# Online Appendix

## Global Patterns of Renewable Energy Innovation, 1990-2009

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# 1 Data Description

The following Figures A1 to A8 illustrate distributions of our main variables from our paper.

- Figure A1 shows the histogram of oil prices per barrel (lagged).
- Figure A2 shows the histogram of renewable energy electricity generation (lagged).
- Figure A3 shows the histogram of our corruption variable (lagged).
- Figure A4 shows the histogram of logged GDP. (lagged)
- Figure A5 shows the histogram of net FDI inflows (lagged).
- Figure A6 shows the histogram of trade volume as sum of imports and exports (lagged).
- Figure A7 shows the histogram of the share of urban population (lagged).
- Figure A8 shows the histogram of urban air pollution (PM10, lagged).

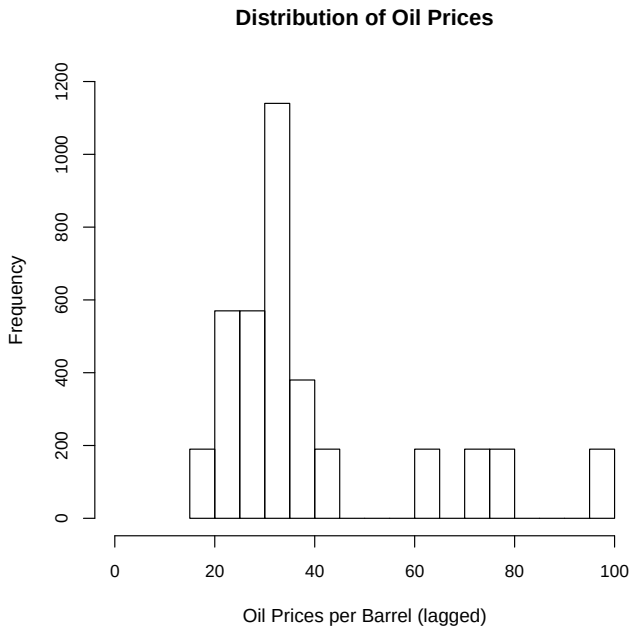


Figure A1: Histogram of oil prices in constant 2010 US$ per barrel (lagged).

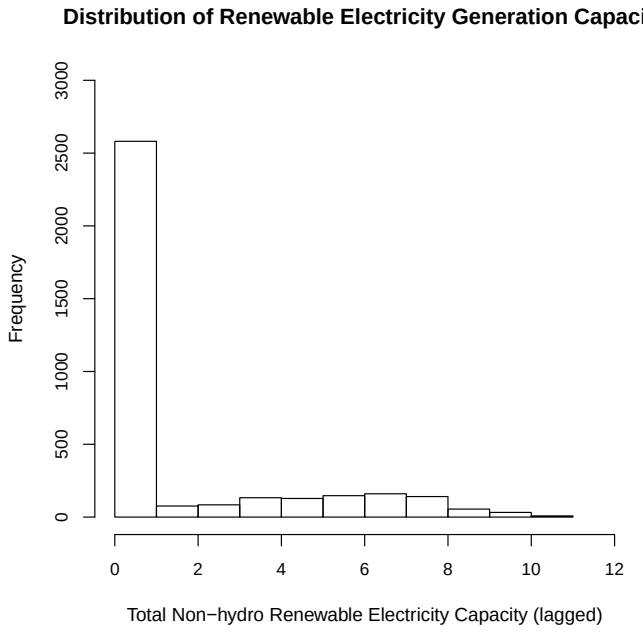


Figure A2: Histogram of logged renewable electricity generation capacity in million kW (lagged).

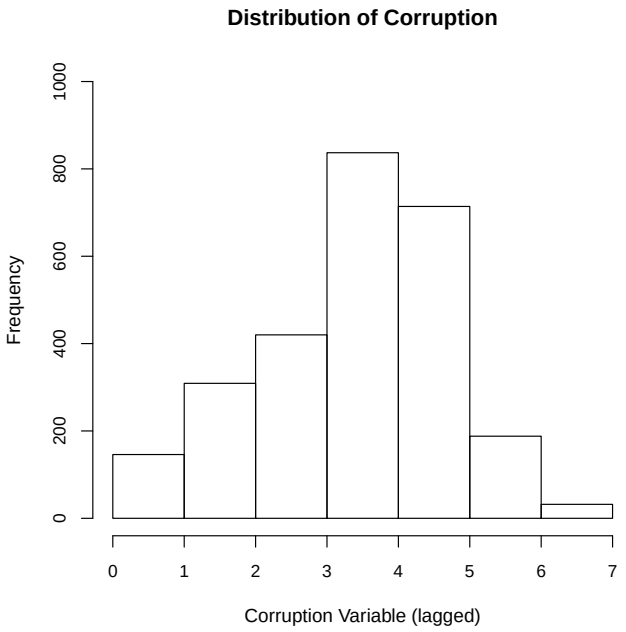


Figure A3: Histogram of corruption variable (lagged).

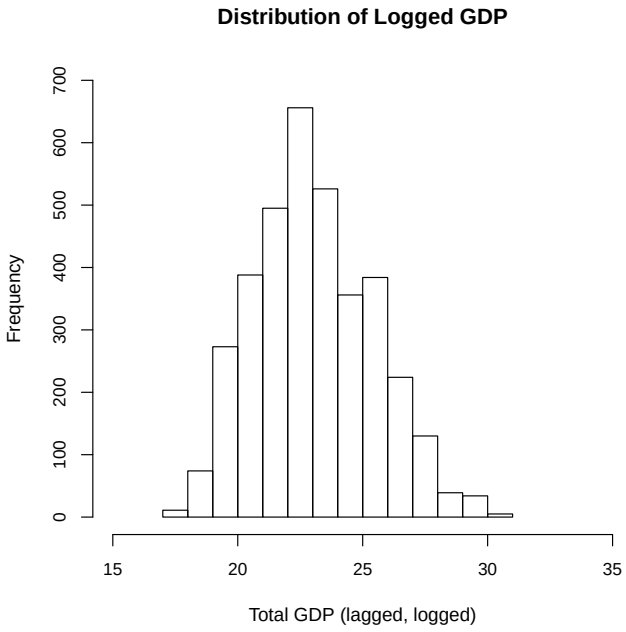


Figure A4: Histogram of logged GDP (lagged).

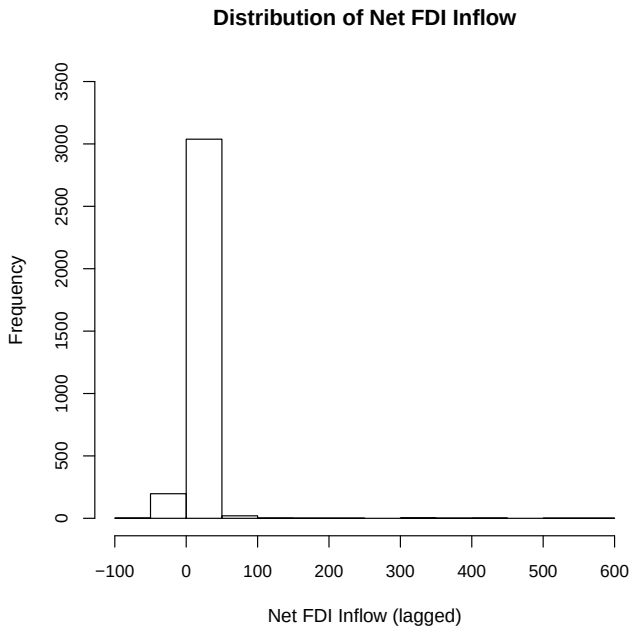


Figure A5: Histogram of net FDI inflows as percentage of GDP (lagged).

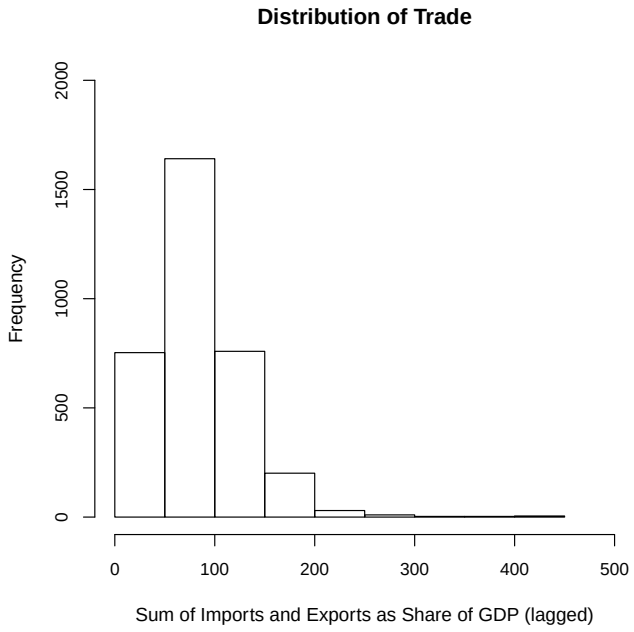


Figure A6: Histogram of the trade volume as sum of imports and exports as percentage of GDP (lagged).

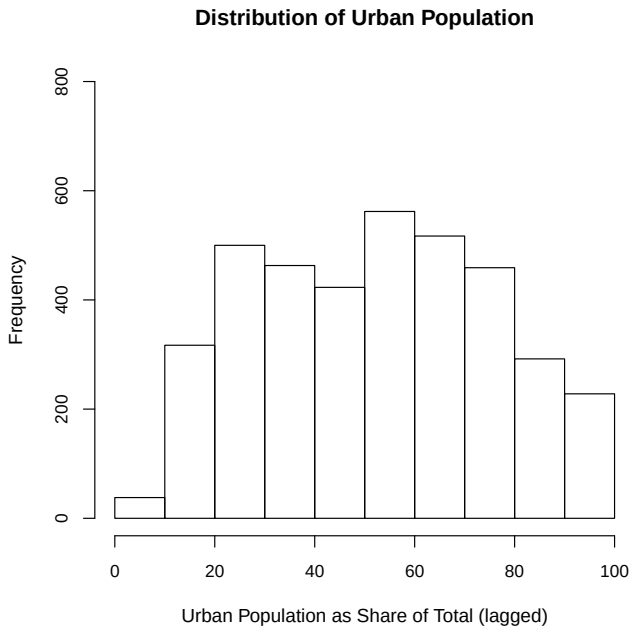


Figure A7: Histogram of the urban population as share of total (lagged).

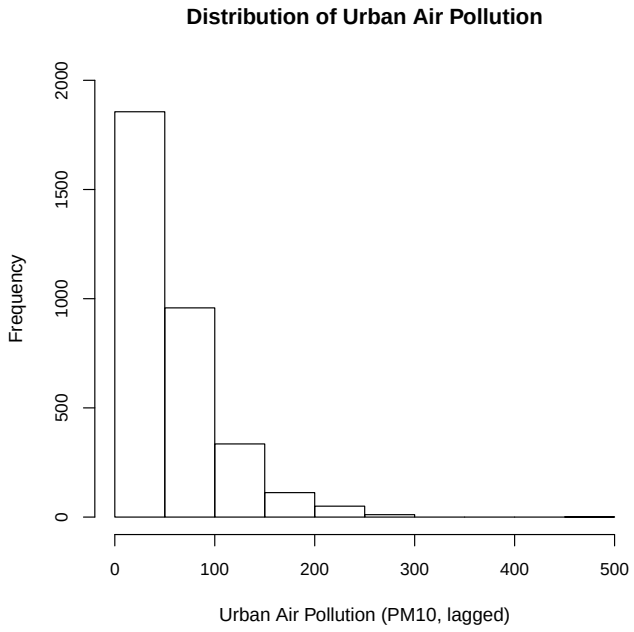


Figure A8: Histogram of the urban air population (PM10, lagged).

## 2 Robustness: Excluding Regions

Tables A1 to A5 show regression results when we exclude patents counts from all regions separately. We exclude renewable patents counts from Africa, Asia, the Americas, Europe, and Oceania, respectively. As the results show, our findings are robust to these exclusions. Oil prices and renewable electricity capacity are still found to have strong positive and statistically significant effects on patent counts in all our models. In addition, democracy also seems to have a strong influence on patent counts, but often lacks statistical significance at conventional levels. We interpret this as weak evidence as especially for models without projects from Asia (Table A2) or the Americas (Table A3) the coefficient is rarely statistically significant, even though it has the expected positive sign. As to corruption, we do not find any indication that good governance matters much for patent innovation.

**Models without patents from Africa**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.006*** | 0.005*** | 0.013*** | 0.006*** | 0.005*** |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.001) |
| Renew electricity capacity (lagged, logged) | 0.177*** | 0.148*** | 0.126*** | 0.128*** | 0.159*** |
| | (0.036) | (0.043) | (0.040) | (0.039) | (0.041) |
| Democracy (lagged) | 0.868*** | 0.899** | 0.936** | 0.755** | 0.068 |
| | (0.314) | (0.364) | (0.371) | (0.313) | (0.368) |
| Corruption (lagged) | -0.042 | -0.030 | 0.020 | -0.044 | -0.024 |
| | (0.040) | (0.044) | (0.044) | (0.039) | (0.040) |
| OECD membership (lagged) | -0.594** | -0.616* | -0.386 | -0.688*** | -0.866*** |
| | (0.268) | (0.324) | (0.280) | (0.262) | (0.258) |
| GDP (lagged, logged) | | | | 0.267*** | 0.073 |
| | | | | (0.096) | (0.114) |
| FDI (pct GDP, lagged) | | | | | 0.003 |
| | | | | | (0.002) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.003* |
| | | | | | (0.002) |
| Urban population (pct total, lagged) | | | | | 0.010 |
| | | | | | (0.008) |
| Urban air pollution (PM10, lagged) | | | | | -0.033*** |
| | | | | | (0.007) |
| Constant | -3.151*** | -3.532*** | -3.072*** | -9.851*** | -3.237 |
| | (0.351) | (0.454) | (0.395) | (2.416) | (3.232) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 1238 | 957 | 1104 | 1216 | 1095 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table A1: Results from fixed-effects negative binomial models when we exclude African patents counts.

**Models without patents from Asia**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.006*** | 0.005*** | 0.012*** | 0.006*** | 0.004*** |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.001) |
| Renew electricity capacity (lagged, logged) | 0.151*** | 0.130** | 0.100** | 0.137*** | 0.133*** |
| | (0.041) | (0.051) | (0.046) | (0.044) | (0.046) |
| Democracy (lagged) | 0.954* | 0.601 | 1.022* | 0.942* | 0.712 |
| | (0.509) | (0.586) | (0.533) | (0.514) | (0.593) |
| Corruption (lagged) | -0.055 | -0.060 | 0.017 | -0.059 | -0.054 |
| | (0.044) | (0.049) | (0.049) | (0.044) | (0.044) |
| OECD membership (lagged) | -1.041*** | -0.910** | -0.860*** | -1.050*** | -1.124*** |
| | (0.324) | (0.456) | (0.330) | (0.329) | (0.359) |
| GDP (lagged, logged) | | | | 0.134 | 0.079 |
| | | | | (0.139) | (0.148) |
| FDI (pct GDP, lagged) | | | | | 0.004 |
| | | | | | (0.002) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.001 |
| | | | | | (0.003) |
| Urban population (pct total, lagged) | | | | | 0.029* |
| | | | | | (0.016) |
| Urban air pollution (PM10, lagged) | | | | | -0.032*** |
| | | | | | (0.009) |
| Constant | -2.563*** | -2.611*** | -2.454*** | -6.019* | -5.078 |
| | (0.483) | (0.650) | (0.510) | (3.635) | (4.098) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 1018 | 787 | 890 | 1016 | 942 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table A2: Results from fixed-effects negative binomial models when we exclude Asia patents counts.

**Models without patents from the Americas**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.005*** | 0.005*** | 0.009*** | 0.005*** | 0.004*** |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.001) |
| Renew electricity capacity (lagged, logged) | 0.225*** | 0.179*** | 0.199*** | 0.179*** | 0.199*** |
| | (0.038) | (0.043) | (0.042) | (0.042) | (0.043) |
| Democracy (lagged) | 0.634* | 0.725* | 0.678 | 0.526 | -0.305 |
| | (0.344) | (0.394) | (0.422) | (0.345) | (0.447) |
| Corruption (lagged) | -0.068 | -0.058 | -0.014 | -0.068 | -0.033 |
| | (0.043) | (0.047) | (0.051) | (0.041) | (0.042) |
| OECD membership (lagged) | -0.690** | -0.612* | -0.531* | -0.809*** | -0.964*** |
| | (0.273) | (0.324) | (0.284) | (0.269) | (0.268) |
| GDP (lagged, logged) | | | | 0.258** | 0.031 |
| | | | | (0.101) | (0.121) |
| FDI (pct GDP, lagged) | | | | | 0.003 |
| | | | | | (0.002) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.003 |
| | | | | | (0.002) |
| Urban population (pct total, lagged) | | | | | 0.007 |
| | | | | | (0.009) |
| Urban air pollution (PM10, lagged) | | | | | -0.037*** |
| | | | | | (0.007) |
| Constant | -2.859*** | -3.135*** | -2.736*** | -9.335*** | -1.324 |
| | (0.370) | (0.456) | (0.431) | (2.555) | (3.446) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 1138 | 882 | 996 | 1116 | 996 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table A3: Results from fixed-effects negative binomial models when we exclude American patents counts.

**Models without patents from Europe**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.007*** | 0.002 | 0.017*** | 0.007*** | 0.005*** |
| | (0.002) | (0.002) | (0.003) | (0.002) | (0.002) |
| Renew electricity capacity (lagged, logged) | 0.352*** | 0.356*** | 0.250*** | 0.359*** | 0.364*** |
| | (0.057) | (0.061) | (0.066) | (0.074) | (0.083) |
| Democracy (lagged) | 1.025** | 1.047** | 1.141** | 1.056** | 0.643 |
| | (0.401) | (0.452) | (0.485) | (0.414) | (0.507) |
| Corruption (lagged) | 0.061 | 0.048 | 0.120** | 0.061 | 0.104* |
| | (0.052) | (0.055) | (0.049) | (0.052) | (0.057) |
| OECD membership (lagged) | -0.316 | -0.560 | -0.086 | -0.296 | -0.332 |
| | (0.371) | (0.419) | (0.426) | (0.397) | (0.409) |
| GDP (lagged, logged) | | | | -0.023 | -0.051 |
| | | | | (0.162) | (0.170) |
| FDI (pct GDP, lagged) | | | | | -0.019 |
| | | | | | (0.016) |
| Sum of imports and exports (pct GDP, lagged) | | | | | 0.001 |
| | | | | | (0.002) |
| Urban population (pct total, lagged) | | | | | 0.011 |
| | | | | | (0.013) |
| Urban air pollution (PM10, lagged) | | | | | -0.020** |
| | | | | | (0.008) |
| Constant | -6.895*** | -8.081*** | -5.636*** | -6.381* | -5.261 |
| | (0.630) | (0.740) | (0.687) | (3.764) | (4.288) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 780 | 590 | 682 | 760 | 677 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table A4: Results from fixed-effects negative binomial models when we exclude European patents counts.

**Models without patents from Oceania**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.007*** | 0.005*** | 0.014*** | 0.007*** | 0.006*** |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.001) |
| Renew electricity capacity (lagged, logged) | 0.173*** | 0.151*** | 0.121*** | 0.115*** | 0.149*** |
| | (0.035) | (0.042) | (0.039) | (0.039) | (0.040) |
| Democracy (lagged) | 0.904*** | 0.925** | 0.923** | 0.763** | -0.040 |
| | (0.318) | (0.368) | (0.376) | (0.316) | (0.365) |
| Corruption (lagged) | -0.040 | -0.032 | 0.018 | -0.041 | -0.030 |
| | (0.039) | (0.044) | (0.043) | (0.038) | (0.038) |
| OECD membership (lagged) | -0.600** | -0.632* | -0.387 | -0.709*** | -0.812*** |
| | (0.269) | (0.324) | (0.281) | (0.262) | (0.257) |
| GDP (lagged, logged) | | | | 0.322*** | 0.113 |
| | | | | (0.097) | (0.114) |
| FDI (pct GDP, lagged) | | | | | 0.003 |
| | | | | | (0.002) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.005*** |
| | | | | | (0.002) |
| Urban population (pct total, lagged) | | | | | 0.017** |
| | | | | | (0.008) |
| Urban air pollution (PM10, lagged) | | | | | -0.027*** |
| | | | | | (0.006) |
| Constant | -3.224*** | -3.651*** | -3.146*** | -11.314*** | -4.996 |
| | (0.361) | (0.465) | (0.402) | (2.440) | (3.150) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 1338 | 1032 | 1176 | 1316 | 1186 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table A5: Results from fixed-effects negative binomial models when we exclude Oceanian patents counts.

## 3 Robustness: Excluding Zero-Patent Counts and Outliers

In Tables A6 to A8 we check how sensitive our estimation results are to extreme values on both ends of our dependent variable's distribution. For this, we exclude all country-years for which patents counts are zero (Table A6), for which patents counts lie in the 95% percentile (Table A7), and for which both holds true (Table A8).

When we drop all observations with zero patents counts, our results continue to hold, but weaken a bit. This is an important insight as zero-inflated negative binomial models which econometrically account for the high share of zeros in our dataset do not converge. The robustness of our main results testifies to the plausibility of our arguments and reassures us that our results are not driven by zero-inflation. More specifically, we find that without zero patents counts, the oil price effect is still statistically significant, but the renewable electricity capacity effect attenuates a bit and is only significant in three out of five models. Given the large reductions in sample size of between 40% and 50% depending on the model specification, this should not be too disconcerting. When we exclude outliers (top 5% percentile), then the oil price coefficients are statistically significant in only three out of five models, while the renewable electricity capacity result stands up strong again. Finally, combining the two robustness checks, i.e., dropping country-years with zero patents and excluding the top 5% percentile, poses the strongest test to our hypotheses. Even though statistical significance reduces for our findings, oil price coefficients and renewable electricity capacity coefficients do always have the correct signs and are statistically significant half of the time. We take this as reliable evidence in favor of the robustness of our findings.

**Models without zero patents counts**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.007*** | 0.005*** | 0.013*** | 0.007*** | 0.005*** |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.001) |
| Renew electricity capacity (lagged, logged) | 0.095*** | 0.063 | 0.039 | 0.088** | 0.101** |
| | (0.036) | (0.041) | (0.042) | (0.040) | (0.041) |
| Democracy (lagged) | 0.416 | 0.427 | 0.268 | 0.403 | -0.140 |
| | (0.357) | (0.379) | (0.494) | (0.358) | (0.441) |
| Corruption (lagged) | -0.091** | -0.090** | -0.027 | -0.090** | -0.074* |
| | (0.041) | (0.044) | (0.045) | (0.040) | (0.042) |
| OECD membership (lagged) | -0.958*** | -0.711** | -0.758*** | -0.977*** | -1.060*** |
| | (0.255) | (0.297) | (0.270) | (0.259) | (0.267) |
| GDP (lagged, logged) | | | | 0.037 | -0.122 |
| | | | | (0.101) | (0.119) |
| FDI (pct GDP, lagged) | | | | | 0.001 |
| | | | | | (0.003) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.004** |
| | | | | | (0.002) |
| Urban population (pct total, lagged) | | | | | -0.003 |
| | | | | | (0.009) |
| Urban air pollution (PM10, lagged) | | | | | -0.028*** |
| | | | | | (0.007) |
| Constant | -1.525*** | -2.235*** | -1.250** | -2.460 | 3.648 |
| | (0.393) | (0.461) | (0.508) | (2.557) | (3.376) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 698 | 596 | 578 | 698 | 668 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A6: Results from fixed-effects negative binomial models without zero patents counts.

**Models without outliers**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.003** | 0.003 | 0.006*** | 0.003* | 0.002 |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.001) |
| Renew electricity capacity (lagged, logged) | 0.214*** | 0.153*** | 0.192*** | 0.147*** | 0.146*** |
| | (0.042) | (0.050) | (0.047) | (0.045) | (0.047) |
| Democracy (lagged) | 1.194*** | 1.258*** | 1.083*** | 0.952*** | 0.416 |
| | (0.355) | (0.426) | (0.405) | (0.346) | (0.410) |
| Corruption (lagged) | 0.035 | 0.056 | 0.069 | 0.049 | 0.091** |
| | (0.047) | (0.054) | (0.048) | (0.045) | (0.045) |
| OECD membership (lagged) | -0.588** | -0.483 | -0.453 | -0.664** | -0.597** |
| | (0.291) | (0.369) | (0.291) | (0.279) | (0.288) |
| GDP (lagged, logged) | | | | 0.510*** | 0.303** |
| | | | | (0.115) | (0.138) |
| FDI (pct GDP, lagged) | | | | | 0.003 |
| | | | | | (0.002) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.005*** |
| | | | | | (0.002) |
| Urban population (pct total, lagged) | | | | | 0.020** |
| | | | | | (0.009) |
| Urban air pollution (PM10, lagged) | | | | | -0.032*** |
| | | | | | (0.006) |
| Constant | -2.973*** | -3.375*** | -2.800*** | -15.792*** | -9.939*** |
| | (0.412) | (0.531) | (0.448) | (2.899) | (3.615) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 1316 | 1000 | 1175 | 1294 | 1162 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table A7: Results from fixed-effects negative binomial models without outliers.

**Models without zero patents counts and outliers**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.003** | 0.002 | 0.006*** | 0.003** | 0.002 |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.002) |
| Renew electricity capacity (lagged, logged) | 0.102** | 0.047 | 0.082* | 0.072 | 0.068 |
| | (0.042) | (0.049) | (0.048) | (0.044) | (0.047) |
| Democracy (lagged) | 0.585 | 0.602 | -0.253 | 0.449 | -0.126 |
| | (0.432) | (0.467) | (0.725) | (0.434) | (0.499) |
| Corruption (lagged) | -0.007 | -0.002 | 0.011 | 0.003 | 0.021 |
| | (0.048) | (0.055) | (0.049) | (0.047) | (0.050) |
| OECD membership (lagged) | -0.831*** | -0.466 | -0.703** | -0.918*** | -0.791*** |
| | (0.280) | (0.346) | (0.282) | (0.278) | (0.292) |
| GDP (lagged, logged) | | | | 0.243** | 0.025 |
| | | | | (0.122) | (0.148) |
| FDI (pct GDP, lagged) | | | | | 0.002 |
| | | | | | (0.002) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.007*** |
| | | | | | (0.002) |
| Urban population (pct total, lagged) | | | | | 0.004 |
| | | | | | (0.011) |
| Urban air pollution (PM10, lagged) | | | | | -0.022*** |
| | | | | | (0.007) |
| Constant | -1.091** | -1.861*** | -0.284 | -7.130** | -0.304 |
| | (0.490) | (0.569) | (0.760) | (3.049) | (4.003) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 636 | 534 | 541 | 636 | 606 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A8: Results from fixed-effects negative binomial models without zero patents counts and outliers.

# 4 Robustness: Controlling for Country Openness, Domestic, and International Institutions

Tables A9 to A11 show regression results when we control for country openness (Table A9), domestic institutions (Table A10), and international institutions (Table A11). To account for country openness we add controls for a country's capital account openness (Chinn and Ito, 2006) and the KOF index of globalization (Dreher, 2006). To proxy domestic institutions, we include two control variables on a country's investment profile from the political risk rating of the *International Country Risk Guide* and a measure for executive constraints from the World Bank's Database of Political Institutions (Beck et al., 2001). For international institutions we add two dummy variables, one on a country's ratification of the Kyoto Protocol and another one for EU membership.

Our three robustness checks for country openness, domestic institutions, and international institutions strongly support our main results. Without additional controls, all our effects continues to hold as expected. Oil prices and renewable electricity capacity positively affect patent counts and are statistically significant at very high levels. Democracy again has a positive coefficient in four out of five models, while the corruption variable is statistically indistinguishable from zero.

As to the additional controls, none of the openness and globalization indices nor Kyoto ratification seems to have a strong relationship with patent innovation. Investment profile, EU membership, and our checks and balances variable are, however, all negatively and strongly statistically significantly correlated with the number of renewable patent applications.

**Models with controls for country openness**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.006*** | 0.005*** | 0.013*** | 0.007*** | 0.005*** |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.002) |
| Renew electricity capacity (lagged, logged) | 0.185*** | 0.159*** | 0.130*** | 0.117*** | 0.153*** |
| | (0.037) | (0.044) | (0.041) | (0.041) | (0.044) |
| Democracy (lagged) | 0.930*** | 0.810** | 0.994** | 0.806** | 0.124 |
| | (0.331) | (0.369) | (0.403) | (0.323) | (0.376) |
| Corruption (lagged) | -0.018 | -0.023 | 0.047 | -0.020 | -0.008 |
| | (0.040) | (0.044) | (0.044) | (0.038) | (0.039) |
| OECD membership (lagged) | -0.470 | -0.456 | -0.239 | -0.644** | -0.803*** |
| | (0.295) | (0.346) | (0.312) | (0.283) | (0.271) |
| Capital account openness (lagged) | -0.020 | 0.017 | -0.040 | -0.049 | -0.068 |
| | (0.051) | (0.064) | (0.054) | (0.051) | (0.052) |
| KOF globalization index (lagged) | 0.008 | 0.003 | 0.009 | 0.019** | 0.010 |
| | (0.008) | (0.010) | (0.010) | (0.009) | (0.011) |
| GDP (lagged, logged) | | | | 0.356*** | 0.131 |
| | | | | (0.102) | (0.123) |
| FDI (pct GDP, lagged) | | | | | 0.008** |
| | | | | | (0.004) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.003* |
| | | | | | (0.002) |
| Urban population (pct total, lagged) | | | | | 0.008 |
| | | | | | (0.008) |
| Urban air pollution (PM10, lagged) | | | | | -0.033*** |
| | | | | | (0.007) |
| Constant | -4.011*** | -4.007*** | -3.951*** | -13.612*** | -5.422 |
| | (0.643) | (0.755) | (0.680) | (2.799) | (3.690) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 1309 | 1024 | 1147 | 1308 | 1185 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A9: Results from fixed-effects negative binomial models with openness controls.

**Models with controls for domestic institutions**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.004*** | -0.002 | 0.011*** | 0.005*** | 0.003** |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.002) |
| Renew electricity capacity (lagged, logged) | 0.187*** | 0.161*** | 0.147*** | 0.138*** | 0.165*** |
| | (0.036) | (0.043) | (0.040) | (0.039) | (0.041) |
| Democracy (lagged) | 0.915*** | 0.841** | 1.065*** | 0.802** | 0.231 |
| | (0.321) | (0.372) | (0.386) | (0.321) | (0.376) |
| Corruption (lagged) | -0.040 | -0.058 | 0.028 | -0.042 | -0.023 |
| | (0.039) | (0.044) | (0.044) | (0.038) | (0.038) |
| OECD membership (lagged) | -0.609** | -0.658** | -0.403 | -0.715*** | -0.910*** |
| | (0.272) | (0.330) | (0.282) | (0.266) | (0.261) |
| Executive constraints (lagged) | -0.031 | -0.033 | -0.055** | -0.035* | -0.055*** |
| | (0.019) | (0.020) | (0.023) | (0.020) | (0.021) |
| Investment profile (lagged) | -0.055*** | -0.133*** | -0.059*** | -0.053** | -0.051** |
| | (0.021) | (0.029) | (0.021) | (0.021) | (0.022) |
| GDP (lagged, logged) | | | | 0.275*** | 0.090 |
| | | | | (0.096) | (0.114) |
| FDI (pct GDP, lagged) | | | | | 0.003 |
| | | | | | (0.002) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.003 |
| | | | | | (0.002) |
| Urban population (pct total, lagged) | | | | | 0.008 |
| | | | | | (0.009) |
| Urban air pollution (PM10, lagged) | | | | | -0.033*** |
| | | | | | (0.006) |
| Constant | -3.116*** | -4.037*** | -2.971*** | -9.976*** | -3.532 |
| | (0.363) | (0.486) | (0.411) | (2.420) | (3.222) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 1356 | 1049 | 1192 | 1334 | 1204 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table A10: Results from fixed-effects negative binomial models with domestic institution controls.

**Models with controls for international institutions**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.006*** | 0.004*** | 0.012*** | 0.006*** | 0.005*** |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.001) |
| Renew electricity capacity (lagged, logged) | 0.204*** | 0.187*** | 0.154*** | 0.158*** | 0.176*** |
| | (0.035) | (0.043) | (0.039) | (0.039) | (0.041) |
| Democracy (lagged) | 0.904*** | 0.921** | 0.992*** | 0.787** | 0.188 |
| | (0.316) | (0.363) | (0.375) | (0.315) | (0.373) |
| Corruption (lagged) | -0.024 | -0.016 | 0.033 | -0.027 | -0.008 |
| | (0.040) | (0.043) | (0.044) | (0.038) | (0.039) |
| OECD membership (lagged) | -0.549** | -0.585* | -0.347 | -0.649** | -0.853*** |
| | (0.265) | (0.322) | (0.276) | (0.260) | (0.258) |
| EU membership (lagged) | -0.416*** | -0.386** | -0.467*** | -0.419*** | -0.298** |
| | (0.134) | (0.172) | (0.149) | (0.137) | (0.144) |
| Kyoto Protocol ratification (lagged) | -0.088 | -0.118 | -0.057 | -0.092 | -0.094 |
| | (0.068) | (0.078) | (0.073) | (0.067) | (0.068) |
| GDP (lagged, logged) | | | | 0.262*** | 0.105 |
| | | | | (0.094) | (0.112) |
| FDI (pct GDP, lagged) | | | | | 0.003 |
| | | | | | (0.002) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.003 |
| | | | | | (0.002) |
| Urban population (pct total, lagged) | | | | | 0.009 |
| | | | | | (0.008) |
| Urban air pollution (PM10, lagged) | | | | | -0.031*** |
| | | | | | (0.006) |
| Constant | -3.233*** | -3.763*** | -3.086*** | -9.784*** | -4.290 |
| | (0.373) | (0.512) | (0.416) | (2.365) | (3.144) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 1378 | 1062 | 1212 | 1356 | 1224 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table A11: Results from fixed-effects negative binomial models with international institution controls.

# 5 Robustness: Controlling for Learning Effects

To account for learning dynamics, Table A12 provides regression results when we include the cumulative count of CDM projects, normalized per one million inhabitants. CDM projects are projects to provide clean development in non-OECD countries under the flexible mechanisms of the Kyoto Protocol. Many of these projects are linked to renewable energy and can, therefore, serve as a nice proxy for a country's innovation capacity in renewable energy technology. As a country's technological prowess increases over time, we constructed the cumulative count of CDM projects to account for learning potential. Since CDM projects only exit since 2003, we coded the cumulative CDM count variable as zero in years before 2003 to avoid loss of observations from our dataset. As this robustness check shows, even controlling for learning dynamics over time, our main findings for oil prices and renewable electricity capacity are still found in the data. Moreover, the cumulative CDM count control also has a positive and statistically significant effect on renewable patent applications, which lends credibility to the plausibility of this robustness check. As alternative measures to operationalize learning, we also tried to use a three-year moving average of renewable patents counts and cumulative patents counts. With correlations as high as $r = 0.9665$ and $r = 0.9762$, respectively, estimating our models fails because of estimation instability.

**Models with control for learning effects**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.005*** | 0.004** | 0.011*** | 0.005*** | 0.004*** |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.001) |
| Renew electricity capacity (lagged, logged) | 0.190*** | 0.161*** | 0.137*** | 0.150*** | 0.171*** |
| | (0.035) | (0.041) | (0.040) | (0.039) | (0.041) |
| Democracy (lagged) | 0.774** | 0.793** | 0.906** | 0.666** | 0.055 |
| | (0.329) | (0.385) | (0.385) | (0.329) | (0.365) |
| Corruption (lagged) | -0.044 | -0.041 | 0.017 | -0.046 | -0.025 |
| | (0.040) | (0.044) | (0.044) | (0.038) | (0.039) |
| OECD membership (lagged) | -0.616** | -0.611* | -0.410 | -0.693*** | -0.804*** |
| | (0.270) | (0.329) | (0.280) | (0.265) | (0.263) |
| Cumulative CDM count (per million pop) | 0.210*** | 0.206*** | 0.234*** | 0.202*** | 0.134*** |
| | (0.043) | (0.042) | (0.081) | (0.045) | (0.043) |
| GDP (lagged, logged) | | | | 0.220** | 0.068 |
| | | | | (0.098) | (0.112) |
| FDI (pct GDP, lagged) | | | | | 0.003 |
| | | | | | (0.002) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.003* |
| | | | | | (0.002) |
| Urban population (pct total, lagged) | | | | | 0.014 |
| | | | | | (0.008) |
| Urban air pollution (PM10, lagged) | | | | | -0.027*** |
| | | | | | (0.006) |
| Constant | -3.094*** | -3.518*** | -3.055*** | -8.598*** | -3.769 |
| | (0.361) | (0.463) | (0.405) | (2.476) | (3.115) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 1378 | 1062 | 1212 | 1356 | 1224 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A12: Results from fixed-effects negative binomial models with cumulative CDM count as control.

# 6 Robustness: Controlling for Size of the Electricity Sector

To ensure that our results are not unduly driven by differences in the size of a country's electricity sector, we include electric power consumption in kWh as an additional control variable. As usual, we lag this variable by one period and logarithmize it to account for its non-normal distribution. Since this proxy for the size of the electricity sector is highly correlated with a country's lagged and logged GDP ($r = +0.8905$), we drop the GDP variable whenever we include electric power consumption. This avoids problems of estimation instability due to high levels of multicollinearity.

Table A13 below shows the results from this additional robustness check. Again, oil prices and renewable electricity generation capacity are inducive to innovation levels. Corruption does not have an effect, while democratic institutions may have a positive effect. This effect is, however, not statistically significant in all estimated model. This is why, as in the main text, we caution against a too literal interpretation. As expected, we find that countries with larger electricity sectors hold more patents, and are more innovative in that sense.

**Models with control for electricity sector size**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.006*** | 0.005*** | 0.012*** | 0.006*** | 0.005*** |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.001) |
| Renew electricity capacity (lagged, logged) | 0.118*** | 0.078* | 0.062 | 0.118*** | 0.130*** |
| | (0.039) | (0.045) | (0.043) | (0.039) | (0.040) |
| Democracy (lagged) | 0.874*** | 0.917** | 1.009** | 0.874*** | 0.268 |
| | (0.339) | (0.382) | (0.413) | (0.339) | (0.393) |
| Corruption (lagged) | -0.042 | -0.048 | 0.033 | -0.042 | -0.019 |
| | (0.038) | (0.041) | (0.042) | (0.038) | (0.038) |
| OECD membership (lagged) | -0.726*** | -0.697** | -0.521* | -0.726*** | -0.915*** |
| | (0.262) | (0.311) | (0.277) | (0.262) | (0.252) |
| Electric power consumption (lagged, logged) | 0.458*** | 0.460*** | 0.535*** | 0.458*** | 0.317*** |
| | (0.101) | (0.119) | (0.118) | (0.101) | (0.115) |
| FDI (pct GDP, lagged) | | | | | 0.003 |
| | | | | | (0.002) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.002 |
| | | | | | (0.002) |
| Urban population (pct total, lagged) | | | | | 0.013 |
| | | | | | (0.008) |
| Urban air pollution (PM10, lagged) | | | | | -0.028*** |
| | | | | | (0.006) |
| Constant | -14.611*** | -15.000*** | -16.440*** | -14.611*** | -9.899*** |
| | (2.490) | (2.943) | (2.900) | (2.490) | (3.180) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 1315 | 1062 | 1133 | 1315 | 1224 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table A13: Results from fixed-effects negative binomial models with electric power consumption as control.

# 7 Robustness: Controlling for Education Expenditures and Skilled Labor

Since innovation is likely to be higher in countries with better educational systems and a more skilled workforce, we control for a country's total expenditures on education (lagged and logged) and for the share of tertiary education (lagged). Expenditure data comes from the *World Development Indicators*, and education data is taken from the World Bank's *EdStats* database for education statistics. Tables A14 and A15 show the results when we include these additional control variables. Consistent with the findings presented in the main text, oil prices and renewable energy capacity positively affect innovation activities, whereas corruption is not found to have any significant effects. The results for our democracy variable suggest a positive relationship, but these effects need to be treated more carefully because coefficients lack statistical significance in one out of five (Table A14) and three out of five models (Table A15), respectively. Given the loss in the number of observations in the latter model, for which sample size reduces by more than 50 percent due to data limitations, this result is not too worrisome. While education expenditures do not have a consistent effect on innovation, the tertiary education coefficient is positive and statistically significant in four out of five models. Thus, a better educated workforce positively affects innovation, but higher expenditures does not necessarily do so. These additional robustness checks confirm our main conclusions.

**Models with control for education expenditures**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.007*** | 0.005*** | 0.013*** | 0.007*** | 0.005*** |
| | (0.001) | (0.002) | (0.002) | (0.001) | (0.001) |
| Renew electricity capacity (lagged, logged) | 0.189*** | 0.163*** | 0.145*** | 0.169*** | 0.189*** |
| | (0.042) | (0.050) | (0.048) | (0.046) | (0.046) |
| Democracy (lagged) | 1.045** | 0.882* | 1.235** | 0.976** | 0.401 |
| | (0.446) | (0.494) | (0.573) | (0.445) | (0.495) |
| Corruption (lagged) | -0.034 | -0.040 | 0.015 | -0.035 | -0.027 |
| | (0.047) | (0.053) | (0.051) | (0.046) | (0.046) |
| OECD membership (lagged) | -0.723** | -0.681** | -0.494* | -0.764*** | -0.971*** |
| | (0.287) | (0.339) | (0.298) | (0.287) | (0.291) |
| Educdation expenditures (lagged, logged) | -0.042 | -0.093 | -0.124 | 0.007 | -0.002 |
| | (0.253) | (0.289) | (0.298) | (0.258) | (0.276) |
| GDP (lagged, logged) | | | | 0.125 | -0.040 |
| | | | | (0.118) | (0.149) |
| FDI (pct GDP, lagged) | | | | | 0.006 |
| | | | | | (0.004) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.002 |
| | | | | | (0.003) |
| Urban population (pct total, lagged) | | | | | 0.003 |
| | | | | | (0.013) |
| Urban air pollution (PM10, lagged) | | | | | -0.039*** |
| | | | | | (0.008) |
| Constant | -3.219*** | -3.343*** | -3.130*** | -6.408** | 0.071 |
| | (0.600) | (0.728) | (0.685) | (3.063) | (4.477) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 894 | 740 | 769 | 894 | 845 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table A14: Results from fixed-effects negative binomial models with education expenditures as control.

**Models with control for tertiary education**

| | (1) Model | (2) Model | (3) Model | (4) Model | (5) Model |
|---|---|---|---|---|---|
| Oil prices (lagged) | 0.005** | 0.004** | 0.013*** | 0.004** | 0.002 |
| | (0.002) | (0.002) | (0.003) | (0.002) | (0.002) |
| Renew electricity capacity (lagged, logged) | 0.165*** | 0.121** | 0.149** | 0.122** | 0.127** |
| | (0.050) | (0.053) | (0.062) | (0.056) | (0.052) |
| Democracy (lagged) | 1.300* | 1.370* | 0.684 | 1.172 | 1.191 |
| | (0.706) | (0.734) | (0.831) | (0.718) | (0.991) |
| Corruption (lagged) | -0.089 | -0.081 | -0.035 | -0.095* | -0.073 |
| | (0.056) | (0.057) | (0.067) | (0.053) | (0.049) |
| Educdation expenditures (lagged, logged) | -0.190 | -0.303 | -0.089 | -0.052 | -0.475 |
| | (0.334) | (0.340) | (0.418) | (0.347) | (0.350) |
| OECD membership (lagged) | -0.489 | -0.349 | -0.278 | -0.553 | -0.830** |
| | (0.352) | (0.389) | (0.347) | (0.347) | (0.341) |
| Tertiary education (lagged) | 0.015** | 0.014* | 0.010 | 0.014** | 0.013* |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| GDP (lagged, logged) | | | | 0.239* | -0.116 |
| | | | | (0.139) | (0.183) |
| FDI (pct GDP, lagged) | | | | | 0.009* |
| | | | | | (0.005) |
| Sum of imports and exports (pct GDP, lagged) | | | | | -0.003 |
| | | | | | (0.003) |
| Urban population (pct total, lagged) | | | | | -0.002 |
| | | | | | (0.021) |
| Urban air pollution (PM10, lagged) | | | | | -0.060*** |
| | | | | | (0.011) |
| Constant | -3.800*** | -3.866*** | -2.893*** | -10.052*** | 3.078 |
| | (0.872) | (0.909) | (1.022) | (3.720) | (5.801) |
| Region Fixed Effects | Yes | Yes | Yes | Yes | Yes |
| Linear Time Trend | Yes | Yes | Yes | Yes | Yes |
| Observations | 522 | 491 | 431 | 522 | 519 |

Standard errors in parentheses
Dependent variable: Renewable patents count.
Model (2) excludes years before 1995.
Model (3) excludes years after 2007.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A15: Results from fixed-effects negative binomial models with tertiary education as control.

## Supplementary Appendix: References

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