

# FOR ONLINE PUBLICATION

## Online Supplementary Material

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### Directed Technological Change and General Purpose Technologies: Can AI Accelerate the Energy Transition?

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## A Additional Figures and Tables On Data

### A.A List of Technology Codes Used to Identify Energy Technologies

Table SI1: Clean Electricity Technologies

Code	Sub-sector
F02B43/08	Biomass and waste
Y02E40/70	Enabling technologies Systems integration
Y04S	Enabling technologies Systems integration
Y02E30	Nuclear Energy
Y02E10	Renewable Energy
Y02B10	Renewable Energy
F03G4	Renewable Energy Geothermal
F03G7/04	Renewable Energy Geothermal
F24J3	Renewable Energy Geothermal
Y02E10/10	Renewable Energy Geothermal
Y02E10/20	Renewable Energy Hydro
E02B9/08	Renewable Energy Marine
F03B13/10	Renewable Energy Marine
F03B13/12	Renewable Energy Marine
F03G7/05	Renewable Energy Marine
Y02E10/30	Renewable Energy Marine
E04D13/18	Renewable Energy Solar
F03G6	Renewable Energy Solar
F24J2	Renewable Energy Solar
F26B3/28	Renewable Energy Solar
H01L31/04	Renewable Energy Solar
H02N6	Renewable Energy Solar
Y02E10/40	Renewable Energy Solar
Y02E10/50	Renewable Energy Solar
Y02E10/60	Renewable Energy Solar
F03D	Renewable Energy Wind
H01L27/142	Renewable Energy Wind
Y02E10/70	Renewable Energy Wind

Table SI2: Grey Electricity Technologies

Code	Sub-sector
C10L5/40	Biomass and waste
F01K25/14	Biomass and waste
Y02E20	Biomass and waste
Y02E50	Biomass and waste
B01J8/20	Efficiency
B01J8/24	Efficiency
C10J3	Efficiency
F01K17/06	Efficiency
F01K23	Efficiency
F01K27	Efficiency
F01K3	Efficiency
F01K5	Efficiency
F02B1/12	Efficiency
F02B11	Efficiency
F02B13/02	Efficiency
F02B3/06	Efficiency
F02B49	Efficiency
F02B7	Efficiency
F02C3/20	Efficiency
F02C3/32	Efficiency
F02C3/34	Efficiency
F02C3/36	Efficiency
F02C6/10	Efficiency
F02C7/30	Efficiency
F02G5	Efficiency
F22B31	Efficiency
F22B33/14	Efficiency
F22G	Efficiency
F23B10	Efficiency
F23B30	Efficiency
F23B70	Efficiency
F23B80	Efficiency
F23C1	Efficiency
F23C10	Efficiency
F23C5/24	Efficiency
F23C6	Efficiency
F23D1	Efficiency
F23D17	Efficiency
F23D7	Efficiency
F27B15	Efficiency
Y02E20/10	Efficiency
Y02E20/30	Efficiency
Y02E40	Efficiency

Table SI3: Dirty Electricity Technologies

Code	Sub-sector
C10G1	Hydrofracturing
E21B43	Hydrofracturing
C10J	Traditional Fossil Fuels
C10L1	Traditional Fossil Fuels
C10L3	Traditional Fossil Fuels
C10L5	Traditional Fossil Fuels
F01K	Traditional Fossil Fuels
F02C	Traditional Fossil Fuels
F22	Traditional Fossil Fuels
F23	Traditional Fossil Fuels
F24J	Traditional Fossil Fuels
F27	Traditional Fossil Fuels
F28	Traditional Fossil Fuels

Table SI4: Clean Transport Technologies

Code	Sub-sector
Y02T10/70	Batteries
B60K1	Electric vehicles
B60L	Electric vehicles
B60L11	Electric vehicles
B60L15	Electric vehicles
B60L3	Electric vehicles
B60L7	Electric vehicles
B60R16	Electric vehicles
B60R16/033	Electric vehicles
B60R16/04	Electric vehicles
B60S5/06	Electric vehicles
B60W10	Electric vehicles
Y02T10/64	Electric vehicles
Y02T90	Enabling technologies
Y02T90/167	Enabling technologies Systems integration
Y02T90/168	Enabling technologies Systems integration
Y02T90/169	Enabling technologies Systems integration
H01M	Fuel cells, Batteries
B60K6	Hybrid vehicles
B60L7/10	Hybrid vehicles
B60L7/20	Hybrid vehicles
B60W20	Hybrid vehicles
Y02T10/62	Hybrid vehicles
B60L11/18	Hydrogen vehicles / fuel cells
B60W10/28	Hydrogen vehicles / fuel cells
Y02T50	Mitigation Air
Y02T70	Mitigation Maritime
Y02T30	Mitigation Rail
Y02T10	Mitigation Road

Table SI5: Grey Transport Technologies

Code	Sub-sector
F02B47/06	Efficiency
F02D41	Efficiency
F02M23	Efficiency
F02M25	Efficiency
F02M3	Efficiency
F02M39	Efficiency
F02M41	Efficiency
F02M43	Efficiency
F02M45	Efficiency
F02M47	Efficiency
F02M49	Efficiency
F02M51	Efficiency
F02M53	Efficiency
F02M55	Efficiency
F02M57	Efficiency
F02M59	Efficiency
F02M61	Efficiency
F02M63	Efficiency
F02M65	Efficiency
F02M67	Efficiency
F02M69	Efficiency
F02M71	Efficiency
Y02T10/10	Efficiency

Table SI6: Dirty Transport Technologies

Code	Sub-sector
F02B	Internal combustion engine
F02D	Internal combustion engine
F02F	Internal combustion engine
F02M	Internal combustion engine
F02N	Internal combustion engine
F02P	Internal combustion engine

## A.B Overlap between AI and ICT Patent Families

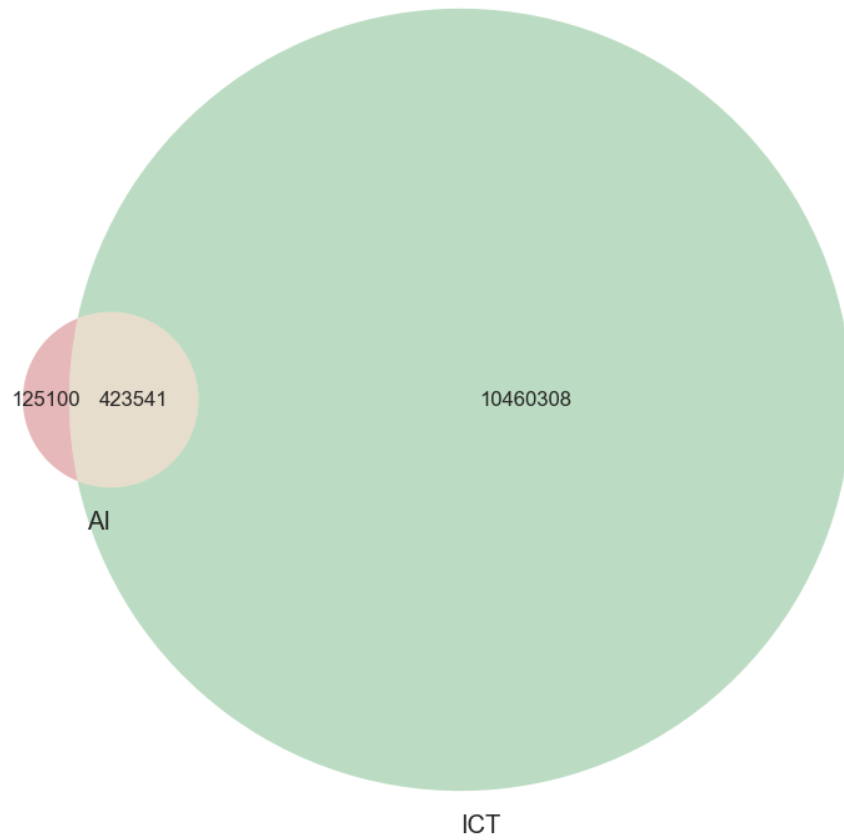


Figure SI1: AI and ICT Overlap



## **A.C Data Cleaning Steps for Orbis Firm-level Data**

For each vintage, the year was defined as the current year if the variable “closing date” was on or after June 1st, and the previous year if the “closing date” was before June 1st.

Sometimes firms report both a consolidated and unconsolidated account, leading to duplicate observations. To deal with such duplicates, we first drop observations with consolidation code C2 (consolidated account, when there is an unconsolidated companion). For remaining duplicates with differing consolidation codes, we then drop observations with consolidation code LF (Limited number of financial item), followed by those with code C1 (Consolidated account, when there is no recorded unconsolidated companion), and lastly U2 (Unconsolidated account, when there is a recorded consolidated companion). We drop all observations of a firm with a given consolidation code. Where duplicates remain with multiple values of the variable “closing date” we retain the most recently reported observations. We then take the average of all competing values for any remaining duplicates.

We drop each observation with total assets, operating revenue, sales and employment simultaneously missing. We also set total assets and employment to missing if they change by more than 100% upwards or 50% downwards one year and the reverse the following year. We also drop each firm which has an employment, sales, total assets, or tangible fixed assets figure that is negative in any year, or if the ratio of employment to sales, employment to total assets, employment to revenue, or sales to total assets and vice versa is larger than 99.9 pct in any year.

We construct a full panel which contains an observation for each firm and year in our sample. We then construct variables indicating when a firm was first and last observed within our Orbis data, and drop any observations with years before the “first observed” or after the “last observed” variable. For any years in between for which the firm is missing in Orbis, financial variables are set to missing, and patenting variables depend on whether a patent family in PATSTAT during this year is associated with the firm. For any year-firm observation which does not have any associated patent families, patent flow variables are set to 0.

To measure firm age (which is used as a control variable in our firm-level regressions) we collect the year of incorporation from Orbis. This yields a few observations with incorporation years going back very far in time (one all the way to 1000, the others starting in the 1300s). As this may be due to data entry errors, we conduct a quality check on those observations with the most suspicious incorporation years. As some “firms” are universities (whose founding years do go back to the middle ages), we first filter out institutions whose names include “univers”. We then identify 52 remaining firms with incorporation years before 1800 and search for information on their founding year manually. Surprisingly, 43 of those 52 can be verified as accurate. Different incorporation years were found and entered for a further 6 companies. We set the variable to “missing” for the remaining 3 which could not be identified. The earliest founding year left in our dataset which does not relate to a university is 1491.

Table SI7: Similar to Table SI7 but using count of citations to AI and ICT

	(1) AI	(2) AI	(3) AI	(4) AI	(5) ICT	(6) ICT	(7) ICT	(8) ICT
Clean Family	1.167*** (0.018)	0.886*** (0.037)	0.749*** (0.020)	0.697*** (0.029)	1.425*** (0.015)	1.097*** (0.056)	1.230*** (0.039)	1.176*** (0.048)
Grey Family	0.775*** (0.002)	0.388*** (0.025)	0.297*** (0.021)	0.270*** (0.026)	0.203*** (0.001)	0.154*** (0.030)	0.112*** (0.025)	0.086*** (0.037)
Nbr Citations Made (log)	1.265*** (0.016)	1.243*** (0.015)	1.242*** (0.038)	1.219*** (0.027)	1.259*** (0.025)	1.221*** (0.025)	1.209*** (0.040)	1.141*** (0.022)
Constant (Dirty)	-6.281*** (0.067)	-5.575*** (0.055)	-5.535*** (0.170)	-4.964*** (0.125)	-3.771*** (0.076)	-3.086*** (0.054)	-3.238*** (0.138)	-2.713*** (0.050)
Ratio Clean/Dirty	1.19*** (0.00)	1.16*** (0.00)	1.14*** (0.01)	1.15*** (0.01)	1.39*** (0.00)	1.36*** (0.00)	1.39*** (0.00)	1.45*** (0.01)
Sample			Gr. Triadic	Gr. Triadic			Gr. Triadic	Gr. Triadic
Year FEs	X	X	X	X	X	X	X	X
Firm FEs		X	X	X		X	X	X
Quality Proxies				X				X
R2	0.381	0.470	0.406	0.415	0.610	0.709	0.632	0.641
Observations	2.53e+06	2.43e+06	3.30e+05	3.30e+05	2.53e+06	2.83e+06	3.87e+05	3.87e+05

Poisson pseudo-maximum likelihood regression. Standard errors in parentheses.

Dependent Variable: Count of backward citations going to AI or ICT

*Note:* Ratio Clean/Dirty corresponds to the ratio of the sum of coefficient on Clean plus the constant over the constant. Quality Proxies include the number of citations received within three years, the size of the family and the number of countries where the family was filed.

Table SI8: Long Version of Table 4

	(1) AI	(2) AI	(3) AI	(4) AI	(5) ICT	(6) ICT	(7) ICT	(8) ICT
Clean Family	0.486*** (0.029)	0.492*** (0.030)	0.442*** (0.040)	0.441*** (0.040)	0.486*** (0.029)	0.519*** (0.049)	0.442*** (0.040)	0.438*** (0.048)
Grey Family	0.294*** (0.025)	0.303*** (0.025)	0.289*** (0.036)	0.294*** (0.036)	0.294*** (0.025)	0.368*** (0.023)	0.289*** (0.036)	0.328*** (0.033)
Nbr Patents in Family	0.008** (0.004)	0.008** (0.003)	0.011*** (0.002)	0.011*** (0.002)	0.008** (0.004)	0.007* (0.004)	0.011*** (0.002)	0.011*** (0.003)
Nbr Countries in Family	0.013** (0.006)	0.013** (0.006)	-0.013 (0.010)	-0.013 (0.009)	0.013** (0.006)	0.015** (0.006)	-0.013 (0.010)	-0.012 (0.010)
Granted	0.394*** (0.069)	0.396*** (0.069)	0.492*** (0.061)	0.496*** (0.060)	0.394*** (0.069)	0.400*** (0.070)	0.492*** (0.061)	0.497*** (0.063)
Triadic	0.147*** (0.043)	0.148*** (0.044)	0.218*** (0.029)	0.218*** (0.029)	0.147*** (0.043)	0.146*** (0.043)	0.218*** (0.029)	0.217*** (0.028)
Nbr Citations Made (log)	0.674*** (0.062)	0.670*** (0.065)	0.587*** (0.029)	0.581*** (0.031)	0.674*** (0.062)	0.646*** (0.067)	0.587*** (0.029)	0.560*** (0.033)
AI Citing		0.227*** (0.085)		0.160*** (0.037)				
Clean X Citing AI		-0.164*** (0.008)		-0.054** (0.027)				
Grey X Citing AI		-0.209*** (0.027)		-0.108*** (0.030)				
ICT Citing						0.412*** (0.096)		0.252*** (0.046)
Clean X Citing ICT						-0.273*** (0.007)		-0.096*** (0.012)
Grey X Citing ICT						-0.340*** (0.024)		-0.149*** (0.021)
Constant (Dirty)	-1.973*** (0.194)	-1.978*** (0.195)	-1.752*** (0.184)	-1.752*** (0.186)	-1.973*** (0.194)	-2.018*** (0.205)	-1.752*** (0.184)	-1.767*** (0.192)
Sample								
Year FEs	X	X	X	X	X	X	X	X
Firm FEs			X	X			X	X
Quality Proxies	X	X	X	X	X	X	X	X
Pseudo R2	0.367	0.367	0.446	0.446	0.367	0.369	0.446	0.447
Observations	5.55e+05	5.55e+05	7.40e+05	7.40e+05	5.55e+05	5.55e+05	7.40e+05	7.40e+05

Poisson Pseudo-Likelihood Regression.

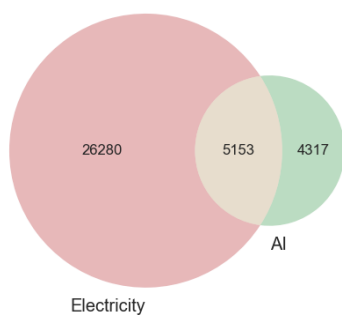
Standard Errors in Parentheses. Clustered at the type and firm level.

Dependent Variable: Citations Received Within 3 Years of Priority.

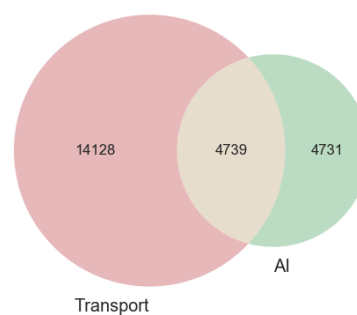
## B Additional Figures and Tables For Family-Level Analysis

## C Additional Figures and Tables For Firm-Level Analysis

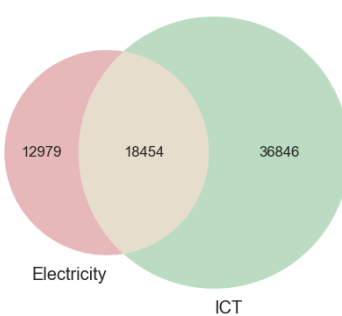
### C.A Firms Patenting in Energy and AI/ICT



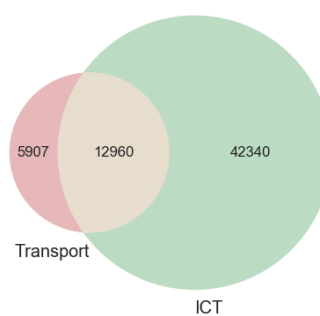
(a) Firms Patenting in Electricity and AI



(b) Firms Patenting in Transport and AI



(c) Firms Patenting in Electricity and ICT



(d) Firms Patenting in Transport and ICT

Figure SI2: Firms Patenting in Energy and AI

**C.B Dependent variable: Count citing AI and ICT**

Table SI9: Main table but with all variables

	(1) AI	(2) AI	(3) AI	(4) AI	(5) ICT	(6) ICT	(7) ICT	(8) ICT
Family Count (log)	0.917*** (0.031)	0.921*** (0.032)	1.009*** (0.029)	1.000*** (0.032)	0.956*** (0.024)	0.989*** (0.021)	0.994*** (0.019)	1.005*** (0.017)
Stock AI (log, t-1)	0.277*** (0.030)	0.273*** (0.040)	0.103** (0.043)	0.073 (0.051)				
Stock Energy (log, t-1)	-0.102*** (0.020)	-0.102*** (0.020)	-0.154*** (0.036)	-0.152*** (0.036)	-0.084*** (0.015)	-0.100*** (0.013)	-0.203*** (0.029)	-0.215*** (0.030)
Clean Portfolio	0.629*** (0.088)	0.493*** (0.071)	0.809*** (0.074)	0.567*** (0.072)	0.763*** (0.032)	0.861*** (0.039)	0.754*** (0.028)	0.711*** (0.056)
Grey Portfolio	0.514*** (0.060)	0.509*** (0.062)	0.480*** (0.053)	0.471*** (0.062)	0.320*** (0.032)	0.272*** (0.043)	0.282*** (0.034)	0.144** (0.057)
Transport Portfolio	0.599*** (0.058)	0.711*** (0.060)	0.439*** (0.034)	0.502*** (0.038)	-0.218*** (0.029)	0.173*** (0.042)	-0.268*** (0.029)	0.091* (0.051)
Clean X Stock AI (log, t-1)		0.042 (0.031)		0.066** (0.032)				
Grey X Stock AI (log, t-1)		0.005 (0.021)		0.007 (0.027)				
Transport X Stock AI (log, t-1)		-0.037*** (0.014)		-0.016 (0.014)				
Total Assets (log)			0.155*** (0.047)	0.160*** (0.047)			0.078** (0.036)	0.081** (0.036)
Nbr Employees (log)			-0.134*** (0.037)	-0.132*** (0.036)			-0.058 (0.037)	-0.063* (0.037)
Age (log)			-0.353** (0.176)	-0.354** (0.180)			-0.265*** (0.096)	-0.266*** (0.096)
Stock ICT (log, t-1)					0.170*** (0.015)	0.209*** (0.015)	0.097** (0.038)	0.125*** (0.040)
Clean X Stock ICT (log, t-1)						-0.019** (0.008)		0.006 (0.011)
Grey X Stock ICT (log, t-1)						0.006 (0.009)		0.021* (0.013)
Transport X Stock ICT (log, t-1)						-0.068*** (0.009)		-0.054*** (0.011)
Constant	-4.076*** (0.085)	-4.073*** (0.078)	-4.015*** (0.849)	-4.025*** (0.838)	-2.182*** (0.039)	-2.400*** (0.045)	-1.189** (0.598)	-1.355** (0.602)
Portfolio FEs	X	X	X	X	X	X	X	X
Year FEs	X	X	X	X	X	X	X	X
Firm FEs			X	X			X	X
Firm level controls			X	X			X	X
Observations	134,891	134,891	54,880	54,880	134,891	134,891	79,963	79,963
R2	0.567	0.567	0.638	0.639	0.702	0.705	0.764	0.765

Poisson pseudo-maximum likelihood regression. Standard errors in parentheses, Clustered at firm level.

Dependent variable: Count of Families citing AI or ICT.

Firm level controls include total assets (log), number of employees (log), and years since incorporation (log).

The label (log) refers to the natural logarithm of 1 + the variable in question.

Interaction terms for Grey and Transport are included but not shown on the table for brevity.

*Note:* Stock Energy corresponds to the firm's total stock of energy patents (i.e., the sum of patent stocks for clean, grey and dirty electricity/transportation).

Table SI10: Robustness check for AI

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	AI	AI	AI	AI	AI	AI	AI	AI
Family Count (log)	1.000*** (0.032)	0.861*** (0.050)	1.089*** (0.056)	1.003*** (0.030)	0.940*** (0.042)	0.814*** (0.056)	1.031*** (0.065)	0.896*** (0.041)
Stock AI (log, t-1)	0.073 (0.051)	0.091 (0.087)	0.103 (0.074)	0.008 (0.055)	0.158** (0.073)	0.209* (0.107)	0.073 (0.116)	-0.060 (0.090)
Stock Energy (log, t-1)	-0.152*** (0.036)	-0.124* (0.064)	-0.120* (0.068)	-0.133*** (0.044)	-0.169*** (0.059)	-0.227** (0.089)	-0.032 (0.109)	-0.113 (0.081)
Clean Portfolio	0.567*** (0.072)	1.354*** (0.142)	-0.024 (0.120)	0.418*** (0.064)	0.849*** (0.167)	1.436*** (0.211)	0.083 (0.308)	0.225 (0.154)
Clean X Stock AI (log, t-1)	0.066** (0.032)	0.078** (0.036)	0.064 (0.083)	0.001 (0.023)	0.025 (0.048)	0.072 (0.046)	0.082 (0.120)	0.038 (0.037)
Firm Sample	All Firms	Transport	Electricity	Both	All Firms	Transport	Electricity	Both
Family Count	All	All	All	All	at least 5	at least 5	at least 5	at least 5
Portfolio FEs	X	X	X	X	X	X	X	X
Year FEs	X	X	X	X	X	X	X	X
Firm FEs	X	X	X	X	X	X	X	X
Firm level controls	X	X	X	X	X	X	X	X
Observations	54,880	7,474	6,485	32,820	11,746	2,990	1,210	6,155
R2								

Poisson pseudo-maximum likelihood regression. Standard errors in parentheses, Clustered at firm level.

Dependent variable: Count of Families citing AI

Firm level controls include total assets (log), number of employees (log), and years since incorporation (log).

The label (log) refers to the natural logarithm of 1 + the variable in question.

Interaction terms for Grey and Transport are included but not shown on the table for brevity.

*Note:* Stock Energy corresponds to the firm's total stock of energy patents (i.e., the sum of patent stocks for clean, grey and dirty electricity/transportation).

Table SI11: Robustness check for ICT

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ICT	ICT	ICT	ICT	ICT	ICT	ICT	ICT
Family Count (log)	1.022*** (0.013)	0.924*** (0.027)	1.108*** (0.035)	1.004*** (0.020)	0.939*** (0.017)	0.865*** (0.033)	0.912*** (0.058)	0.854*** (0.026)
Stock ICT (log, t-1)	0.068*** (0.025)	0.072 (0.055)	0.012 (0.049)	0.058* (0.031)	0.124*** (0.041)	0.110 (0.074)	0.034 (0.105)	0.088 (0.062)
Stock Energy (log, t-1)	-0.149*** (0.024)	-0.120** (0.054)	-0.051* (0.031)	-0.149*** (0.032)	-0.198*** (0.039)	-0.136* (0.077)	-0.062 (0.070)	-0.204*** (0.060)
Clean Portfolio	0.815*** (0.052)	1.229*** (0.108)	0.639*** (0.069)	0.827*** (0.060)	1.045*** (0.124)	1.673*** (0.180)	0.063 (0.240)	1.001*** (0.150)
Clean X Stock ICT (log, t-1)	-0.022** (0.010)	-0.042** (0.019)	-0.028 (0.022)	-0.032*** (0.011)	-0.046** (0.018)	-0.097*** (0.028)	0.069 (0.045)	-0.049** (0.021)
Firm Sample	All Firms	Transport	Electricity	Both	All Firms	Transport	Electricity	Both
Family Count	All	All	All	All	at least 5	at least 5	at least 5	at least 5
Portfolio FEs	X	X	X	X	X	X	X	X
Year FEs	X	X	X	X	X	X	X	X
Firm FEs	X	X	X	X	X	X	X	X
Firm level controls	X	X	X	X	X	X	X	X
Observations	79,963	9,982	15,130	45,474	13,092	3,245	1,766	6,672
R2								

Poisson pseudo-maximum likelihood regression. Standard errors in parentheses, Clustered at firm level.

Dependent variable: Count of Families citing ICT.

Firm level controls include total assets (log), number of employees (log), and years since incorporation (log).

The label (log) refers to the natural logarithm of 1 + the variable in question.

Interaction terms for Grey and Transport are included but not shown on the table for brevity.

*Note:* Stock Energy corresponds to the firm's total stock of energy patents (i.e., the sum of patent stocks for clean, grey and dirty electricity/transportation).

**C.C Dependent variable: Percentage citing AI and ICT**

Table SI12: Main table but with all variables

	(1) AI	(2) AI	(3) AI	(4) AI	(5) ICT	(6) ICT	(7) ICT	(8) ICT
Stock AI (log, t-1)	1.692*** (0.109)	1.256*** (0.089)	-0.417** (0.211)	-0.842*** (0.214)				
Stock Energy (log, t-1)	-0.765*** (0.054)	-0.761*** (0.053)	-0.519*** (0.171)	-0.517*** (0.171)	-4.218*** (0.146)	-4.221*** (0.145)	-1.978*** (0.425)	-1.972*** (0.425)
Clean Portfolio	2.116*** (0.125)	1.384*** (0.137)	2.197*** (0.170)	1.416*** (0.203)	21.427*** (0.309)	20.078*** (0.415)	19.539*** (0.386)	16.514*** (0.641)
Grey Portfolio	1.779*** (0.134)	1.507*** (0.156)	1.795*** (0.165)	1.463*** (0.207)	4.867*** (0.289)	4.794*** (0.400)	3.819*** (0.356)	3.052*** (0.580)
Transport Portfolio	3.198*** (0.117)	3.343*** (0.133)	2.462*** (0.140)	2.408*** (0.173)	-1.775*** (0.263)	2.430*** (0.353)	-3.418*** (0.317)	0.920* (0.507)
Clean X Stock AI (log, t-1)		0.980*** (0.113)		0.699*** (0.114)				
Grey X Stock AI (log, t-1)		0.379*** (0.086)		0.316*** (0.096)				
Transport X Stock AI (log, t-1)		-0.143* (0.077)		0.076 (0.079)				
Total Assets (log)			0.134 (0.169)	0.136 (0.169)			0.314 (0.352)	0.328 (0.354)
Nbr Employees (log)			-0.431* (0.224)	-0.433* (0.224)			-0.519 (0.472)	-0.533 (0.470)
Age (log)			-0.981* (0.592)	-0.992* (0.592)			-3.812*** (1.202)	-3.846*** (1.206)
Stock ICT (log, t-1)					5.229*** (0.128)	5.715*** (0.152)	-0.877** (0.434)	-0.733* (0.441)
Clean X Stock ICT (log, t-1)						0.470*** (0.115)		0.822*** (0.144)
Grey X Stock ICT (log, t-1)						-0.044 (0.110)		0.193 (0.135)
Transport X Stock ICT (log, t-1)						-1.589*** (0.095)		-1.192*** (0.115)
Constant	2.494*** (0.106)	2.798*** (0.115)	7.953** (3.610)	8.391** (3.605)	16.794*** (0.255)	15.782*** (0.284)	41.807*** (7.248)	41.284*** (7.257)
Portfolio FEs	X	X	X	X	X	X	X	X
Year FEs	X	X	X	X	X	X	X	X
Firm FEs			X	X			X	X
Firm level controls			X	X			X	X
Observations	134,891	134,891	91,329	91,329	134,891	134,891	91,329	91,329
R2	0.019	0.019	0.205	0.206	0.111	0.113	0.336	0.337

Linear regression. Standard errors in parentheses, Clustered at firm level.

Dependent variable: Percentage of Families which Cite AI or ICT.

Firm level controls include total assets (log), number of employees (log), and years since incorporation (log).

The label (log) refers to the natural logarithm of 1 + the variable in question.

Interaction terms for Grey and Transport are included but not shown on the table for brevity.

*Note:* Stock Energy corresponds to the firm's total stock of energy patents (i.e., the sum of patent stocks for clean, grey and dirty electricity/transportation).

Table SI13: Robustness check for AI

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	AI	AI	AI	AI	AI	AI	AI	AI
Stock AI (log, t-1)	-0.842*** (0.214)	-1.111* (0.575)	0.053 (0.484)	-0.905*** (0.293)	-0.105 (0.231)	0.361 (0.512)	0.254 (0.382)	-0.547 (0.334)
Stock Energy (log, t-1)	-0.517*** (0.171)	-0.285 (0.542)	-0.400 (0.253)	-0.591** (0.239)	-0.589** (0.235)	-1.169** (0.454)	0.055 (0.262)	-0.428 (0.368)
Clean Portfolio	1.416*** (0.203)	4.831*** (0.820)	0.019 (0.321)	1.421*** (0.279)	1.062*** (0.401)	4.009*** (1.242)	-1.360 (0.920)	-0.113 (0.458)
Clean X Stock AI (log, t-1)	0.699*** (0.114)	1.059*** (0.357)	-0.138 (0.419)	0.586*** (0.143)	0.628*** (0.122)	1.223*** (0.405)	0.874** (0.412)	0.588*** (0.130)
Firm Sample	All Firms	Transport	Electricity	Both	All Firms	Transport	Electricity	Both
Family Count	All	All	All	All	at least 5	at least 5	at least 5	at least 5
Portfolio FEs	X	X	X	X	X	X	X	X
Year FEs	X	X	X	X	X	X	X	X
Firm FEs	X	X	X	X	X	X	X	X
Firm level controls	X	X	X	X	X	X	X	X
Observations	91,329	11,312	20,410	50,120	13,337	3,273	1,857	6,814
R2	0.206	0.272	0.276	0.192	0.381	0.479	0.472	0.354

Linear regression. Standard errors in parentheses, Clustered at firm level.

Dependent variable: Percentage of Families which Cite AI or ICT.

Firm level controls include total assets (log), number of employees (log), and years since incorporation (log).

The label (log) refers to the natural logarithm of 1 + the variable in question.

Interaction terms for Grey and Transport are included but not shown on the table for brevity.

*Note:* Stock Energy corresponds to the firm's total stock of energy patents (i.e., the sum of patent stocks for clean, grey and dirty electricity/transportation).

Table SI14: Robustness check for ICT

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ICT	ICT	ICT	ICT	ICT	ICT	ICT	ICT
Stock ICT (log, t-1)	-0.733* (0.441)	2.018** (0.978)	-3.073*** (0.807)	-0.864 (0.660)	0.589 (0.830)	1.313 (1.061)	-2.255 (1.427)	-0.108 (1.553)
Stock Energy (log, t-1)	-1.972*** (0.425)	-2.792*** (0.996)	-0.157 (0.716)	-2.650*** (0.643)	-2.409*** (0.842)	-1.949* (1.125)	1.358 (1.307)	-4.050*** (1.478)
Clean Portfolio	16.514*** (0.641)	16.648*** (1.987)	15.624*** (1.193)	16.785*** (0.926)	10.143*** (1.964)	20.728*** (4.905)	-5.590 (5.827)	13.498*** (3.114)
Clean X Stock ICT (log, t-1)	0.822*** (0.144)	-0.068 (0.488)	1.807*** (0.421)	0.846*** (0.191)	1.585*** (0.300)	-0.169 (0.888)	4.631*** (1.084)	1.182*** (0.434)
Firm Sample	All Firms	Transport	Electricity	Both	All Firms	Transport	Electricity	Both
Family Count	All	All	All	All	at least 5	at least 5	at least 5	at least 5
Portfolio FEs	X	X	X	X	X	X	X	X
Year FEs	X	X	X	X	X	X	X	X
Firm FEs	X	X	X	X	X	X	X	X
Firm level controls	X	X	X	X	X	X	X	X
Observations	91,329	11,312	20,410	50,120	13,337	3,273	1,857	6,814
R2	0.337	0.382	0.473	0.298	0.628	0.640	0.830	0.587

Linear regression. Standard errors in parentheses, Clustered at firm level.

Dependent variable: Percentage of Families which Cite AI or ICT.

Firm level controls include total assets (log), number of employees (log), and years since incorporation (log).

The label (log) refers to the natural logarithm of 1 + the variable in question.

Interaction terms for Grey and Transport are included but not shown on the table for brevity.

*Note:* Stock Energy corresponds to the firm's total stock of energy patents (i.e., the sum of patent stocks for clean, grey and dirty electricity/transportation).