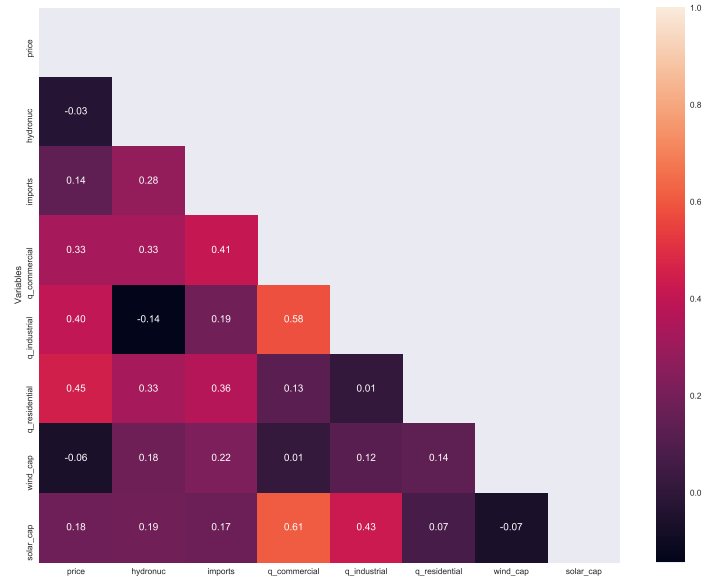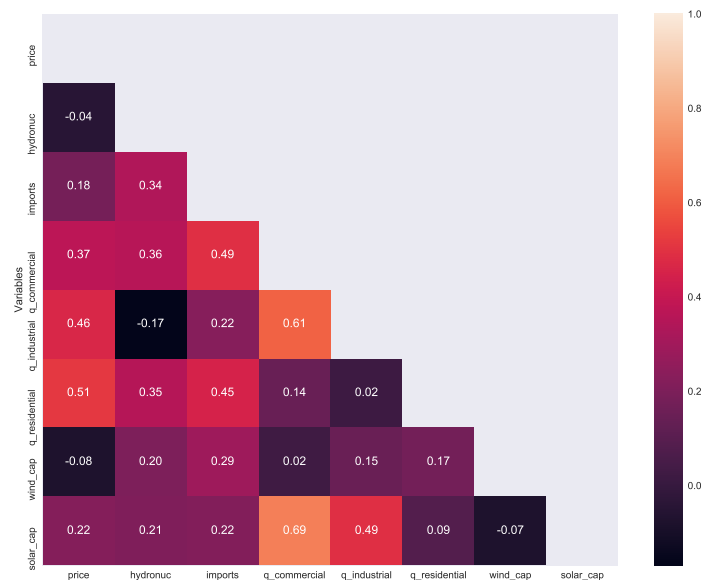# Web Appendix - not for publication

A Additional Figures and Tables

Figure A.1: K-means clustering algorithm and correlation patterns


(a) Correlation matrix in original data

(b) Correlation matrix with 100 clusters

Notes: This figure shows how the clustered data (Panel b) capture the original correlations in the data (Panel a). The algorithm successfully captures the main patterns in the data.

Figure A.2: K-means clustering algorithm and correlation patterns
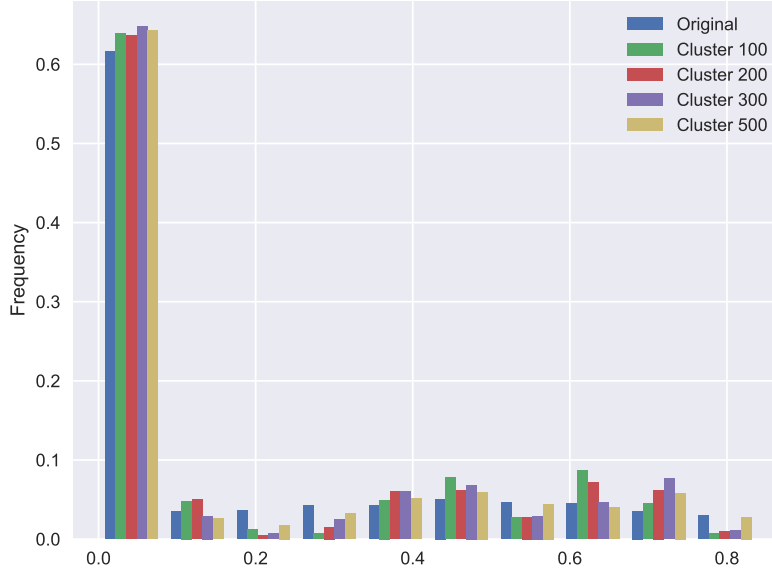
(a) Distribution of solar capacity factor in original and clustered data
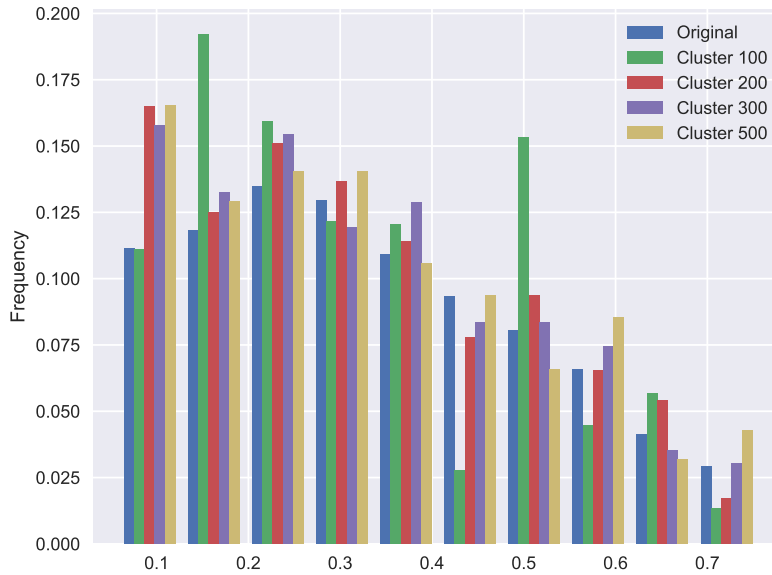
(b) Distribution of wind capacity factor in original and clustered data

Notes: This figure shows how the clustered data capture the distribution of wind and solar output in the original data. The results are shown for an increasing number of clusters (100,200,300 and 500).

Figure A.3: Role of Contract Reshuffling under a Carbon Tax
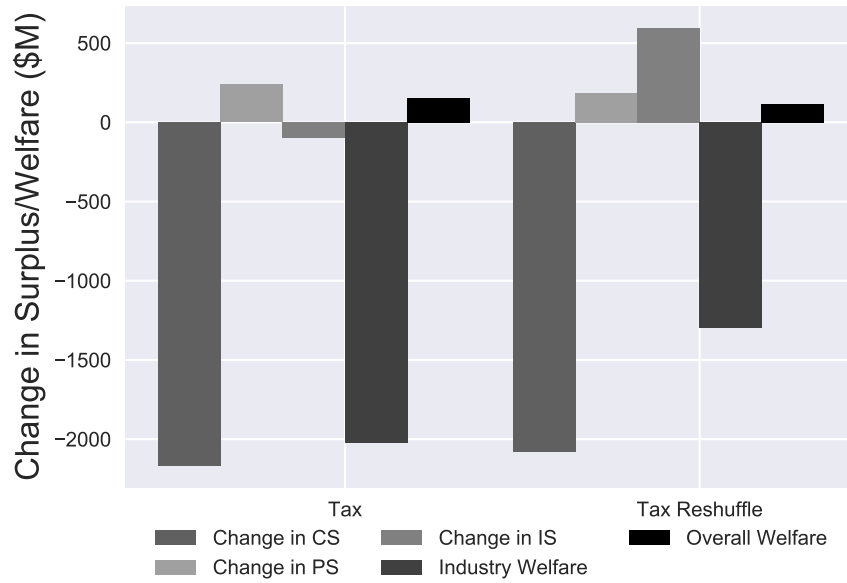
Notes: This figure shows the changes in consumer surplus (CS), producer surplus (PS), import surplus (IS) and their sum (Overall Change) with the introduction of a $15 carbon tax. It also reports overall welfare changes when accounting for the environmental benefits (Including Externality). The no reshuffling case assumes imports are taxed, whereas in the reshuffling case importers can evade the tax.

Figure A.4: Redistribution across consumer types under alternative elasticities
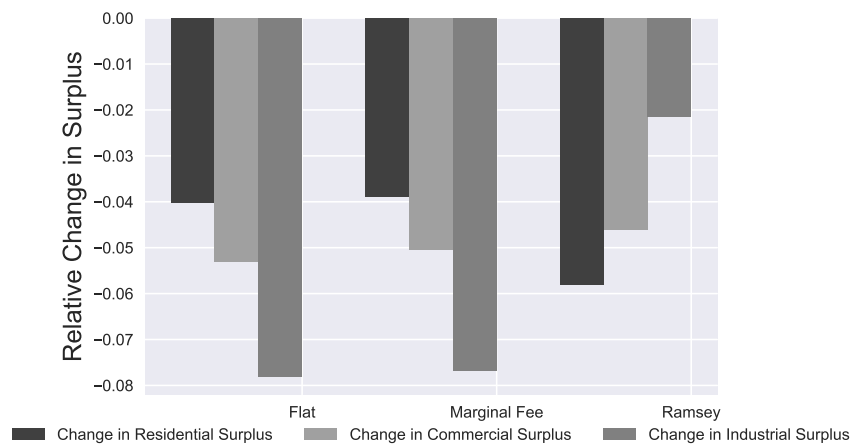
Notes: This figure shows the changes in consumer surplus across customer classes under a feed-in-tariff and alternative retail tariffs, when compared to the case with no environmental policy. The assumed elasticities for residential, commercial and industrial customers are 0.15, 0.20 and 0.30, respectively.

Table A.1: Main Results with High Gas Prices ($4/MMbtu)

Main Outcomes				
	No policy	Tax	FiT	RPS
Wholesale Price ($/MWh)	41.27	51.07	39.96	39.97
Retail Price ($/MWh)	41.27	51.07	35.22	43.45
Incentive ($/MWh)	0.00	27.38	108.35	48.63
Demand (GWh)	26.23	24.43	27.34	25.83
In-state Production (GWh)	18.33	16.69	19.52	18.01
Imports (GWh)	7.90	7.74	7.82	7.82
New gas (GW)	1.74	1.85	0.49	0.43
Wind (GW)	0.00	0.00	9.73	5.69
Solar (GW)	0.00	0.00	1.36	0.05
% New Renewable	0.00	0.00	0.12	0.07

Welfare Impacts				
	No policy	Tax	FiT	RPS
Producer Surplus	1948	2223	2495	1998
- Hydro and Nuclear	1049	1439	1001	1000
- Existing Gas	887	770	761	752
- New Gas	12	13	1	1
- New Wind	0	0	713	244
- New Solar	0	0	19	0
Import Surplus	2314	2173	2228	2227
Consumer Surplus	19880	17703	21297	19381
- Residential	11915	11029	12478	11714
- Commerical	6695	5711	7340	6469
- Industrial	1270	964	1479	1198
Additional Policy Payments	0	1939	-3226	0
SUBTOTAL WELFARE	24141	24038	22794	23605
Emissions domestic costs	-1472	-1255	-1245	-1245
Emissions imports costs	-889	-870	-880	-880
TOTAL WELFARE	21780	21913	20669	21481

Notes: All parameters set as in baseline simulations, except for the gas price which is $4/MMbtu instead of $3/MMbtu.

Table A.2: Main Results with More Responsive Imports

Main Outcomes				
	No policy	Tax	FiT	RPS
Wholesale Price ($/MWh)	34.59	43.60	33.27	33.28
Retail Price ($/MWh)	34.59	43.60	29.56	37.15
Incentive ($/MWh)	0.00	24.20	107.15	55.64
Demand (GWh)	27.46	25.80	28.38	26.99
In-state Production (GWh)	19.97	18.53	21.03	19.62
Imports (GWh)	7.49	7.27	7.35	7.36
New gas (GW)	1.72	2.21	0.41	0.40
Wind (GW)	0.00	0.00	9.50	5.79
Solar (GW)	0.00	0.00	1.26	0.03
% New Renewable	0.00	0.00	0.12	0.07

Welfare Impacts				
	No policy	Tax	FiT	RPS
Producer Surplus	1801	2047	2281	1833
- Hydro and Nuclear	793	1142	743	743
- Existing Gas	997	886	841	837
- New Gas	12	19	1	1
- New Wind	0	0	680	252
- New Solar	0	0	16	0
Import Surplus	1648	1557	1568	1570
Consumer Surplus	21450	19347	22680	20839
- Residential	12538	11701	13017	12297
- Commerical	7410	6454	7973	7131
- Industrial	1502	1193	1690	1411
Additional Policy Payments	0	1851	-3104	0
SUBTOTAL WELFARE	24899	24802	23425	24242
Emissions domestic costs	-1708	-1477	-1468	-1467
Emissions imports costs	-842	-818	-827	-828
TOTAL WELFARE	22349	22507	21130	21947

Notes: All parameters set as in baseline simulations, except for the elasticity of the import supply, which is increased to 0.5 from 0.3.

Table A.3: Main Results with Dirtier Imports

Main Outcomes				
	No policy	Tax	FiT	RPS
Wholesale Price ($/MWh)	34.65	44.30	32.98	32.99
Retail Price ($/MWh)	34.65	44.30	28.64	37.86
Incentive ($/MWh)	0.00	25.45	115.32	59.98
Demand (GWh)	27.44	25.67	28.55	26.86
In-state Production (GWh)	19.98	18.78	21.18	19.49
Imports (GWh)	7.47	6.90	7.37	7.37
New gas (GW)	1.74	2.42	0.14	0.12
Wind (GW)	0.00	0.00	11.04	6.55
Solar (GW)	0.00	0.00	1.91	0.34
% New Renewable	0.00	0.00	0.14	0.08

Welfare Impacts				
	No policy	Tax	FiT	RPS
Producer Surplus	1810	2090	2494	1857
- Hydro and Nuclear	794	1173	732	732
- Existing Gas	1005	894	807	801
- New Gas	12	23	0	0
- New Wind	0	0	918	323
- New Solar	0	0	37	1
Import Surplus	1874	1366	1775	1775
Consumer Surplus	21435	19190	22908	20672
- Residential	12532	11637	13106	12231
- Commerical	7403	6382	8077	7055
- Industrial	1500	1170	1725	1386
Additional Policy Payments	0	2348	-3965	0
SUBTOTAL WELFARE	25119	24993	23212	24304
Emissions domestic costs	-1701	-1498	-1411	-1411
Emissions imports costs	-1374	-1269	-1356	-1356
TOTAL WELFARE	22045	22226	20445	21537

Notes: All parameters set as in baseline simulations, except for the emissions rate of the import supply, which is increased to 0.7 from 0.428.

Table A.4: Main Results with More Expensive Renewables

Main Outcomes				
	No policy	Tax	FiT	RPS
Wholesale Price ($/MWh)	34.65	43.94	33.25	33.25
Retail Price ($/MWh)	34.65	43.95	29.49	37.99
Incentive ($/MWh)	0.00	25.23	140.09	73.89
Demand (GWh)	27.44	25.74	28.39	26.83
In-state Production (GWh)	19.98	18.39	21.01	19.45
Imports (GWh)	7.47	7.35	7.38	7.39
New gas (GW)	1.74	2.15	0.31	0.37
Wind (GW)	0.00	0.00	10.49	5.33
Solar (GW)	0.00	0.00	0.00	0.00
% New Renewable	0.00	0.00	0.12	0.06

Welfare Impacts				
	No policy	Tax	FiT	RPS
Producer Surplus	1810	2048	2623	1841
- Hydro and Nuclear	794	1157	742	742
- Existing Gas	1005	873	841	830
- New Gas	12	18	0	1
- New Wind	0	0	1040	268
- New Solar	0	0	0	0
Import Surplus	1874	1776	1788	1791
Consumer Surplus	21435	19270	22696	20641
- Residential	12532	11669	13024	12218
- Commerical	7403	6418	7980	7041
- Industrial	1500	1182	1693	1381
Additional Policy Payments	0	1923	-4165	0
SUBTOTAL WELFARE	25119	25018	22942	24272
Emissions domestic costs	-1701	-1460	-1457	-1456
Emissions imports costs	-840	-826	-830	-831
TOTAL WELFARE	22579	22731	20656	21985

Notes: All parameters set as in baseline simulations, except for the investment costs of wind and solar, which go to from $1,877/KW to $2,354/KW, and from $2,534/KW to $4,120/KW, respectively.