Supplemental Appendix for "Deforestation, Foreign Demand and Export Dynamics in Indonesia"

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This document is the Supplemental Appendix for the paper "Deforestation, Foreign Demand and Export Dynamics in Indonesia." The following sections provide (A) a historical timeline of corporate timber purchasing policies in export markets, (B) a detailed data description and all summary statistics which were omitted from the main text, (C) reduced-form evidence of the impact abatement has on firm-level energy, materials and capital intensity, (D) a detailed description for the numerical solution of the firm's dynamic problem and (E) a simple model used to provide intuition behind our counterfactual experiments.

A Corporate Timber Purchasing Policies

In the section we provide documentation for a number of timber purchasing policies which were enacted during our sample period among firms which are global purchasers of tropical timber products. This list is not intended to be exhaustive; there were many of these policies enacted in many different countries during our sample period. Unfortunately, there is no complete source that documents all such policies. Instead, we chose to focus on only those firms with international profiles for whom we could find ready information on their timber purchasing history.

Table SA1 documents the timber purchasing policy in over 40 large international firms during our sample period. We include information for these firms beyond the sample period to document their continuing commitment to international environmental issues in timber markets. Similarly, Table SA2 documents the founding date of national timber-purchasing groups dedicated to only purchasing timber products from environmentally certified producers. Again, we document that numerous groups were founded before or during our sample period and many more were founded in the years that followed our sample period. We also document the year the buying group joined the Global Forest and Trade Network (GFTN), a global timber purchasing group administered by the World Wildlife Fund (WWF). While national timber purchasing groups differed in policy before joining the GFTN, the firms and countries joined to the GFTN follow similar purchasing guidelines. These guidelines include independent certification requirements, such as FSC certification. Details can be found on the website: http://gftn.panda.org/ along with a list of the hundreds of corporations committed to following GFTN purchasing policies. The information contained in these tables was compiled from Kupfer (1993), Viana (1996), Hansen (1998), Owens (1998), Fletcher and Hansen (1999), Greenpeace International (1999), Howard and Rainey (2000), IKEA (2004), World Wildlife Fund (2006), GFTN (2011) and the corporate web sites for *B&Q*, *Carrefour*, *Home Depot* and *Walmart*.

Table SA2: A History of National Timber Purchasing Groups

Country	First Launched Buyer's Group	Joined GFTN	Country*	First Launched Buyer's Group	Joined GFTN
United Kingdom	1991	1999	Japan	1999	—
Belgium	1994	1999	Brazil	2000	2000
Netherlands	1992	1999	Russia[c]	2000	2000
France	1995	1999	Malaysia	2004	2004
Ireland	1995	2000	Cameroon	2005	2005
Switzerland	1995	1999	China	2005	2005
Austria	1995	1999	Indonesia	2005	2005
Germany	1995	1999	Romania	2005	2005
Spain	1995	1999	Bolivia	2006	2006
Sweden	1995	1999	Peru	2006	2006
North America[a]	1995	1999	Vietnam	2006	2006
Denmark	1998	1999	Republic of Congo	2007	2007
Finland	1998	1999	Portugal	2008	2008
Norway	1998	1999	India	2009	2009
Australia[b]	1999	2006	Lao PDR	2009	2009
Italy	1999	—			

Notes: (a) United States and Canada. (b) GFTN date is estimated based on the year the first available member in that country joined GFTN. (c) In Russia, this is a producer group rather than a consumer group. (*) GFTN is also has groups operating in Ghana, Belize, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, Panama and Puerto Rico. We were not able to determine the earliest date at which these groups began operating and excluded them from the table for this reason.

B 1994-1997 Sample Summary Statistics

In this section we present summary statistics for the 1994-1997 sample. Tables SA3-SA6 are analogous to Tables 3-6 in the main text. In general, the all tables are very similar to those in the main text with only one exception in Table SA3. As such, we largely refer the reader to the main text for a longer discussion of the features of the data.

In Table SA3 we observe that average domestic sales increase in both industries. This is largely due to changing composition of exporting and non-exporting firms. The Asian crisis reaches Indonesia in the fall of 1997. Because of this many previous exporters choose to stop exporting in 1997 and focus on domestic markets. This has two effects. First, since exporting firms are generally larger and more productive than non-exporting firms when former exporters choose to stop exporting they increase the average size of a non-exporting firm. Second, smaller exporters, though still larger than domestic firms, were those most likely to stop exporting. As

Table SA1: Corporate Timber Purchasing Policies

Retailer/Firm	Core/Related Product	Year	Policy	Countries of Operation
Assi Doman	Logging/Timber Products	1990s	Ceases logging ancient forests and purchasing products from such forests.	Sweden
B&Q[a,b]	DIY/Garden Furniture	early 1990s	Adopts a coded basis for wood purchases to track sources and sustainability of harvesting.	United Kingdom, China, Ireland
		1991	Founds British Forest and Trade Network	
		1993	Helps found FSC certification and begins reducing wood purchases from non-FSC certified sources.	
		2011	Eliminates all non-FSC certified wood from global supply chain.	
Bridgman	Furniture	1991	Founds British Forest and Trade Network	
Bouwfonds[c]	Property Development	early 1990s	Begins phasing out tropical timber without FSC certification.	Netherlands
Carrefour	Hypermarkets	1997	Begins phasing out unsustainably harvested wood from its supply chain.	France, Argentina, Azerbaijan, Bahrain, Belgium, Brazil, Bulgaria China, Colombia, Dominican Republic, Egypt, Greece, Indonesia, Iran, Italy, Japan, Jordan, Kuwait, Malaysia, Monaco, Morocco, Oman, Pakistan, Poland, Portugal, Qatar, Romania, Saudi Arabia Singapore, Slovenia, Spain, Syria, Taiwan, Thailand, Tunisia, Turkey, United Arab Emirates.
		1998	Works with WWF towards achieving FSC certification.	
		2006	Discontinues selling furniture made from teak wood.	
		2007	Discontinues selling furniture made from keruing.	

Notes: (a) Members of the British Forest and Trade Network commit to standard independent certification (later FSC, 1995), phasing out of wood products from non-certified (later non-FSC) forests, phasing-in of (later FSC) certified products, bi-annual published progress reports. (b) In 1999 the British Forest and Trade Network joins other national buying agencies to form the Global Forest and Trade Network (GFTN). The GFTN presently operates in over 30 countries and has over 300 companies as members. (c) Along with project development giant Bouwfonds 72 additional Dutch project developers and 180 additional Dutch builders signed similar letters of intent signed by Dutch throughout the early 1990s.

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Retailer/Firm	Core/Related Product	Year	Policy	Countries of Operation
Carillion plc	Construction	1997	Joins British Forest and Trade Network	United Kingdom
Chindwell Company Ltd	Timber Products/Furniture	1992	Joins British Forest and Trade Network	United Kingdom
Cinnabar	Set Construction	1993	Reduces use of tropical timber in set construction.	United States
Clarks Wood Company	Hardwood Importer	1992	Joins British Forest and Trade Network	United Kingdom
David Craig Ltd	Garden Furniture	1991	Founds British Forest and Trade Network	United Kingdom
ENSO/Stora-Enso	Timber Products/Pulp	1990s	Ceases logging ancient forests and purchasing products from such forests.	Sweden
Finewood	Doors	1991	Founds British Forest and Trade Network	United Kingdom
Focus	DIY/Garden Furniture	1992	Joins British Forest and Trade Network	United Kingdom
FW Mason and Sons	Timber Products	1991	Founds British Forest and Trade Network	United Kingdom
Graefe	Veneered Marquetry	1991	Founds British Forest and Trade Network	United Kingdom
Habitat	Furniture	1991	Founds British Forest and Trade Network	United Kingdom
Hollywood Center Studios	Film Prod./Set Construction	1990	Ceases using tropical wood in set construction	United States

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Retailer/Firm	Core/Related Product	Year	Policy	Countries of Operation
Homebase Ltd	DIY/Garden Furniture	1995	Joins British Forest and Trade Network	United Kingdom
Home Depot	DIY/Garden Furniture	1990	Forms working environmental group to study deforestation and other environmental issues.	United States, Canada Mexico, China
		1993	Founding member of the Forest Stewardship Council.	
		1995	Dramatically reduces wood purchases without FSC certification.	
		1999, 2002	Further reductions in wood purchases without FSC certification.	
IKEA	Furniture Retailer	1992	Commits to only using wood from responsibly-managed forests that replant and maintain biological diversity.	Sweden, Norway, Denmark, Switzerland, Germany, Germany, Australia, Hong Kong, Canada, Austria, Singapore, Netherlands, Spain, Iceland, France, Saudi Arabia, Belgium, Kuwait, United States, United Kingdom, Italy, Hungary, Poland, Taiwan Czech Republic, Slovakia United Arab Emirates, Finland, Malaysia
Intergamma (Gamma and Karwei)	DIY/Garden Furniture	1993	Begins phasing out wood products sourced without FSC certification.	Netherlands, Belgium United States
J Sainbury plc	Supermarkets/Furniture	1991	Founds British Forest and Trade Network	United Kingdom
Lexington	Set Construction	1993	Reduces use of tropical timber in set construction.	United States

Table SA1: Corporate Timber Purchasing Policies

Retailer/Firm	Core/Related Product	Year	Policy	Countries of Operation
Magnet Ltd	Kitchen Cabinets	1991	Founds British Forest and Trade Network	United Kingdom
M&N Norman	Timber Products	1991	Founds British Forest and Trade Network	United Kingdom
MCA/Universal	Film Prod./Set Construction	1993	Reduces use of tropical timber in set construction.	United States
Meyer International	Timber Product Importing	1998	Commits to only purchasing FSC certified products.	United Kingdom
MFI	Furniture	1991	Founds British Forest and Trade Network	United Kingdom
Moore's Furniture Group	Furniture	1998	Joins British Forest and Trade Network	United Kingdom
OBI	DIY/Garden Furniture	1993	Ceases selling wood without FSC certification.	Germany, Italy, Austria, Czech Republic, Hungary
Otto-Versand	Mail Order Products	1990s	Begins reducing use of tropical timber in its product range.	Germany
Paramount Pictures	Film Prod./Set Construction	1993	Reduces use of tropical timber in set construction.	United States
Praktiker	DIY	1993	Ceases selling wood without FSC certification.	Germany, Greece, Luxembourg
Praxis	DIY	1990s	Gradually phases out wood products sourced without FSC certification.	Netherlands
Premium Timber Products	Timber Products	1991	Founds British Forest and Trade Network	United Kingdom

Table SA1: Corporate Timber Purchasing Policies

Retailer/Firm	Core/Related Product	Year	Policy	Countries of Operation
Richard Burbidge Ltd	Stairs, Decking	1991	Founds British Forest and Trade Network	United Kingdom
Saint-Gobain Bldg Dist	Building Materials	1998	Joins British Forest and Trade Network	United Kingdom
SCA	Timber Products/Pulp	1990s	Ceases logging ancient forests and purchasing products from such forests.	Sweden
Shadbolt International	Doors	1992	Joins British Forest and Trade Network	United Kingdom
Sony Pictures Studios	Film Prod./Set Construction	1993	Reduces use of tropical timber in set construction.	United States
Texas Homecare	DIY	1991	Founds British Forest and Trade Network	United Kingdom
Twentieth Century Fox	Film Prod./Set Construction	1993	Reduces use of tropical timber in set construction.	United States
Walmart	Dept Store/Garden Furniture	1993 2008	Limited introduction of "Ecostore" outlets which only sell products made with sustainably produced lumber. Begins reducing unsustainably harvested wood from its supply chain. Aims to eliminate such wood by 2013.	United States, Brazil, Canada, Chile, China, Argentina, India, Costa Rica, El Salvador, Guatemala, Honduras, Hong Kong, Japan, Mexico, Nicaragua, Pakistan, Puerto Rico, United Kingdom.
Walt Disney Pictures	Film Prod./Set Construction	1993	Reduces use of tropical timber in set construction.	United States
Warner Bros.	Film Prod./Set Construction	1993	Reduces use of tropical timber in set construction.	United States

such, the group of remaining exporters are on average larger than before.

Despite the similarity in the two samples, the change in export behaviour in 1997 was a potential cause for concern. Because of this we focus on the 1994-1996 in the main text. However, when we repeat the estimation exercise including 1997 we find almost identical parameter estimates.[1]

Table SA3: Average Sales, 1994-1997

Saw Mills				Wood Furniture			
	Non-Exporters	Exporters			Non-Exporters	Exporters	
	Average Domestic Sales	Average Domestic Sales	Average Export Sales		Average Domestic Sales	Average Domestic Sales	Average Export Sales
1994	20,770	27,504	161,527	1994	3,599	7,122	13,181
1995	20,317	31,811	127,487	1995	3,450	8,109	12,629
1996	13,907	32,176	165,744	1996	3,693	6,999	15,820
1997	31,872	53,664	157,296	1997	5,483	13,593	18,303

Table SA4: Average Sales Across Abatement Status 1994-1997

	Non-Exporters		Exporters	
	Non-Abate	Abate	Non-Abate	Abate
Saw Mills	22,956	17,772	173,141	223,716
Wood Furniture	3,943	5,814	18,838	20,395

Notes: Abatement expenditures are measured in thousands of 1983 Indonesian rupiahs.

Table SA5: Abatement and Export Behaviour, 1994-1997

Abatement Rates and Expenditures

Industry	Saw Mills			Wood Furniture			All		
	Rate	Expend.	Obs.	Rate	Expend.	Obs.	Rate	Expend.	Obs.
Exporter	28.26	225.71	559	16.15	16.35	322	20.52	218.82	10171
Non-Exporter	16.53	41.05	1337	9.21	7.44	1162	13.33	50.31	60423

Export Rates and Revenues

Industry	Saw Mills			Wood Furniture			All		
	Rate	Revenues	Obs.	Rate	Revenues	Obs.	Rate	Revenues	Obs.
Abater	41.69	183,196.00	379	32.70	15,839.40	159	20.58	71,029.81	10140
Non-Abater	26.43	140,619.70	1517	20.38	12,388.23	1325	13.37	39,612.86	60454

Notes: Abatement expenditures are measured in thousands of 1983 Indonesian rupiahs.

[1]See the Supplemental Appendix for these results.

Table SA6: Annual Transition Rates for Continuing Plants, 1994-1997

Saw Mills

	Status in $t+1$			
Status in t	Neither	only Exp.	only Abt.	Both
All Firms	0.594	0.202	0.119	0.086
Neither	0.888	0.043	0.059	0.099
only Exp.	0.199	0.661	0.028	0.113
only Abt.	0.306	0.006	0.612	0.076
Both	0.101	0.271	0.124	0.504

Wood Furniture

	Status in $t+1$			
Status in t	Neither	only Exp.	only Abt.	Both
All Firms	0.717	0.174	0.074	0.035
Neither	0.913	0.037	0.046	0.004
only Exp.	0.293	0.660	0.026	0.022
only Abt.	0.413	0.053	0.453	0.080
Both	0.109	0.196	0.152	0.544

C Abatement, Investment and Energy Intensity

In the main text we outlined that there is little reason to believe that environmental expenditures may be directed towards changing the production process to reduce the impact of industrial production on emissions or energy use. While we cannot directly observe the exact nature of firm-level expenditures on abatement, we can check if abatement has any significant impact on energy use, intermediate demand or capital stock. As noted by Cole and Elliott (2003) capital stock is strongly correlated to air and water pollutants. If we find that capital stock or energy usage falls in response to abatement we may be concerned that abatement in the wood products industry is directed towards air or water pollution abatement rather than deforestation.

To examine this possibility we consider the following reduced form specification for the indirect impact of expenditures on energy use:

$$\Delta f_{it} = \Delta d_{it}\alpha + \Delta Z_{it}\beta + \zeta_{it}$$

where f_{it} is the logarithm of the firm's energy/input choice, d_{it} is the firm's decision to abate or not and the matrix Z_{it} contains a number of control variables including firm-specific productivity, the logarithm of firm-specific capital and year dummies. Note firm-specific productivity is measured using Olley-Pakes (1996) control-function methods (as described in the main text). The results for the saw mills and wood furniture industries are presented in Tables SA7 and SA8. We expect that if changes in abatement behavior reduce energy use we should observe a negative coefficient on the firm-level change in abatement status, α.

Tables SA7 and SA8 document the impact of abatement on four firm-level inputs: fuel, electricity, intermediate materials, and capital stock in the saw mill and wood furniture industries. In all the regressions it appears that input use, regardless of type, is almost entirely driven by firm-level productivity. More productive firms will, on average, have greater sales and as such demand greater amounts of inputs. The results also indicate that there are important differences across firms of different sizes, larger plants (with larger capital stocks) use less energy, conditional on productivity. This may reflect economies of scale. Surprisingly the coefficient on

Table SA7: Energy Use and Abatement in the Saw Mill Industry

Dependent Variable	Fuel				Electricity			
Change in Abatement Status (Δd_t)	-0.141	-0.149			0.070	0.063		
	(0.092)	(0.093)			(0.131)	(0.131)		
Lagged Change in Abatement Status			0.109	0.108			0.016	0.014
			(0.106)	(0.106)			(0.150)	(0.151)
Change in Export Status (Δe_t)		0.062				0.385		
		(0.210)				(0.301)		
Lagged Change in Export Status				-0.095				0.054
				(0.114)				(0.160)
$\Delta(d_t \times e_t)$		0.052				-0.159		
		(0.125)				(0.178)		
Change in Total Factor Productivity	2.751	2.766	2.771	2.780	2.905	2.916	2.903	2.891
	(0.270)	(0.270)	(0.271)	(0.271)	(0.397)	(0.399)	(0.397)	(0.399)
Change in Capital Stock	-0.338	-0.341	-0.339	-0.341	-0.335	-0.338	-0.333	-0.331
	(0.053)	(0.053)	(0.053)	(0.053)	(0.076)	(0.076)	(0.076)	(0.076)
Observations	566				322			

Dependent Variable	Inter. Inputs				Capital			
Change in Abatement Status (Δd_t)	-0.044	-0.046			0.002	-0.006		
	(0.033)	(0.033)			(0.073)	(0.073)		
Lagged Change in Abatement Status			0.179	0.179			0.083	0.083
			(0.037)	(0.037)			(0.083)	(0.083)
Change in Export Status (Δe_t)		0.077				0.069		
		(0.075)				(0.166)		
Lagged Change in Export Status				0.034				-0.067
				(0.040)				(0.083)
$\Delta(d_t \times e_t)$		-0.044				0.028		
		(0.045)				(0.099)		
Change in Total Factor Productivity	5.186	5.185	5.219	5.216	3.928	3.928	3.928	3.937
	(0.096)	(0.096)	(0.094)	(0.094)	(0.133)	(0.133)	(0.133)	(0.134)
Change in Capital Stock	-0.675	-0.675	-0.679	-0.678				
	(0.019)	(0.019)	(0.019)	(0.019)				
Observations	577				577			

Notes: Standard errors are in parentheses.

Table SA8: Energy Use and Abatement in the Wood Furniture Industry

Dependent Variable	Fuel				Electricity			
Change in Abatement Status (Δd_t)	0.107	0.100			-0.095	-0.102		
	(0.130)	(0.130)			(0.161)	(0.162)		
Lagged Change in Abatement Status			0.132	0.134			-0.081	-0.074
			(0.128)	(0.128)			(0.159)	(0.159)
Change in Export Status (Δe_t)		-0.051				0.102		
		(0.205)				(0.256)		
Lagged Change in Export Status				0.073				0.191
				(0.122)				(0.153)
$\Delta(d_t \times e_t)$		-0.043				-0.172		
		(0.128)				(0.160)		
Change in Total Factor Productivity	4.116	4.165	4.140	4.164	4.059	4.119	4.037	4.074
	(0.821)	(0.824)	(0.821)	(0.823)	(0.976)	(0.978)	(0.977)	(0.976)
Change in Capital Stock	-0.093	-0.092	-0.095	-0.094	-0.093	-0.089	-0.093	-0.087
	(0.043)	(0.043)	(0.043)	(0.043)	(0.052)	(0.052)	(0.052)	(0.052)
Observations	420				398			

Dependent Variable	Inter. Inputs				Capital			
Change in Abatement Status (Δd_t)	-0.029	-0.029			-0.111	-0.119		
	(0.056)	(0.056)			(0.146)	(0.147)		
Lagged Change in Abatement Status			0.107	0.109			0.002	-0.003
			(0.053)	(0.054)			(0.142)	(0.142)
Change in Export Status (Δe_t)		0.023				-0.214		
		(0.089)				(0.233)		
Lagged Change in Export Status				0.047				-0.159
				(0.053)				(0.139)
$\Delta(d_t \times e_t)$		-0.038				0.173		
		(0.056)				(0.146)		
Change in Total Factor Productivity	14.024	14.04	14.041	14.056	12.099	12.021	12.101	12.022
	(0.350)	(0.351)	(0.348)	(0.349)	(0.714)	(0.718)	(0.714)	(0.718)
Change in Capital Stock	-0.448	-0.447	-0.448	-0.447				
	(0.018)	(0.018)	(0.018)	(0.018)				
Observations	443				443			

Notes: Standard errors are in parentheses.

Table SA9: Energy Intensity and Abatement in the Saw Mill Industry

Dependent Variable	Fuel/Worker				Elec./Worker			
Change in Abatement Status (Δd_t)	-0.084	-0.093			0.073	0.063		
	(0.092)	(0.092)			(0.134)	(0.134)		
Lagged Change in Abatement Status			0.065	0.063			0.073	0.074
			(0.105)	(0.105)			(0.154)	(0.154)
Change in Export Status (Δe_t)		0.038				0.273		
		(0.208)				(0.308)		
Lagged Change in Export Status				-0.136				-0.045
				(0.114)				(0.164)
$\Delta(d_t \times e_t)$		0.088				-0.058		
		(0.124)				(0.182)		
Change in Total Factor Productivity	2.286	2.305	2.298	2.310	2.341	2.372	2.345	2.355
	(0.269)	(0.269)	(0.269)	(0.270)	(0.406)	(0.408)	(0.406)	(0.408)
Change in Capital Stock	-0.304	-0.308	-0.305	-0.307	-0.279	-0.286	-0.277	-0.279
	(0.053)	(0.053)	(0.053)	(0.053)	(0.078)	(0.078)	(0.078)	(0.078)
Observations	566				322			

Dependent Variable	Inter. Inputs/Worker				Capital/Worker			
Change in Abatement Status (Δd_t)	0.013	0.010			0.059	0.050		
	(0.041)	(0.042)			(0.081)	(0.081)		
Lagged Change in Abatement Status			0.139	0.139			0.047	0.046
			(0.047)	(0.047)			(0.092)	(0.092)
Change in Export Status (Δe_t)		0.054				0.048		
		(0.094)				(0.183)		
Lagged Change in Export Status				-0.007			-0.111	
				(0.051)			(0.010)	
$\Delta(d_t \times e_t)$		-0.009				0.064		
		(0.056)				(0.109)		
Change in Total Factor Productivity	4.702	4.705	4.727	4.728	3.586	3.587	3.590	3.593
	(0.120)	(0.120)	(0.119)	(0.119)	(0.147)	(0.147)	(0.148)	(0.148)
Change in Capital Stock	-0.639	-0.640	-0.642	-0.642				
	(0.024)	(0.024)	(0.024)	(0.024)				
Observations	577				577			

Notes: Standard errors are in parentheses.

Table SA10: Energy Intensity and Abatement in the Wood Furniture Industry

Dependent Variable	Fuel/Worker				Elec./Worker			
Change in Abatement Status (Δd_t)	0.094	0.085			-0.111	-0.121		
	(0.134)	(0.135)			(0.168)	(0.169)		
Lagged Change in Abatement Status			0.050	0.053			-0.164	-0.155
			(0.132)	(0.132)			(0.166)	(0.166)
Change in Export Status (Δe_t)		-0.073				0.084		
		(0.212)				(0.267)		
Lagged Change in Export Status				0.110				0.224
				(0.126)				(0.160)
$\Delta(d_t \times e_t)$		-0.068				-0.197		
		(0.132)				(0.167)		
Change in Total Factor Productivity	3.342	3.415	3.356	3.392	3.066	3.146	3.023	3.067
	(0.850)	(0.852)	(0.851)	(0.852)	(1.02)	(1.021)	(1.02)	(1.019)
Change in Capital Stock	-0.118	-0.116	-0.120	-0.118	-0.105	-0.101	-0.106	-0.10
	(0.045)	(0.045)	(0.045)	(0.045)	(0.054)	(0.054)	(0.054)	(0.054)
Observations	420				398			

Dependent Variable	Inter. Inputs/Worker				Capital/Worker			
Change in Abatement Status (Δd_t)	-0.034	-0.037			-0.114	-0.125		
	(0.064)	(0.064)			(0.149)	(0.150)		
Lagged Change in Abatement Status			0.030	0.139			-0.075	-0.079
			(0.062)	(0.047)			(0.145)	(0.145)
Change in Export Status (Δe_t)		0.001				-0.232		
		(0.102)				(0.237)		
Lagged Change in Export Status				-0.007			-0.121	
				(0.051)			(0.142)	
$\Delta(d_t \times e_t)$		-.062				0.148		
		(0.064)				(0.149)		
Change in Total Factor Productivity	13.074	13.112	13.077	13.102	10.915	10.867	10.908	10.845
	(0.403)	(0.404)	(0.403)	(0.403)	(0.729)	(0.734)	(0.730)	(0.734)
Change in Capital Stock	-0.468	-0.466	-0.467	-0.466				
	(0.021)	(0.021)	(0.021)	(0.021)				
Observations	443				443			

Notes: Standard errors are in parentheses.

abatement status, either in the current period or in the previous year, are always insignificant with one exception in both industries. In the third and fourth columns of Tables SA7 and SA8 the coefficient on abatement status implies a statistically significant impact of abatement on intermediate input use. However, the coefficient takes the wrong sign indicating that abating firms tend to use more intermediate inputs relative to similar non-abating firms. Similarly, the insignificant impact of abatement on capital stock in Tables SA7 and SA8 suggest that firm-level abatement does not have a strong influence on the capital stock of firms in the saw mill and wood furniture industries. As such, we find no evidence that abatement is strongly correlated with (air or water) emissions-related variables in these industries. Moreover, our assumption that there is little variation in firm-level capital stock over time in Section 2 of the main text appears quite plausible.[2]

The results, however, may be contaminated by the fact that firms which choose to adopt abatement technology tend to be larger and, as such, demand more inputs. We repeat the experiment using the log of input intensity, measured as fuel, electricity, intermediate inputs, and capital per worker, in place of the logarithm of the level variables. The results are reported in Tables SA9 and SA10. Again, we find that changes in input intensity are largely driven by firm-specific productivity changes where more productive firms still demand higher amounts of inputs even after controlling for firm size. Consistent with the results in the previous tables, we find no evidence that abatement causes any significant reduction in input-intensity across all input groups. In fact, the results for exporting are also very similar; export status has little impact on energy use once we control for productivity.

Overall, these results would suggest that if firms are reducing their environmental impact through their abatement choices it is not greatly affecting these margins. While this does not imply that abatement choices are not improving local environmental quality,[3] it is consistent with observation that firms in the wood products sector are largely concerned with mitigating deforestation rather than other environmental concerns. Furthermore, our evidence is consistent with that in Pargal and Wheeler (1996) which suggests that local pollution in the Indonesian timber industry is relatively small.

D Computation of the Firm's Dynamic Problem

In this section we provide detailed information regarding the the computation of the firm's dynamic problem. We need to solve each firm's dynamic optimization problem in order to compute the conditional choice probabilities for exporting , $P(e_{it}|z_{it}, k_{it}, \omega_{it}, \Phi_X, e_{it-1}, d_{it-1})$, and abatement, $P(d_{it}|z_{it}, k_{it}, \omega_{it}, \Phi_X, e_{it-1}, d_{it-1})$. For a state vector $s = (z, \omega, e_{-1}, d_{-1}, k, \phi_X)$

[2] We have also examined the correlation with the level of abatement expenditure and have found similar results.

[3] Pargal and Wheeler (1996) find that larger firms in more easily observable parts of Indonesia were more likely to create less water pollution, a dimension we cannot observe in our data.

we use equations (6)-(9) in the main text and the following algorithm to calculate the value functions for each firm.

1. Guess the value of the initial value function $V^0(s)$.

2. Calculate the expected value

$$EV^0 = \int_{z'} \int_{\omega'} (z', \omega', e, k, \Phi_X) dF(\omega'|\omega, d, e) dF(z'|z, d)$$

   where we calculate $F(\omega'|\omega, d, e)$ and $F(z'|z, d)$ are calculated according to equations (4) and (5), respectively.

3. Using EV^0 we calculate V_t^{E0} and V_t^{D0} using equations (7) and (8):

$$\begin{aligned} V^{E0}(d_{-1}) \quad = \quad & P[\delta EV^0(e=1, d=1) - \delta EV^0(e=1, d=0) > d_{-1}\gamma^A + (1-d_{-1})\gamma^D] \cdot \\ & (EV^0(e=1, d=1) - d_{-1}E(\gamma^A|\cdot) - (1-d_{-1})E(\gamma^D|\cdot)) + \\ & P[\delta EV^0(e=1, d=1) - \delta EV^0(e=1, d=0) \leq d_{-1}\gamma^A + (1-d_{-1})\gamma^D] \cdot \\ & EV^0(e=1, d=0) \end{aligned}$$

   and

$$\begin{aligned} V^{D0}(d_{-1}) \quad = \quad & P[\delta EV^0(e=0, d=1) - \delta EV^0(e=0, d=0) > d_{-1}\gamma^A + (1-d_{-1})\gamma^D] \cdot \\ & (EV^0(e=0, d=1) - d_{-1}E(\gamma^A|\cdot) - (1-d_{-1})E(\gamma^D|\cdot)) + \\ & P[\delta EV^0(e=0, d=1) - \delta EV^0(e=0, d=0) \leq d_{-1}\gamma^A + (1-d_{-1})\gamma^D] \cdot \\ & EV^0(e=0, d=0) \end{aligned}$$

4. Using our calculations in step (3) we construct the value function $V^1(z, \omega, e_{-1}, d_{-1}, k, \Phi_X)$ using equation (9) as:

$$\begin{aligned} & V^1(z, \omega, e_{-1}, d_{-1}, k, \Phi_X) = \\ & \quad \pi^D(z, \omega, k) + P[\pi^X(z, \omega, k, \Phi_X) + V^{E0}(d_{-1}) - V^{D0}(d_{-1}) > e_{-1}\gamma^F + (1-e_{-1})\gamma_S] \cdot \\ & \quad (\pi^X(z, \omega, k, \Phi_X) + V^{E0}(d_{-1}) - V^{D0}(d_{-1}) - e_{-1}E(\gamma^F|\cdot) - (1-e_{-1})E(\gamma_S|\cdot)) \\ & \quad P[\pi^X(z, \omega, k, \Phi_X) + V^{E0}(d_{-1}) - V^{D0}(d_{-1}) \leq e_{-1}\gamma^F + (1-e_{-1})\gamma_S] \cdot V^{D0}(d_{-1}) \end{aligned}$$

5. We then repeat steps (2)-(4) until convergence, $V^{j+1} - V^j < \epsilon$.

We adopt Rust's (1997) method to discretize the state space since it is very large in this case. We fix the grid values for k with 8 categories and select $N = 100$ low-discrepancy points for ω and z: $(\omega_1, z_1), \ldots, (\omega_n, z_n), \ldots, (\omega_N, z_N)$. On each grid point we solve the firm's dynamic problem as described above for the value function $\hat{V}$. We can then calculate EV using the discrete Markov operator:

$$\begin{aligned} EV &= \int_{z'} \int_{\omega'} V^0(z', \omega', e, k, \Phi_X) dF(\omega'|\omega, d, e) dF(z'|z, d) \\ &= \frac{1}{N} \sum_{n=1}^{N} \hat{V}(z_n, \omega_n, e, d, k, \Phi_X) p^N(z_n, \omega_n | z, \omega, e, d) \end{aligned}$$

where $p^N(z_n, \omega_n|z, \omega, e, d) = \frac{p(z_n|z)p(\omega_n|\omega,e,d)}{\sum_{n=1}^{N} p(z_n|z)p(\omega_n|\omega,e,d)}$.

E A Simple Model of Abatement and Exporting

In the section we describe a simple, static model of exporting and abatement. In order to provide intuition for the firm-level decisions in the spirit of Melitz (2003) we simplify the model described in Section 2 of the main text using the following assumptions:

- Firm-level productivity is constant over time and invariant to exporting decisions.
- All firms face the export demand shock z^n which is constant over time.
- Define $\tilde{z}^n \equiv \exp\{z^n\}$. If a firm chooses to abate its export demand shock increases to $\tilde{z}^a = \beta \tilde{z}^n$ where $\beta > 1$ in the current period. Any benefit from abatement on the export market lasts only 1 period.
- Firms pay the same fixed cost of exporting, γ^F, and there are no sunk export costs.
- Firms that choose to abate also incur a fixed abatement cost, γ^A. There are no sunk abatement costs.
- Capital and input prices are normalized to 1 and β_0 is normalized to 0 in equation (5) from the main text.
- Firms expect that the size of the export market, Φ^X, is constant over time.

Using the above restrictions and equation (5) from the main text we can write the profit from exporting for a non-abating firm as

$$\pi^X = \rho \Phi^X \tilde{\omega} \tilde{z}^n - \gamma^F,$$

while for the abating firm export profit can be written as

$$\pi^{XA} = \rho \Phi^X \tilde{\omega} \tilde{z}^a - \gamma^F - \gamma^A$$

where $\rho = (\eta_X/(\eta_X+1))^{\eta_X+1}$ and $\tilde{\omega} = \exp\{-\omega(\eta_X+1)\}$ is an index of productivity.

Suppose that the marginal exporter chooses not to abate. In this case, we can derive the threshold productivity for exporting, $\tilde{\omega}^X$, without abatement by setting the profit from exporting to zero

$$\pi^X = 0 \;\Rightarrow\; \tilde{\omega}^X = \frac{\gamma^F}{\rho \Phi^X \tilde{z}^n}.$$

Similarly, we can determine the threshold for productivity for exporting and abatement in this case by comparing the two current export profit levels across abatement status

$$\pi^X = \pi^{XA} \;\Rightarrow\; \tilde{\omega}^{XA} = \frac{\gamma^A}{\beta \rho \Phi^X \tilde{z}^n}$$

Examining these two conditions it is evident that there is no reason to expect that the threshold for abatement and exporting to necessarily be above the threshold for exporting alone. In fact, we will have the threshold ordering $\tilde{\omega}^{XA} < \tilde{\omega}^X$ only when $\gamma^F(\beta - 1) > \gamma^A$.[4] These conditions imply that it is more likely that the marginal exporter will also optimally choose to abate when β is large and γ^A is relatively small. Allowing z^n to vary across firms it is straightforward to further demonstrate that among firms with a large export market (large z^n) the marginal exporter will also choose to abate, while the marginal exporter will not necessarily choose to abate among firms with a relatively small export market (small z^n).

In order to capture the differential effects of policy change across firms and industries we focus on two cases below. In scenario 1 (sc 1), $\tilde{\omega}^{XA} > \tilde{\omega}^X$ we predict that some firms will choose to export but not abate. This case is likely for firms with smaller export markets (small z^n) and in industries where the export gain from abatement is small (β is small), the fixed abatement cost is large (γ^A is large) and the fixed export cost is small (γ^X is small). This case is depicted in Figure SA1. In scenario 2 (sc 2), $\tilde{\omega}^{XA} < \tilde{\omega}^X$ we predict that all firms which choose to export will also abate. This case is likely for firms with large export markets and in industries where the export gain from abatement is large, the fixed abatement cost is small and the fixed export cost is large. We demonstrate this case in Figure SA2.

In what follows, we now consider the effect of the two policy experiments discussed in the main text. Throughout we continue to consider the partial equilibrium effects of the changes in policy. First, we analyze the impact of trade liberalization which we interpret as an increase in the effective size of the export market, Φ^X. The change in trade policy increases the export profits for both abaters and non-abaters without influencing fixed costs. This results in an upward rotation in the slope of both profit functions in Figure SA3 where π^X moves up to $\pi^{X\prime}$ and π^{XA} to $\pi^{XA\prime}$. Note that the profit function rotates further inward because $\beta > 1$ and the trade liberalization is particularly beneficial for firms which abate. For a sufficiently

[4] If all exporting firms abate the productivity of the marginal exporter (and abater) can be found where $\pi^{XA} = 0$ which implies $\tilde{\omega}^{XA} = \frac{\gamma^F + \gamma^A}{\rho \Phi^X \tilde{z}^n \beta}$.

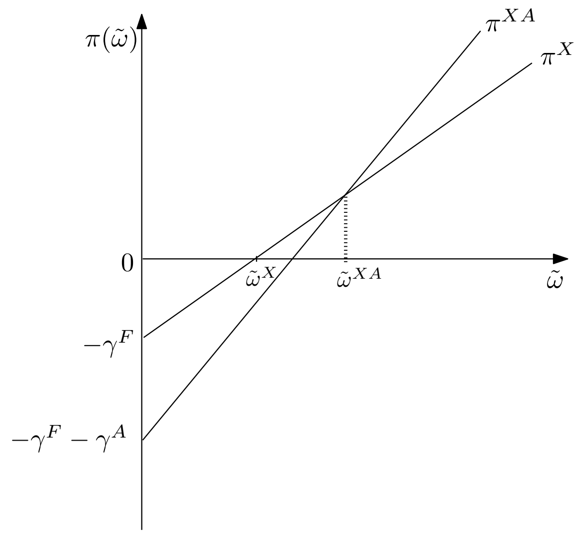

Figure WA1: Export Profits (sc 1)

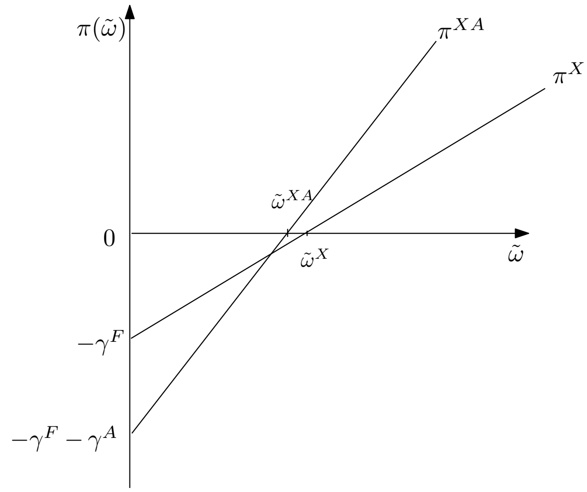

Figure WA2: Export Profits (sc 2)

large increase in the size of the export market this change in policy could shift the threshold for exporting and abatement below the threshold for exporting alone (scenario 2).

The productivity threshold for exporting drops from $\tilde{\omega}^{X}$ to $\tilde{\omega}^{X\prime}$ while that for both exporting and abating is lowered from $\tilde{\omega}^{XA}$ to $\tilde{\omega}^{XA\prime}$. As a result of the change in trade policy, less productive firms who were not able to export can now do so. Likewise, some exporting firms which were not previously abating now find it profitable to export and abate. Hence, firms with productivity between $\tilde{\omega}^{X\prime}$ and $\tilde{\omega}^{X}$ enter the export market and firms which have productivity between $\omega^{XA\prime}$ and ω^{XA} begin abating and exporting.

In Figure SA4 we present the effect of the same policy change on firms in scenario 2. Again we observe an inward rotation of the export profit functions, where the rotation is largest for the profit function for abating firms. In this case the simple model implies that trade liberalization will reinforce the fact that threshold for abatement and exporting is below the threshold for exporting alone. Among the firms that are induced to begin exporting because of the change in policy they will also all begin abating.

The second policy experiment we consider is abatement subsidies which we interpret as a decrease in the fixed cost of abatement. The fixed cost of abating and exporting is lower as γ^{A} decreases to $\gamma^{A\prime}$. In Figures SA5 and SA6 this is represented by a parallel leftward shift of the profit function, π^{XA}, to $\pi^{XA\prime}$. The profit line for exporting alone is unaffected. In Figure SA5, the cutoff productivity for exporting and abating decreases to $\omega^{XA\prime}$. A number of exporting firms with productivity less than the previous cutoff, ω^{XA}, now find it profitable to abate. Since the productivity threshold for firms that only export is the same, the proportion of firms that only export shrinks with an abatement subsidy. Again if the subsidy is large enough the export

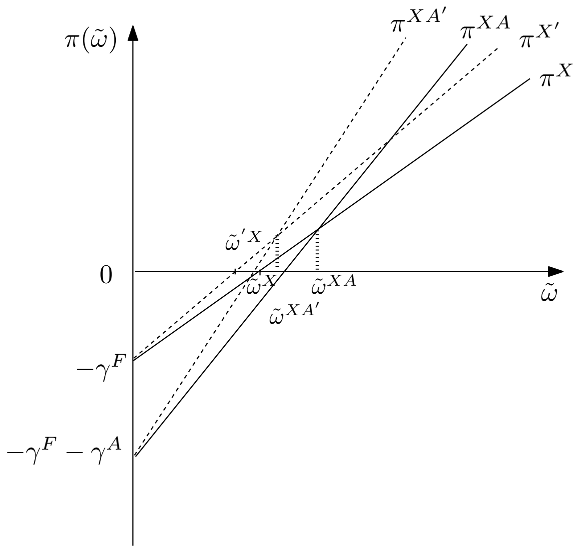

Figure SA3: Trade Liberalization (sc 1)

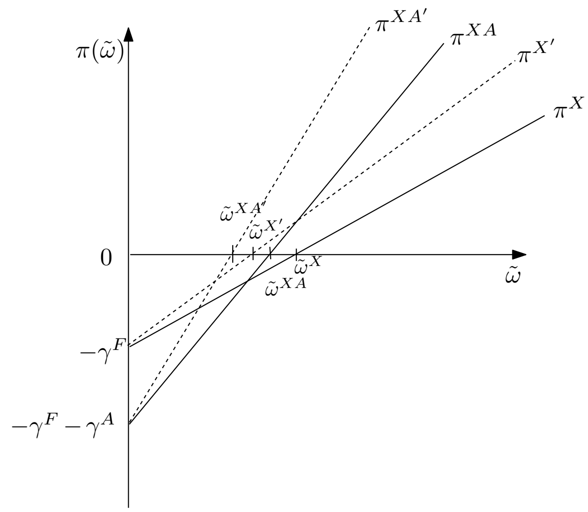

Figure SA4: Trade Liberalization (sc 2)

profit function π^{XA} could shift far enough to the left such that the productivity threshold for abating and exporting is now lower than that for exporting only (scenario 2). In Figure SA6 the abatement subsidy will increase both the number of firms which abate and the number of firms which export since all exporting firms optimally choose to abate. In this scenario, the export threshold is a function of the abatement fixed cost directly and, as such, sensitive to the changes in environmental policy.

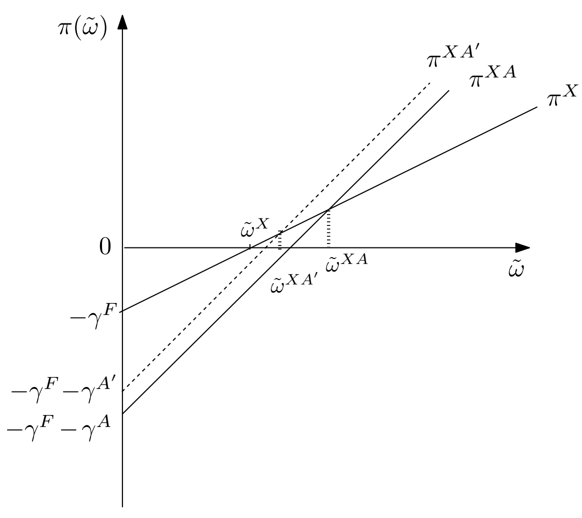

Figure SA5: Abatement Subsidies (sc 1)

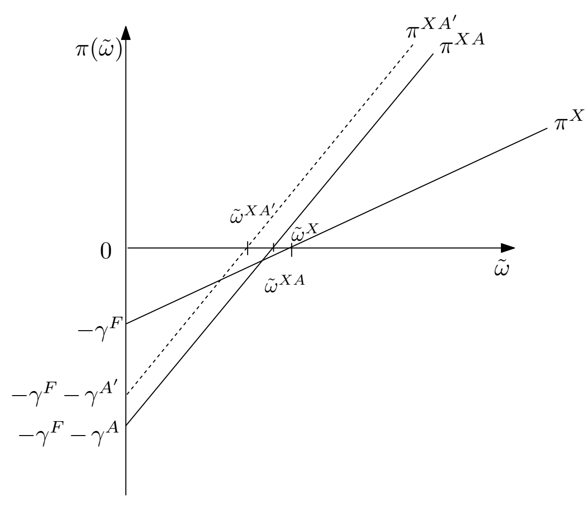

Figure SA6: Abatement Subsidies (sc 2)

References

[1] B&Q. 2011. "B&Q Timber Policy and Buying Standards," http://www.diy.com/diy/jsp/aboutbandq/social_responsibility/BQSRTIMB.PDF (last accessed May 13, 2011).

[2] Carrefour. 2007. "Promoting responsible trade," http://www.carrefour.com/docroot/groupe/C4com/Pieces_jointes/RA/Carrefour%20GB%20corporate%204th%20part.pdf (last accessed May 13, 2011).

[3] Cole, Matthew A. and Robert J.R. Elliott. 2003. "Determining the trade-environment composition effect: the role of capital, labor and environmental regulations," *Journal of Environmental Economics and Management*, 46: 363-383.

[4] Fletcher, Rick and Eric Hansen. 1999. "Forest Certification Trends in North America and Europe," *New Zealand Journal of Forestry,* August: 4-6.

[5] GFTN Global Forest and Trade Website (as part of the World Wildlife Fund for Nature Organization). 2011. Available at: http://gftn.panda.org/ (last accessed May 13, 2011).

[6] Greenpeace International. 1999. *Re-Source: Market Alternatives to Ancient Forest Destruction*, Greenpeace International, Amsterdam.

[7] Hansen, Eric. 1998. "Certified Forest Products Marketplace," *Forest Products Annual Market Review, 1997-1998*, 17-28.

[8] Home Depot. 2011. "Wood Purchasing Policy," http://corporate.homedepot.com/wps/portal/Wood_Purchasing (last accessed May 13, 2011).

[9] Howard, Stephen and Margaret Rainey. 2000. "FSC Certification: The Greening of an International Commodity Market," *Sustainable Development International*, 79-84. Available at: http://www.p2pays.org/ref/40/39735.pdf (last accessed May 13, 2011).

[10] IKEA. 2004. "Social & Environmental Responsibility Report 2004," http://www.ikea.com/ms/en_AU/about_ikea/pdf/ikea_se_report_2004.pdf (last accessed May 13, 2011).

[11] Kupfer, David. 1993. "The Greening of Hollywood," *Earth Island Journal*, 8(3): 1-4.

[12] Melitz, Marc J. 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 71: 1695-1725.

[13] Olley, G. Steven and Ariel Pakes. 1996. "The Dynamics of Productivity in the Telecommunications Equipment Industry," *Econometrica*, 65(1); 245-276.

[14] Owens, Heidi. 1998. "IKEA: A Natural Step Case Study," Oregon Natural Step Network, http://www.naturalstep.org/en/usa/ikea (last accessed May 13, 2011).

[15] Pargal, Sheoli and David Wheeler, 1996. "Informal Regulation of Industrial Pollution in Developing Countries: Evidence from Indonesia," *Journal of Political Economy*, 104(6): 1314-1327.

[16] Viana, Virgilio M. 1996. "Certification as a Catalyst for Change in Tropical Forest Management" In: V.M. Viana, J. Ervin, R. Donovan, C. Elliott and H. Gholz, Editors, Certification of Forest Products: Issues and perspectives, Island Press, Washington, DC (1996).

[17] Walmart. 2011. "Sustainability," http://walmartstores.com/Sustainability/9172.aspx (last accessed May 13, 2011).

[18] WWF World Wildlife Fund. 2006. *WWF-UK FTN Annual Report*, World Wildlife Fund for Nature, WWF-UK, Surrey.