Firm Export and Goods Complexity

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Motivation

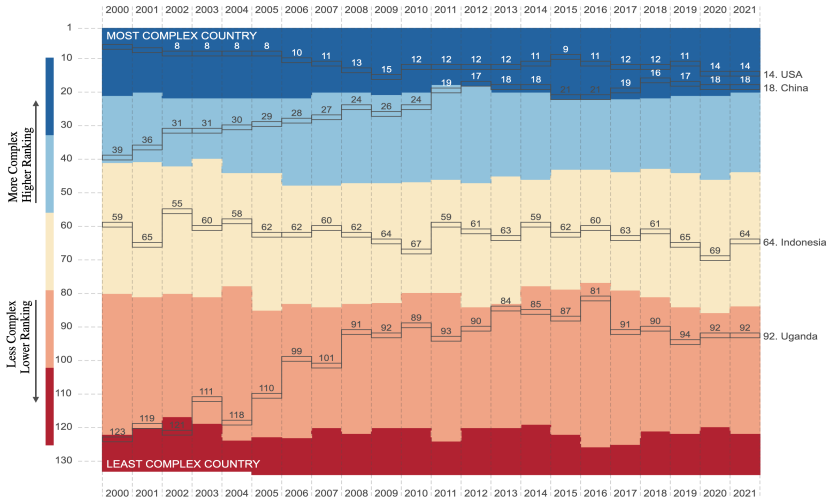
- Level of economic development correlates with what goods one country produce;
  One dimension: **Complexity** (e.g. aircraft vs. car vs. bicycle);
- Standard trade or growth models do not differentiate goods in this dimension;
  Existing research on complexity focuses on country level analysis;
- Today: Chinese firm level facts on export and complexity, and its evolution.

Measure of Complexity: Hidalgo and Hausmann (2009)

- Extract trade data to infer country and product complexity;
  - A country is complex if it produces many products, especially those that are relatively rare;
  - A product is complex if on average produced by more complex countries;
- A product is rare, because it needs more (latent) ability that fewer countries have;
  - Production $\mathbf{M}$: $M_{cp} = 1$ if country c produces product p (above a given threshold);
  - Endowment $\mathbf{C}$: $C_{ca} = 1$ if country c masters ability a;
  - Technology $\mathbf{P}$: $P_{pa} = 1$ if product p requires ability a;

$$\mathbf{M}_{cp} = \mathbf{C}_{ca} \underbrace{\odot}_{\text{E.g., Leontief}} \mathbf{P}_{pa};$$

Country Complexity Rankings: 2000 - 2021



Source: The Atlas of Economic Complexity (`https://atlas.cid.harvard.edu/rankings`).

Summary of Results

- Evolution of China's export complexity:
  - Both **within- and across-sector reallocation** contribute positively;
  - Both within- and across-**firm** reallocation contribute positively;
  - **Exiting** firms contribute positively, while **entering** firms contribute slightly negatively;

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- Cross-sectional: firm export value $\sim$ complexity:
  - **Firm-level** export complexity exhibit a **U-shape** relationship with export value;
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- Export growth $\sim$ complexity:
  - Higher **firm-level** export complexity correlates with **faster** export growth;
  - Corresponding firm-**sector**-level result goes away when controlling for current export value;
  - More complex exporting firms have higher **survival rate** and greater **sector/good expansion**.

Literature

- Country and Product Complexity

  Hausmann and Rodrik (2007); Hidalgo and Hausmann (2009); Schetter (2020);

- Export Quality and Scope

  Bernard, Redding, and Schott (2010); Kugler and Verhoogen (2012); Manova and Zhang (2012); Khandelwal, Schott, and Wei (2013); Atkin, Khandelwal, and Osman (2017); Verhoogen (2023);

- Trade and Growth

  Krugman (1979); Goldberg, Khandelwal, Pavcnik, and Topalova (2010); Brandt, Van Biesebroeck, Wang, and Zhang (2017); Atkin, Costinot, and Fukui (2022); Boehm and Oberfield (2022).

Roadmap

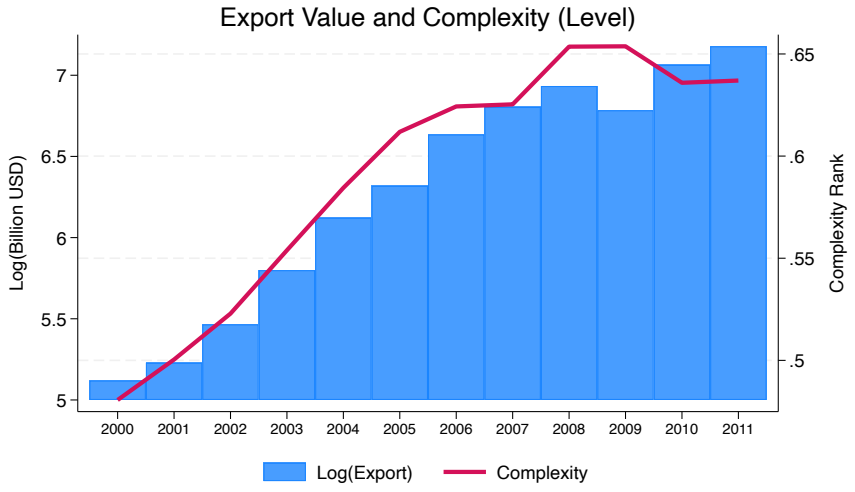
1. **Evolution of China's Export Complexity**
2. **Cross-sectional: Export and Complexity**
3. **Export Growth and Complexity**

Evolution of China's Export Complexity

Data

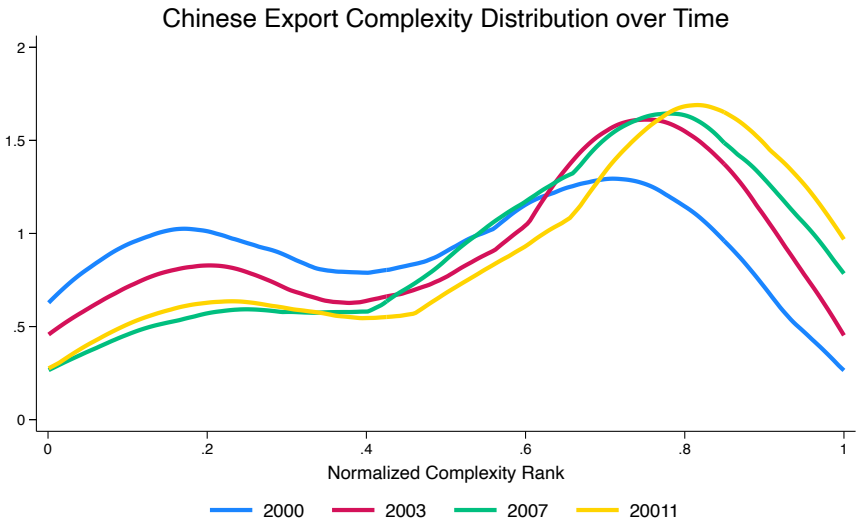
- Chinese Customs Data: the universe of Chinese trade transactions from 2000-2011;
  - F.o.b. value and quantity of exports and imports in USD by product (HS8d) and trade partner;
  - Firm id linking over years;
  - Drop intermediary trading firms according to Ahn, Khandelwal, Wei (2011);
- Hidalgo and Hausmann (2009): Measure of product (HS4d) complexity from 2000-2011;
  - Normalized by rank for each year (1 = most complex, 0 = least complex);

Aggregate Export Value and Complexity: 2000 - 2011



Notes: Complexity $= \sum_{i \in F_t} \left(x_{it} c_{it} / \sum_{i \in F_t} x_{it} \right)$.

Distribution



Complexity Change: Within- and Across-Sector Decomposition

- HS2d sector: indexed by s; HS4d product: indexed by p;
- Aggregate export complexity:

$$C = \sum_s \sum_p \frac{x_{sp} c_p}{\sum_s \sum_p x_{sp}},$$

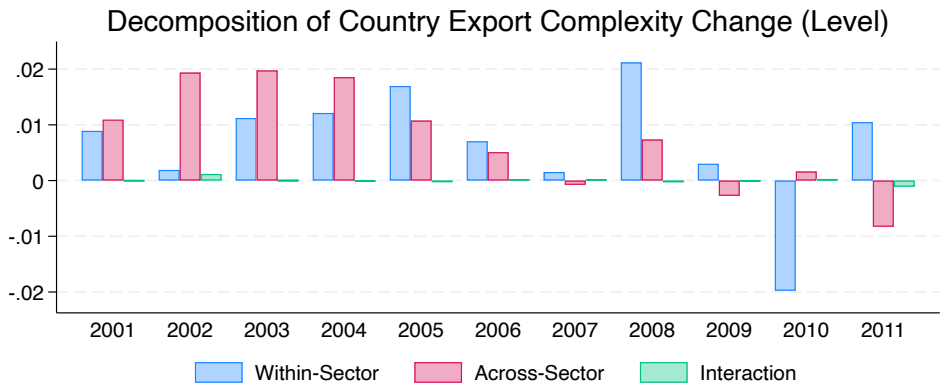
where x_{sp} is aggregate export value of $p \in s$, and c_p is the complexity measure of p;

- Change of aggregate complexity:

$$C_{t+1} - C_t = \underbrace{\sum_s w_{s,t} \left(\bar{c}_{s,t+1} - \bar{c}_{s,t} \right)}_{\text{Within-Sector}} + \underbrace{\sum_s \left(w_{s,t+1} - w_{s,t} \right) \bar{c}_{s,t}}_{\text{Across-Sector}} + \text{Interaction Term},$$

where w_s is value share of sector s, and $\bar{c}_s$ is value-weighted average complexity of sector s.

Within- and Across-Sector Decomposition



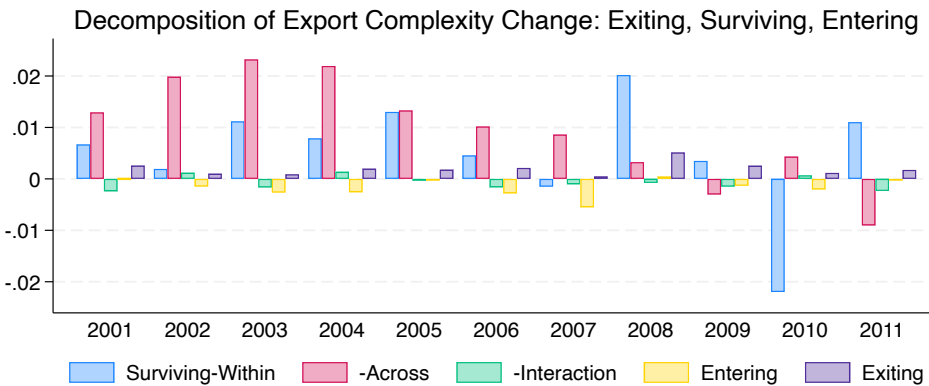
Complexity Change: Surviving, Entering, Exiting Decomposition

- Individual firm: indexed by i; Group: indexed by $G = S, E, X$;
- Let $s_{G,t} = \sum_{i \in G} s_{i,t}$, and $\bar{c}_{G,t} = \sum_{i \in G} \frac{s_{i,t}\bar{c}_{i,t}}{s_{G,t}}$, where $\bar{c}_i$ is firm i's average export complexity;
- Decomposition according to Melitz and Polanec (2015):

$$C_{t+1} - C_t = \underbrace{\left(\bar{c}_{S,t+1} - \bar{c}_{S,t}\right)}_{\text{Surviving}} + \underbrace{s_{E,t+1}\left(\bar{c}_{E,t+1} - \bar{c}_{S,t+1}\right)}_{\text{Entering Firms}} + \underbrace{s_{X,t}\left(\bar{c}_{S,t} - \bar{c}_{X,t}\right)}_{\text{Exiting}},$$

where "Surviving" can be further decomposed into within-firm, across-firm, and interaction.

Surviving, Entering, Exiting Decomposition



Cross-sectional: Export and Complexity

Export Value and Complexity

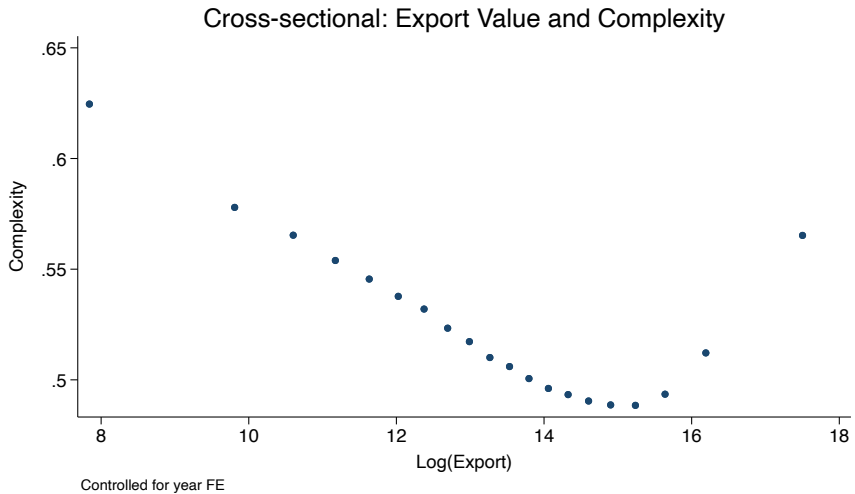
- Are larger firms on average exporting more or less complex goods?

$$c_i \sim \beta \log(x_i);$$

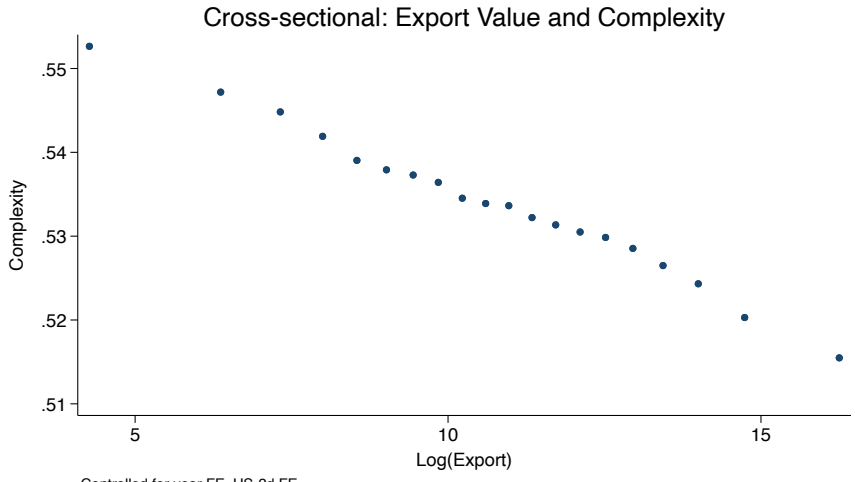
- Firm-sector level correlation:

$$c_{is} \sim \beta \log(x_{is}) + \alpha_s;$$

Firm Level

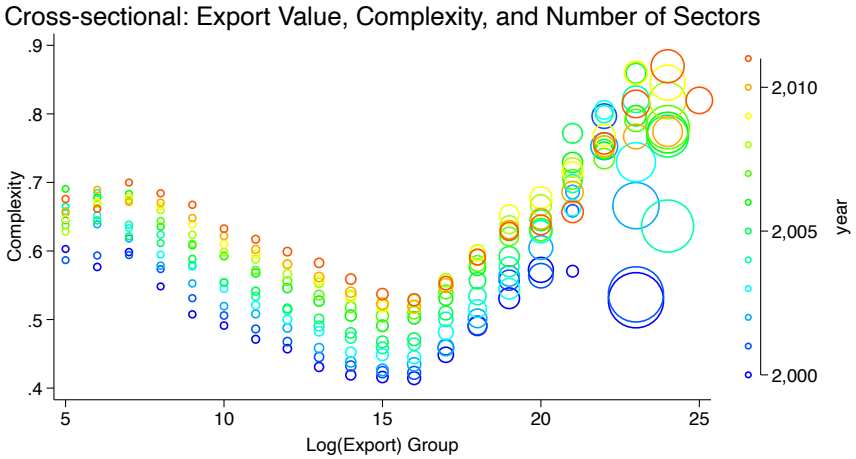

Cross-sectional: Export Value and Complexity
.65
.6
.55
.5
Complexity
8
10
12
14
16
18
Log(Export)
Controlled for year FE

Firm-Sector Level



Firm FE

Larger Firms Export in More Sectors



Size of circle is weighted average of number of HS2d sectors for each year-group;
The min is 1.11, max is 81, median is 3.02, mean is 7.10

◂ Number of Sectors ∼ Log(Export) ◂ Complexity ∼ Number of Sectors

Export Growth and Complexity

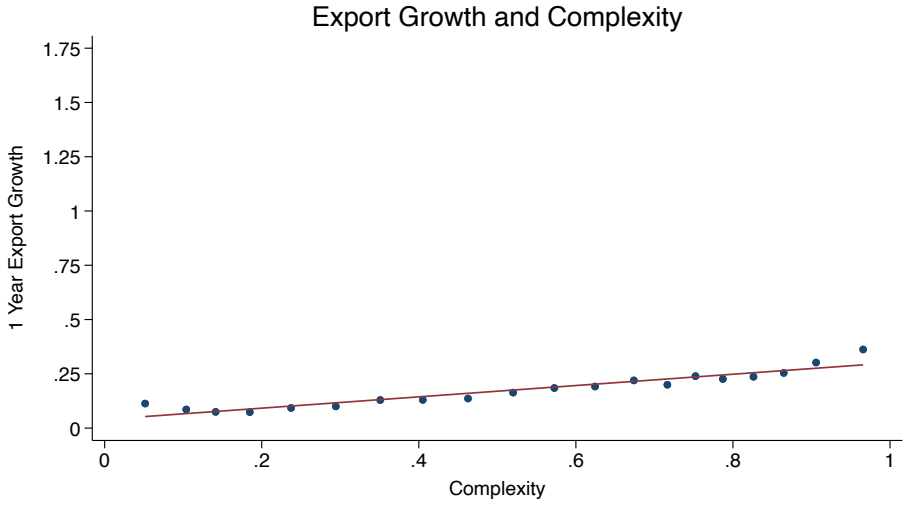
Export Growth and Complexity

- Are firms producing more complex goods today growing faster? For $h = 1, \ldots, 10$,

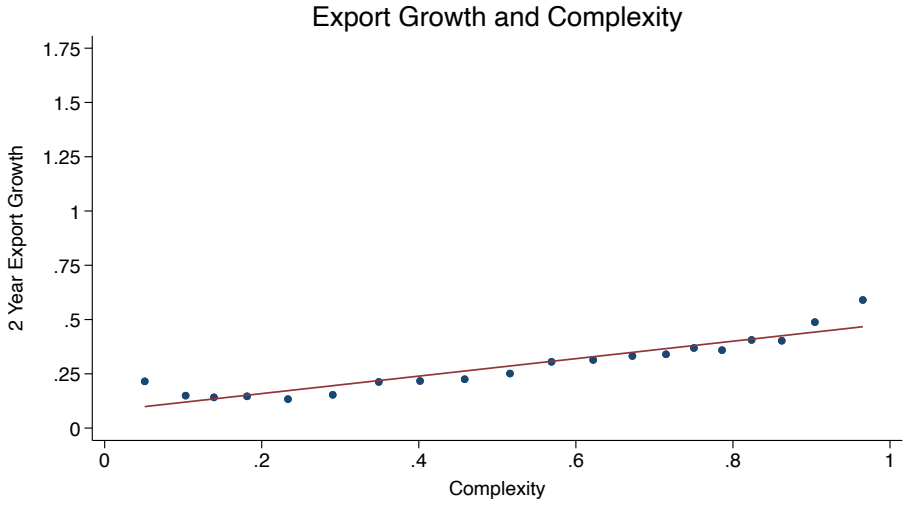
$$\log\left(\frac{x_{i,t+h}}{x_{i,t}}\right) \sim \beta c_{i,t} + \alpha_t;$$

- Control for current export value: $\log\left(x_{i,t}\right)$;
- Within HS2d sector: $\log\left(\frac{x_{is,t+h}}{x_{is,t}}\right)$.

Firm Growth Rate



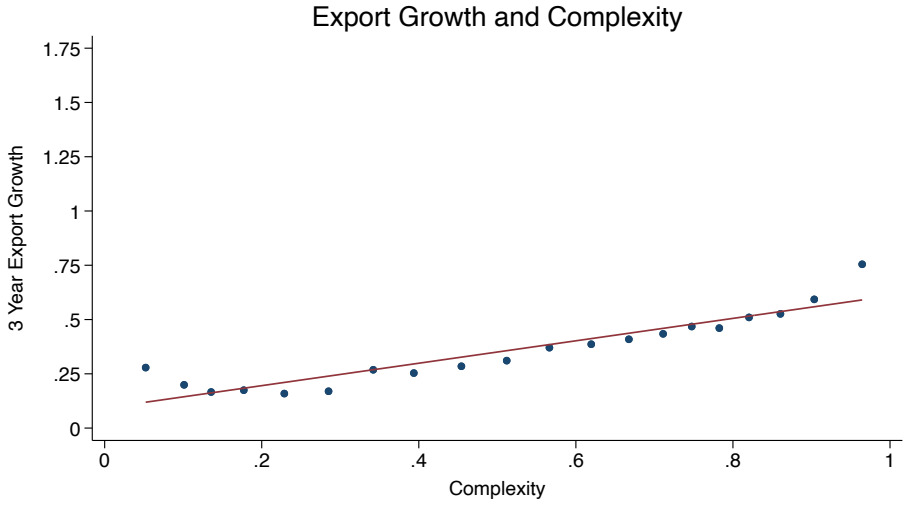
Firm Growth Rate



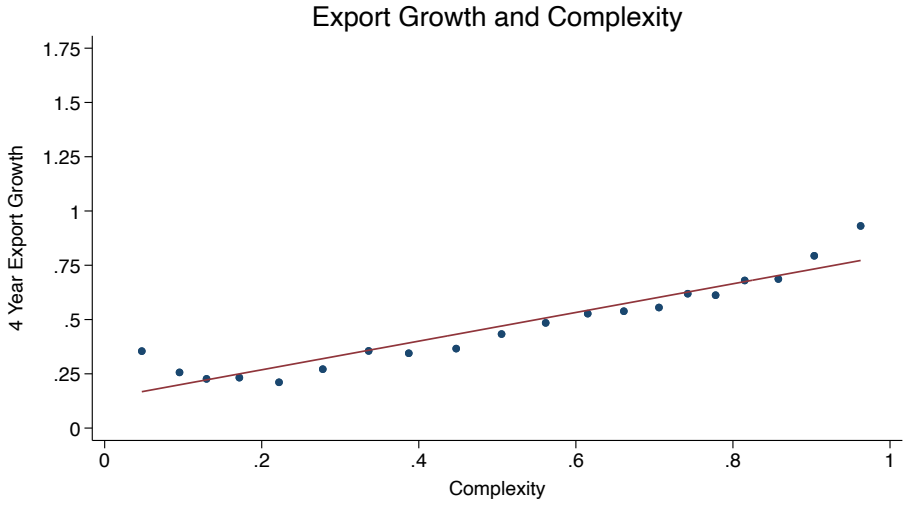
Controlled for year FE

Level

Firm Growth Rate



Firm Growth Rate



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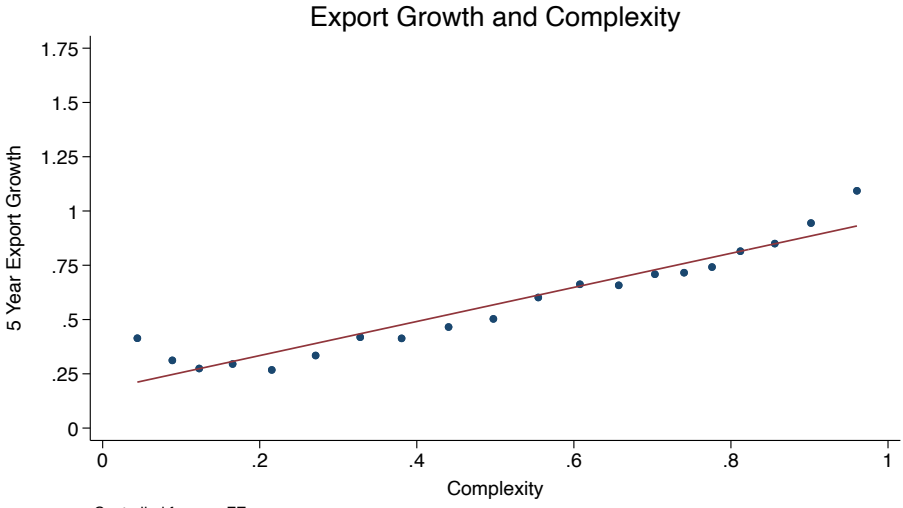

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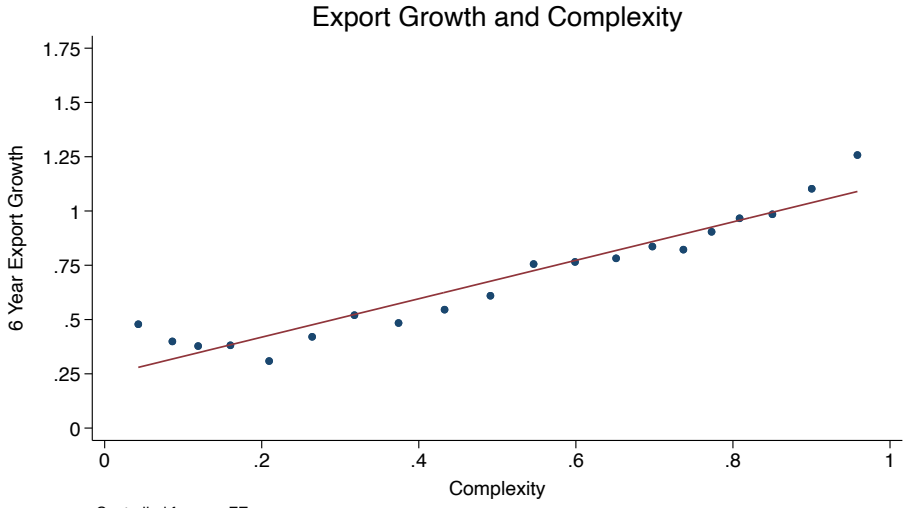

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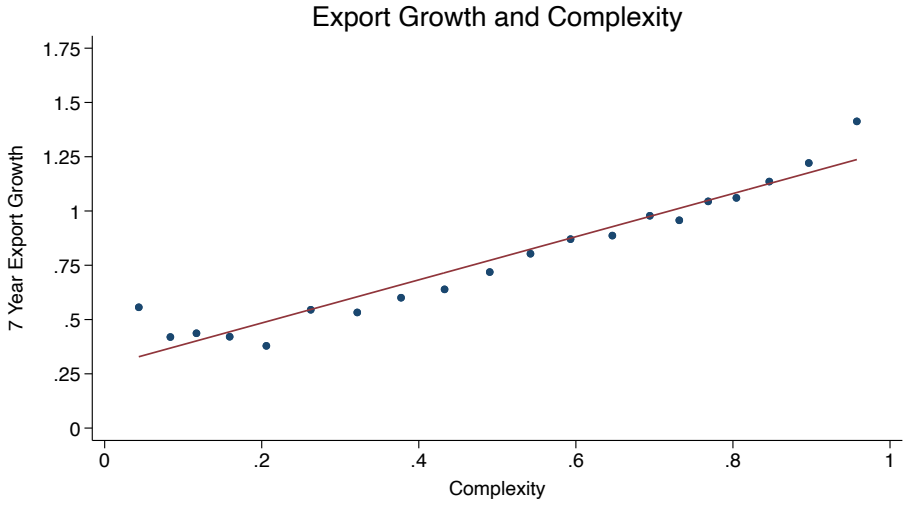

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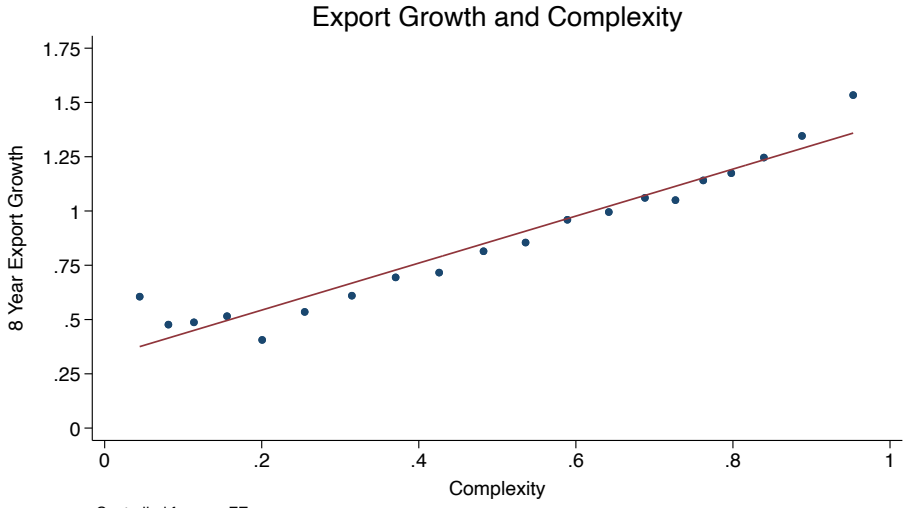

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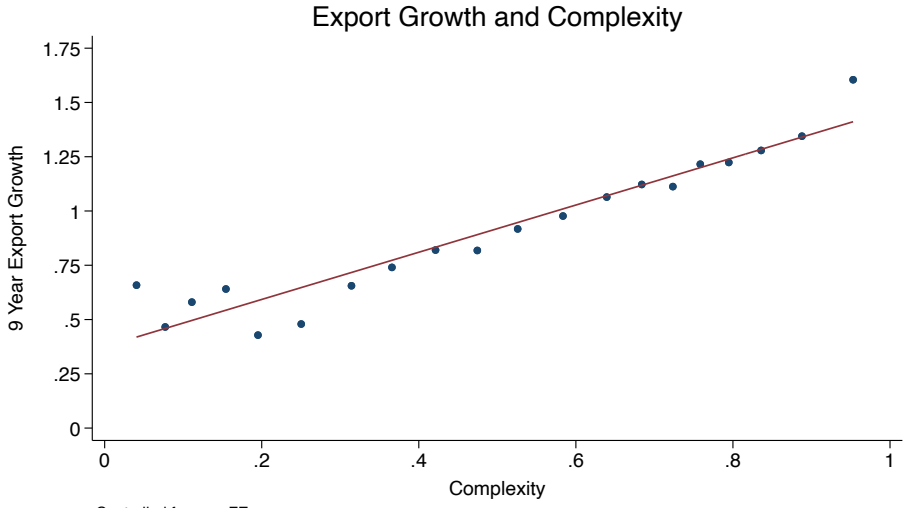

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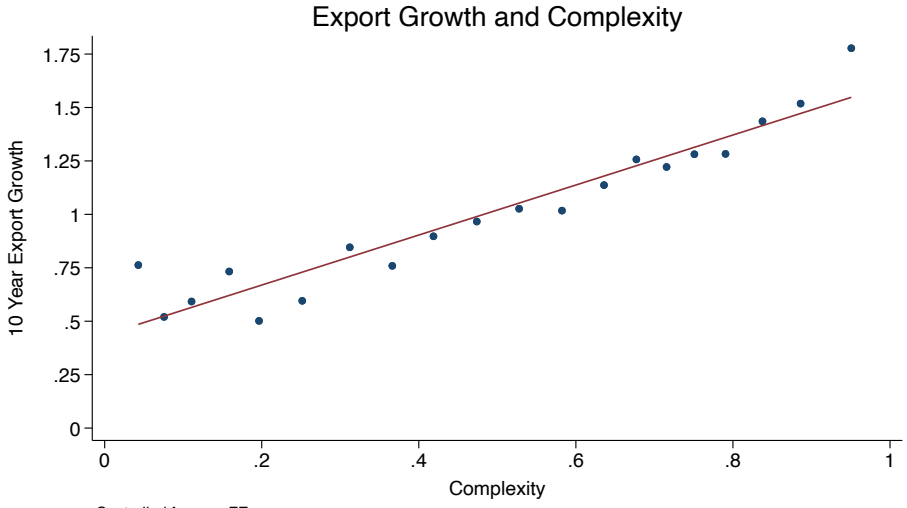
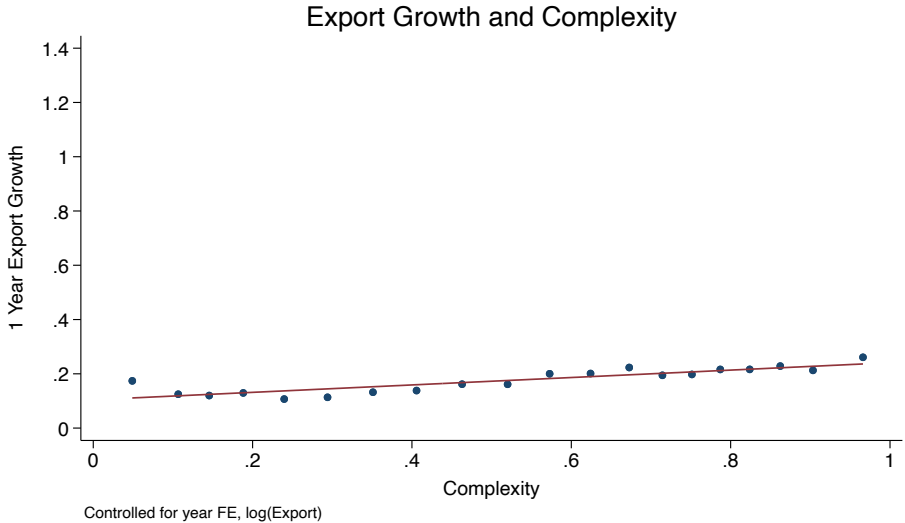


Controlled for year FE

Level

Firm Growth Rate: Control for Current Export Value



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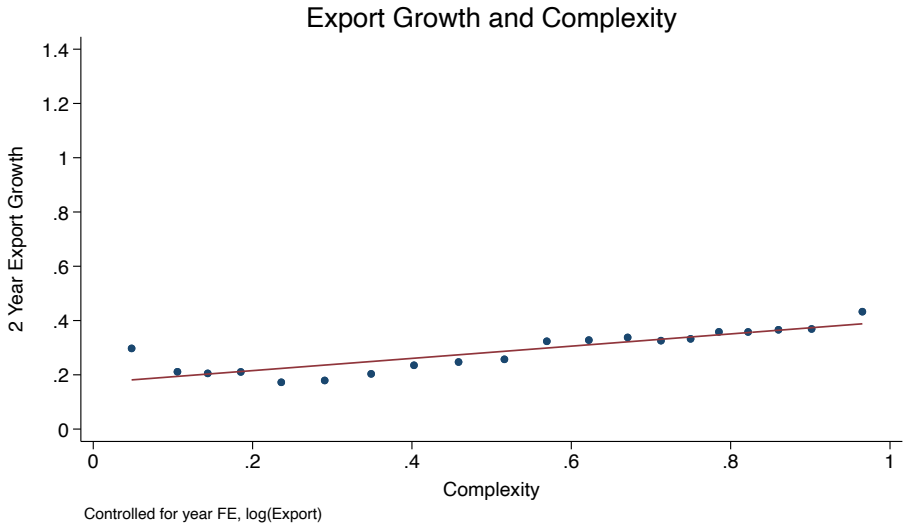

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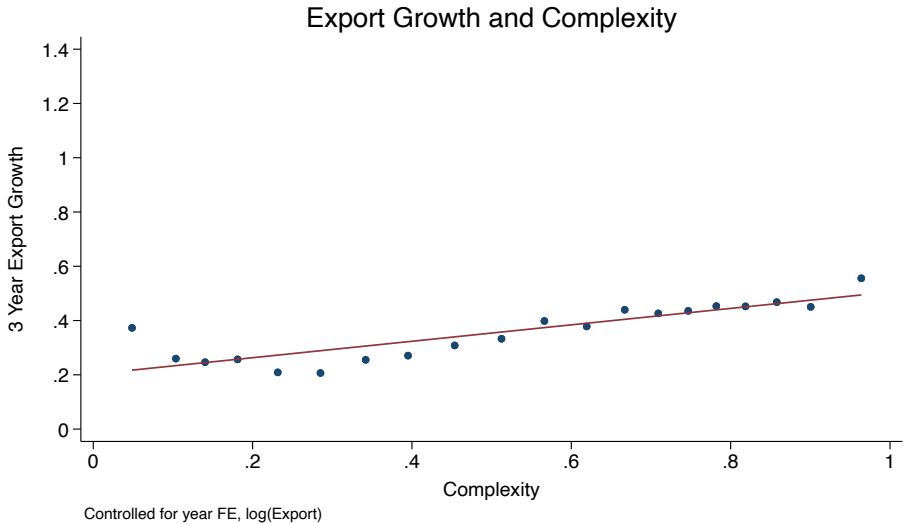

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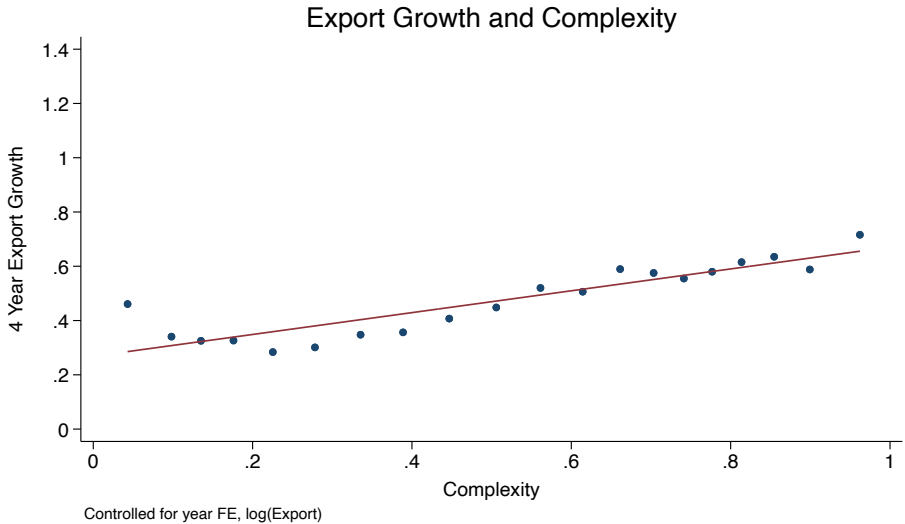

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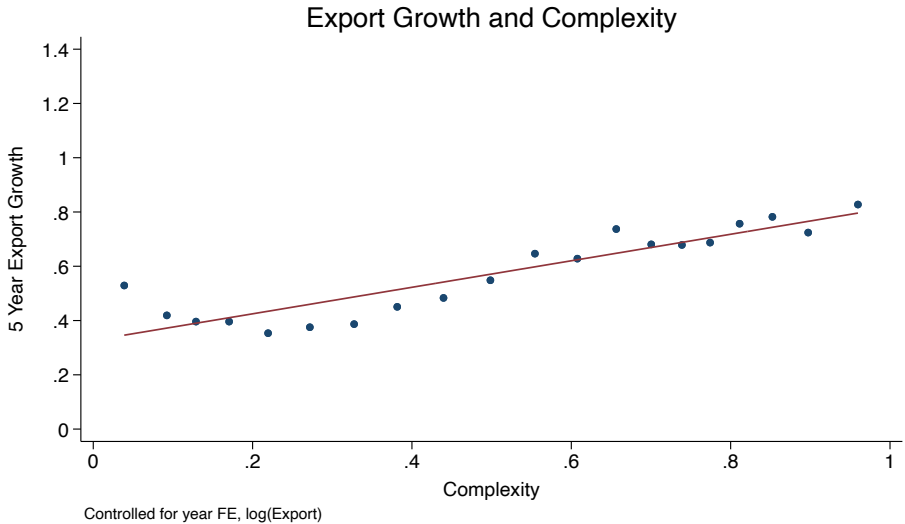

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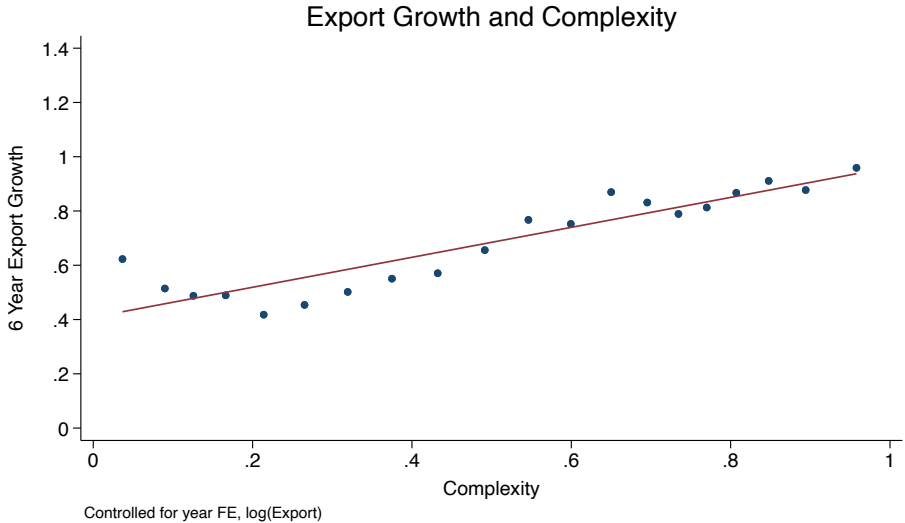

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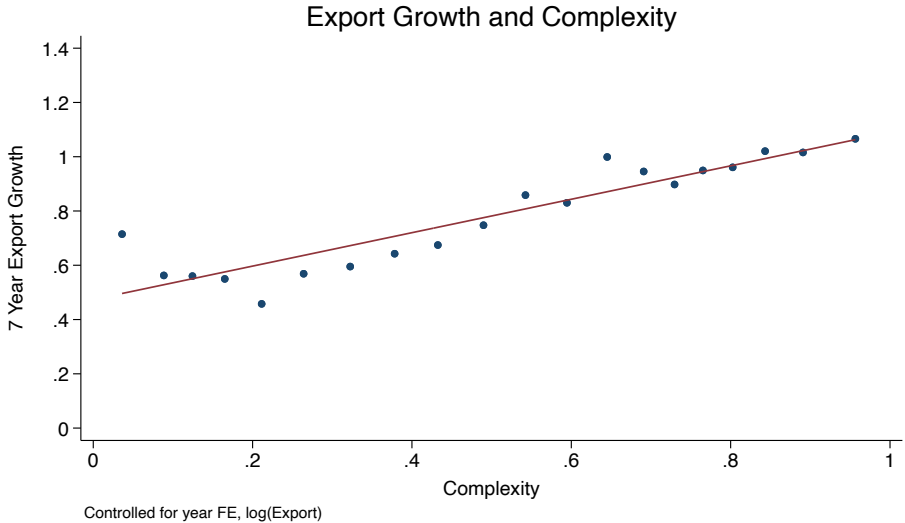

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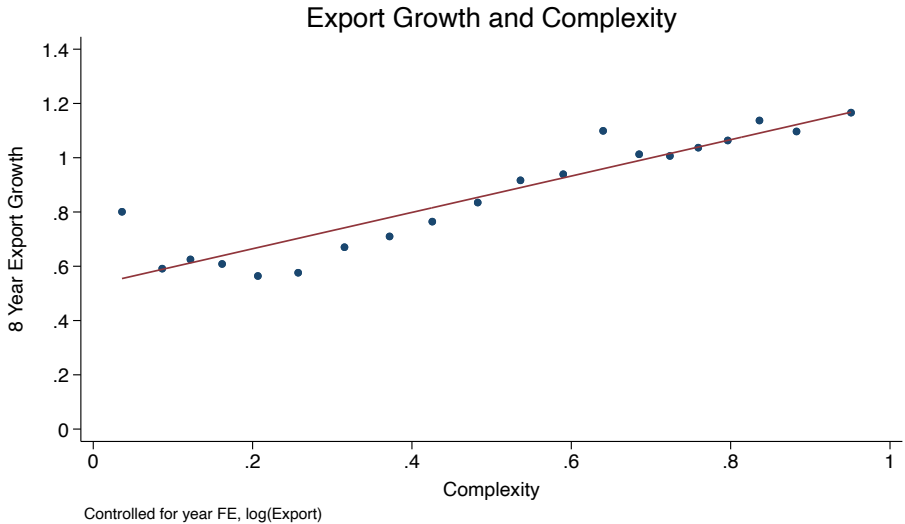

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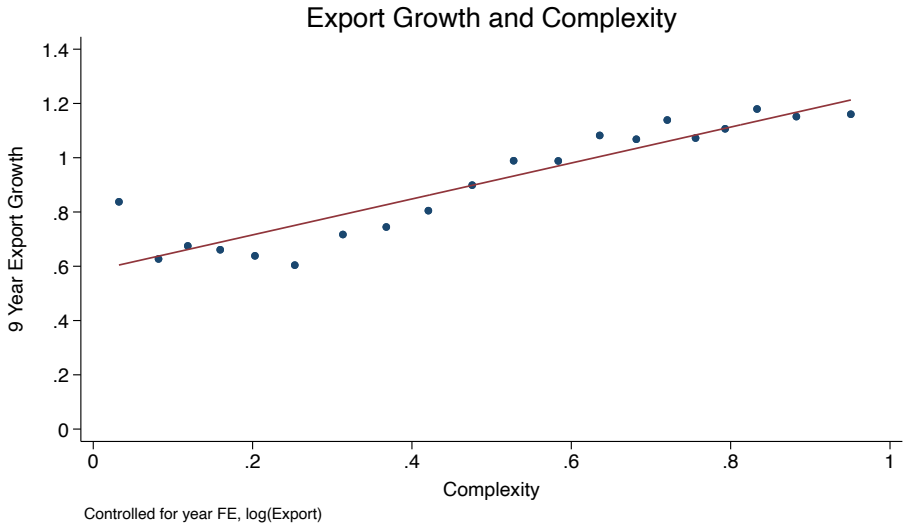

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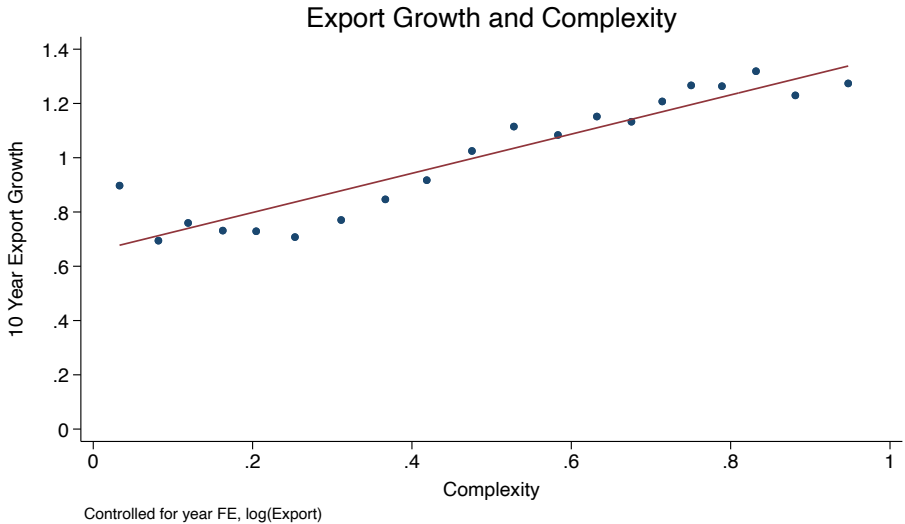
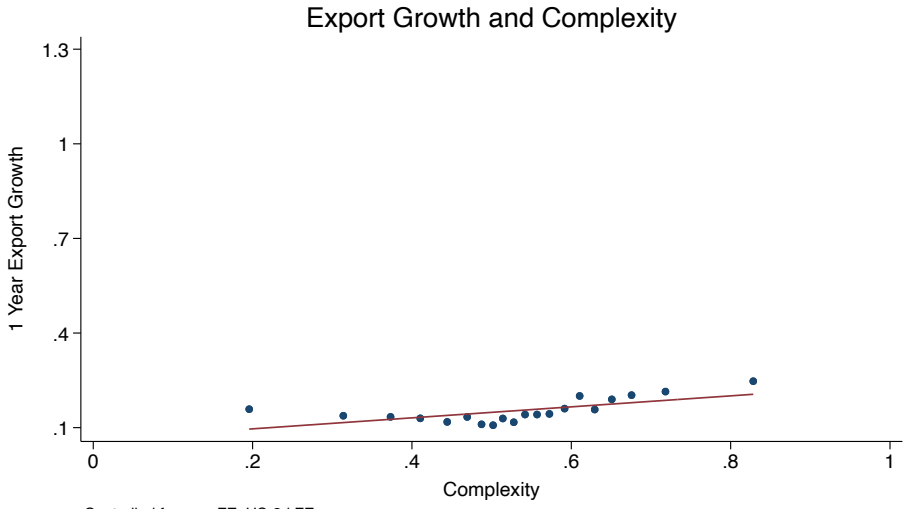


Firm-Sector Growth Rate



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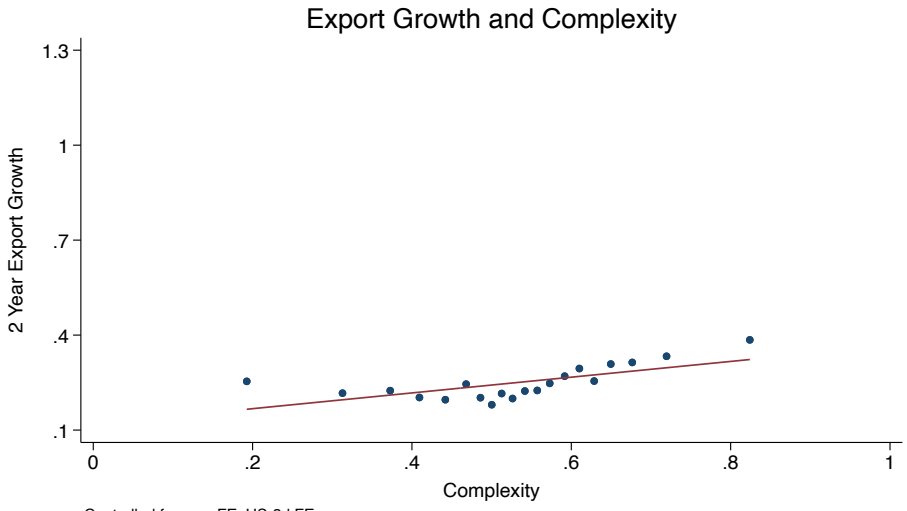

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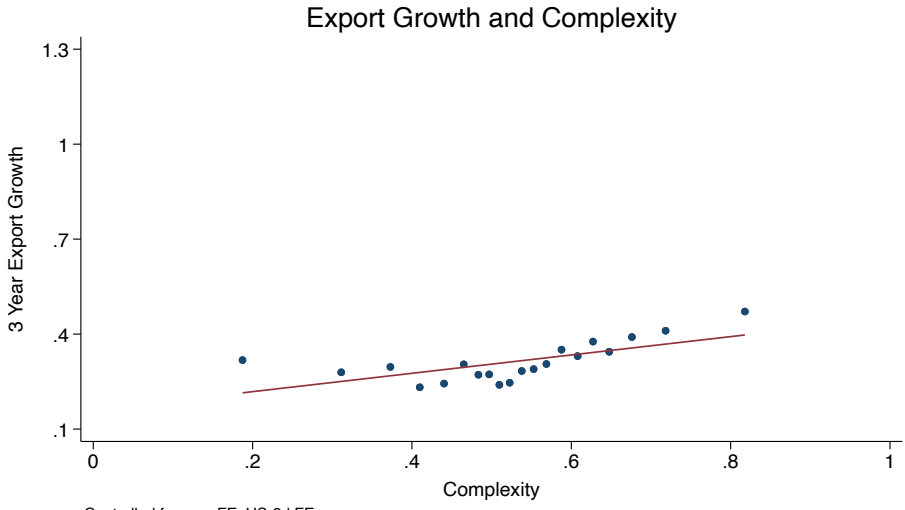

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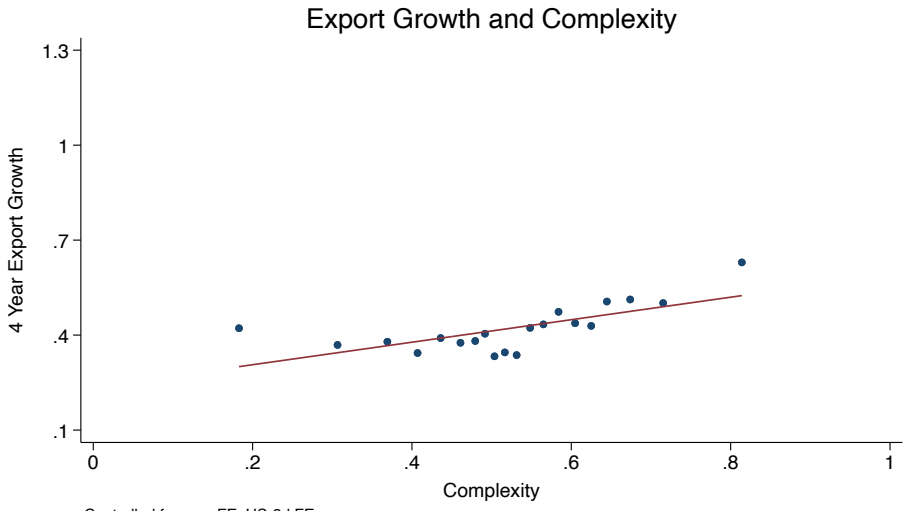

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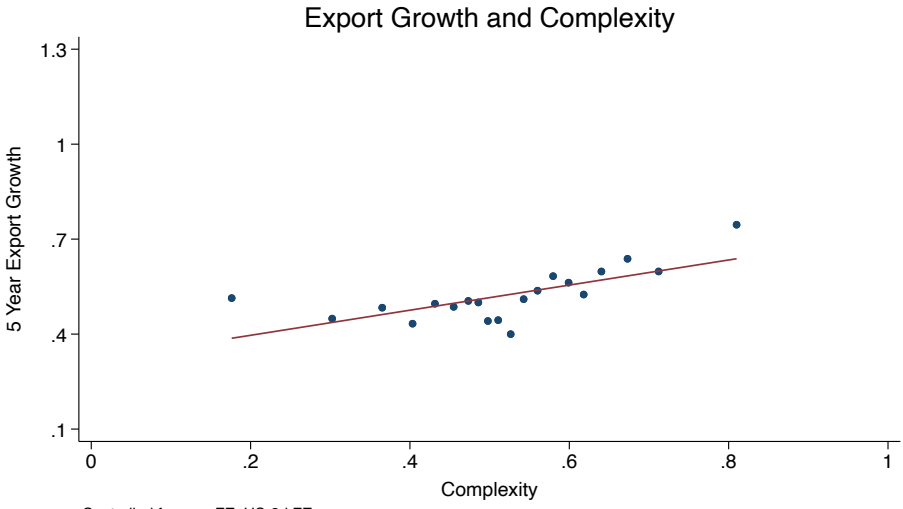

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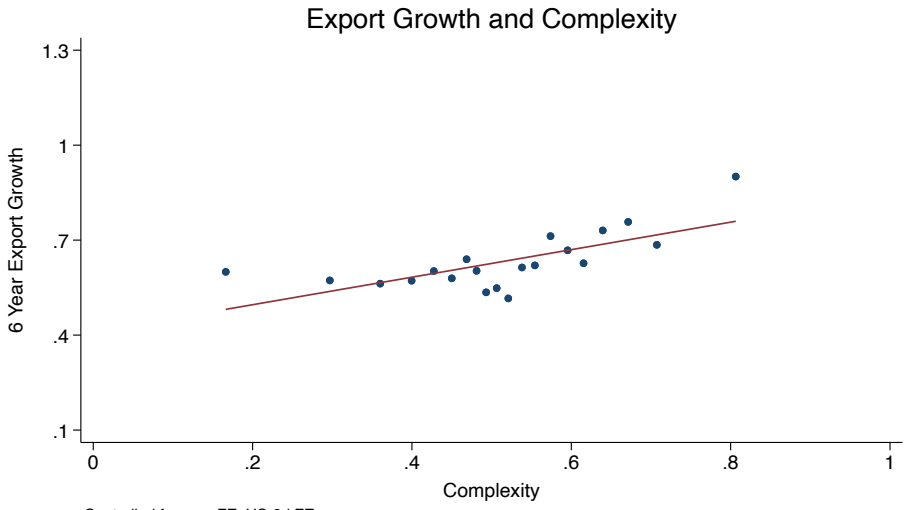

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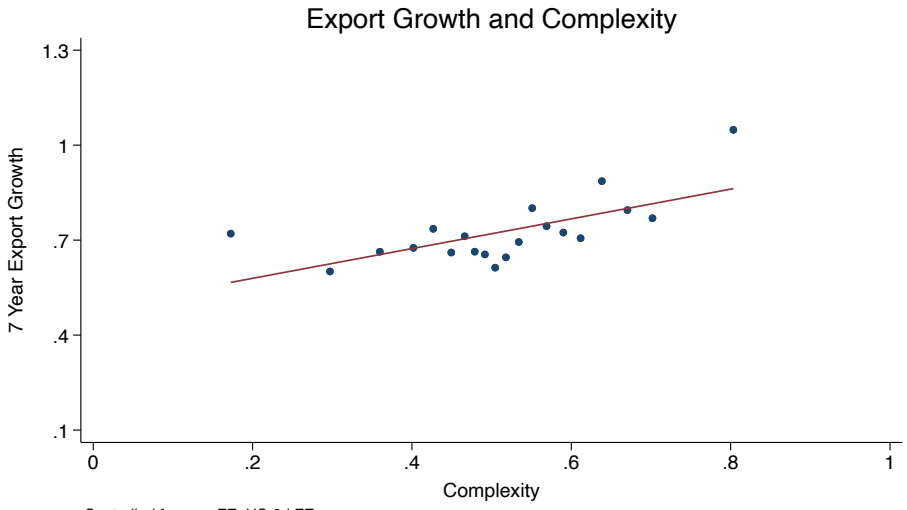

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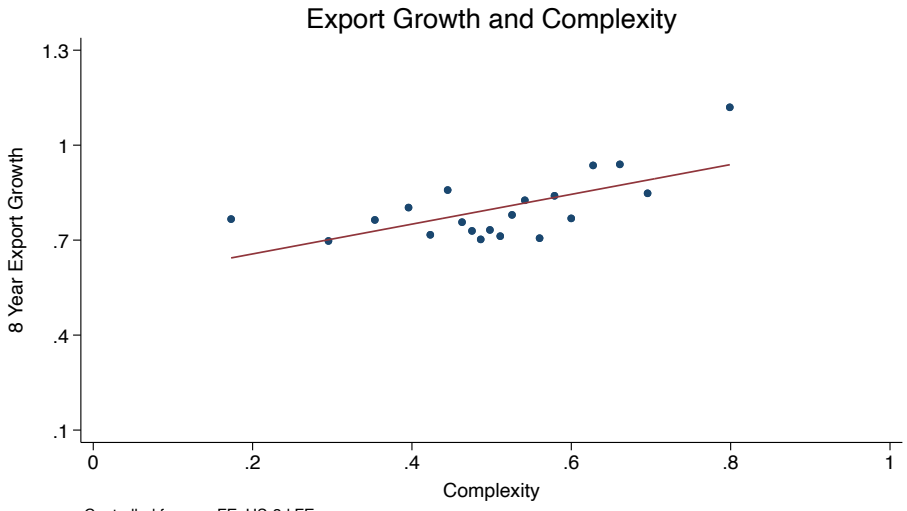

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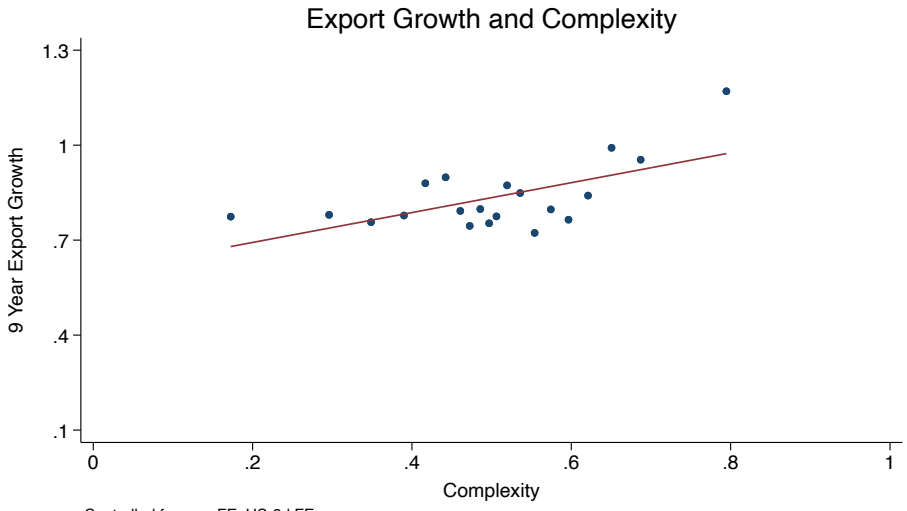

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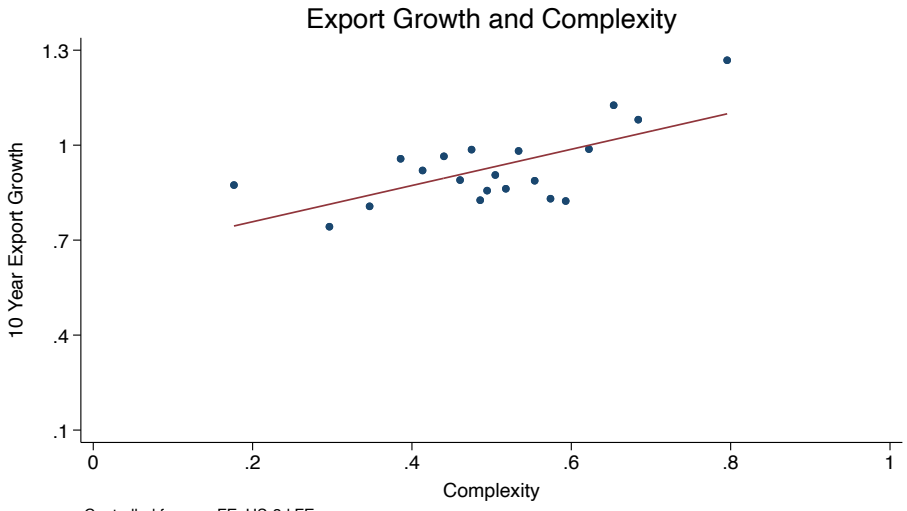
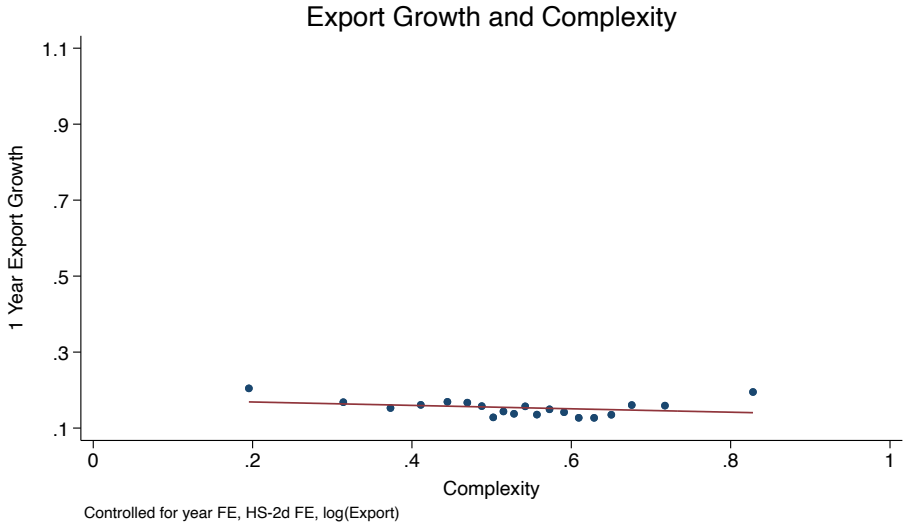


Firm-Sector Growth Rate: Control for Current Export Value



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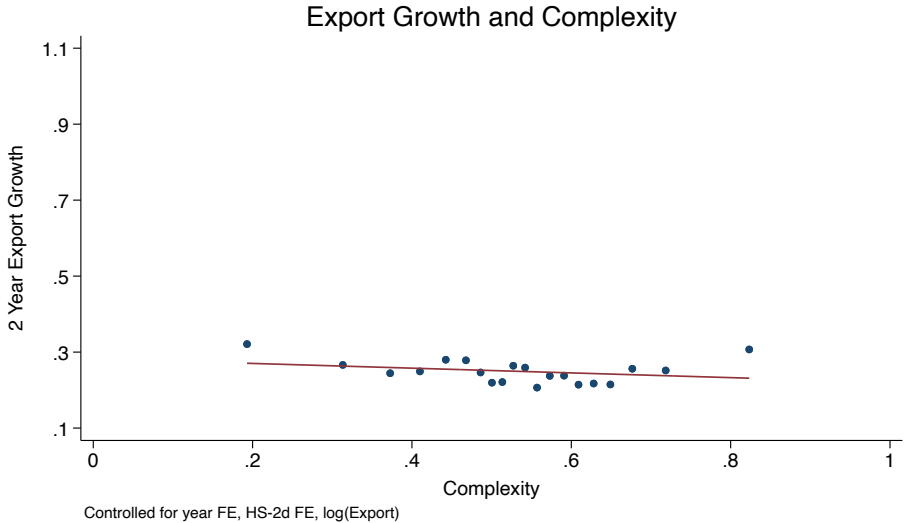

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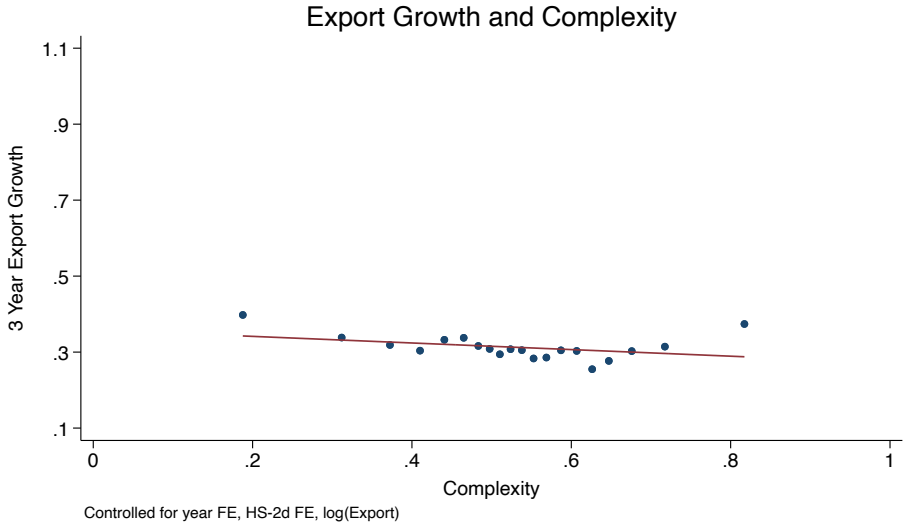

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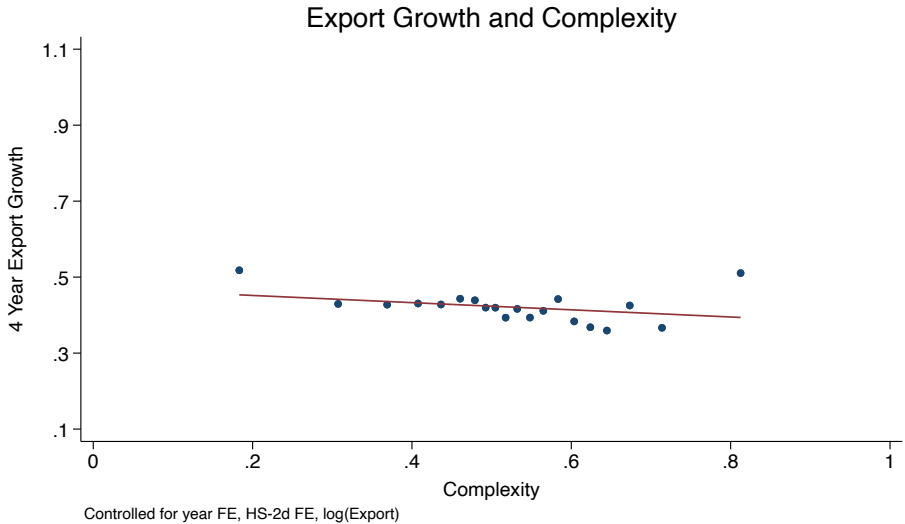

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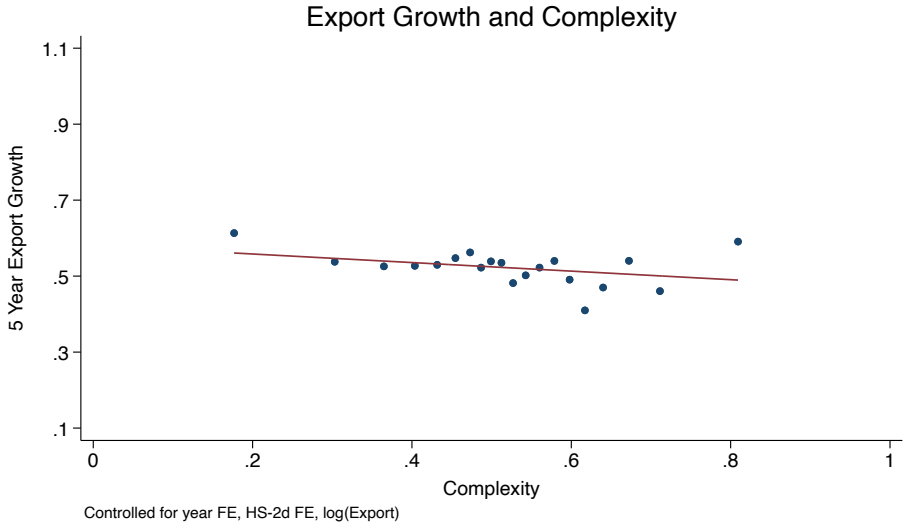
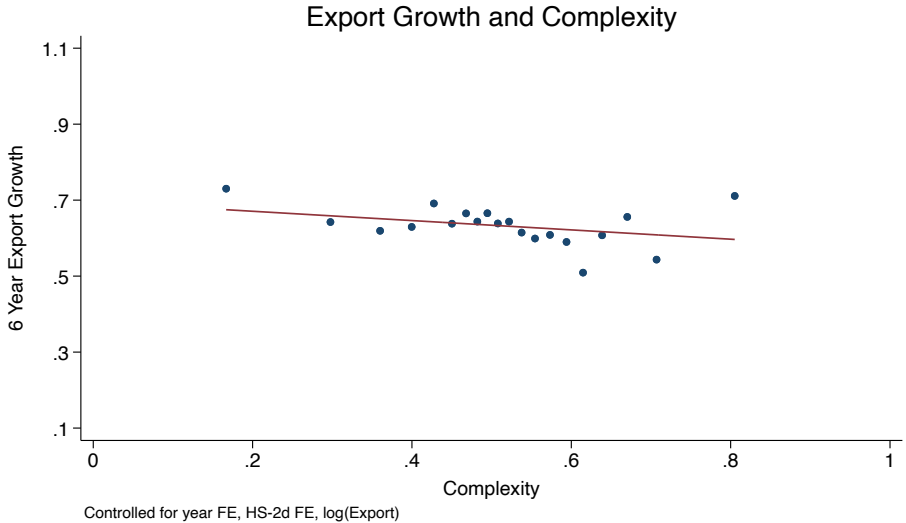
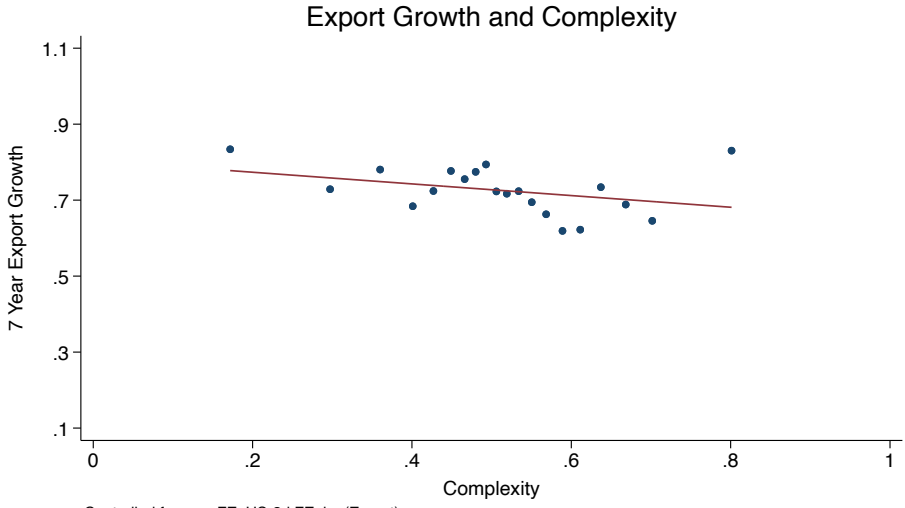


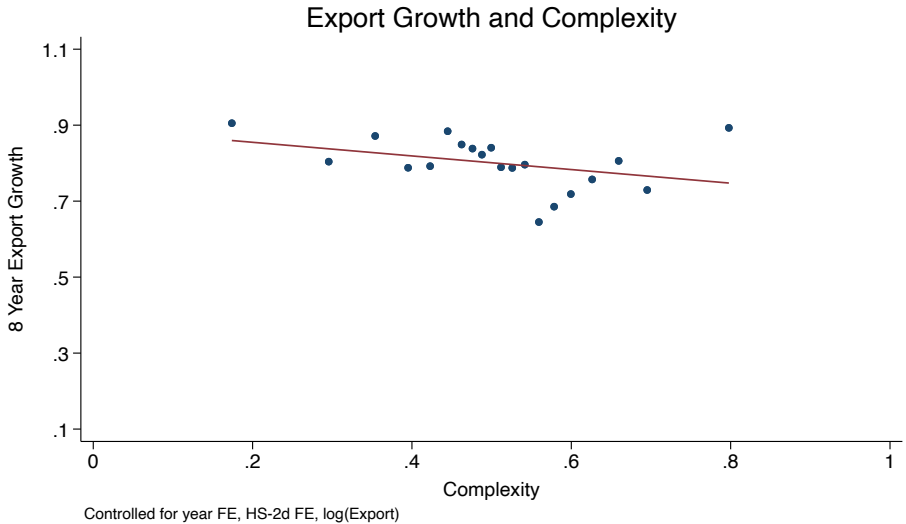
Firm-Sector Growth Rate: Control for Current Export Value



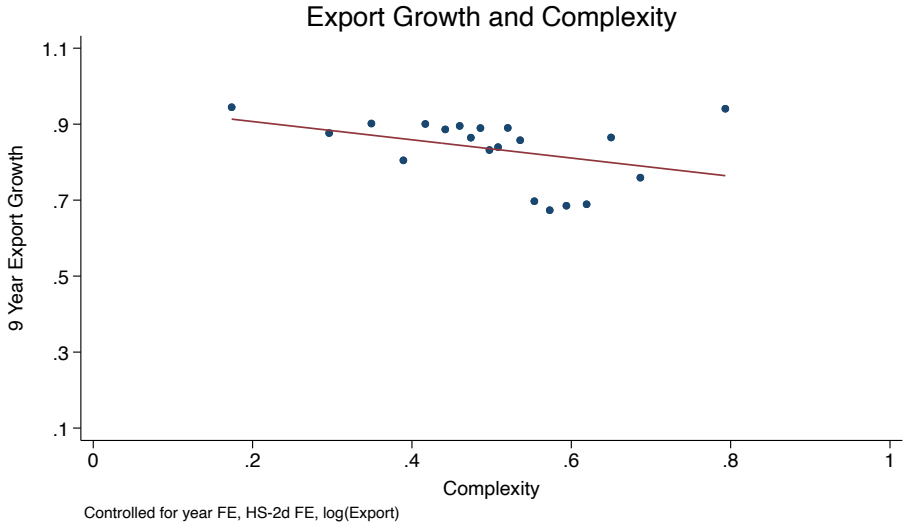
Firm-Sector Growth Rate: Control for Current Export Value



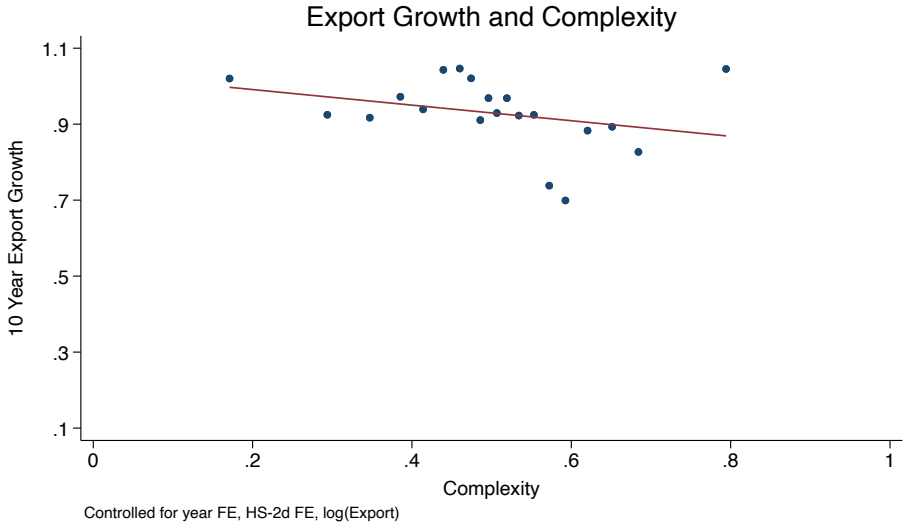
Firm-Sector Growth Rate: Control for Current Export Value



Firm-Sector Growth Rate: Control for Current Export Value



Firm-Sector Growth Rate: Control for Current Export Value



Survival Rate

- Are more complex firm more likely to survive exporting? For $h = 1, \ldots, 10$,

$$\mathbb{1}_{\{x_{i,t+h}>0\}} \sim \beta c_{i,t} + \gamma \log(x_{i,t}) + \alpha_t;$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Complexity	0.0503**	0.0837**	0.112**	0.133**	0.149**	0.167**	0.176**	0.181**	0.178**	0.174*
	(0.00274)	(0.00347)	(0.00402)	(0.00585)	(0.00737)	(0.00779)	(0.00902)	(0.00466)	(0.00414)	(0.00352)
Log(Export)	0.0486**	0.0552**	0.0569**	0.0560**	0.0542**	0.0516**	0.0489**	0.0465**	0.0433**	0.0402**
	(0.00166)	(0.00128)	(0.00108)	(0.000699)	(0.000807)	(0.000866)	(0.00109)	(0.000246)	(0.000467)	(0.000624)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Within R^2	.096	.084	.077	.07	.064	.06	.056	.053	.05	.048
Dep. Var. Mean	.85	.75	.67	.6	.54	.5	.44	.4	.35	.31
Observations	1139378	985451	842904	707901	573063	448800	352765	260277	181521	114951

◂ Year Binscatters ◂ Firm-Sector Regression ◂ ... with Firm FE

Number of Exporting Sectors

- Are more complex firm increasing number of exporting sectors more? For $h = 1, \ldots, 10$,

$$\text{Sector } \#_{i,t+h} - \text{Sector } \#_{i,t} \sim \beta c_{i,t} + \gamma \log(x_{i,t}) + \alpha_t;$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Complexity	0.205**	0.374**	0.539**	0.723**	0.905**	1.074**	1.219**	1.313**	1.388*	1.489*
	(0.0357)	(0.0380)	(0.0395)	(0.0447)	(0.0532)	(0.0602)	(0.0587)	(0.0943)	(0.141)	(0.108)
Log(Export)	-0.0808**	-0.0906**	-0.0978**	-0.106**	-0.107**	-0.113**	-0.118**	-0.122**	-0.120**	-0.107*
	(0.00517)	(0.00667)	(0.00635)	(0.00381)	(0.00330)	(0.00451)	(0.00387)	(0.00403)	(0.00495)	(0.00390)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Within R^2	.005	.006	.008	.01	.012	.014	.015	.016	.016	.015
Dep. Var. Mean	.07	.12	.16	.2	.25	.31	.38	.45	.54	.63
Observations	966325	734572	561345	422030	310476	224600	156517	104072	63632	35089

◂ # Sector Growth ◂ # Goods ◂ # Goods Growth

Take-aways & Future Plans

Take-aways:

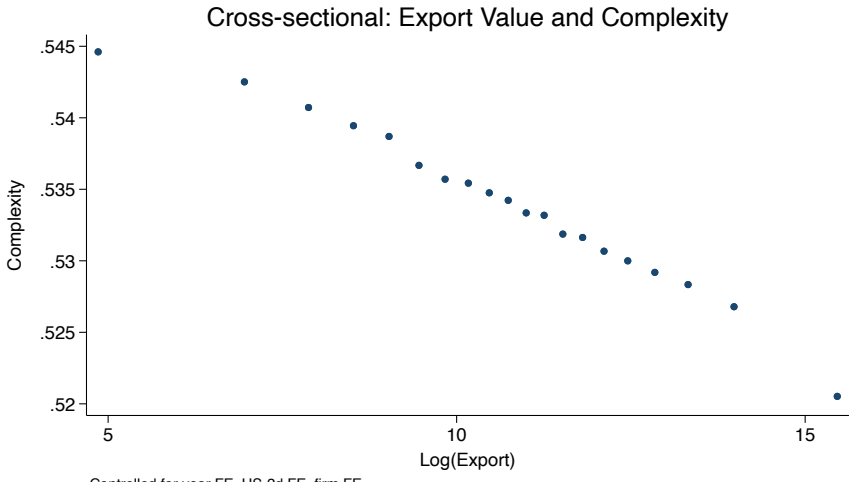
- More complex exporting firm-sectors are smaller, but they grow faster;
- The growth seems to come from expanding across sectors and goods;

Future Plans:

- What goods are introduced?
- How are complexity related to quality and productivity?
- Other countries and better data?
- Causality?
- The role of the demand side, other countries, GE?
- Microfoundation for the measure? Framework?

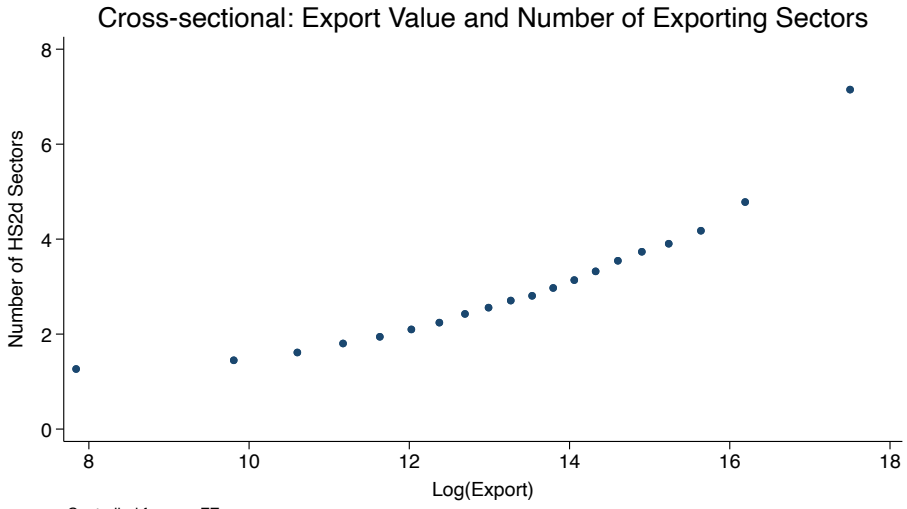
Appendix

$$c_{is} \sim \beta \log(x_{is}) + \alpha_s + \alpha_i$$



Return

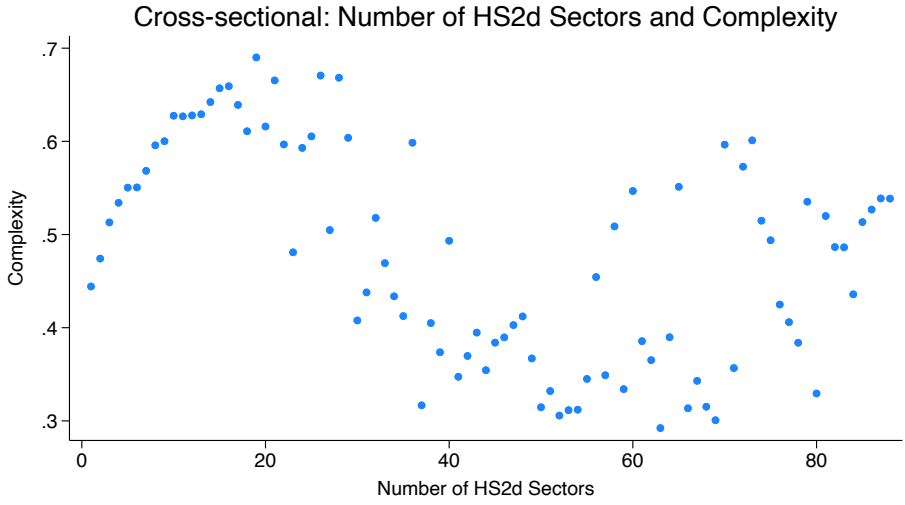
Numer of Sectors and Export Value



Controlled for year FE

Return

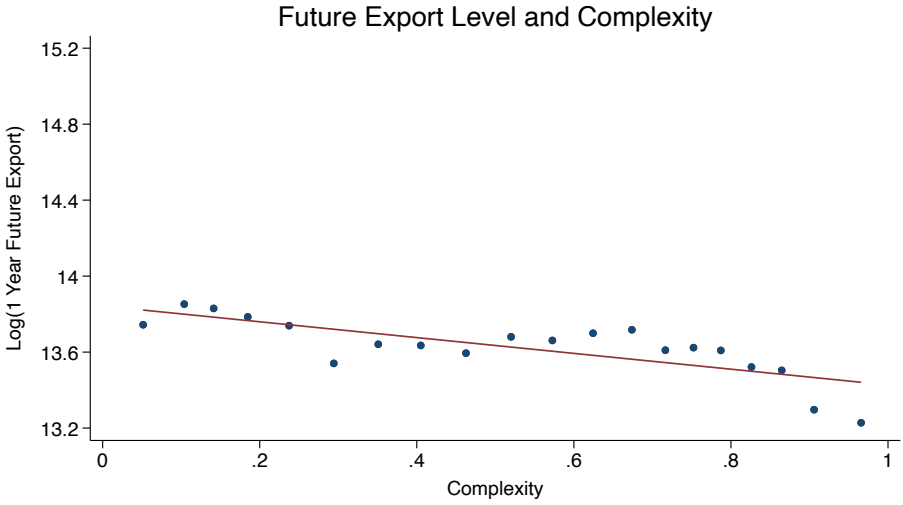
Complexity and Numer of Sectors



Complexity demeaned with year FE and added 2000 average

Return

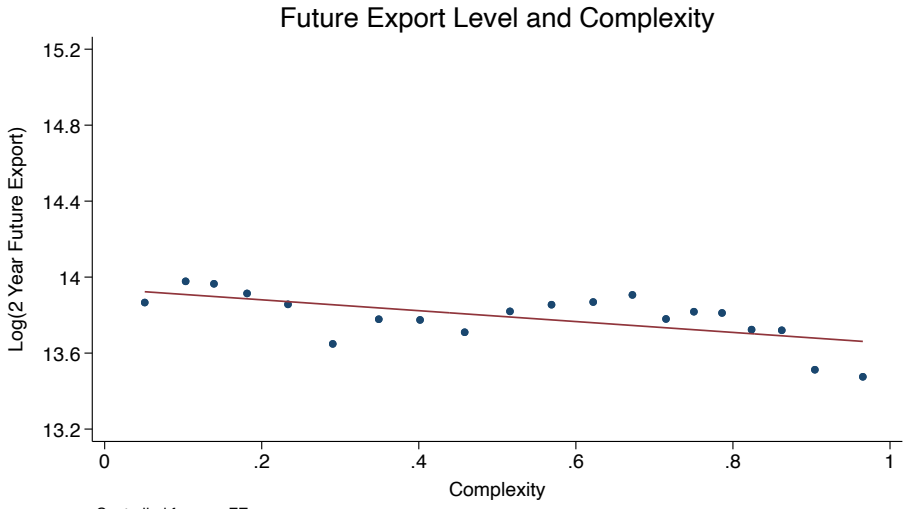
Firm Future Export Level



Controlled for year FE

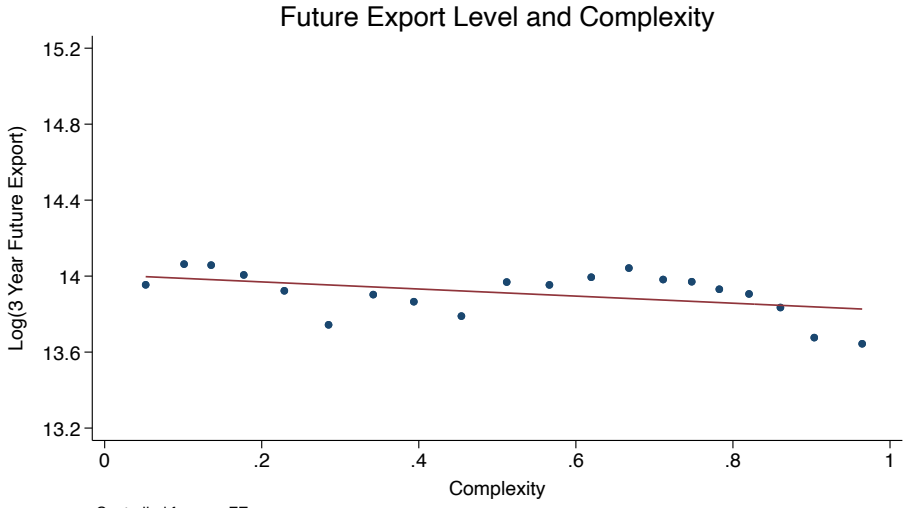
Return

Firm Future Export Level



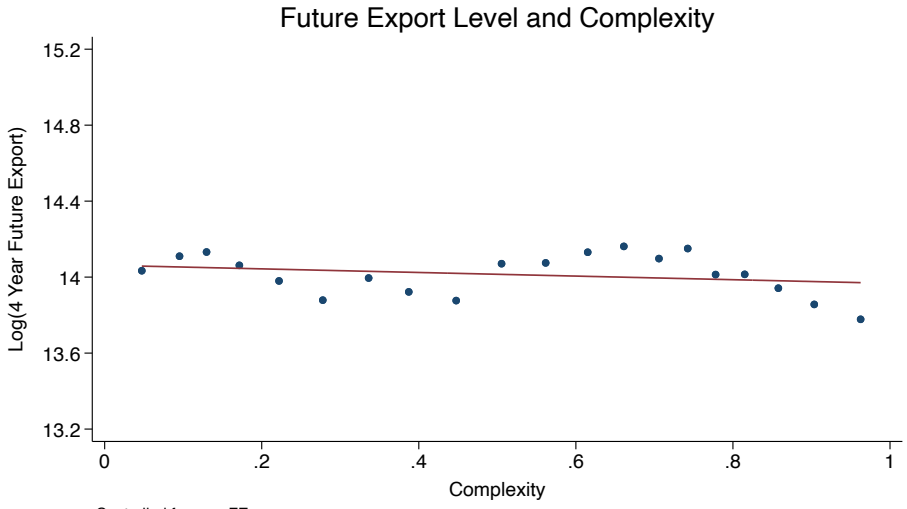
Return

Firm Future Export Level



Return

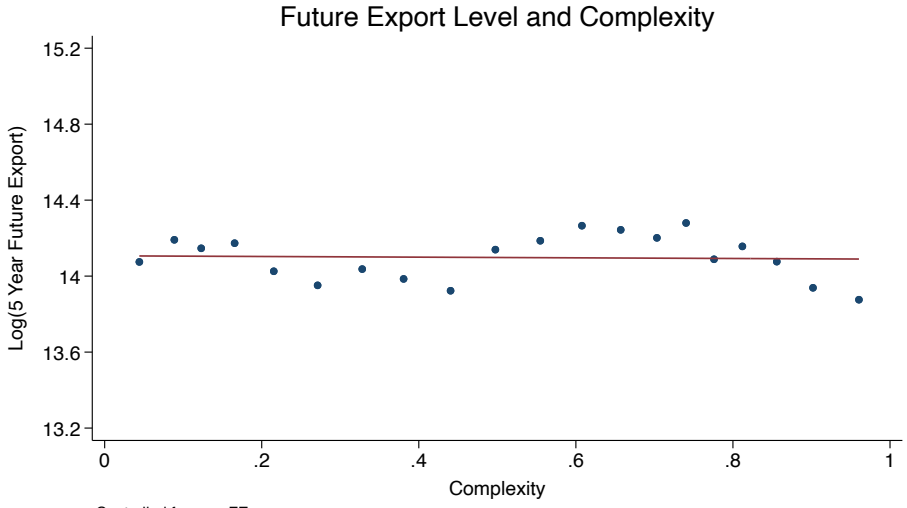
Firm Future Export Level



Controlled for year FE

Return

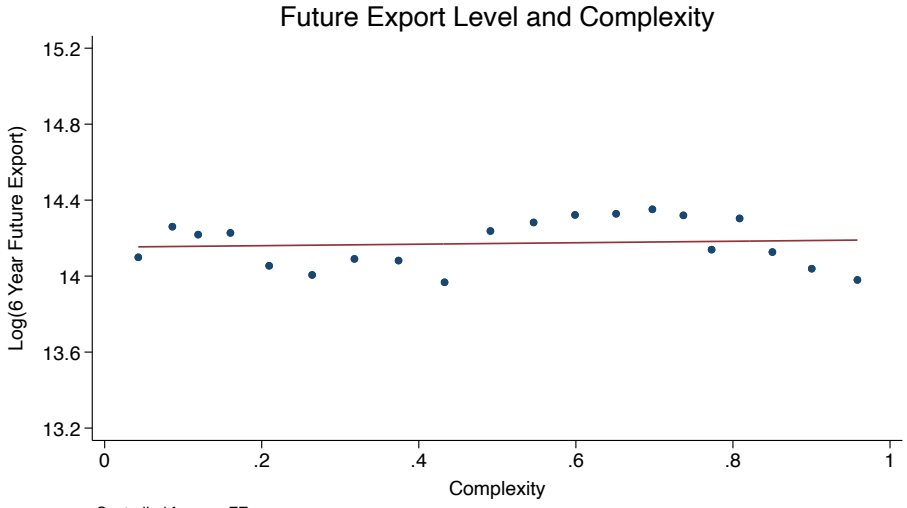
Firm Future Export Level



Controlled for year FE

Return

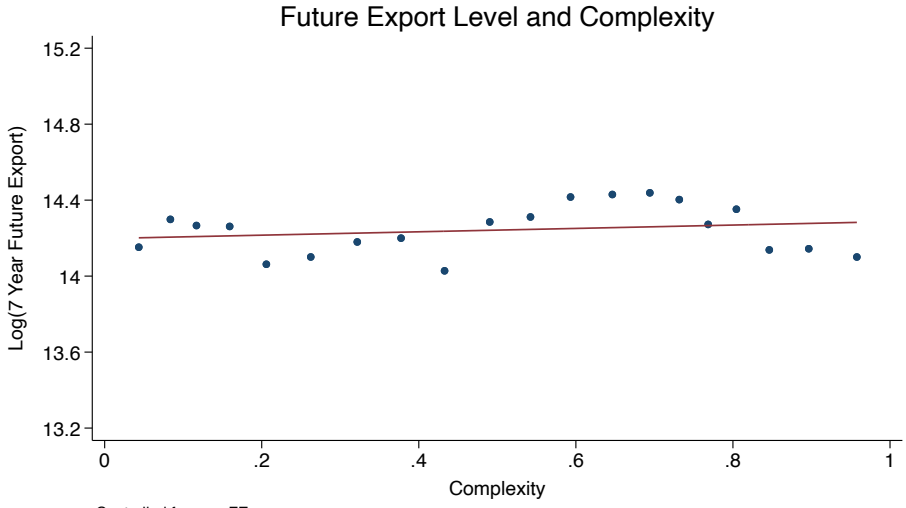
Firm Future Export Level



Controlled for year FE

Return

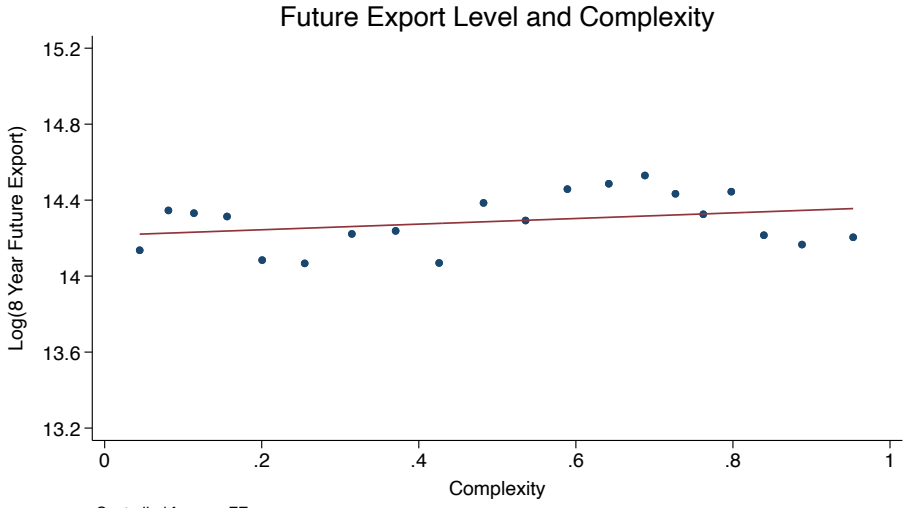
Firm Future Export Level



Controlled for year FE

Return

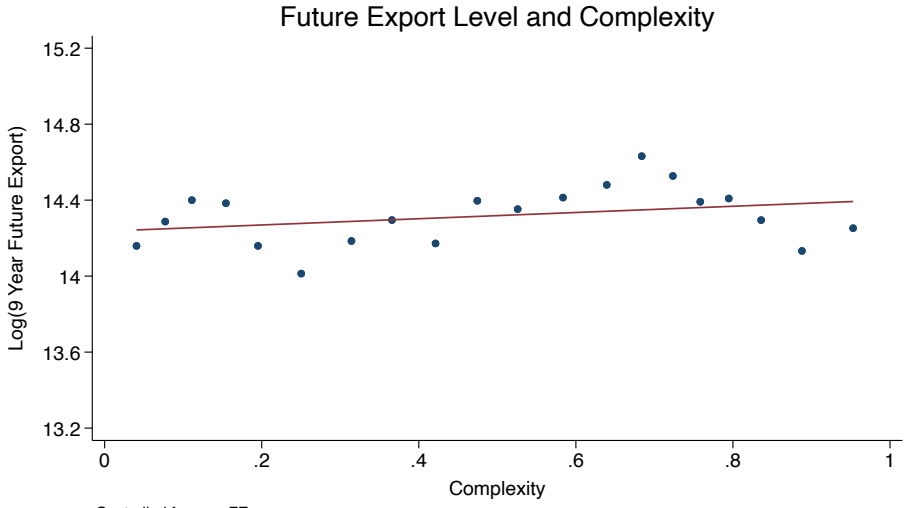
Firm Future Export Level



Controlled for year FE

Return

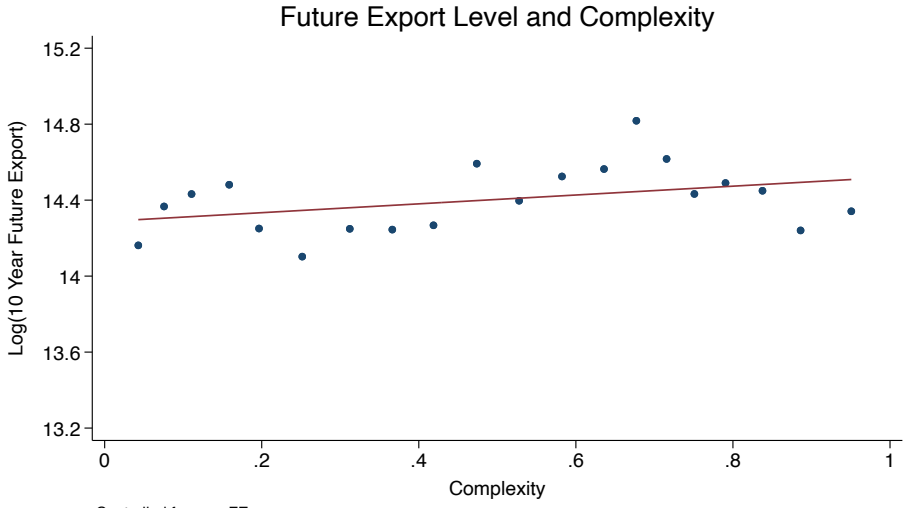
Firm Future Export Level



Controlled for year FE

Return

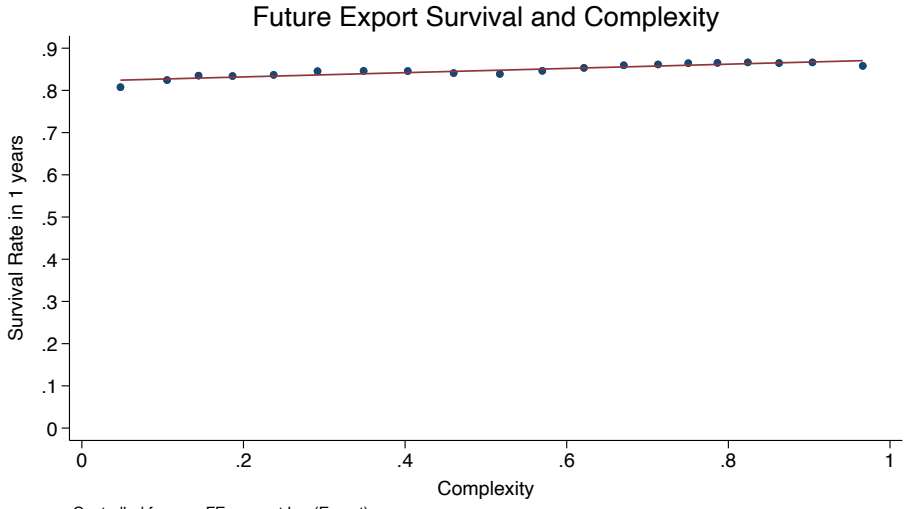
Firm Future Export Level



Controlled for year FE

Return

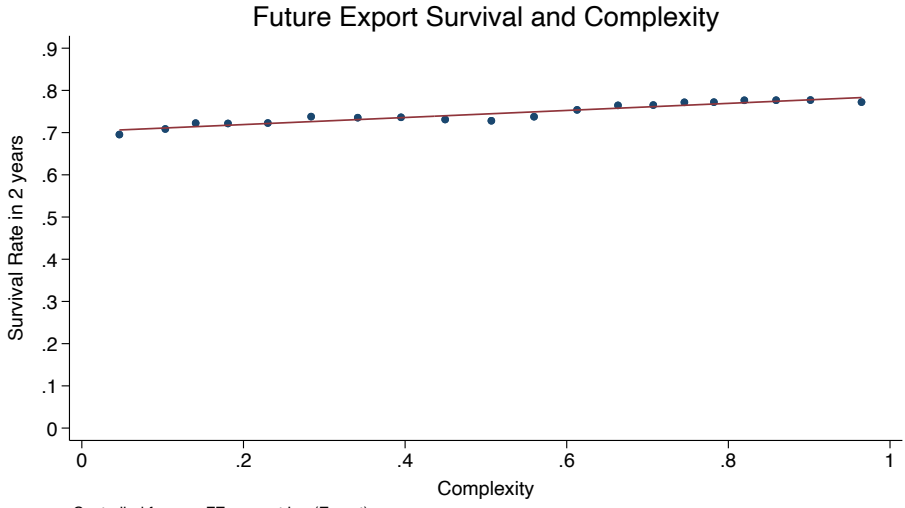
Survival Rate and Complexity



Controlled for year FE, current Log(Export)

Return

Survival Rate and Complexity



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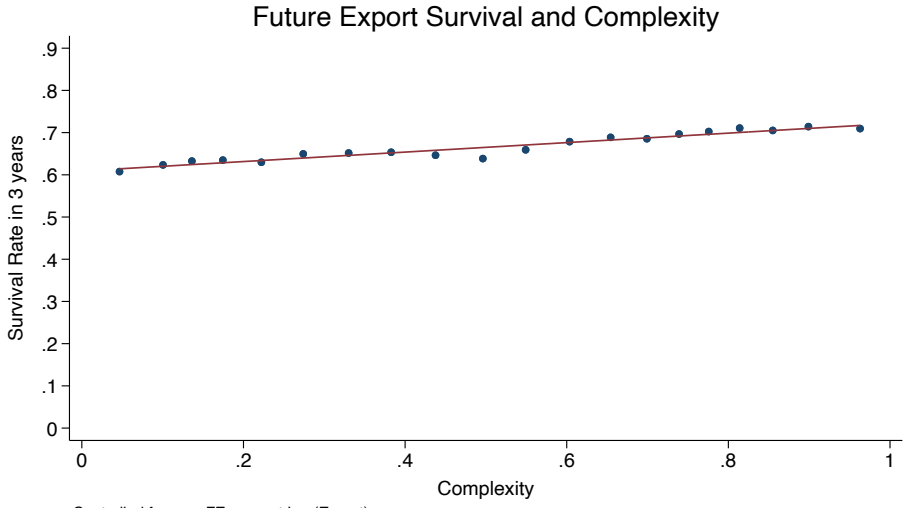
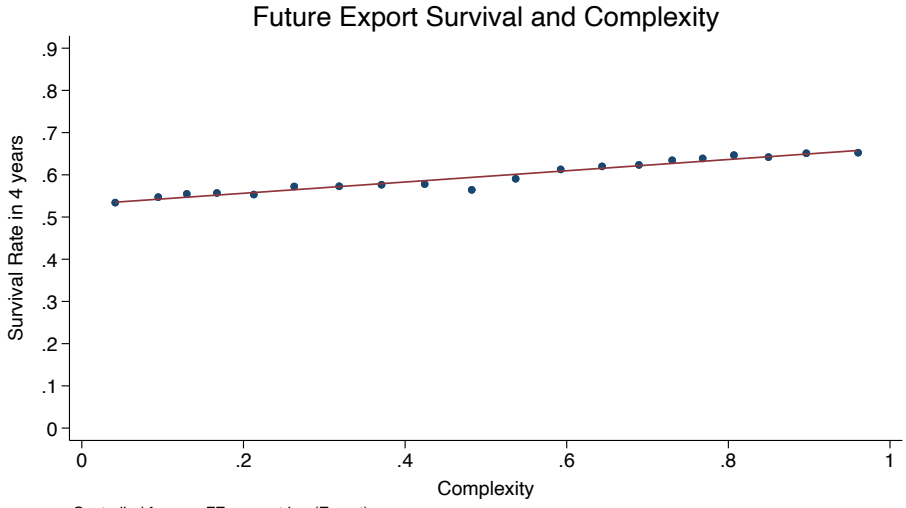
Return

Survival Rate and Complexity



Return

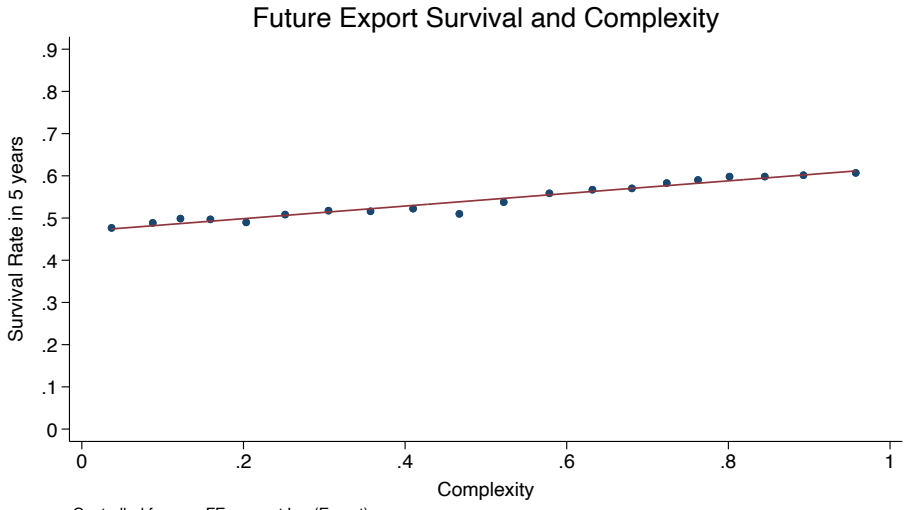
Survival Rate and Complexity



Controlled for year FE, current Log(Export)

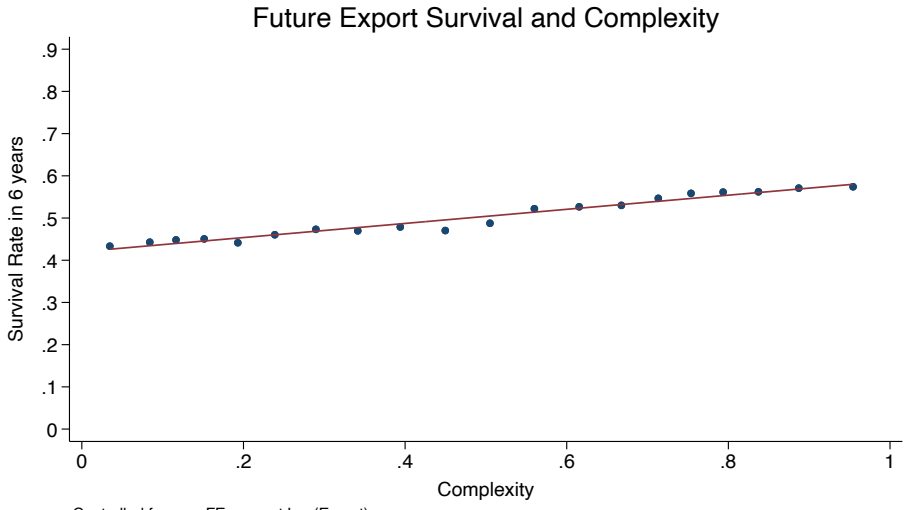
Return

Survival Rate and Complexity



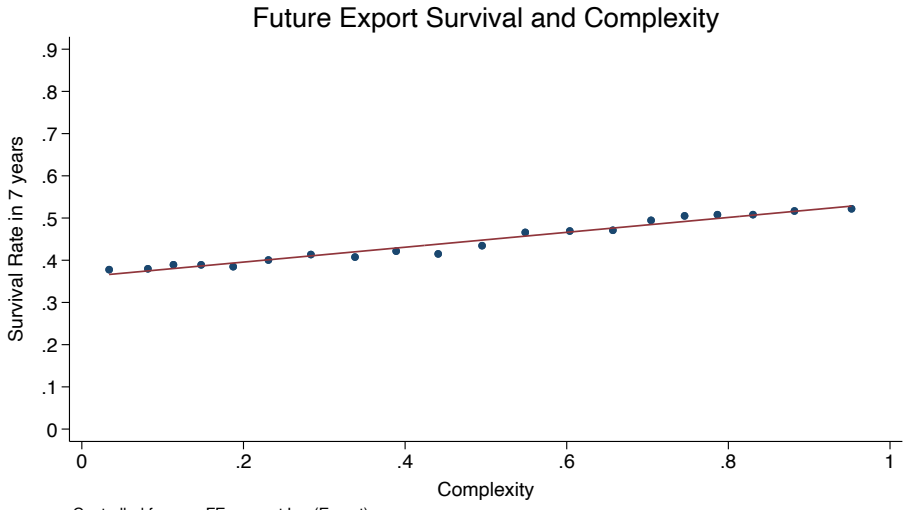
Return

Survival Rate and Complexity



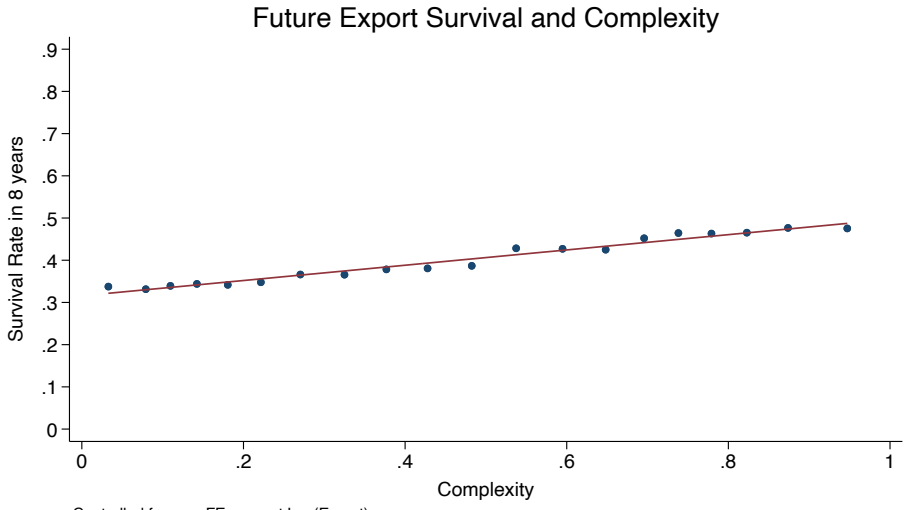
Return

Survival Rate and Complexity



Return

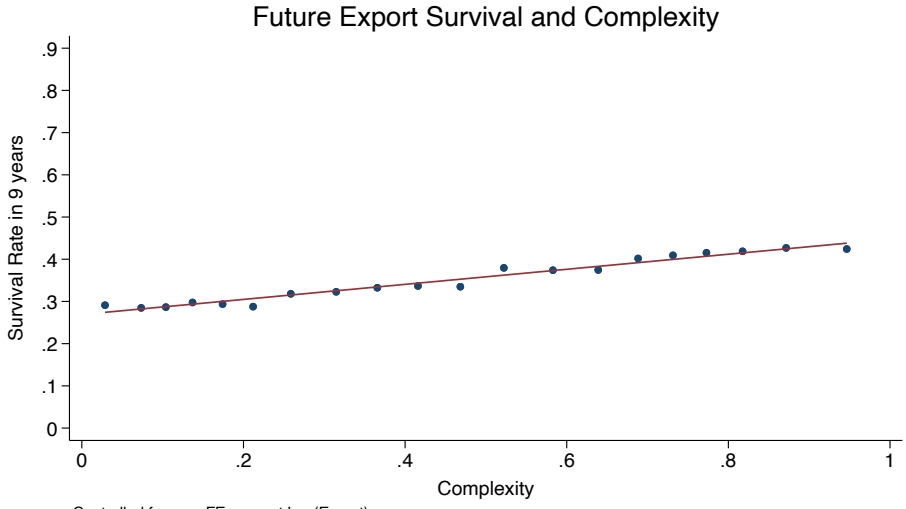
Survival Rate and Complexity



Controlled for year FE, current Log(Export)

Return

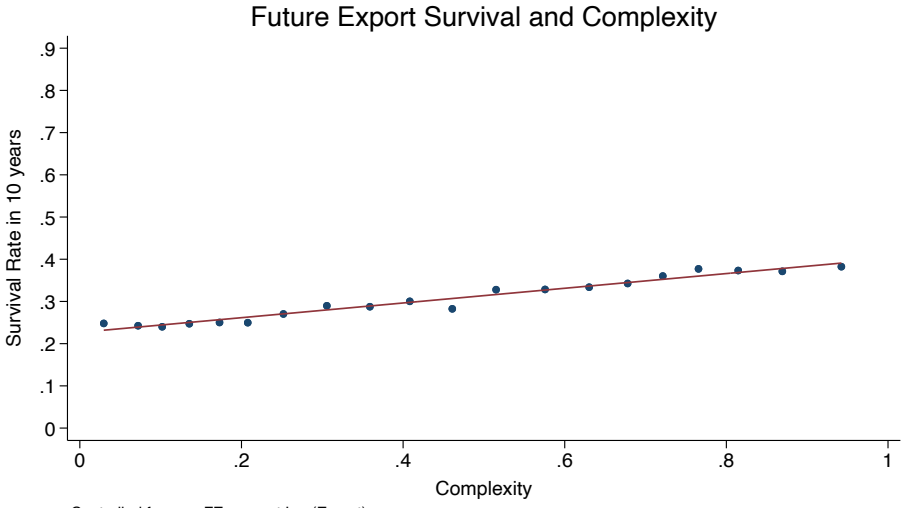
Survival Rate and Complexity



Controlled for year FE, current Log(Export)

Return

Survival Rate and Complexity



Return

Survival Rate at Firm-Sector Level

- Similar results hold at the firm-sector level with HS2d FE:

$$\mathbb{1}_{\{x_{is,t+h}>0\}} \sim \beta c_{is,t} + \gamma \log\left(x_{is,t}\right) + \alpha_s + \alpha_t;$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Complexity	0.0405**	0.0565**	0.0648**	0.0713**	0.0726**	0.0715**	0.0723**	0.0653**	0.0586**	0.0489
	(0.00311)	(0.00344)	(0.00423)	(0.00566)	(0.00673)	(0.00731)	(0.00879)	(0.00677)	(0.00432)	(0.0102)
Log(Export)	0.0624**	0.0618**	0.0587**	0.0547**	0.0507**	0.0468**	0.0425**	0.0386**	0.0347**	0.0313**
	(0.00138)	(0.00109)	(0.000822)	(0.000934)	(0.000773)	(0.00108)	(0.00136)	(0.000408)	(0.000615)	(0.000467)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
HS2d FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Within R^2	.151	.133	.119	.106	.095	.084	.073	.064	.056	.05
Dep. Var. Mean	.67	.55	.47	.4	.36	.33	.29	.26	.23	.2
Observations	3383253	2916662	2497018	2103714	1686124	1295887	1011826	731039	499580	308937

◂ Return

Survival Rate at Firm-Sector Level

- Yet the opposite is true with firm FE:

$$\mathbb{1}_{\{x_{is,t+h}>0\}} \sim \beta c_{is,t} + \gamma \log(x_{is,t}) + \alpha_s + \alpha_t + \alpha_i;$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Complexity	-0.00663**	-0.0105**	-0.0131**	-0.0126**	-0.0130**	-0.0159**	-0.0136**	-0.0108*	-0.00801	-0.0125
	(0.00180)	(0.00167)	(0.00200)	(0.00240)	(0.00206)	(0.00116)	(0.00186)	(0.00229)	(0.00358)	(0.00954)
Log(Export)	0.0626**	0.0568**	0.0511**	0.0456**	0.0412**	0.0376**	0.0333**	0.0298**	0.0264**	0.0237*
	(0.00129)	(0.00113)	(0.00134)	(0.000974)	(0.00100)	(0.00152)	(0.00136)	(0.000873)	(0.000663)	(0.000471)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
HS2d FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Firm FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Within R^2	.144	.127	.113	.101	.091	.082	.074	.066	.06	.056
Dep. Var. Mean	.67	.55	.47	.4	.36	.33	.29	.26	.23	.2
Observations	3340931	2875736	2458193	2065440	1653230	1273437	988046	710587	482795	293647

◂ Return

Number of Exporting Sectors Growth

- Number of exporting sector growth rate:

$$\frac{\text{Sector } \#_{i,t+h} - \text{Sector } \#_{i,t}}{\text{Sector } \#_{i,t}} \sim \beta c_{i,t} + \gamma \log(x_{i,t}) + \alpha_t;$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Complexity	0.0749**	0.149**	0.232**	0.315**	0.400**	0.491**	0.578**	0.647**	0.701**	0.778*
	(0.0106)	(0.0136)	(0.0149)	(0.0195)	(0.0238)	(0.0250)	(0.0178)	(0.0353)	(0.0579)	(0.0505)
Log(Export)	-0.0390**	-0.0479**	-0.0522**	-0.0566**	-0.0568**	-0.0583**	-0.0605**	-0.0621**	-0.0603**	-0.0550**
	(0.00222)	(0.00187)	(0.00210)	(0.00190)	(0.00152)	(0.00292)	(0.00219)	(0.00135)	(0.00302)	(0.000752)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Within R^2	.01	.012	.013	.015	.017	.019	.02	.02	.019	.019
Dep. Var. Mean	.17	.25	.3	.35	.39	.44	.5	.55	.61	.67
Observations	966325	734572	561345	422030	310476	224600	156517	104072	63632	35089

Return

Number of Exporting Goods

- Number of exporting goods:

$$\text{Goods } \#_{i,t+h} - \text{Goods } \#_{i,t} \sim \beta c_{i,t} + \gamma \log(x_{i,t}) + \alpha_t;$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Complexity	1.833	4.665**	7.260**	9.677**	12.19**	12.82**	17.37**	19.31**	21.29**	24.17*
	(1.284)	(1.365)	(1.570)	(1.854)	(2.018)	(1.879)	(0.323)	(1.048)	(1.025)	(1.486)
Log(Export)	-0.693	-0.227	-0.167	-0.0338	0.276	-0.600	2.167**	2.474**	2.715*	2.740
	(1.135)	(1.220)	(1.446)	(1.784)	(2.127)	(2.372)	(0.361)	(0.199)	(0.326)	(0.550)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Within R^2	0	0	0	.001	.001	.001	.002	.002	.002	.002
Dep. Var. Mean	2.08	3.65	4.54	5.66	6.92	6.09	11.98	13.76	15.74	17.99
Observations	966325	734572	561345	422030	310476	224600	156517	104072	63632	35089

◂ Return

Number of Exporting Goods Growth

- Number of exporting goods growth rate:

$$\frac{\text{Goods } \#_{i,t+h} - \text{Goods } \#_{i,t}}{\text{Goods } \#_{i,t}} \sim \beta c_{i,t} + \gamma \log(x_{i,t}) + \alpha_t;$$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Complexity	-0.0900	0.103	0.422**	0.655**	0.831**	0.953**	1.391**	1.748**	2.182**	2.891+
	(0.114)	(0.102)	(0.101)	(0.135)	(0.158)	(0.144)	(0.0843)	(0.0758)	(0.0872)	(0.371)
Log(Export)	-0.290**	-0.424**	-0.509**	-0.614**	-0.680**	-0.699**	-0.793**	-0.901**	-1.020**	-1.165*
	(0.0213)	(0.0177)	(0.0209)	(0.0458)	(0.0580)	(0.0485)	(0.0498)	(0.0374)	(0.0819)	(0.0698)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Within R^2	.003	.002	.019	.025	.013	.017	.017	.02	.016	.017
Dep. Var. Mean	.64	.95	1.19	1.47	1.72	1.75	2.23	2.56	2.92	3.39
Observations	966325	734572	561345	422030	310476	224600	156517	104072	63632	35089

Return