeta_i$.

Table 1. Descriptive statistics (2024 election)

District/township-level variables	N	Mean	Std Dev
Eligible voters	368	53121.01	69077.06
Vote share of DPP	368	0.2674	0.0918
Vote share of KMT	368	0.2426	0.0679
Vote share of TPP	368	0.1685	0.0395
Share of not voting	368	0.3216	0.0788
$20 \leq age < 29$	368	0.1183	0.0446
$30 \leq age < 39$	368	0.1373	0.0383
$40 \leq age < 49$	368	0.1688	0.0315
$50 \leq age < 59$	368	0.1688	0.0185
$60 \leq age < 69$	368	0.1825	0.0276
$age \geq 70$	368	0.2243	0.0675
$Male$	368	0.5098	0.0254
$Female$	368	0.4902	0.0254
$Elementary$	368	0.1730	0.0822
$Junior\ high$	368	0.1527	0.0527
$Senior\ high$	368	0.3241	0.0489
$College$	368	0.3502	0.1393

Descriptive statistics for the 2020 election are reported in Table S1 in Appendix S.

Table 2. Structural estimation results

Panel A. 2024 Election				Panel B. 2020 Election	
Parameter	Est.	Parameter	Est.	Parameter	Est.
x_b	1.6585***	x_w	1.0847***	x_b	0.8788***
	(0.2950)		(0.0669)		(0.0211)
φ	1.5830***	ρ	0.0076	φ	0.0281
	(0.0206)		(0.1139)		(0.0250)
σ_1	1.0404***	σ_2	0.7228***	σ_1	0.5735***
	(0.1810)		(0.0658)		(0.0174)
$\mu(D_i)$		$\lambda(D_i)$		$\mu(D_i)$	
$constant$	1.0109***	$constant$	-0.4493**	$constant$	0.2925***
	(0.2037)		(0.2570)		(0.0569)
$20 \leq age < 29$	0.0177	$20 \leq age < 29$	0.2509	$20 \leq age < 29$	-0.0011
	(0.1428)		(0.2986)		(0.0668)
$30 \leq age < 39$	0.1213**	$30 \leq age < 39$	0.1998	$30 \leq age < 39$	-0.0263
	(0.0554)		(0.1732)		(0.1567)
$40 \leq age < 49$	-0.0615***	$40 \leq age < 49$	0.1389***	$40 \leq age < 49$	-0.0397
	(0.0100)		(0.0596)		(0.0712)
$50 \leq age < 59$	0.0367	$50 \leq age < 59$	0.0333	$50 \leq age < 59$	0.0029
	(0.1926)		(0.0807)		(0.1283)
$60 \leq age < 69$	0.0715***	$60 \leq age < 69$	0.0339	$60 \leq age < 69$	0.0042
	(0.0117)		(0.1914)		(0.0944)
$age \geq 70$	Omitted	$age \geq 70$	Omitted	$age \geq 70$	Omitted
$Male$	-0.1635***	$Male$	0.0780	$Male$	-0.0452
	(0.0061)		(0.1611)		(0.3847)
$Elementary$	-0.5018***	$Elementary$	0.2335**	$Elementary$	-0.0366
	(0.0141)		(0.1384)		(0.1347)
$Junior\ high$	-0.3533***	$Junior\ high$	0.2497***	$Junior\ high$	-0.1310**
	(0.0866)		(0.0483)		(0.0745)
$Senior\ high$	-0.2974***	$Senior\ high$	-0.0452***	$Senior\ high$	0.0231*
	(0.0555)		(0.0045)		(0.0170)
$College$	Omitted	$College$	Omitted	$College$	Omitted

Standard errors are reported in parentheses. * denotes significance at a 10% level. ** denotes significance at a 5% level. *** denotes significance at a 1% level.

Table 3. The two major parties' incentives to further polarize

Counterfactual scenarios	Votes for green	Votes for blue	Votes for white
Panel A: 2024 election			
x_g decreases by 0.1	**-0.55%**	+0.78%	+0.61%
x_b increases by 0.1	+0.89%	**-0.65%**	+0.60%
x_g decreases by $0.1 \cdot std(\mu(D_i) + \eta_i)$	**-0.59%**	+0.82%	+0.65%
x_b increases by $0.1 \cdot std(\mu(D_i) + \eta_i)$	+0.95%	**-0.69%**	+0.64%
Panel B: 2024 election if without the third-party entry			
x_g decreases by 0.1	**-1.02%**	+1.90%	NA
x_b increases by 0.1	+2.05%	**-1.28%**	NA
x_g decreases by $0.1 \cdot std(\mu(D_i) + \eta_i)$	**-1.09%**	+2.02%	NA
x_b increases by $0.1 \cdot std(\mu(D_i) + \eta_i)$	+2.18%	**-1.36%**	NA

This table reports changes in vote shares defined as votes for a candidate divided by eligible voters.

Table 4. Decomposing the effect of polarization across extreme and central voters

Counterfactual scenarios	Votes for green	Votes for blue	Votes for white
Panel A: 2024 election if x_g decreases by 0.1			
Left voters ($\mu(D_i) + \eta_i < original\ x_g$)	+**0.71%**	-0.04%	-0.21%
Central voters ($original\ x_g \leq \mu(D_i) + \eta_i \leq original\ x_b$)	-1.23%	+0.57%	+0.75%
Right voters ($\mu(D_i) + \eta_i > original\ x_b$)	-0.02%	+**0.25%**	+0.06%
Panel B: 2024 election if x_b increases by 0.1			
Left voters ($\mu(D_i) + \eta_i < original\ x_g$)	+**0.32%**	-0.05%	+0.05%
Central voters ($original\ x_g \leq \mu(D_i) + \eta_i \leq original\ x_b$)	+0.59%	-1.29%	+0.88%
Right voters ($\mu(D_i) + \eta_i > original\ x_b$)	-0.02%	+**0.69%**	-0.32%
Panel C: 2024 election without the third-party entry if x_g decreases by 0.1			
Left voters ($\mu(D_i) + \eta_i < original\ x_g$)	+**0.46%**	-0.01%	NA
Central voters ($original\ x_g \leq \mu(D_i) + \eta_i \leq original\ x_b$)	-1.48%	+1.59%	NA
Right voters ($\mu(D_i) + \eta_i > original\ x_b$)	-0.01%	+**0.33%**	NA
Panel D: 2024 election without the third-party entry if x_b increases by 0.1			
Left voters ($\mu(D_i) + \eta_i < original\ x_g$)	+**0.53%**	-0.02%	NA
Central voters ($original\ x_g \leq \mu(D_i) + \eta_i \leq original\ x_b$)	+1.53%	-1.55%	NA
Right voters ($\mu(D_i) + \eta_i > original\ x_b$)	0.00%	+**0.29%**	NA

This table reports changes in vote shares defined as votes for a candidate divided by eligible voters. Left (right) voters means voters on the left-hand (right-hand) side on the horizontal axis of Figure 1.

Table 5. Third party's gains from adjusting its ideological position

Counterfactual scenarios	Votes for green	Votes for blue	Votes for white
x_w copies x_g	-8.34%	+10.60%	**-1.05%**
x_w decreases by 0.5	-6.23%	+5.81%	**+0.56%**
x_w decreases by 0.4	-5.36%	+4.77%	**+0.67%**
x_w decreases by 0.3	-4.38%	+3.73%	**+0.70%**
x_w decreases by 0.2	-3.34%	+2.70%	**+0.65%**
x_w decreases by 0.1	-2.24%	+1.73%	**+0.51%**
x_w remains the same (baseline)			
x_w increases by 0.1	+1.11%	-0.70%	**-0.37%**
x_w increases by 0.2	+2.21%	-1.25%	**-0.80%**
x_w increases by 0.3	+3.27%	-1.65%	**-1.29%**
x_w increases by 0.4	+4.30%	-1.88%	**-1.84%**
x_w increases by 0.5	+5.29%	-1.92%	**-2.43%**
x_w copies x_b	+6.00%	-1.85%	**-2.89%**

This table reports changes in vote shares defined as votes for a candidate divided by eligible voters.

Table 6. Counterfactual analyses: No third-party entry in 2024 presidential

Matched turnout rate	Corresponding p_1/p_0	Vote share for green	Vote share for blue
No matching	1	23.77%	24.90%
65%	1.7331	31.97%	33.03%
66%	1.7877	32.49%	33.51%
67%	1.8445	33.00%	34.00%
68%	1.9037	33.52%	34.48%
69%	1.9654	34.04%	34.96%
70%	2.0301	34.56%	35.44%
71%	2.0981	35.08%	35.92%
72%	**2.1697**	**35.61%**	**36.39%**
73%	2.2456	36.13%	36.87%
74%	2.3262	36.65%	37.35%
75%	2.4122	37.18%	37.82%
76%	2.5045	37.71%	38.29%
77%	2.6038	38.23%	38.77%
78%	2.7114	38.76%	39.24%
79%	2.8287	39.29%	39.71%
80%	2.9572	39.82%	40.18%

Given the structural estimates reported in panel A of Table 2, the resulting ξ, and a numerical value of p_1/p_0 (in column 2), using equations (8.1) and (8.2), we construct the utilities of voting for DPP or KMT without TPP's entry. Then, we calculate individual-level choice probabilities and aggregate them up to the national level (columns 3 and 4).

Table 7. Ko's influence in the blue-white alliance and the white-blue alliance

	Blue-white alliance		**White-blue alliance**	
	Hou (blue) as president Ko (white) as vice-president		Ko (white) as president Hou (blue) as vice-president	
	Parameter	**Est.**	**Parameter**	**Est.**
Weights for **ideological stance**	ϖ_{bw1}	0.4774*** (0.0824)	ϖ_{wb1}	0.6782*** (0.0491)
Weights for **Ko's nonideological effect**	ϖ_{bw2}	0.2407*** (0.0732)	ϖ_{wb2}	0.3864** (0.1985)
Weights for **location-level shock**	ϖ_{bw3}	0.0000 (0.3683)	ϖ_{wb3}	0.2865* (0.2182)

Given the estimates of $\{\mu, \lambda, \sigma_1, \sigma_2, \rho, x_b, x_w, \varphi\}$ reported in panel A of Table 2, $\{\varpi_{bw1}, \varpi_{bw2}, \varpi_{bw3}\}$ or $\{\varpi_{wb1}, \varpi_{wb2}, \varpi_{wb3}\}$ are estimated accordingly. The standard errors in parentheses are adjusted using the correction methods developed by Murphy and Topel (1985). * denotes significance at a 10% level. ** denotes significance at a 5% level. *** denotes significance at a 1% level.

Table 8. Vote shares of the blue-white alliance and the white-blue alliance

Panel A: 2024 election (baseline)	Votes for green	Votes for blue	Votes for white
All eligible voters	28.58% {40.05%}	23.89% {33.49%}	18.88% {26.46%}
Left voters ($\mu(D_i) + \eta_i < original\ x_g$)	16.92%	0.22%	1.63%
Central voters ($original\ x_g \leq \mu(D_i) + \eta_i \leq original\ x_b$)	11.57%	10.43%	14.35%
Right voters ($\mu(D_i) + \eta_i > original\ x_b$)	0.09%	13.25%	2.90%
Panel B: Blue-white alliance **Hou (blue) as president; Ko (white) as vice-president**	Votes for green	Votes for blue-white alliance	
All eligible voters	31.16% {45.24%}	37.72% {54.76%}	
Left voters ($\mu(D_i) + \eta_i < original\ x_g$)	18.52%	0.13%	
Central voters ($original\ x_g \leq \mu(D_i) + \eta_i \leq original\ x_b$)	12.57%	21.00%	
Right voters ($\mu(D_i) + \eta_i > original\ x_b$)	0.07%	16.58%	
Panel C: White-blue alliance **Ko (white) as president; Hou (blue) as vice-president**	Votes for green	Votes for blue-white alliance	
All eligible voters	29.63% {44.35%}	37.19% {55.65%}	
Left voters ($\mu(D_i) + \eta_i < original\ x_g$)	17.77%	0.19%	
Central voters ($original\ x_g \leq \mu(D_i) + \eta_i \leq original\ x_b$)	11.71%	21.58%	
Right voters ($\mu(D_i) + \eta_i > original\ x_b$)	0.15%	15.41%	

The percentages in {} equal votes for a candidate divided by total votes for all the candidates, which add up to one. The percentages not in {} equal votes for a candidate divided by eligible voters, which add up to the turnout rate.

Table 9. Welfare Analyses

Scenario	2024 actual (baseline)	No third-party entry	Blue-white alliance	White-blue alliance
Winning candidate	Green party	Blue party	Blue-white alliance	White-blue alliance
Formula	$\sum_i u_{ig}$	$\sum_i u_{ib}$	$\sum_i u_{ibw}$	$\sum_i u_{iwb}$
Welfare	-2.4455e+06	-2.3627e+06	-2.2049e+06	-2.1955e+06

The level of social welfare (either the sign or the magnitude) is not directly interpretable. What is interpretable is the difference.

Online Supplemental Appendix

Appendix A. Derivation from u_j to V_j

A.1. Two-party political system

Suppose that there are only two candidates, g and b. Denote the numbers of votes for candidates g and b without voter i's vote as N_g and N_b, respectively. The situations facing voter i are classified into five mutually exclusive events: $N_g = N_b$, $N_g - N_b = 1$, $N_b - N_g = 1$, $N_g - N_b > 1$, and $N_b - N_g > 1$. The first three are pivotal events. After voter i makes her choice, if the number of votes for g is greater than that for b, then voter i obtains a utility u_g; if the number of votes for b is greater than that for b, then voter i obtains a utility u_b; if there is a tie, voter i's expected utility is $(u_g + u_b)/2$. The cost of turning out is φ. The utilities associated with voter i's different choices in different events are summarized in the following table:

Table A.1. Pivotal Events under Two Parties

	Mutually exclusive events				
Without voter i	$\boldsymbol{N_g = N_b}$	$\boldsymbol{N_g - N_b = 1}$	$\boldsymbol{N_b - N_g = 1}$	$N_g - N_b > 1$	$N_b - N_g > 1$
Vote for g	$\boldsymbol{u_g}$	$\boldsymbol{u_g}$	$\boldsymbol{(u_g + u_b)/2}$	u_g	u_b
Vote for b	$\boldsymbol{u_b}$	$\boldsymbol{(u_g + u_b)/2}$	$\boldsymbol{u_b}$	u_g	u_b
Not vote	$\boldsymbol{(u_g + u_b)/2}$	$\boldsymbol{u_g}$	$\boldsymbol{u_b}$	u_g	u_b

Without knowing other voters' choices, the expected utilities of voter i for voting for candidates g and b and the expected utility of not voting are as follows:

$$\begin{aligned}\tilde{V}_g = {} & Prob(N_g = N_b)u_g + Prob(N_g - N_b = 1)u_g \\ & + Prob(N_b - N_g = 1)\,(u_g + u_b)/2 + Prob(N_g - N_b > 1)u_g \\ & + Prob(N_b - N_g > 1)u_b - \varphi\end{aligned} \tag{A.1}$$

$$\begin{aligned}\tilde{V}_b = {} & Prob(N_g = N_b)u_b + Prob(N_g - N_b = 1)(u_g + u_b)/2 \\ & + Prob(N_b - N_g = 1)u_b + Prob(N_g - N_b > 1)u_g \\ & + Prob(N_b - N_g > 1)u_b - \varphi\end{aligned} \tag{A.2}$$

$$\begin{aligned}\tilde{V}_o = {} & Prob(N_g = N_b)(u_g + u_b)/2 + Prob(N_g - N_b = 1)u_g \\ & + Prob(N_b - N_g = 1)u_b + Prob(N_g - N_b > 1)u_g \\ & + Prob(N_b - N_g > 1)u_b\end{aligned} \tag{A.3}$$

Given that only the differences among these utilities matter, we can normalize the utility of the outside option as $V_o = 0$. Correspondingly, we have the following:

$$V_g = \tilde{V}_g - \tilde{V}_o = Prob(N_g = N_b)(u_g - u_b)/2 + Prob(N_b - N_g = 1)(u_g - u_b)/2 - \varphi \quad \text{(A.4)}$$

$$V_b = \tilde{V}_b - \tilde{V}_o = Prob(N_g = N_b)(u_g - u_b)/2 + Prob(N_g - N_b = 1)(u_g - u_b)/2 - \varphi \quad \text{(A.5)}$$

Assuming that $Prob(N_g = N_b) = Prob(N_b - N_g = 1) = Prob(N_g - N_b = 1) = p$, we have the following:

$$V_g = p(u_g - u_b) - \varphi \quad \text{(A.6)}$$

$$V_b = p(u_b - u_g) - \varphi \quad \text{(A.7)}$$

The estimation for the 2020 election is based on the structure of equations (A.6) and (A.7).

A.2. Three-party political system

Suppose that there are three candidates g, b, and w. Denote the numbers of votes for candidates g, b, and w without voter i's vote as N_g, N_b, and N_w, respectively. The situation facing voter i can be classified into three types of mutually exclusive events: voter i's choice is pivotal for all three candidates, pivotal for only two candidates, or not pivotal at all. Given the large number of eligible voters, the probability of voter i's choice being pivotal for all three candidates is a higher-order small amount than that of being pivotal for only two candidates and hence can be ignored. Consequently, we need to consider only the latter two types.

The latter two types of mutually exclusive events can be further classified into three categories: N_w is sufficiently smaller than N_g and N_b; N_b is sufficiently smaller than N_g and N_w; or N_g is sufficiently smaller than N_b and N_w. Denote these three categories as {I}, {II}, and {III}, respectively. The utilities associated with voter i's different choices in different events are summarized in Table A.2. The first three of the five events in each category are pivotal events. There are nine pivotal events in total.

Table A.2. Pivotal Events under Three Parties

	Events in category I (N_w is sufficiently smaller than N_g and N_b)				
Choice	$\boldsymbol{N_g = N_b}$	$\boldsymbol{N_g - N_b = 1}$	$\boldsymbol{N_b - N_g = 1}$	$N_g - N_b > 1$	$N_b - N_g > 1$
Vote for g	$\boldsymbol{u_g}$	$\boldsymbol{u_g}$	$\boldsymbol{(u_g + u_b)/2}$	u_g	u_b
Vote for b	$\boldsymbol{u_b}$	$\boldsymbol{(u_g + u_b)/2}$	$\boldsymbol{u_b}$	u_g	u_b
Vote for w	$\boldsymbol{(u_g + u_b)/2}$	$\boldsymbol{u_g}$	$\boldsymbol{u_b}$	u_g	u_b
Not vote	$\boldsymbol{(u_g + u_b)/2}$	$\boldsymbol{u_g}$	$\boldsymbol{u_b}$	u_g	u_b
	Events in category II (N_b is sufficiently smaller than N_g and N_w)				
Choice	$\boldsymbol{N_g = N_w}$	$\boldsymbol{N_g - N_w = 1}$	$\boldsymbol{N_w - N_g = 1}$	$N_g - N_w > 1$	$N_w - N_g > 1$
Vote for g	$\boldsymbol{u_g}$	$\boldsymbol{u_g}$	$\boldsymbol{(u_g + u_w)/2}$	u_g	u_w
Vote for b	$\boldsymbol{(u_g + u_w)/2}$	$\boldsymbol{u_g}$	$\boldsymbol{u_w}$	u_g	u_w
Vote for w	$\boldsymbol{u_w}$	$\boldsymbol{(u_g + u_w)/2}$	$\boldsymbol{u_w}$	u_g	u_w
Not vote	$\boldsymbol{(u_g + u_w)/2}$	$\boldsymbol{u_g}$	$\boldsymbol{u_w}$	u_g	u_w
	Events in category III (N_g is sufficiently smaller than N_b and N_w)				
Choice	$\boldsymbol{N_b = N_w}$	$\boldsymbol{N_b - N_w = 1}$	$\boldsymbol{N_w - N_b = 1}$	$N_b - N_w > 1$	$N_w - N_b > 1$
Vote for g	$\boldsymbol{(u_b + u_w)/2}$	$\boldsymbol{u_b}$	$\boldsymbol{u_w}$	u_b	u_w
Vote for b	$\boldsymbol{u_b}$	$\boldsymbol{u_b}$	$\boldsymbol{(u_b + u_w)/2}$	u_b	u_w
Vote for w	$\boldsymbol{u_w}$	$\boldsymbol{(u_b + u_w)/2}$	$\boldsymbol{u_w}$	u_b	u_w
Not vote	$\boldsymbol{(u_b + u_w)/2}$	$\boldsymbol{u_b}$	$\boldsymbol{u_w}$	u_b	u_w

Without knowing other voters' choices, the expected utilities of voter i for voting for candidates g, b, or w and the expected utility of not voting are as follows:

$$\tilde{V}_g = Prob(N_g = N_b \; and \; \{\mathrm{I}\})u_g + Prob(N_g - N_b = 1 \; and \; \{\mathrm{I}\})u_g + Prob(N_b - N_g = 1 \; and \; \{\mathrm{I}\})(u_g + u_b)/2 + Prob(N_g - N_b > 1 \; and \; \{\mathrm{I}\})u_g + Prob(N_b - N_g > 1 \; and \; \{\mathrm{I}\})u_b + Prob(N_g = N_w \; and \; \{\mathrm{II}\})u_g + Prob(N_g - N_w = 1 \; and \; \{\mathrm{II}\})u_g + Prob(N_w - N_g = 1 \; and \; \{\mathrm{II}\})(u_g + u_w)/2 + Prob(N_g - N_w > 1 \; and \; \{\mathrm{II}\})u_g + Prob(N_w - N_g > 1 \; and \; I\{\mathrm{II}\})u_w + Prob(N_b = N_w \; and \; \{III\})(u_b + u_w)/2 + Prob(N_b - N_w = 1 \; and \; \{\mathrm{III}\})u_b + Prob(N_w - N_b = 1 \; and \; \{\mathrm{III}\})u_w + Prob(N_b - N_w > 1 \; and \; \{\mathrm{III}\})u_b + Prob(N_w - N_b > 1 \; and \; \{\mathrm{III}\})u_w - \varphi \quad (A.8)$$

$$\tilde{V}_b = Prob(N_g = N_b \; and \; \{\mathrm{I}\})u_b + Prob(N_g - N_b = 1 \; and \; \{\mathrm{I}\})(u_g + u_b)/2 + Prob(N_b - N_g = 1 \; and \; \{\mathrm{I}\})u_b + Prob(N_g - N_b > 1 \; and \; \{\mathrm{I}\})u_g + Prob(N_b - N_g > 1 \; and \; \{\mathrm{I}\})u_b + Prob(N_g = N_w \; and \; \{\mathrm{II}\})(u_g + u_w)/2 + Prob(N_g - N_w = 1 \; and \; \{\mathrm{II}\})u_g + Prob(N_w - N_g = 1 \; and \; \{\mathrm{II}\})u_w + Prob(N_g - N_w > 1 \; and \; \{\mathrm{II}\})u_g + Prob(N_w - N_g > 1 \; and \; I\{\mathrm{II}\})u_w + Prob(N_b = N_w \; and \; \{\mathrm{III}\})u_b + Prob(N_b - N_w = 1 \; and \; \{\mathrm{III}\})u_b + Prob(N_w - N_b = 1 \; and \; \{\mathrm{III}\})(u_b + u_w)/2 + Prob(N_b - N_w > 1 \; and \; \{\mathrm{III}\})u_b + Prob(N_w - N_b > 1 \; and \; \{\mathrm{III}\})u_w - \varphi \quad (A.9)$$

$$\tilde{V}_w = Prob(N_g = N_b \; and \; \{\mathrm{I}\})(u_g + u_b)/2 + Prob(N_g - N_b = 1 \; and \; \{\mathrm{I}\})u_g + Prob(N_b - N_g = 1 \; and \; \{\mathrm{I}\})u_b + Prob(N_g - N_b > 1 \; and \; \{\mathrm{I}\})u_g + Prob(N_b - N_g > 1 \; and \; \{\mathrm{I}\})u_b + Prob(N_g = N_w \; and \; \{\mathrm{II}\})u_w + Prob(N_g - N_w = 1 \; and \; \{\mathrm{II}\})(u_g + u_w)/2 + Prob(N_w - N_g = 1 \; and \; \{\mathrm{II}\})u_w + Prob(N_g - N_w > 1 \; and \; \{\mathrm{II}\})u_g + Prob(N_w - N_g > 1 \; and \; I\{\mathrm{II}\})u_w + Prob(N_b = N_w \; and \; \{\mathrm{III}\})u_w + Prob(N_b - N_w = 1 \; and \; \{\mathrm{III}\})(u_b + u_w)/2 + Prob(N_w - N_b = 1 \; and \; \{\mathrm{III}\})u_w + Prob(N_b - N_w > 1 \; and \; \{\mathrm{III}\})u_b + Prob(N_w - N_b > 1 \; and \; \{\mathrm{III}\})u_w - \varphi \quad (A.10)$$

$$\begin{aligned}\tilde{V}_o = {} & Prob(N_g = N_b \; and \; \{\mathrm{I}\})(u_g + u_b)/2 + Prob(N_g - N_b = 1 \; and \; \{\mathrm{I}\})u_g \\ & + Prob(N_b - N_g = 1 \; and \; \{\mathrm{I}\})u_b \\ & + Prob(N_g - N_b > 1 \; and \; \{\mathrm{I}\})u_g \\ & + Prob(N_b - N_g > 1 \; and \; \{\mathrm{I}\})u_b \\ & + Prob(N_g = N_w \; and \; \{\mathrm{II}\})(u_g + u_w)/2 \\ & + Prob(N_g - N_w = 1 \; and \; \{\mathrm{II}\})u_g \\ & + Prob(N_w - N_g = 1 \; and \; \{\mathrm{II}\})u_w \\ & + Prob(N_g - N_w > 1 \; and \; \{\mathrm{II}\})u_g \\ & + Prob(N_w - N_g > 1 \; and \; I\{\mathrm{II}\})u_w \\ & + Prob(N_b = N_w \; and \; \{\mathrm{III}\})(u_b + u_w)/2 \\ & + Prob(N_b - N_w = 1 \; and \; \{\mathrm{III}\})u_b \\ & + Prob(N_w - N_b = 1 \; and \; \{\mathrm{III}\})u_w \\ & + Prob(N_b - N_w > 1 \; and \; \{\mathrm{III}\})u_b \\ & + Prob(N_w - N_b > 1 \; and \; \{\mathrm{III}\})u_w \end{aligned} \tag{A.11}$$

Given that only the differences among these utilities matter, we can normalize the utility of the outside option as $V_o = 0$. Correspondingly, we have the following:

$$\begin{aligned} V_g = \tilde{V}_g - \tilde{V}_o = {} & Prob(N_g = N_b \; and \; \{\mathrm{I}\})(u_g - u_b)/2 \\ & + Prob(N_b - N_g = 1 \; and \; \{\mathrm{I}\})(u_g - u_b)/2 \\ & + Prob(N_g = N_w \; and \; \{\mathrm{II}\})(u_g - u_w)/2 \\ & + Prob(N_w - N_g = 1 \; and \; \{\mathrm{II}\})(u_g - u_w)/2 - \varphi \end{aligned} \tag{A.12}$$

$$\begin{aligned} V_b = \tilde{V}_b - \tilde{V}_o = {} & Prob(N_g = N_b \; and \; \{\mathrm{I}\})(u_b - u_g)/2 \\ & + Prob(N_g - N_b = 1 \; and \; \{\mathrm{I}\})(u_b - u_g)/2 \\ & + Prob(N_b = N_w \; and \; \{\mathrm{III}\})(u_b - u_w)/2 \\ & + Prob(N_w - N_b = 1 \; and \; \{\mathrm{III}\})(u_b - u_w)/2 - \varphi \end{aligned} \tag{A.13}$$

$$\begin{aligned} V_w = \tilde{V}_w - \tilde{V}_o = {} & Prob(N_g = N_w \; and \; \{\mathrm{II}\})(u_w - u_g)/2 \\ & + Prob(N_g - N_w = 1 \; and \; \{\mathrm{II}\})(u_w - u_g)/2 \\ & + Prob(N_b = N_w \; and \; \{\mathrm{III}\})(u_w - u_b)/2 \\ & + Prob(N_b - N_w = 1 \; and \; \{\mathrm{III}\})(u_w - u_b)/2 - \varphi \end{aligned} \tag{A.14}$$

For simplicity, we assume that the subjective probability of voter i's vote being pivotal for any two parties is identical. Let the probability of any of the nine pivotal events equal p:

$$\begin{aligned} Prob(N_g = N_b \; and \; \{\mathrm{I}\}) = {} & Prob(N_b - N_g = 1 \; and \; \{\mathrm{I}\}) \\ = {} & Prob(N_g = N_w \; and \; \{\mathrm{II}\}) = Prob(N_w - N_g = 1 \; and \; \{\mathrm{II}\}) \\ = {} & Prob(N_g - N_b = 1 \; and \; \{\mathrm{I}\}) = Prob(N_b = N_w \; and \; \{\mathrm{III}\}) \\ = {} & Prob(N_w - N_b = 1 \; and \; \{\mathrm{III}\}) \\ = {} & Prob(N_g - N_w = 1 \; and \; \{\mathrm{II}\}) \\ = {} & Prob(N_b - N_w = 1 \; and \; \{\mathrm{III}\}) = p \end{aligned} \tag{A.15}$$

Given this assumption, we have the following:

$$V_g = p(2u_g - u_b - u_w) + \varphi \tag{A.16}$$

$$V_b = p(2u_b - u_g - u_w) + \varphi \quad \text{(A.17)}$$

$$V_w = p(2u_w - u_g - u_b) + \varphi \quad \text{(A.18)}$$

The estimation for the 2024 election is based on the structure of equations (A.16) through (A.18).

The assumption represented by equation (A.15) requires that the subjective probabilities that voter i's choice is pivotal for candidates g and b, for g and w, or for b and w are indifferent to one another. However, one may argue that the subjective pivotal probability for the two candidates ranking first and second in the poll before the election may be greater than that for the two candidates ranking first and third and that for the two candidates ranking second and third.

There are at least three rationales behind the assumption represented by equation (A.15). First, the vote shares of the three candidates are not far different from each other both in the actual election (40.05%, 33.49%, and 26.46%) and in the ex ante polls (38.9%~41.3%, 33.0%~36.0%, and 24.5%~27.0%). Second, besides several major polls with sufficient reliability, many other entities conducted polls and published different results in Taiwan. Polls predicting the blue candidate or the white candidate as the winner also existed; meanwhile, voters in favor of a certain candidate are more likely to trust the polls that are biased toward that candidate. Third, unlike the U.S., poll entities are prohibited by laws in Taiwan from publishing polling results during the ten days immediately before the election date (the blackout period on polling), which introduces some ambiguity regarding each candidate's current approval rate for voters' decision making on the election date.[46]

A.3. Relaxing the assumption represented by equation (A.15)

As robustness checks, we allow the subjective probabilities that voter i's choice is pivotal for candidates g and b, for g and w, or for b and w are different. Let

$$\begin{aligned} Prob(N_g = N_b \; and \; \{\mathrm{I}\}) &= Prob(N_b - N_g = 1 \; and \; \{\mathrm{I}\}) \\ &= Prob(N_g - N_b = 1 \; and \; \{\mathrm{I}\}) = \mathbb{p}_1 \end{aligned} \quad \text{(A.19)}$$

$$\begin{aligned} Prob(N_g = N_w \; and \; \{\mathrm{II}\}) &= Prob(N_w - N_g = 1 \; and \; \{\mathrm{II}\}) \\ &= Prob(N_g - N_w = 1 \; and \; \{\mathrm{II}\}) = \mathbb{p}_2 \end{aligned} \quad \text{(A.20)}$$

[46] This prohibition and the resulting ambiguity of each candidate's current approval rate on the election date may partially explain why the turnout rate is substantially greater in Taiwan than in the U.S. Within the ten days right before the election date, entities in Taiwan can still conduct polls but can only publish the results after the election.

$$Prob(N_b = N_w \; and \; \{\text{III}\}) = Prob(N_w - N_b = 1 \; and \; \{\text{III}\}) = Prob(N_b - N_w = 1 \; and \; \{\text{III}\}) = \mathbb{p}_3 \quad \text{(A.21)}$$

Then, we have the following:

$$V_g = (\mathbb{p}_1 + \mathbb{p}_2)u_g - \mathbb{p}_1 u_b - \mathbb{p}_2 u_w - \varphi \quad \text{(A.22)}$$

$$V_b = (\mathbb{p}_1 + \mathbb{p}_3)u_b - \mathbb{p}_1 u_g - \mathbb{p}_3 u_w - \varphi \quad \text{(A.23)}$$

$$V_w = (\mathbb{p}_2 + \mathbb{p}_3)u_w - \mathbb{p}_2 u_g - \mathbb{p}_3 u_b - \varphi \quad \text{(A.24)}$$

Denote the vote shares of candidates g, b, and w published by the Formosa poll's last wave prior to ten days before the election as $\hat{S}_g$, $\hat{S}_b$, and $\hat{S}_w$, respectively. Assume the following:

$$\mathbb{p}_1 = \hat{S}_g \hat{S}_b \mathbb{p} \quad \text{(A.25)}$$

$$\mathbb{p}_2 = \hat{S}_g \hat{S}_w \mathbb{p} \quad \text{(A.26)}$$

$$\mathbb{p}_3 = \hat{S}_b \hat{S}_w \mathbb{p} \quad \text{(A.27)}$$

where $\mathbb{p}$ is a scalar. Then, we have the following:

$$V_g = \left(\hat{S}_g \hat{S}_b + \hat{S}_g \hat{S}_w\right)\mathbb{p} u_g - \hat{S}_g \hat{S}_b \mathbb{p} u_b - \hat{S}_g \hat{S}_w \mathbb{p} u_w - \varphi \quad \text{(A.28)}$$

$$V_b = \left(\hat{S}_g \hat{S}_b + \hat{S}_b \hat{S}_w\right)\mathbb{p} u_b - \hat{S}_g \hat{S}_b \mathbb{p} u_g - \hat{S}_b \hat{S}_w \mathbb{p} u_w - \varphi \quad \text{(A.29)}$$

$$V_w = \left(\hat{S}_g \hat{S}_w + \hat{S}_b \hat{S}_w\right)\mathbb{p} u_w - \hat{S}_g \hat{S}_w \mathbb{p} u_g - \hat{S}_b \hat{S}_w \mathbb{p} u_b - \varphi \quad \text{(A.30)}$$

Because $\mathbb{p}$ is a scalar and can be captured by the parameters in u_g, u_b, and u_w, we can rewrite equations (A.31), (A.32), and (A.33) as follows:

$$V_g = \left(\hat{S}_g \hat{S}_b + \hat{S}_g \hat{S}_w\right)u_g - \hat{S}_g \hat{S}_b u_b - \hat{S}_g \hat{S}_w u_w - \varphi \quad \text{(A.31)}$$

$$V_b = \left(\hat{S}_g \hat{S}_b + \hat{S}_b \hat{S}_w\right)u_b - \hat{S}_g \hat{S}_b u_g - \hat{S}_b \hat{S}_w u_w - \varphi \quad \text{(A.32)}$$

$$V_w = \left(\hat{S}_g \hat{S}_w + \hat{S}_b \hat{S}_w\right)u_w - \hat{S}_g \hat{S}_w u_g - \hat{S}_b \hat{S}_w u_b - \varphi \quad \text{(A.33)}$$

The results of the structural estimation based on this alternative assumption are similar to those based on the original assumption and they are available upon request.

Appendix B. Concerns about the methodology

B.1. Concerns about strategic voting

One underlying assumption for the structural model developed in Section 4 is that voters do not vote strategically. Strategic voting means that, for instance, voters inherently favoring the third party and meanwhile having a strong will to unseat the ruling party DPP may vote for KMT to concentrate the votes if they believe that the approval rate for KMT is much higher than that for the third party.

In fact, the strategic voting effect did not occur in the 2024 presidential election, though KMT advocated blue voters who supported Ko to vote strategically for KMT. Ko's vote share

in the election was close to the approval rates reported by major polls from several weeks to immediately before the election date. The number of popular votes for Ko in the presidential election (26.46%) was even greater than that for TPP (22.07%) in the simultaneous election of legislators-at-large, which should not suffer from the strategic voting effect.[47] TPP's party vote share in the election of legislators-at-large was also close to the party approval rates reported by many polls from several weeks to immediately before the election date.[48]

Multiple factors contributed to the absence of a strategic voting effect in the 2024 presidential election. First, Ko did not fall far behind the other two candidates in polls before the election. Second, on the night before the election date, TPP held a campaign rally with over 300,000 participants on Ketagalan Boulevard in front of the presidential office building in Taipei, which dramatically strengthened the supporters' belief. The numbers of participants in the other two parties' rallies on that day and in rallies held on previous presidential elections' eves were smaller. Third, unlike in the U.S., poll entities are prohibited by laws in Taiwan from publishing polling results during the ten days immediately before the election date (the blackout period on polling), which brings in some ambiguity regarding each candidate's current approval rate for voters' decision making on the election date.[49] Fourth, against KMT's advocates that blue voters supporting Ko should strategically vote for KMT, Ko's campaign team insistently urged that voters ought to truthfully express their preferences in voting. Fifth, most of Ko's supporters belong to the younger generation, who care more about expressing their stances by voting (expressive voting) and are less "instrumentally rational" than the older generation. Meanwhile, young people can be easily attracted by Ko's personal charisma and follow his advocates.

Even if some blue voters who inherently supported Ko voted strategically for the KMT candidate, we would underestimate the ideological gap between the two major parties because

[47] If any strategic voting effect were present in the election of legislators-at-large, then TPP's popular vote should be elevated by strategic voters switching from small parties to TPP instead of being reduced by strategic voters switching from TPP to KMT. Because a party needs to have its popular vote surpass the 5% threshold to be qualified to split the at-large seats proportionally, TPP absorbed many voters who inherently supported other small parties but desired to have some representatives in the Legislative Yuan. For example, the New Power Party obtained 7.7% of the popular vote in the 2020 election of legislators-at-large and was allocated three at-large seats accordingly, but it only obtained 2.6% of the popular vote in 2024 and was thus allocated zero at-large seats.

[48] There are 34 seats of legislators-at-large in the Legislative Yuan, which are split by parties according to their party vote shares in the election.

[49] During the blackout period, poll entities can still conduct surveys but can only publish the poll results after the election.

we would treat those voters as inherently favoring the KMT candidate the most in their preferences. Accordingly, given that TPP lies between KMT and DPP in the ideological dimension, the estimation process needs to move KMT's ideological position in the model toward the center to fit the enlarged share of voters supporting KMT. However, our estimates still indicate that the ideological gap between the two major parties ($x_b - x_g$) is larger in the 2024 election with the third-party entry than in the 2020 election without this entry.

In the literature, Pons and Tricaud (2018) studied elections in France and provided evidence that is inconsistent with strategic voting. Additionally, multiple survey-based studies have shown that the percentage of voters voting strategically rather than expressively is very small (e.g., Alvarez and Nagler, 2000; Blais et al., 2001; Hillygus, 2007; Kiewiet, 2013).

B.2. Concerns about other dimensions in voters' preferences

We explicitly model only two dimensions of voters' preferences for candidates: the dimension of ideological stances and the dimension of candidates' valences. Other policy differences across candidates are not voters' main concerns for this election.

First, the ideological dimension was always Taiwan voters' major concern, and it was even more salient in the 2024 context. In campaigns for the 2024 election, KMT advocated that the 2024 presidential election is the choice between war and peace, while DPP advocated that the election is the choice between democracy and autocracy. As shown in the Formosa poll, only 17.8% of respondents agreed that the election was neither the choice between war and peace nor the choice between democracy and autocracy.

Second, compared with the ideological dimension, economic issues became of second-order importance. On Dec 21, 2023, China announced that they would cease the tariff deduction for 12 petrochemical products in the Economic Cooperation Framework Agreement (ECFA) in 2024, signaling a threat to Taiwan's economy to restrain "pro-independence" forces. However, according to a poll by the Taiwanese Public Opinion Foundation, 88.4% of respondents answered that the announcement would not affect their voting decisions, and 5% of respondents did not provide an answer.

Third, voters' preferences in other dimensions could be highly correlated with their preference in the ideological dimension. According to the Formosa poll, people's degrees of satisfaction with the current economic situation are highly correlated with their green-blue ideological stances (see Table S.3 in Appendix S).

Fourth, besides the green-blue ideological dimension, the personal charisma of Ko (the third party's candidate) plays an important role in the preferences of voters supporting him. In a political system dominated by two parties, a third party usually has neither a strong local branch system to closely contact voters in each location nor many party members serving as local mayors or council members to gain political resources. Correspondingly, whether the third party can obtain an essential vote share in the presidential election heavily relies on a star candidate.

B.3. Validity of employing a pivotal-voter framework for a large-scale election

The literature has two main types of theoretical models of voting: pivotal-voter models (e.g., Riker and Ordeshook, 1968; Ledyard, 1984; Palfrey and Rosenthal, 1983 & 1985) and ethical-voter models (Feddersen and Sandroni, 2006). Each type has its own advantages and disadvantages, and a canonical model actually does not yet exist (see discussions in Feddersen, 2004).[50] We employ a pivotal-voter framework because empirically, with certain adjustments of the interpretation of some model parameters, the disadvantages of pivotal-voter models can be overcome while some merits of ethical-voter models can be carried over (e.g., voters are motivated to vote not only by their own concerns about election outcomes but also by a sense of civic duty).

While the pivotal probability is not our focus, we need to point out that one potential drawback of theoretical pivotal-voter models is that the pivotal probabilities in large-scale elections are close to zero and hence voters theoretically should not turn out given a positive voting cost. However, first, what affect voters' turnout decisions are their subjective pivotal probabilities, and experimental studies have shown that voters' subjective pivotal probabilities are much higher than the actual pivot probability (e.g., Duffy and Tavits, 2008).

Second, if a voter's preferences across candidates are highly differential (such as in a polarized two-party system) and the election outcome is important (such as in presidential elections), the utility difference from having her preferred candidate in office relative to another one will be huge and hence the product of the pivotal probability and the utility difference will not be small. Third, following the spirit of ethical models, a voter's utility of an election outcome may include not only her own benefit but also her perception of the entire society's

[50] The literature also has other types of models, such as uncertain-voter models (Degan and Merlo, 2011) and mobilization models (Uhlaner, 1989; Shachar and Nalebuff, 1999).

benefit (though different voters have different perceptions). Therefore, the utility difference can be even huger. On the one hand, KMT advocated that the choice between DPP and KMT in the 2024 election is a choice between war and peace; on the other hand, DPP advocated that the choice between DPP and KMT is a choice between democracy and autocracy. Many voters are educated in such a way that "if it turns out you are the pivotal voter and you did not turn out, then you will become a guilty person in history."

Using a maximum likelihood approach, Coate et al. (2008) estimated a pivotal-voter model with an assumption that voters have rational expectations on the actual pivotal probability; the actual pivotal probability in equilibrium depends on the number of eligible voters and the distribution of their preferences. The simulation exercises in Coate et al. (2008) showed that the pivotal-voter model's predictions could well match the true data for the turnout levels but not for the size of the winning margins.

Different from Coate et al. (2008) and similar to Kawai et al. (2021), the pivotal probability in our model is a parameter to be gauged or underlying other structural parameters, which captures voters' subjective perceptions instead of the true pivotal probability in equilibrium that is calculated from additional theoretical equations. Moreover, we employ the BLP-style generalized method of moments (GMM), which is widely used in the industrial organization literature for consumers' discrete choices over differentiated products. In this method, the moments matching between the model prediction and the real data for the turnout levels and those matching for the size of the winning margins (vote shares of each candidate) are both included.[51]

Similar to Kawai et al. (2021), the pivotal probability parameter in our model can be broadly interpreted as voters' subjective perception of voting efficacy. Moreover, following the spirit of rule-utilitarian models, if a voter's utility of an election outcome includes not her own benefit but her perception of the entire society or a certain group's benefit, the "pivotal probability" parameter in our model can be interpreted even more broadly as voters' tendency to follow a voting rule that they believe, if followed by all in their group, would maximize aggregate utility or a certain group's utility.[52] Although our study employs a pivotal-voter

[51] In the literature, there are other defenses for the pivotal-voter framework, such as in Levine and Palfrey (2007).

[52] The rule-utilitarian model in Feddersen and Sandroni (2006) assumed that individuals follow a voting rule that they believe maximizes aggregate utility (altruism). In contrast, the rule-utilitarian model in Coate and Conlin (2004) assumed that individuals follow a voting rule that they believe maximizes the

framework, the main results do not depend on the interpretation of the "pivotal probability" parameter because our focus is on how third-party entry affects the two major incumbent parties' ideological positions. We fit a pivotal-voter model using vote and poll data to recover the two major parties' ideological positions.

Other studies employing the pivotal-voter framework without interpreting the pivotal probability parameter as the actual pivot probability in equilibrium include Kanazawa (1998), Bendor et al. (2003), Minozzi (2013), and Esponda and Pouzo (2017).

Appendix D. Welfare calculation

D.1. The actual election in 2024

In the actual 2024 election with three candidates, the winning party was the green party. We aggregate the individual-specific utility associated with this outcome (not the ex ante expected utility of a voting choice) across all eligible voters:

$$W_1 = \sum_i u_{ig} = -\sum_i |\mu(D_i) + \eta_i| + \sum_i \varsigma_{kg}$$

$\sum_i |\mu(D_i) + \eta_i|$ is available from the estimation process. While each ς_{kg} given location k cannot be directly solved from the linear equation system of (4.11), (4.12), and (4.13) because the determinant of the coefficient matrix of the system is zero, we can still calculate $\sum_i \varsigma_{kg}$.

Considering equation (4.12) plus (4.13), we have

$$\xi_{kb} + \xi_{kw} = \varsigma_{kb} + \varsigma_{kw} - 2\varsigma_{kg} - 2\varrho_k = (\varsigma_{kb} + \varsigma_{kw} + \varsigma_{kg}) - 3\varsigma_{kg} - 2\varrho_k$$

Aggregating across all eligible voters, we have

$$\sum_i (\xi_{kb} + \xi_{kw}) = \sum_i (\varsigma_{kb} + \varsigma_{kw} + \varsigma_{kg}) - 3\sum_i \varsigma_{kg} - 2\sum_i \varrho_k \qquad \text{(D.1)}$$

Because ς_{kb}, ς_{kw}, and ς_{kg} are location-level random shocks to preferences, $\sum_k (\varsigma_{kb} + \varsigma_{kw} + \varsigma_{kg}) = 0$. Consequently, $\sum_i (\varsigma_{kb} + \varsigma_{kw} + \varsigma_{kg})$ should be close to zero. Because ϱ_k is the location-level random shock to voting costs, $\sum_k \varrho_k = 0$. Consequently, $\sum_i \varrho_k$ should be close to zero.

Therefore, from equation (D.1), we have

$$\sum_i \varsigma_{kg} = -\frac{1}{3}\sum_i (\xi_{kb} + \xi_{kw})$$

payoff of a group (collectivism).

ξ_{kg}, ξ_{kb}, and ξ_{kw} are available from the estimation procedure.

D.2. No third-party entry

In the counterfactual scenario of no third-party entry, the winning party is the blue party. We aggregate the individual-specific utility associated with this outcome across all eligible voters:

$$W_2 = \sum_i u_{ib} = -\sum_i |\mu(D_i) + \eta_i - x_b| + \sum_i \varsigma_{kb}$$

Similarly, we have

$$\sum_i \varsigma_{kb} = -\frac{1}{3}\sum_i (\xi_{kg} + \xi_{kw})$$

D.3. Blue-white alliance

In the counterfactual scenario where the blue-white alliance was formed, the winning candidate is the blue-white alliance. We aggregate the individual-specific utility associated with this outcome across all eligible voters:

$$\begin{aligned} W_3 = \sum_i u_{ibw} = -\sum_i |\mu(D_i) + \eta_i - [(1 - \varpi_{bw1})x_b + \varpi_{bw1} x_w]| \\ + \varpi_{bw2}\sum_i [\lambda(D_i) + \zeta_i] + \sum_i \varsigma_{kb} + \varpi_{bw3}\sum_i (\varsigma_{kw} - \varsigma_{kb}) \end{aligned} \quad \text{(D.2)}$$

The first three components on the right-hand side of equation (D.2) are available from the estimation process. To calculate the last component, considering equation (4.13) minus equation (4.12), we have

$$\varsigma_{kw} - \varsigma_{kb} = \frac{1}{3}(\xi_{kw} - \xi_{kb})$$

D.4. White-blue alliance

In the counterfactual scenario where the white-blue alliance was formed, the winning candidate is the blue-white alliance. We aggregate the individual-specific utility associated with this outcome across all eligible voters:

$$W_4 = \sum_i u_{ibw} = -\sum_i |\mu(D_i) + \eta_i - [(1-\varpi_{wb1})x_b + \varpi_{wb1}x_w]|$$

$$+ \varpi_{wb2}\sum_i [\lambda(D_i) + \zeta_i] + \sum_i \varsigma_{kb} + \varpi_{wb3}\sum_i (\varsigma_{kw} - \varsigma_{kb})$$

D.5. Voting costs

When calculating welfare, we do not subtract the voting costs φ for voters who turn out. Our calculation of the utility associated with an election outcome (not the utility of a voting choice) is scaled by the unidentified pivotal probability p_0, which should be a very small number. Consequently, the true utility associated with an outcome, and hence the true social welfare, should be at a tremendously larger scale than our calculation. The voting costs are ignorable relative to that scale.

Appendix E. Endorsement

Although the potential alliance of KMT and TPP eventually broke down on November 24, 2023, KMT continued to seek Ko's endorsement before the election. KMT publicly announced that if elected, it would set up a coalition government and appoint the premier, vice-premier, and other officials jointly with TPP.[53] KMT advocated that voters supporting Ko should vote for Hou in order to concentrate the votes and accomplish ruling party alternation. However, by election day, Ko had not publicly announced that he would endorse Hou. Rather, Ko advocated that voters ought to truthfully express their preferences in voting.

The long-version Formosa poll conducted during December 20-21 in 2023 asked two relevant questions. The first question was as follows: "If Ko publicly endorses Lai several days before the election, for whom will you vote?" The second question was as follows: "If Ko publicly endorses Hou several days before the election, for whom will you vote?"

In this section, we examine how Ko's public endorsements could have altered voters' preferences over available choices.

E.1. Ko endorses the green candidate

[53] Taiwan has a semi-presidential system: the president is elected by voters; the premier (head of Executive Yuan) is nominated by the president.

If Ko had publicly endorsed Lai (the green candidate), the utility of having the green candidate in office for voter i at location k is assumed to be as follows:

$$u_{ig} = -\left|\mu(D_i) + \eta_i - \left[\left(1-\kappa_{g1}\right)x_g + \kappa_{g1}x_w\right]\right| + \kappa_{g2}[\lambda(D_i) + \zeta_i] + \left(1-\kappa_{g3}\right)\varsigma_{kg} + \kappa_{g3}\varsigma_{kw} = \bar{u}_{ig} + \left(1-\kappa_{g3}\right)\varsigma_{kg} + \kappa_{g3}\varsigma_{kw} \quad \text{(E.1)}$$

The utilities of having the blue candidate or the white candidate in office for voter i at location k remain unchanged (represented by equations (4.2) and (4.3)).

Voter i's utilities of voting for the green, blue, and white candidates, respectively, are as follows:

$$\begin{aligned} V_{ig} &= 2u_{ig} - u_{ib} - u_{iw} - \varphi - \varrho_k + \epsilon_{ig} \\ &= 2\bar{u}_{ig} - \bar{u}_{ib} - \bar{u}_{iw} + \frac{1}{3}\left[\left(3-2\kappa_{g3}\right)\xi_{kg} + 2\kappa_{g3}\xi_{kw}\right] - \varphi \\ &\quad + \epsilon_{ig} \end{aligned} \quad \text{(E.2)}$$

$$\begin{aligned} V_{ib} &= 2u_{ib} - u_{ig} - u_{iw} - \varphi - \varrho_k + \epsilon_{ib} \\ &= 2\bar{u}_{ib} - \bar{u}_{ig} - \bar{u}_{ig} + \frac{1}{3}\left[\kappa_{g3}\xi_{kg} + 3\xi_{kb} - \kappa_{g3}\xi_{kw}\right] - \varphi \\ &\quad + \epsilon_{ib} \end{aligned} \quad \text{(E.3)}$$

$$\begin{aligned} V_{iw} &= 2u_{iw} - u_{ig} - u_{ib} - \varphi - \varrho_k + \epsilon_{iw} \\ &= 2\bar{u}_{iw} - \bar{u}_{ig} - \bar{u}_{ib} + \frac{1}{3}\left[\kappa_{g3}\xi_{kg} + \left(3-\kappa_{g3}\right)\xi_{kw}\right] - \varphi \\ &\quad + \epsilon_{iw} \end{aligned} \quad \text{(E.4)}$$

Derivations from the first line to the last line of equations (E.2), (E.3), and (E.4) are presented in Appendix R.3.

The structural parameters $\theta_{K_endorse_g} = \{\kappa_{g1}, \kappa_{g2}, \kappa_{g3}\}$ can be identified and estimated by the following two sets of moments that match the structural-model predictions to their empirical counterparts in the poll data. The first set of moments matches the average probability of voting for $j \in \{g, b, w\}$ conditional on that the lth dimension of demographic characteristics D_{il} equals a certain value $\bar{D}_{ls}$. The moments are given by the following:

$$Prob[y_i' = j' | D_{il} = \bar{D}_{ls}], \ \ j' \in \{g, b, w\} \quad \text{(E.5)}$$

The demographic characteristics have four dimensions, including age, gender, education, and region.

The second set of moments matches the average probability of voting for $j' \in \{g, b, w\}$ in the situation of endorsing the green candidate conditional on voting for $j \in \{g, b, w\}$ in the

situation of no endorsement. The moments are given by the following:

$$Prob[y_i' = j' | y_i = j\ ], \qquad j \in \{g, b, w\}, j' \in \{g, b, w\} \tag{E.6}$$

E.2. Ko endorses the blue candidate

If Ko had publicly endorsed Hou (the blue candidate), the utility of having the blue candidate in office for voter i at location k is assumed to be as follows:

$$\begin{aligned} u_{ib} = -|\mu(D_i) + \eta_i - [(1-\kappa_{b1})x_b + \kappa_{b1}x_w]| + \kappa_{b2}[\lambda(D_i) + \zeta_i] \\ + (1-\kappa_{b3})\varsigma_{kb} + \kappa_{b3}\varsigma_{kw} = \bar{u}_{ib} + (1-\kappa_{b3})\varsigma_{kb} + \kappa_{b3}\varsigma_{kw} \end{aligned} \tag{E.7}$$

The utilities of having the green candidate or the white candidate in office for voter i at location k remain unchanged (represented by equations (4.1) and (4.3)).

Voter i's utilities of voting for the green, blue, and white candidates can be derived similarly by following the logic of equations (E.2) through (E.4) in Section E.1. The structural parameters $\theta_{K_endorse_b} = \{\kappa_{b1}, \kappa_{b2}, \kappa_{b3}\}$ can be identified and estimated by two sets of moments similar to equations (E.5) and (E.6).

E.3. Estimation results and discussion

Columns 1 and 2 in Table E.1 report the estimation results for Ko's endorsements of the green and blue candidates, respectively. Ko's endorsement of the green candidate would have had little effect on the green candidate's ideological position as perceived by voters, whereas Ko's endorsement of the blue candidate could have substantially altered voters' perception of the blue candidate's ideological position. The reason is that Ko's ideological position is closer to the blue candidate's than to the green candidate's and many green party members firmly insist on their doctrines.

Through his endorsement, Ko's nonideological effect (political valence) could have been substantially transmitted to the green candidate (0.5265) but could not have been transmitted to the blue candidate. One possible reason is that a large proportion of KMT supporters are elderly people, who are unlikely to be abstracted by a candidate's personal charisma. In contrast, both TPP and DPP have many young supporters.

Similarly, through Ko's endorsement, location-level shocks to voters' preference for Ko could have dramatically transmitted to voters' preference for the green candidate (0.9367), whereas the shocks could not have transmitted to voters' preference for the blue candidate. One

possible reason is that TPP is stronger in online propaganda than both DPP and KMT are and is weaker in local organizations. TPP's "air forces" can influence young voters (who are also DPP's main voter base) but cannot influence elderly voters (KMT's main voter base), who can only be contacted by "ground troops."[54]

Each component of $\{\kappa_{b1}, \kappa_{b2}, \kappa_{b3}\}$ reported in Table E.1 is smaller in magnitude than their counterparts in $\{\varpi_{bw1}, \varpi_{bw2}, \varpi_{bw3}\}$ and $\{\varpi_{wb1}, \varpi_{wb2}, \varpi_{wb3}\}$ as reported in Table 7, suggesting that endorsing is less influential than allying.

Table E.1. Ko's influence through endorsement

	Ko endorses green		**Ko endorses blue**	
Weights for	**Parameter**	**Est.**	**Parameter**	**Est.**
Ideological stance	κ_{g1}	0.0358***	κ_{b1}	0.3615**
		(0.0130)		(0.1744)
Ko's nonideological effect	κ_{g2}	0.5265***	κ_{b2}	0.0000
		(0.0637)		(0.0019)
Location-level shock	κ_{g3}	0.9367***	κ_{b3}	0.0000
		(0.1502)		(0.5134)

Given the estimates of $\{\mu, \lambda, \sigma_1, \sigma_2, \rho, x_b, x_w, \varphi\}$ reported in panel A of Table 2, $\{\kappa_{g1}, \kappa_{g2}, \kappa_{g3}\}$ or $\{\kappa_{b1}, \kappa_{b2}, \kappa_{b3},\}$ are estimated accordingly. The standard errors in parentheses are adjusted using the correction methods developed by Murphy and Topel (1985). * denotes significance at a 10% level. ** denotes significance at a 5% level. *** denotes significance at a 1% level.

Appendix R.

R.1. Derivations from the first line to the last line of equations (8.1) and (8.2)

Based on equations (8.1) and (8.2), we have the following:

[54] The estimation results indicate that $var(\varsigma_{kw}) < var(\varsigma_{kb})$. This pattern is consistent with the fact that the online penetration is more even across locations than the local-force presence. KMT has substantially stronger local organizations in Northern Taiwan than in Southern Taiwan. To see $var(\varsigma_{kw}) < var(\varsigma_{kb})$, we only need to note from the estimation process that $var(\xi_{kw}) = 0.2704 < var(\xi_{kb}) = 0.9892$. From equations (4.12) and (4.13), we can derive that $var(\varsigma_{kw}) - var(\varsigma_{kb}) = \big(var(\xi_{kw}) - var(\xi_{kb})\big)/3$.

$$V_{ig} = \frac{p_1}{p_0}(u_{ig} - u_{ib}) - \varphi - \varrho_k + \epsilon_{ig}$$
$$= \frac{p_1}{p_0}(\bar{u}_{ig} - \bar{u}_{ib} + \varsigma_{kg} - \varsigma_{kb}) - \varrho_k - \varphi + \epsilon_{ig} \quad \text{(R.1)}$$

$$V_{ib} = \frac{p_1}{p_0}(u_{ib} - u_{ig}) - \varphi - \varrho_k + \epsilon_{ib}$$
$$= \frac{p_1}{p_0}(\bar{u}_{ib} - \bar{u}_{ig} + \varsigma_{kb} - \varsigma_{kg}) - \varrho_k - \varphi + \epsilon_{ib} \quad \text{(R.2)}$$

Adding equations (4.11), (4.12), and (4.13) together, we obtain the following:

$$\varrho_k = -\frac{1}{3}(\xi_{kg} + \xi_{kb} + \xi_{kw}) \quad \text{(R.3)}$$

Considering equation (4.11) minus equation (4.12), we have the following:

$$\varsigma_{kg} - \varsigma_{kb} = \frac{1}{3}(\xi_{kg} - \xi_{kb}) \quad \text{(R.4)}$$

Plugging (R.3) and (R.4) into (R.1) and (R.2), we have the following:

$$V_{ig} = \frac{p_1}{p_0}(\bar{u}_{ig} - \bar{u}_{ib}) + \frac{p_1}{p_0}\frac{1}{3}(\xi_{kg} - \xi_{kb}) + \frac{1}{3}(\xi_{kg} + \xi_{kb} + \xi_{kw}) - \varphi + \epsilon_{ig}$$
$$= \frac{p_1}{p_0}(\bar{u}_{ig} - \bar{u}_{ib}) + \frac{1}{3}\left[\left(1 + \frac{p_1}{p_0}\right)\xi_{kg} + \left(1 - \frac{p_1}{p_0}\right)\xi_{kb} + \xi_{kw}\right] \quad \text{(R.5)}$$
$$- \varphi + \epsilon_{ig}$$

$$V_{ib} = \frac{p_1}{p_0}(\bar{u}_{ib} - \bar{u}_{ig}) + \frac{p_1}{p_0}\frac{1}{3}(\xi_{kb} - \xi_{kg}) + \frac{1}{3}(\xi_{kg} + \xi_{kb} + \xi_{kw}) - \varphi + \epsilon_{ib}$$
$$= \frac{p_1}{p_0}(\bar{u}_{ib} - \bar{u}_{ig}) + \frac{1}{3}\left[\left(1 - \frac{p_1}{p_0}\right)\xi_{kg} + \left(1 + \frac{p_1}{p_0}\right)\xi_{kb} + \xi_{kw}\right] \quad \text{(R.6)}$$
$$- \varphi + \epsilon_{ib}$$

R.2. Derivations from the first line to the last line of equations (9.2) and (9.3)

$$V_{ig} = \frac{p_2}{p_0}(u_{ig} - u_{ibw}) - \varphi - \varrho_k + \epsilon_{ig}$$
$$= \frac{p_2}{p_0}\left[\bar{u}_{ig} - \bar{u}_{ibw} + \varsigma_{kg} - (1 - \varpi_{bw3})\varsigma_{kb} - \varpi_{bw3}\varsigma_{kw}\right] - \varrho_k$$
$$- \varphi + \epsilon_{ig} \quad \text{(R.7)}$$
$$= \frac{p_2}{p_0}[\bar{u}_{ig} - \bar{u}_{ibw} + \varsigma_{kg} - \varsigma_{kw} - (1 - \varpi_{bw3})(\varsigma_{kb} - \varsigma_{kw})]$$
$$- \varrho_k - \varphi + \epsilon_{ig}$$

$$
\begin{aligned}
V_{ibw} &= \frac{p_2}{p_0}\left[u_{ibw} - u_{ig}\right] - \varphi - \varrho_k + \epsilon_{ibw} \\
&= \frac{p_2}{p_0}\left[\bar{u}_{ibw} - \bar{u}_{ig} + (1 - \varpi_{bw3})\varsigma_{kb} + \varpi_{bw3}\varsigma_{kw} - \varsigma_{kg}\right] - \varrho_k \\
&\quad - \varphi + \epsilon_{ibw} \\
&= \frac{p_2}{p_0}\left[\bar{u}_{ibw} - \bar{u}_{ig} + (1 - \varpi_{bw3})(\varsigma_{kb} - \varsigma_{kw}) + \varsigma_{kw} - \varsigma_{kg}\right] \\
&\quad - \varrho_k - \varphi + \epsilon_{ibw}
\end{aligned}
\tag{R.8}
$$

Considering equation (4.11) minus equation (4.13), we have the following:

$$
\varsigma_{kg} - \varsigma_{kw} = \frac{1}{3}\left(\xi_{kg} - \xi_{kw}\right) \tag{R.9}
$$

Considering equation (4.12) minus equation (4.13), we have the following:

$$
\varsigma_{kb} - \varsigma_{kw} = \frac{1}{3}\left(\xi_{kb} - \xi_{kw}\right) \tag{R.10}
$$

Plugging (R.3), (R.9), and (R.10) into (R.7) and (R.8), we have the following:

$$
\begin{aligned}
V_{ig} &= \frac{p_2}{p_0}\left(\bar{u}_{ig} - \bar{u}_{ibw}\right) \\
&\quad + \frac{1}{3}\left[\left(1 + \frac{p_2}{p_0}\right)\xi_{kg} + \left(1 - \frac{p_2}{p_0}(1 - \varpi_{bw3})\right)\xi_{kb}\right. \\
&\quad \left. + \left(1 - \frac{p_2}{p_0}\varpi_{bw3}\right)\xi_{kw}\right] - \varphi + \epsilon_{ig}
\end{aligned}
\tag{R.11}
$$

$$
\begin{aligned}
V_{ibw} &= \frac{p_2}{p_0}\left(\bar{u}_{ibw} - \bar{u}_{ig}\right) \\
&\quad + \frac{1}{3}\left[\left(1 - \frac{p_2}{p_0}\right)\xi_{kg} + \left(1 + \frac{p_2}{p_0}(1 - \varpi_{bw3})\right)\xi_{kb}\right. \\
&\quad \left. + \left(1 + \frac{p_2}{p_0}\varpi_{bw3}\right)\xi_{kw}\right] - \varphi + \epsilon_{ibw}
\end{aligned}
\tag{R.12}
$$

R.3. Derivations from the first line to the last line of equations (E.2), (E.3), and (E.4)

$$
\begin{aligned}
V_{ig} &= 2u_{ig} - u_{ib} - u_{iw} - \varphi - \varrho_k + \epsilon_{ig} \\
&= 2\bar{u}_{ig} - \bar{u}_{ib} - \bar{u}_{iw} + 2\left(1 - \kappa_{g3}\right)\varsigma_{kg} + 2\kappa_{g3}\varsigma_{kw} - \varsigma_{kb} - \varsigma_{kw} \\
&\quad - \varrho_k - \varphi + \epsilon_{ig} \\
&= 2\bar{u}_{ig} - \bar{u}_{ib} - \bar{u}_{iw} + 2\left(1 - \kappa_{g3}\right)\left(\varsigma_{kg} - \varsigma_{kw}\right) + \varsigma_{kw} - \varsigma_{kb} - \varrho_k \\
&\quad - \varphi + \epsilon_{ig}
\end{aligned}
\tag{R.13}
$$

$$
\begin{aligned}
V_{ib} &= 2u_{ib} - u_{ig} - u_{iw} - \varphi - \varrho_k + \epsilon_{ib} \\
&= 2\bar{u}_{ib} - \bar{u}_{ig} - \bar{u}_{ig} + 2\varsigma_{kb} - \left(1 - \kappa_{g3}\right)\varsigma_{kg} - \kappa_{g3}\varsigma_{kw} - \varrho_k - \varphi \\
&\quad + \epsilon_{ib} \qquad \text{(R.14)} \\
&= 2\bar{u}_{ib} - \bar{u}_{ig} - \bar{u}_{ig} + 2(\varsigma_{kb} - \varsigma_{kw}) + \left(1 - \kappa_{g3}\right)\left(\varsigma_{kw} - \varsigma_{kg}\right) \\
&\quad - \varrho_k - \varphi + \epsilon_{ib} \\
V_{iw} &= 2u_{iw} - u_{ig} - u_{ib} - \varphi - \varrho_k + \epsilon_{iw} \\
&= 2\bar{u}_{iw} - \bar{u}_{ig} - \bar{u}_{ib} + 2\varsigma_{kw} - \left(1 - \kappa_{g3}\right)\varsigma_{kg} - \kappa_{g3}\varsigma_{kw} - \varsigma_{kb} \\
&\quad - \varrho_k - \varphi + \epsilon_{iw} \qquad \text{(R.15)} \\
&= 2\bar{u}_{iw} - \bar{u}_{ig} - \bar{u}_{ib} + 2(\varsigma_{kw} - \varsigma_{kb}) + \left(1 - \kappa_{g3}\right)\left(\varsigma_{kw} - \varsigma_{kg}\right) \\
&\quad - \varsigma_{kb} - \varrho_k - \varphi + \epsilon_{iw}
\end{aligned}
$$

Plugging (R.3), (R.9), and (R.10) into (R.13), (R.14), and (R.15), we have the following:

$$V_{ig} = 2\bar{u}_{ig} - \bar{u}_{ib} - \bar{u}_{iw} + \frac{1}{3}\left[\left(3 - 2\kappa_{g3}\right)\xi_{kg} + 2\kappa_{g3}\xi_{kw}\right] - \varphi + \epsilon_{ig} \qquad \text{(R.16)}$$

$$V_{ib} = 2\bar{u}_{ib} - \bar{u}_{ig} - \bar{u}_{ig} + \frac{1}{3}\left[\kappa_{g3}\xi_{kg} + 3\xi_{kb} - \kappa_{g3}\xi_{kw}\right] - \varphi + \epsilon_{ib} \qquad \text{(R.17)}$$

$$V_{iw} = 2\bar{u}_{iw} - \bar{u}_{ig} - \bar{u}_{ib} + \frac{1}{3}\left[\kappa_{g3}\xi_{kg} + \left(3 - \kappa_{g3}\right)\xi_{kw}\right] - \varphi + \epsilon_{iw} \qquad \text{(R.18)}$$

Appendix S. Additional figures and tables

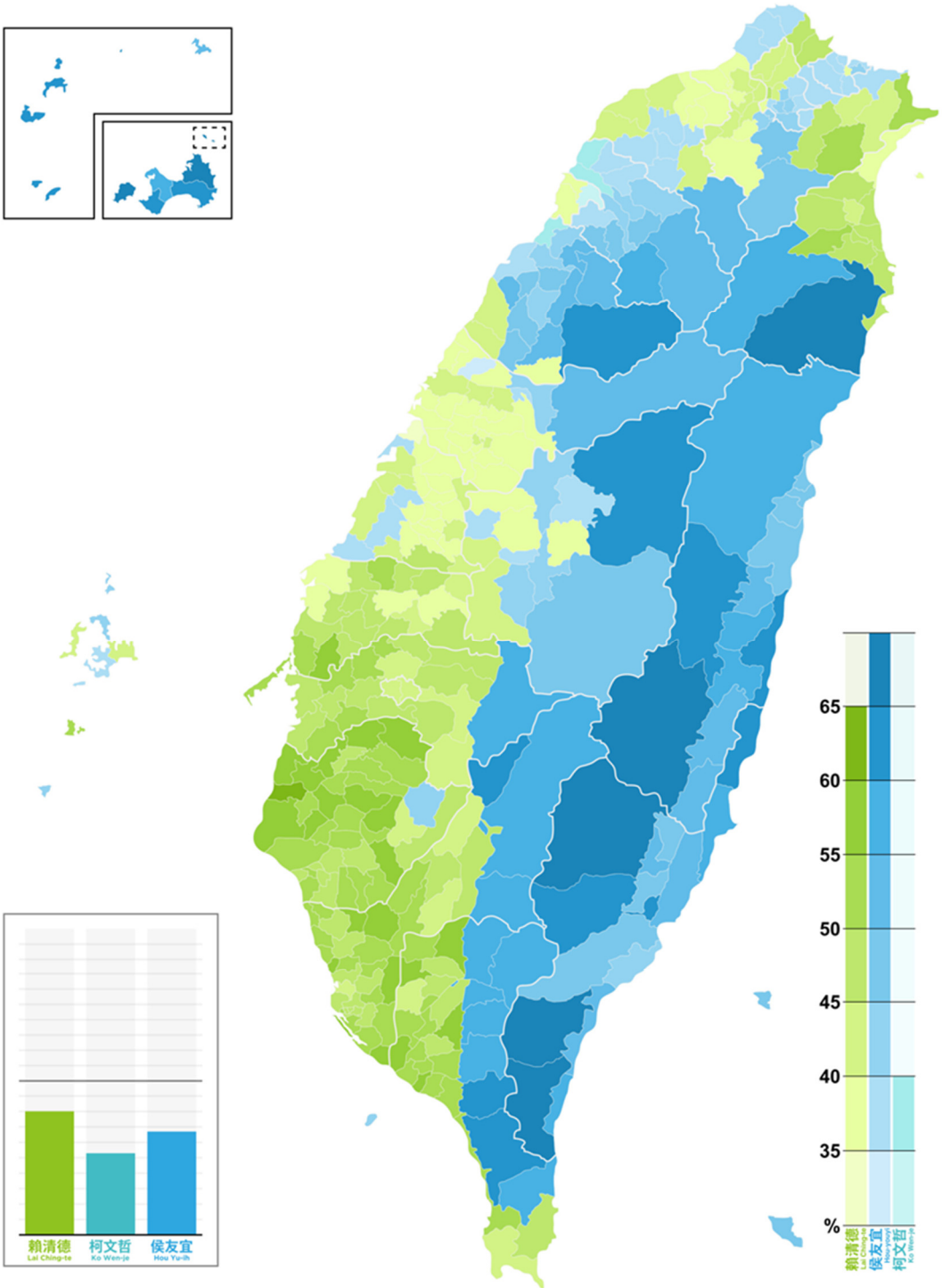


Figure S.1. The 2024 Taiwan presidential election results at the district/township level. (Downloaded from https://en.wikipedia.org/wiki/2024_Taiwanese_presidential_election)

Table S1. Descriptive statistics (2020 election)

District/township-level variables	N	Mean	Std Dev
Eligible voters	368	52475.83	67742.20
Vote share of DPP	368	0.3872	0.1185
Vote share of KMT	368	0.3227	0.0898
Share of not voting	368	0.2900	0.0761
$20 \leq age < 29$	368	0.1615	0.0227
$30 \leq age < 39$	368	0.1715	0.0249
$40 \leq age < 49$	368	0.1826	0.0198
$50 \leq age < 59$	368	0.1935	0.0134
$60 \leq age < 69$	368	0.1584	0.0171
$age \geq 70$	368	0.1325	0.0390
$Male$	368	0.5112	0.0246
$Female$	368	0.4888	0.0246
$Elementary$	368	0.1424	0.0395
$Junior-high$	368	0.1291	0.0287
$Senior-high$	368	0.2806	0.0291
$College$	368	0.4479	0.0822

Table S2. Regions in Taiwan

	Cities and counties included
Region 1	New Taipei City
Region 2	Taipei City
Region 3	Taoyuan City, Hsinchu County, Hsinchu City, and Miaoli County
Region 4	Taichung City, Changhua County, and Nantou County
Region 5	Yunlin County, Chiayi County, Chiayi City, and Tainan City
Region 6	Kaohsiung City and Pingtung County
Region 7	Keelung City, Yilan County, Hualien County, Taitung County, Penghu County, Kinmen County, and Lienchiang County

Table S.3. Correlation between voters' ideological stance and satisfaction with current economic situation

		Degree of satisfaction with the current economic situation				
Ideological grade		Excellent	Good	A little bad	Bad	No answer
1		21.0%	57.9%	13.8%	3.7%	3.6%
2		2.9%	63.5%	19.2%	9.9%	4.6%
3		10.5%	36.6%	27.2%	17.6%	8.1%
4		0.8%	30.2%	26.3%	40.4%	2.3%
5		1.2%	28.8%	20.9%	31.1%	18.0%
6		3.0%	45.5%	26.1%	18.3%	7.0%
7		0%	11.9%	31.5%	51.0%	5.6%
8		0%	5.5%	40.3%	48.8%	5.4%
9		0%	1.8%	26.8%	70.2%	1.3%

Data source: the Formosa poll. The percentages in each row add up to one.

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