This supplementary material consists of two parts

Online Appendix Material (Part I) for

# Untangling the Relationship between Corporate Political Ties and Low-carbon Innovation: The Moderating Roles of Prominence and Favorability

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## Online Appendix A. Robustness Checks

### Online Appendix A1. Rechecking the U-shaped relationship

Lind & Mehlum [5] pointed out that the mere criterion of including and checking the significant level of the quadric term in a regression model is too weak to claim a U-shaped relationship. To ensure the existence of this U-shaped relationship between PT and LCI, we take a step forward to carry out the U-shape test suggested by them, and the results are shown in Online Appendix Table S7. It is evident that (1) the slope of the left-hand side is significantly negative, whereas the slope of the right-hand side is significantly positive; (2) both two estimated extreme point of PT (i.e. 3.82 and 3.71) are within the domain of 95% confidence interval regardless of Fieller method or Delta method. All evidence reassures us of the U-shaped relationship between these two variables of interest.

### Online Appendix A2. Separating channels of corporate political ties

As noted, there are two main channels, namely the government (i.e. Channel 1) and NPC/NPPCC (i.e. Channel 2), that China's listed firms can utilize to seek PT. So, one concern is that the previous combination of two channels may confound previous estimates. To this end, we further partition PT into ***Channel1_PT*** and ***Channel2_PT***. Our previous findings are robust with both more fine-grained types of PT (see Online Appendix Table S8 & Table S9). Also, we report statistical distribution of ***Channel1_PT*** and ***Channel2_PT*** in Appendix Online S5. It reveals that either ***Channel1_PT*** or ***Channel2_PT*** ranges from 0 to 8.

### Online Appendix A3. Alternative measures of corporate prominence

Given China's unique setting, we alter the measurement of each listed firm's prominence by using the Baidu Search Index (http://index.baidu.com). Baidu Search Index (BSI) is a data platform that can be used to capture massive China's netizen behavior and public prominence, which is designed by Baidu, China's leading and well-known search engine. We program a script to crawl the annual BSI for each listed firm in our sample.

Our previous findings are still robust (see Online Appendix Table S10). Note that the sample size has decreased as BSI has been available since 2011.

## Online Appendix A4. Alternating estimation method

Table 2 reminds us that the natural logarithm transformation is not efficient enough to correct the skewness of the LCI variable, thereby potentially leading to estimation bias in linear regressions. Since patent applications and authorizations can be regarded as non-negative integers [6], we adopt the negative binomial regression method to rerun these models. The result of negative binomial regression is reported in Online Appendix Table S11, and evidently, these results are consistent with our previous findings.

## Online Appendix A5. Mitigating omitted variable bias

Our measurement of the level of PT is built on CEOs' or Chairmen's political capital, so it is intuitive to reason that their characteristics may correlate with their political connections and decisions on LCI investment. Following Yu et al. [7], we further control for CEOs' and Chairmen's characteristics, such as age and gender, and the results can be found in Online Appendix Table S12. In sum, our previous findings remain unchanged.

## Online Appendix A6. Correcting for sample selection bias

### Online Appendix A6.1. Two-stage Heckman selection model

Since we exclude firms listed in the financial sector, sample selection bias may occur. Factors that influence whether firms choose to cultivate PT may likely correlate with our dependent variable, LCI. Thus, we use the two-stage Heckman selection model proposed by Heckman [8] to correct for potential sample selection bias. Given that a firm's behavior of seeking PT has the potential to be influenced by its industry peers, and industrial-level PT may not directly affect a firm's LCI [9], we include industrial-level PT in the first-stage model to calculate the inverse Mills ratio (IMR). In the second-stage regression, IMR is added as a control to control for sample selection bias. As shown in Online Appendix Table S13, the result after correcting for sample selection bias remains consistent with our previous estimates.

### Online Appendix A6.2. Propensity Score Matching (PSM)

To further mitigate the concern about the selection bias that firms' behavior of seeking PT is not randomly selected, we employ a PSM approach to match firms with PT to firms without PT. Specifically, a logit regression is used to estimate the propensity of seeking PT within all samples. Then, each firm with PT is matched to a firm without PT using the nearest neighbor matching technique [10]. It appears that the matching technique is useful in balancing the difference in the distribution of the treatment group and control group (see Online Appendix Fig S1), and our results are still robust (see Online Appendix Table S14).

## Online Appendix A7. Correcting for potential reverse causality

It is worthwhile to consider the issue of reverse causality since CEOs or Chairmen who run firms with excellent environmental performance may be likelier to be elected as a delegate of NPC or NPPCC. To address this issue, we take into account the two-stage residual inclusion model (2SRI), which is more efficient than traditional two-stage least square regressions (2SLS) in estimating non-linear econometric models [11], [12]. Following the related literature [6], [9], [13], we select the industrial average of PT (excluding the focal firm itself) as an instrumental variable (IV). The rationale is that removing the firm-specific component of political connections will result in an exogenous component that can then be correlated with a firm's tendency to promote LCI [13]. The result after correcting for reverse causality can be found in Online Appendix Table S15, and our previous findings remain unchanged. Additionally, the validity of this IV is verified by the under-identification test (Anderson LM statistic=78.478, p=0.000) and the weak-identification test (Cragg-Donald Wald F statistic = 78.694, Kleibergen-Paap rk Wald F statistic = 72.935).

## Online Appendix A8. Three-way fixed effects models

Here we rerun specification (1) and (2) with the additional inclusion of Firm FE in addition to Industry FE and Year FE. It appears that the results of three-way fixed effects models remain consistent with that of our previous two-way fixed models (See Online Appendix Table S16). In addition, the stringency of environmental regulations is not balanced among China's regions, and LCI may be impacted by geographical clustering, which may confound our estimations. To rule out this potential, we re-estimate the three-way fixed effects models by including the province-level effects. As a result, it reveals that our previous results are still sound (See Online Appendix Table S17).

## Online Appendix A9. The heterogeneity of innovation patents

Our measurement of LCI is based on patent data, and one concern may arise from strategic patenting. Specifically, invention patents are generally granted under stricter conditions than utility model patents in China, as the former necessitates exceptional substantive characteristics and significant technological advancement. Hence, it is argued that firms may deliberately cater to environmental innovation policies through utility model patents, leading to strategic innovation. Thus, it is plausible to check whether our findings are conditional on the heterogeneity of innovation patents. To this end, we re-estimate models by considering the replacement of invention patents and utility model patents. The results (See Online Appendix Table S18 & Table S19) remind us that either the U-shaped relationship or the moderation role of corporate reputation is not specific to the heterogeneity of patents.

## Online Appendix A10. Mitigating the concern of firm migration

The reasons behind firm migration or relocation may be associated with PT in the real world. For instance, firms may migrate their locations to other places once they find it hard to afford the costs of developing local PT. Considering the relocation of operation address is more usual than headquarter migration for China's listed firms, we create a Python script to carefully screen out all those cases in which the listed firms have ever altered their registered operation places during the sample period. Finally, it turns out that there are 201 sample points (i.e. roughly 6% of total sample firms or 7% of total firm-year observations) with the track record of operation place migrations. Thus, we feel that the concern caused by firm migration in our data, if any, should be minor.

We begin with excluding those observations where firms' operation addresses have been relocated and then rerun regression models with firm FE, industry FE and year FE. As shown in Online Appendix Table S20, the results suggest that our prior estimates have remained robust. Moreover, we decide to add the consideration of whether firm migration occurs into the group of control variables so as to try to control for potential confounding effects brought about by firm migration. Specifically, we construct a dummy variable that quals to 1 if firms' operation addresses have undergone migration and 0 otherwise, which ***Firm_Migration*** denotes. As shown in Online Appendix Table S21, the result suggests that our earlier estimates still hold.

## Online Appendix A11. Mitigating the concern of political turnover

Political turnover is usual in China, and on average, the duration of mayors is less than three years [14]. Hence, political uncertainty induced by political turnover may influence our approach of operationalizing PT. For instance, the turnover of an official may confront firms with the concern that the established PT may be weakened or at worst terminated.

Given that changes in city-level politicians constitute a more representative type of political uncertainty faced by Chinese firms, we pay closer attention to city-level political turnover. Consistent with China's institutional setting and taking inspirations from the current body of literature on political uncertainty [15], [16], we construct three dummy variables respectively denoted as ***Turnover_Headquarter***, ***Turnover_Operation*** and ***Turnover_Headquarter&Operation***. Taking ***Turnover_Headquarter*** as an example, if there is a change in the mayor of the city where a listed firm is headquartered, the variable, ***Turnover_Headquarter***, takes the value of one and zero otherwise. Likewise, if there is a change in the mayor of the city where a listed firm locates its operation office, the variable, ***Turnover_Operation***, takes the value of one and zero otherwise. Finally, if there is a concurrent change in the city's mayor where a listed firm locates its headquarters as well as operation office, the variable, ***Turnover_Headquarter&Operation***, takes the value of one and zero otherwise.

The reason for focusing on political turnover in the mayor is that in China, Party secretaries is mainly responsible for the Party affairs, while the mayor is responsible for specific economic policies and economic affairs [15]. This makes mayors more closely related with firms and accordingly more direct influences on firms' innovation activities. In line with Deng et al. [15], the current year is defined as the turnover year if a new mayor takes office in the sense that the previous one leaves office between January 1 and June 30. Otherwise, if a new mayor takes office in the sense that the previous one leaves office between July 1 and December 31, then the next year is defined as the turnover year.

We respectively multiply three dummy variables with the linear and quadratic terms of corporate political ties to further construct interaction terms, and then rerun regression models with firm FE, industry FE and year FE. As shown in Online Appendix Table S22, it seems that our way of constructing the index of PT is not sensitive to the type of political uncertainty induced by turnover in the mayor who governs the city where the headquarter and operation office of listed firms are located.

In addition, we adopt a straightforward way to exclude observations that have undergone abovementioned type of political turnover and rerun the same regression models. The result is shown in Online Appendix Table S23. Therein, model (1) and (2) display results by excluding observations where firms' headquarters have a track record of political turnover. Model (3) and (4) demonstrate results by excluding observations where firms' registered operation address has undergone political turnover. Finally, model (5) and (6) report results by excluding observations where the list firm's both headquarter and operation office have simultaneously experienced political turnover. Overall, the curvilinear effects of PT are still sound.

## Online Appendix S12. Checking the validity of PT

One may question that whether our way of building PT is valid for SOEs. To this end, we supplement Online Appendix Table S24. First, it indicates that our sample comprises roughly 63% of non-SOEs and 37% of SOEs, as China's capital markets have seen a fundamental shift from state ownership to private ownership over the past decades [1]. Second, it appears that, on average, CEOs or Chairmen of non-SOEs possess relatively higher levels of PT than their state-owned counterparts. This is due to the fact that the motivations for privately-owned listed firms to gain political legitimacy and government-controlled resources are more significant [1]. Third, we calculate the coefficient of variation (C.V.) to compare the dispersion of PT between SOEs and non-SOEs, and it indicates that the variation of PT for SOEs is slighter than non-SOEs, meaning that the distribution of PT among SOEs is more balanced.

It is undeniable to acknowledge the fact that PT of SOEs and non-SOEs should manifest in different ways, given the disparity of legal status and business objectives [2]. In this regard, the distribution pattern of PT should arguably pertain to ownership structure. So, it would be useful to check whether our established PT index can significantly differentiate SOEs and non-SOEs in statistics. If so, we can have a sense that the PT index indeed corresponds to the real-world characteristics of SOEs versus non-SOEs. Otherwise, it indicates that the PT index is not sensitive to cases of SOEs. To do this, we decide to perform a two-tailed T-test in statistics that can be used to compare the mean of PT distribution between SOEs and non-SOEs. The null hypothesis assumes that the mean value of PT for non-SOEs equates to that of SOEs in the sense that the difference in the means of these two groups is zero. The result in Online Appendix Table S24 suggests that the null hypothesis should be rejected. In other words, the result demonstrates a significant difference in average PT index between SOEs and non-SOEs at the 1% significance level. We also perform a Wilcoxon rank-sum test in statistics for the same purpose. The null hypothesis is that the distribution pattern of PT in SOEs is identical to that of non-SOEs and thus shares the same median. The statistical evidence illustrated in Online Appendix Table S24 indicates that this null hypothesis must be rejected. In sum, it can be reasoned that based on our approach, both SOEs and non-SOEs see significantly distinct distribution of PT, which in turn offers justification for the validity of our key independent variable, i.e. PT.

Second, although our PT index is based on real-data exploration, we decide to perform a sensitivity test. In an attempt to attain the distance between China's listed firms and governments, Wang et al. [3] assigned one more unit for the value of hierarchical distance in non-SOEs than in SOEs, because they feel that SOEs are more administratively closer to different levels of government organizations. Following a similar logic, we decide to deliberately assign one additional unit for PT index in SOEs with the assumption that all CEOs or Chairmen of SOEs have at least one unit of PT. However, this is not true when it comes to our data that about 34% of CEOs or Chairmen of SOEs are tied to politics. Under this circumstance, PT with this special treatment is denoted as PT_*ST*. We rerun prior regression models, and it turns out that the estimates are not sensitive to this SOEs-specified turbulence in the PT index (see Online Appendix Table S25).

We also conduct a further analysis to discuss whether the U-shaped curve is subject to ownership structure (see Online Appendix Table S27 for detail). The result suggests that the curvilinear effect is sound in the SOE or non-SOE subsample. Also, it appears that SOEs generate a steeper U-shaped curve than non-SOEs. To accurately reach this conclusion, we conduct Fisher's Permutation test to check the difference between the coefficients on the quadric term of PT of two subsamples. The results reveal significant differences in statistics.

Nonetheless, there may be other functional forms that can interpret the relationship between PT and LCI as well. Thus, we decide to check whether our results are robust to alternative functional forms. Taking inspiration from Barnett and Salomon [4], we rerun models respectively using a cubic function, a quartic function, and a fractional polynomial function as specifications. However, none of these alternative functional forms are supported. Instead, the results consistently supported a U-shaped specification. Thus, *to a certain extent*, the above-mentioned disparity of the U-shaped curve between SOEs and non-SOEs can help verify the validity of PT.

Collectively, the evidence reassures us of the validity of the established PT index to SOEs or non-SOEs.

**Table S1**. Sample distribution across industries and years

| Panel A: Sample distribution across industries | | | |
|---|---|---|---|
| SIC code | Industry | Freq. | Percent (%) |
| A | Agriculture, forestry, animal husbandry, and fishery | 365 | 1.50 |
| B | Mining | 609 | 2.50 |
| C | Manufacturing | 15,690 | 64.5 |
| D | Electricity, heat, gas, and water production and supply | 824 | 3.39 |
| E | Construction industry | 647 | 2.66 |
| F | Wholesale and retail | 1,343 | 5.52 |
| G | Transportation, warehousing, and postal services | 770 | 3.17 |
| H | Hospitality and catering | 90 | 0.37 |
| I | Information and software technology services | 1,459 | 6.00 |
| K | Real estate | 1,142 | 4.70 |
| L | Leasing and business services | 288 | 1.18 |
| M | Scientific research and technical services | 203 | 0.83 |
| N | Environment and public facilities management | 249 | 1.02 |
| O | Residential services and other services | 28 | 0.12 |
| P | Education | 12 | 0.05 |
| Q | Sanitation and social work | 46 | 0.19 |
| R | Culture, sports and entertainment | 300 | 1.23 |
| S | Comprehensive industry | 258 | 1.06 |

| Panel B: Sample distribution across years | | |
|---|---|---|
| Years | Freq. | Percent (%) |
| 2009 | 1,439 | 5.92 |
| 2010 | 1,764 | 7.25 |
| 2011 | 2,058 | 8.46 |
| 2012 | 2,245 | 9.23 |
| 2013 | 2,294 | 9.43 |
| 2014 | 2,422 | 9.96 |
| 2015 | 2,633 | 10.83 |
| 2016 | 2,834 | 11.65 |
| 2017 | 3,268 | 13.44 |
| 2018 | 3,366 | 13.84 |

Note: The category of industries is referred to the Guidelines for the Industry Classification of Listed Companies in China (2012).

**Table S2**. Descriptive statistics and correlations

| | Mean | S.D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. **App** | 0.298 | 0.744 | 1.000 | | | | | | | | | |
| 2. **Auth** | 0.126 | 0.446 | 0.623$^{***}$ | 1.000 | | | | | | | | |
| 3. PT | 2.486 | 3.853 | 0.022$^{***}$ | 0.024$^{***}$ | 1.000 | | | | | | | |
| 4. PT$^2$ | 21.026 | 43.550 | 0.047$^{***}$ | 0.046$^{***}$ | 0.934$^{***}$ | 1.000 | | | | | | |
| 5. PT dummy | 0.360 | 0.480 | -0.016$^{**}$ | -0.007$^{*}$ | 0.860$^{***}$ | 0.643$^{***}$ | 1.000 | | | | | |
| 6. GF | 0.285 | 0.304 | 0.083$^{***}$ | 0.065$^{***}$ | -0.010 | -0.004 | -0.020$^{***}$ | 1.000 | | | | |
| 7. **CP** | 8.633 | 0.830 | 0.112$^{***}$ | 0.130$^{***}$ | -0.041$^{***}$ | -0.025$^{***}$ | -0.055$^{***}$ | 0.028$^{***}$ | 1.000 | | | |
| 8. ROE | 0.074 | 0.113 | 0.060$^{***}$ | 0.028$^{***}$ | 0.065$^{***}$ | 0.066$^{***}$ | 0.047$^{***}$ | 0.037$^{***}$ | -0.068$^{***}$ | 1.000 | | |
| 9. **FirmSize** | 22.039 | 1.280 | 0.216$^{***}$ | 0.217$^{***}$ | 0.055$^{***}$ | 0.060$^{***}$ | 0.037$^{***}$ | 0.026$^{***}$ | 0.416$^{***}$ | 0.093$^{***}$ | 1.000 | |
| 10. FirmLev | 0.422 | 0.211 | 0.066$^{***}$ | 0.067$^{***}$ | -0.010 | -0.014$^{**}$ | 0.002 | -0.064$^{***}$ | 0.189$^{***}$ | -0.171$^{***}$ | 0.521$^{***}$ | 1.000 |
| 11. **Growth** | 0.194 | 0.445 | -0.006 | -0.010 | 0.003 | 0.004 | 0.001 | 0.012$^{*}$ | -0.001 | 0.220$^{***}$ | 0.049$^{***}$ | 0.033$^{***}$ |
| 12. Dual | 0.266 | 0.442 | 0.004 | -0.000 | 0.116$^{***}$ | 0.207$^{***}$ | -0.051$^{***}$ | 0.022$^{***}$ | -0.070$^{***}$ | 0.027$^{***}$ | -0.185$^{***}$ | -0.167$^{***}$ |
| 13. SOE | 0.370 | 0.483 | 0.023$^{***}$ | 0.026$^{***}$ | -0.082$^{***}$ | -0.094$^{***}$ | -0.039$^{***}$ | -0.035$^{***}$ | 0.140$^{***}$ | -0.056$^{***}$ | 0.361$^{***}$ | 0.321$^{***}$ |
| 14. **FirmAge** | 2.766 | 0.382 | -0.026$^{***}$ | 0.008 | -0.080$^{***}$ | -0.070$^{***}$ | -0.067$^{***}$ | 0.053$^{***}$ | 0.270$^{***}$ | -0.078$^{***}$ | 0.181$^{***}$ | 0.210$^{***}$ |
| 15. Top1 | 0.353 | 0.150 | 0.014$^{**}$ | 0.027$^{***}$ | 0.022$^{***}$ | 0.026$^{***}$ | 0.011$^{*}$ | -0.038$^{***}$ | -0.070$^{***}$ | 0.134$^{***}$ | 0.205$^{***}$ | 0.065$^{***}$ |
| 16. BSize | 8.680 | 1.738 | 0.074$^{***}$ | 0.076$^{***}$ | 0.030$^{***}$ | 0.013$^{**}$ | 0.050$^{***}$ | -0.028$^{***}$ | 0.060$^{***}$ | 0.034$^{***}$ | 0.283$^{***}$ | 0.174$^{***}$ |
| 17. BIndep | 0.372 | 0.057 | 0.015$^{**}$ | 0.014$^{**}$ | 0.006 | 0.018$^{***}$ | -0.013$^{**}$ | -0.001 | 0.047$^{***}$ | -0.028$^{***}$ | 0.013$^{**}$ | -0.017$^{***}$ |
| 18. **R&D** | 13.738 | 7.338 | 0.227$^{***}$ | 0.178$^{***}$ | -0.041$^{***}$ | -0.009 | -0.081$^{***}$ | 0.172$^{***}$ | 0.009 | 0.022$^{***}$ | -0.006 | -0.200$^{***}$ |

| | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|
| 11. **Growth** | 1.000 | | | | | | |
| 12. Dual | 0.023$^{***}$ | 1.000 | | | | | |
| 13. SOE | -0.070$^{***}$ | -0.295$^{***}$ | 1.000 | | | | |
| 14. **FirmAge** | -0.018$^{***}$ | -0.102$^{***}$ | 0.172$^{***}$ | 1.000 | | | |
| 15. Top1 | -0.002 | -0.044$^{***}$ | 0.228$^{***}$ | -0.118$^{***}$ | 1.000 | | |
| 16. BSize | -0.022$^{***}$ | -0.172$^{***}$ | 0.267$^{***}$ | 0.023$^{***}$ | 0.023$^{***}$ | 1.000 | |
| 17. BIndep | 0.007 | 0.105$^{***}$ | -0.056$^{***}$ | -0.014$^{**}$ | 0.050$^{***}$ | -0.471$^{***}$ | 1.000 |
| 18. **R&D** | 0.006 | 0.117$^{***}$ | -0.223$^{***}$ | -0.119$^{***}$ | -0.049$^{***}$ | -0.051$^{***}$ | 0.031$^{***}$ |

*Note:* $^{*}$ $p < .10$, $^{**}$ $p < .05$, $^{***}$ $p < .01$. Variables highlighted in bold is through log transformed. PT dummy is a dummy variable that equals 0 if the firm has no PT in a given year and 1, otherwise.

**Table S3**. Corporate low-carbon innovation distribution across industries and ownership structure

| SIC code | Industry | Non-SOEs_Mean | SOEs_Mean | Industry_Mean |
|---|---|---|---|---|
| A | Agriculture, forestry, animal husbandry, and fishery | 0.106 | 0.049 | 0.082 |
| B | Mining | 0.092 | 0.818 | 0.572 |
| C | Manufacturing | 0.270 | 0.357 | 0.294 |
| D | Electricity, heat, gas, and water production and supply | 0.369 | 0.171 | 0.204 |
| E | Construction industry | 0.520 | 0.300 | 0.419 |
| F | Wholesale and retail | 0.007 | 0.012 | 0.009 |
| G | Transportation, warehousing, and postal services | 0.035 | 0.033 | 0.034 |
| H | Hospitality and catering | 0.000 | 0.000 | 0.000 |
| I | Information and software technology services | 0.335 | 0.637 | 0.389 |
| K | Real estate | 0.008 | 0.001 | 0.005 |
| L | Leasing and business services | 0.063 | 0.005 | 0.037 |
| M | Scientific research and technical services | 0.521 | 0.900 | 0.605 |
| N | Environment and public facilities management | 0.945 | 0.112 | 0.601 |
| O | Residential services and other services | 0.193 | 0.015 | 0.097 |
| P | Education | 0.000 | 0.000 | 0.000 |
| Q | Sanitation and social work | 0.000 | 0.000 | 0.000 |
| R | Culture, sports and entertainment | 0.035 | 0.024 | 0.014 |
| S | Comprehensive industry | 0.006 | 0.053 | 0.032 |

Note: Non-SOEs refer to private firms, and SOEs refer to state-owned firms. Figures displayed in this table represent the average number of low-carbon patents applied (log transformed). The category of industries is referred to the Guidelines for the Industry Classification of Listed Companies in China (2012).

**Table S4**. Distribution of PT across years and industries

Panel A: Distribution of PT across years

| Year | PT | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **0** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** |
| **2009** | 825 | 18 | 52 | 88 | 81 | 107 | 68 | 76 | 11 | 31 | 13 | 28 | 8 | 20 | 2 | 11 |
| **2010** | 1006 | 22 | 53 | 108 | 104 | 120 | 80 | 89 | 18 | 51 | 13 | 46 | 8 | 33 | 2 | 11 |
| **2011** | 1169 | 27 | 67 | 122 | 127 | 145 | 94 | 103 | 15 | 64 | 11 | 50 | 9 | 39 | 4 | 11 |
| **2012** | 1275 | 38 | 71 | 120 | 149 | 149 | 102 | 115 | 19 | 68 | 11 | 54 | 10 | 46 | 5 | 12 |
| **2013** | 1340 | 43 | 79 | 120 | 146 | 138 | 99 | 111 | 19 | 63 | 10 | 52 | 9 | 42 | 5 | 18 |
| **2014** | 1465 | 40 | 85 | 116 | 134 | 136 | 101 | 109 | 19 | 80 | 14 | 49 | 7 | 43 | 4 | 20 |
| **2015** | 1833 | 38 | 67 | 84 | 112 | 130 | 83 | 81 | 13 | 76 | 10 | 51 | 7 | 32 | 1 | 15 |
| **2016** | 2003 | 39 | 62 | 103 | 108 | 148 | 88 | 79 | 18 | 66 | 12 | 50 | 5 | 37 | 2 | 14 |
| **2017** | 2249 | 57 | 80 | 121 | 138 | 167 | 93 | 99 | 19 | 87 | 18 | 66 | 7 | 49 | 4 | 14 |
| **2018** | 2396 | 58 | 70 | 118 | 145 | 160 | 93 | 96 | 14 | 80 | 11 | 56 | 6 | 43 | 4 | 16 |

Panel B: Summary statistics of PT across years

| Year | Mean | S.D. | Min | Max |
|---|---|---|---|---|
| 2009 | 2.886 | 3.926 | 0 | 16 |
| 2010 | 2.997 | 4.044 | 0 | 16 |
| 2011 | 2.978 | 4.009 | 0 | 16 |
| 2012 | 2.987 | 4.033 | 0 | 16 |
| 2013 | 2.853 | 4.002 | 0 | 16 |
| 2014 | 2.746 | 3.994 | 0 | 16 |
| 2015 | 2.117 | 3.686 | 0 | 16 |
| 2016 | 2.026 | 3.612 | 0 | 16 |
| 2017 | 2.162 | 3.718 | 0 | 16 |
| 2018 | 1.966 | 3.566 | 0 | 16 |

Panel C: Distribution of PT across industries

| SIC code | Industry | Mean | S.D. | Min | Max |
|---|---|---|---|---|---|
| A | Agriculture, forestry, animal husbandry, and fishery | 1.852 | 2.75 | 0 | 9 |
| B | Mining | 4.412 | 4.181 | 0 | 16 |
| C | Manufacturing | 2.204 | 3.821 | 0 | 16 |
| D | Electricity, heat, gas, and water production and supply | 3.462 | 3.558 | 0 | 14 |
| E | Construction industry | 3.372 | 4.368 | 0 | 16 |
| F | Wholesale and retail | 3.617 | 3.779 | 0 | 16 |
| G | Transportation, warehousing, and postal services | 4.029 | 4.07 | 0 | 15 |
| H | Hospitality and catering | 1.978 | 3.162 | 0 | 8 |
| I | Information and software technology services | 1.504 | 3.327 | 0 | 16 |
| K | Real estate | 2.514 | 2.923 | 0 | 13 |
| L | Leasing and business services | 2.309 | 4.047 | 0 | 14 |
| M | Scientific research and technical services | 3.635 | 5.535 | 0 | 16 |
| N | Environment and public facilities management | 2.747 | 4.744 | 0 | 16 |
| O | Residential services and other services | 1.714 | 2.72 | 0 | 7 |
| P | Education | 6.5 | 4.011 | 0 | 12 |
| Q | Sanitation and social work | 2.326 | 4.017 | 0 | 15 |
| R | Culture, sports and entertainment | 3.557 | 4.374 | 0 | 16 |
| S | Comprehensive industry | 3.5 | 3.273 | 0 | 10 |

Note: The category of industries is referred to the Guidelines for the Industry Classification of Listed Companies in China (2012).

**Table S5**. Distribution of two specific political channels

Panel A: Distribution of corporate low-carbon innovation across Channel1_PT and ownership structure

| Ownership Structure | Channel1_PT | App | | | | Auth | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | S.D. | Min | Max | Mean | S.D. | Min | Max |
| Non-SOEs | 0 | 0.291 | 0.703 | 0 | 6.026 | 0.117 | 0.416 | 0 | 4.710 |
| SOEs | 0 | 0.334 | 0.800 | 0 | 6.550 | 0.146 | 0.498 | 0 | 6.273 |
| Non-SOEs | 1 | 0.201 | 0.520 | 0 | 2.890 | 0.076 | 0.282 | 0 | 2.197 |
| SOEs | 1 | 0.242 | 0.656 | 0 | 3.611 | 0.107 | 0.385 | 0 | 2.890 |
| Non-SOEs | 2 | 0.189 | 0.643 | 0 | 3.951 | 0.061 | 0.309 | 0 | 2.303 |
| SOEs | 2 | 0.124 | 0.474 | 0 | 3.664 | 0.052 | 0.266 | 0 | 2.639 |
| Non-SOEs | 3 | 0.311 | 0.726 | 0 | 4.477 | 0.148 | 0.423 | 0 | 2.639 |
| SOEs | 3 | 0.216 | 0.665 | 0 | 4.625 | 0.094 | 0.352 | 0 | 2.890 |
| Non-SOEs | 4 | 0.259 | 0.676 | 0 | 5.043 | 0.099 | 0.363 | 0 | 2.996 |
| SOEs | 4 | 0.398 | 0.951 | 0 | 6.690 | 0.189 | 0.645 | 0 | 6.603 |
| Non-SOEs | 5 | 0.126 | 0.451 | 0 | 3.829 | 0.071 | 0.237 | 0 | 1.099 |
| SOEs | 5 | 0.237 | 0.841 | 0 | 4.220 | 0.079 | 0.304 | 0 | 1.609 |
| Non-SOEs | 6 | 0.256 | 0.667 | 0 | 3.807 | 0.100 | 0.376 | 0 | 2.890 |
| SOEs | 6 | 0.267 | 0.872 | 0 | 3.401 | 0.091 | 0.306 | 0 | 1.609 |
| Non-SOEs | 7 | 0.237 | 0.608 | 0 | 2.944 | 0.078 | 0.274 | 0 | 1.386 |
| SOEs | 7 | 0.326 | 0.669 | 0 | 2.639 | 0.095 | 0.353 | 0 | 1.946 |
| Non-SOEs | 8 | 0.390 | 0.906 | 0 | 5.468 | 0.189 | 0.578 | 0 | 4.190 |
| SOEs | 8 | 1.307 | 1.864 | 0 | 6.874 | 0.669 | 1.301 | 0 | 6.054 |

Panel B: Distribution of corporate low-carbon innovation across Channel2_PT and ownership structure

| Ownership Structure | Channel2_PT | App | | | | Auth | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | S.D. | Min | Max | Mean | S.D. | Min | Max |
| Non-SOEs | 0 | 0.291 | 0.703 | 0 | 6.026 | 0.117 | 0.416 | 0 | 4.710 |
| SOEs | 0 | 0.334 | 0.800 | 0 | 6.550 | 0.146 | 0.498 | 0 | 6.273 |
| Non-SOEs | 1 | 0.199 | 0.535 | 0 | 4.477 | 0.088 | 0.280 | 0 | 2.197 |
| SOEs | 1 | 0.208 | 0.588 | 0 | 3.611 | 0.090 | 0.329 | 0 | 2.639 |
| Non-SOEs | 2 | 0.181 | 0.618 | 0 | 4.263 | 0.082 | 0.336 | 0 | 2.639 |
| SOEs | 2 | 0.210 | 0.748 | 0 | 4.625 | 0.124 | 0.421 | 0 | 3.367 |
| Non-SOEs | 3 | 0.220 | 0.660 | 0 | 4.820 | 0.100 | 0.379 | 0 | 2.996 |
| SOEs | 3 | 0.223 | 0.711 | 0 | 6.215 | 0.098 | 0.466 | 0 | 4.963 |
| Non-SOEs | 4 | 0.330 | 0.801 | 0 | 5.468 | 0.144 | 0.469 | 0 | 4.190 |
| SOEs | 4 | 0.307 | 0.881 | 0 | 6.690 | 0.134 | 0.546 | 0 | 6.603 |
| Non-SOEs | 5 | 0.291 | 0.768 | 0 | 3.892 | 0.063 | 0.239 | 0 | 1.609 |
| SOEs | 5 | 0.781 | 1.358 | 0 | 4.787 | 0.361 | 0.781 | 0 | 3.367 |
| Non-SOEs | 6 | 0.308 | 0.796 | 0 | 4.718 | 0.161 | 0.511 | 0 | 3.664 |
| SOEs | 6 | 0.202 | 0.714 | 0 | 4.220 | 0.043 | 0.233 | 0 | 1.946 |
| Non-SOEs | 7 | 0.468 | 1.280 | 0 | 3.401 | 0.556 | 0.885 | 0 | 3.045 |
| SOEs | 7 | 0.436 | 0.769 | 0 | 2.944 | 0.106 | 0.312 | 0 | 1.386 |
| Non-SOEs | 8 | 0.543 | 1.029 | 0 | 4.043 | 0.237 | 0.554 | 0 | 2.773 |
| SOEs | 8 | 1.152 | 1.725 | 0 | 6.874 | 0.608 | 1.333 | 0 | 6.054 |

Note: Non-SOEs refer to private firms, and SOEs refer to state-owned firms. App stands for low-carbon patent applications, and Auth stands for low-carbon patent authorizations.

**Table S6**. Distribution of corporate low-carbon innovation across PT index and ownership structure

| Ownership Structure | PT | App | | | | Auth | | | | Obs. | Percent (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | S.D. | Min | Max | Mean | S.D. | Min | Max | | |
| Non-SOEs | 0 | 0.291 | 0.703 | 0 | 6.026 | 0.117 | 0.416 | 0 | 4.710 | 9592 | 39.44% |
| SOEs | 0 | 0.334 | 0.800 | 0 | 6.550 | 0.146 | 0.498 | 0 | 6.273 | 5969 | 24.54% |
| Non-SOEs | 2 | 0.149 | 0.415 | 0 | 2.833 | 0.046 | 0.221 | 0 | 2.197 | 218 | 0.90% |
| SOEs | 2 | 0.204 | 0.544 | 0 | 2.398 | 0.091 | 0.315 | 0 | 1.792 | 162 | 0.67% |
| Non-SOEs | 3 | 0.109 | 0.56 | 0 | 3.091 | 0.033 | 0.284 | 0 | 1.792 | 415 | 1.71% |
| SOEs | 3 | 0.202 | 0.755 | 0 | 3.611 | 0.083 | 0.429 | 0 | 2.890 | 271 | 1.11% |
| Non-SOEs | 4 | 0.204 | 0.612 | 0 | 4.477 | 0.075 | 0.297 | 0 | 1.946 | 609 | 2.50% |
| SOEs | 4 | 0.148 | 0.459 | 0 | 3.664 | 0.057 | 0.252 | 0 | 2.079 | 491 | 2.02% |
| Non-SOEs | 5 | 0.245 | 0.635 | 0 | 4.263 | 0.134 | 0.411 | 0 | 2.639 | 764 | 3.14% |
| SOEs | 5 | 0.209 | 0.705 | 0 | 4.625 | 0.099 | 0.363 | 0 | 2.398 | 480 | 1.97% |
| Non-SOEs | 6 | 0.256 | 0.621 | 0 | 4.043 | 0.090 | 0.324 | 0 | 2.398 | 844 | 3.47% |
| SOEs | 6 | 0.254 | 0.680 | 0 | 4.043 | 0.116 | 0.420 | 0 | 3.367 | 556 | 2.29% |
| Non-SOEs | 7 | 0.300 | 0.820 | 0 | 4.820 | 0.145 | 0.462 | 0 | 2.996 | 583 | 2.40% |
| SOEs | 7 | 0.354 | 0.926 | 0 | 6.215 | 0.168 | 0.634 | 0 | 4.963 | 318 | 1.31% |
| Non-SOEs | 8 | 0.261 | 0.658 | 0 | 5.043 | 0.078 | 0.307 | 0 | 2.485 | 643 | 2.64% |
| SOEs | 8 | 0.324 | 0.855 | 0 | 6.690 | 0.146 | 0.610 | 0 | 6.603 | 317 | 1.30% |
| Non-SOEs | 9 | 0.163 | 0.527 | 0 | 3.091 | 0.058 | 0.251 | 0 | 1.946 | 112 | 0.46% |
| SOEs | 9 | 0.480 | 1.238 | 0 | 4.787 | 0.232 | 0.727 | 0 | 3.367 | 53 | 0.22% |
| Non-SOEs | 10 | 0.237 | 0.620 | 0 | 3.892 | 0.078 | 0.334 | 0 | 2.890 | 563 | 2.31% |
| SOEs | 10 | 0.238 | 0.756 | 0 | 3.970 | 0.069 | 0.293 | 0 | 1.609 | 103 | 0.42% |
| Non-SOEs | 11 | 0.379 | 0.809 | 0 | 2.944 | 0.133 | 0.331 | 0 | 1.386 | 84 | 0.35% |
| SOEs | 11 | 0.325 | 1.003 | 0 | 4.220 | 0.110 | 0.299 | 0 | 1.099 | 39 | 0.16% |
| Non-SOEs | 12 | 0.405 | 0.957 | 0 | 5.468 | 0.189 | 0.587 | 0 | 4.190 | 413 | 1.70% |
| SOEs | 12 | 0.471 | 1.287 | 0 | 5.838 | 0.173 | 0.629 | 0 | 3.850 | 89 | 0.37% |
| Non-SOEs | 13 | 0.365 | 0.775 | 0 | 3.526 | 0.087 | 0.277 | 0 | 1.099 | 41 | 0.17% |
| SOEs | 13 | 1.078 | 1.399 | 0 | 3.932 | 0.428 | 0.78 | 0 | 2.303 | 35 | 0.14% |
| Non-SOEs | 14 | 0.396 | 0.912 | 0 | 4.718 | 0.225 | 0.602 | 0 | 3.664 | 341 | 1.40% |
| SOEs | 14 | 0.452 | 0.742 | 0 | 2.398 | 0.032 | 0.148 | 0 | 0.693 | 43 | 0.18% |
| Non-SOEs | 15 | 1.364 | 1.426 | 0 | 3.401 | 0.736 | 1.029 | 0 | 3.045 | 24 | 0.10% |
| SOEs | 15 | 0.154 | 0.306 | 0 | 0.693 | 0 | 0 | 0 | 0 | 9 | 0.04% |
| Non-SOEs | 16 | 1.266 | 0.709 | 0 | 4.043 | 0.147 | 0.467 | 0 | 2.773 | 89 | 0.37% |
| SOEs | 16 | 1.835 | 1.960 | 0 | 6.874 | 1.056 | 1.622 | 0 | 6.054 | 53 | 0.22% |

Note: Non-SOEs refer to private firms, and SOEs refer to state-owned firms. App stands for low-carbon patent applications, and Auth stands for low-carbon patent authorizations.

**Table S7**. Result of the U-shape test suggested by Lind & Mehlum [5]

| | Dep.Var. = App | | Dep.Var. = Auth | |
|---|---|---|---|---|
| | Left-hand side | Right-hand side | Left-hand side | Right-hand side |
| Slope | -0.015 | 0.051 | -0.007 | 0.025 |
| $t$-value | -2.167** | 2.906*** | -1.885** | 2.530*** |
| Extreme point | 3.82 | | 3.71 | |
| 95% confidence interval, Fieller method | [1.014, 5.235] | | [-0.585, 5.524] | |
| 95% confidence interval, Delta method | [2.415, 5.232] | | [2.063, 5.354] | |

Note: App stands for low-carbon patent applications, and Auth stands for low-carbon patent authorizations.
$^{*}$ $p < .10$, $^{**}$ $p < .05$, $^{***}$ $p < .01$.

**Table S8**. Fixed effect panel regression for low-carbon innovations using Channel 1 political ties

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | App | Auth | App | Auth | App | Auth |
| Channel1_PT | -0.0198 | -0.0103 | -0.0230* | -0.0126 | -0.0200 | -0.0104 |
| | (0.0130) | (0.0076) | (0.0134) | (0.0079) | (0.0130) | (0.0076) |
| Channel1_PT$^2$ | 0.0046** | 0.0025* | 0.0053** | 0.0030** | 0.0045** | 0.0024* |
| | (0.0022) | (0.0013) | (0.0024) | (0.0014) | (0.0022) | (0.0013) |
| Corporate prominence (CP) | | | 0.0040 | 0.0062 | | |
| | | | (0.0189) | (0.0120) | | |
| Channel1_PT×CP | | | -0.0132 | -0.0065 | | |
| | | | (0.0086) | (0.0055) | | |
| Channel1_PT$^2$×CP | | | 0.0052* | 0.0034* | | |
| | | | (0.0027) | (0.0018) | | |
| Generalized favorability (GF) | | | | | 0.0534*** | 0.0131 |
| | | | | | (0.0194) | (0.0114) |
| Channel1_PT×GF | | | | | -0.0291** | -0.0091 |
| | | | | | (0.0119) | (0.0071) |
| Channel1_PT$^2$×GF | | | | | 0.0082*** | 0.0050*** |
| | | | | | (0.0030) | (0.0018) |
| All controls included | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE & Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| $R^2$ | 0.160 | 0.115 | 0.161 | 0.117 | 0.160 | 0.115 |
| *Obs.* | 20680 | 20680 | 20680 | 20680 | 20680 | 20680 |

Note: Robust standard errors clustered at the firm level are in parentheses. App stands for low-carbon patent applications, and Auth stands for low-carbon patent authorizations. $^{*}$ $p < .10$, $^{**}$ $p < .05$, $^{***}$ $p < .01$. The regression coefficients reported in this table are unstandardized.



To be continued, please refer to Part II