Online Appendix for "The Impact of Emerging Market Competition on Innovation and Business Strategy"

(NOT FOR PUBLICATION)

Contents

Appendix A: Supplemental cross-sectional facts on innovation strategy choices from the Survey of Innovation and Business Strategy (SIBS)

Since the amount of disclosure of industry-level summary statistics for the WES is restricted by Statistics Canada and the WES ends in 2006, we also analyzed industry-level data from the related Survey of Innovation and Business Strategy (SIBS) for the year 2009. This survey is only a repeated cross-section and is therefore not useful for our main analysis of within-firm responses to the China shock. But its industry level data are still comparable and it includes other questions related to innovation that provide useful context and summary statistics. In particular, the SIBS industry level summary statistics displayed in table A1 show that a relatively large fraction of firms (almost half) successfully innovate over a three year period.

[Table A1]

Innovation strategies in the SIBS (defined less stringently than in table 1 of the paper, see table notes) are also quite common, and table A1 shows that the high share of manufacturing firms with innovation strategies and outcomes is broad-based and not driven by a few industries. Industries in which more firms adopt innovation strategies have a higher share of firms with successful innovation outcomes but the correlation is well below one. The share of firms with an innovation strategy is sometimes above and sometimes below the share of firms with a successful innovation outcome in an industry. This indicates that innovation strategy may be an important predictor of successful innovation outcomes but is neither a necessary nor a sufficient condition.

Appendix B: Autor-Dorn-Hansen type IV results

In this section, we investigate whether our results are driven by unobserved factors that are specific to the trade patterns between Canada and China. To address this potential concern, Autor, Dorn and Hanson (2013) propose to use the industry exports of China to other countries as instrument for exports increases in a given country (the US in their case, Canada in our case). We use Chinese exports to the same set of countries as ADH (Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, Switzerland) for this purpose, as they have seen similar increases in Chinese exports as Canada and are similar advanced economies.

[Table A2]

Results of using the Autor-Dorn-Hansen IV strategy are reported in table A2. These results are broadly consistent with our baseline IV results in tables 3 and 4.

Appendix C: Controlling for initial industry differences

In this section we investigate whether the innovation responses to intensifying Chinese competition are driven by initial industry differences in innovation or firm size. Recall that our IV strategy relies on initial Chinese competition in 1999. If high import shares from China in 1999 signal that these industries are less innovative or have smaller/less productive firms to begin with, then the decrease in process innovation in the following years might be driven by this initial industry weakness. To address this issue, we construct industry-level measures of the share of firms that report product or process innovations in 1999 as proxy for initial industry level innovativeness. Additionally, we use domestic revenue at the firm-level as a measure of firm productivity, consistent with heterogeneous firm trade models such as Melitz (2003).

[Table A3]

Table A3 documents the results of controlling for initial industry innovativeness and initial firm domestic revenue. All our baseline results remain highly significant and our results on the increase in the number of product innovations are strengthened.

Appendix D: Initial innovation strategies and non-US competition perceptions

As described in section 3.3, identifying innovator performance moments in response to a competition shock requires that initial strategy choices be predetermined. Our main concern is that the firms that benefitted the most from an innovation strategy at the time of China's WTO entry in 2001, were also able to forecast this WTO entry already in 1999. The consequence would be strategy self-selection, which would lead to a downward bias in the exit coefficient and an upward bias in the profit coefficient.

To investigate the plausibility of this strategy self-selection, we again utilize the competition perception data we also use in section 4.1 to validate that Chinese competition was the main shock under consideration. As shown in section 4.1 this data on perceptions of competition by location of competitors did mirror the increase in Chinese competition from international trade data while not reflecting intensifying competition from other sources, such as Mexico or other top export growth countries to Canada. Another key advantage of this data is that it is available at the firm level.

[Table A4]

If it is indeed the case that firms that more strongly believe in increasing Chinese competition did more systematically self-select into innovation strategies, then we should see a strong correlation of perceived non-US international competition and strategy choices. Table A4 shows that there is no significant relationship between perceptions of stronger non-US international competition in 1999, and innovation strategies.

Importantly, due to the panel nature of the WES data, we can go beyond checking whether there is a correlation of initial strategies in 1999 with contemporary competitive perceptions in 1999. We can also analyze whether initial strategy choices in 1999 are correlated with the level of future competitive perceptions in 2005. It is useful to remember that these competitive perceptions correctly reflect the rise in Chinese competition, as documented earlier in table 3. We analyze the correlations of both, the changes in competitive perceptions between 1999 and 2005 as well as the level of future competitive perceptions in 2005. However, as columns (2) and (3) of table A4 show, none of the competitive perception variables is significantly correlated with initial innovation strategies.

Appendix E: Aggregate trends in processing trade

In section 5.1 we controlled for outsourcing as an alternative explanation for declining process innovation in response to Chinese competition. If outsourcing is indeed a major factor for manufacturing, then one would expect this to be related to trade of intermediates, or processing trade. It is worthwhile to inspect the general time trends in overall Chinese trade to Canada, as well as processing trade, in Figure A1.

[Figure A1]

As the figure shows, overall Chinese exports to Canada accelerated sharply after China's WTO entry at the end of 2001. The dashed line captures China's processing trade, which also accelerated, but at a slower pace. In fact, the share of processing trade in China's exports to Canada has been systematically falling since China's entry into the WTO. These aggregate trends already foreshadow some of our empirical analysis in section 5.1.

Appendix F: Controlling for long-run trends

This section addresses the potential issue that industries with intensifying Chinese competition might also have significantly different long run trends as other industries. Since data on innovation and strategy outcomes for Canada do not exist before 1999, we instead use more aggregate data on these outcomes after the end of our sample. Industry-level analysis allows us to add more data from the SIBS dataset on strategic behavior and also enables an analysis of aggregate strategic changes due to entrants with different strategies, even if incumbents are not changing their strategies. Together with selective exit of firms with innovation strategies, this could lead to a change in strategic orientation within an industry without much of a change within continuing firms.

Since the SIBS does not ask firms for all the detailed strategic dimensions of the WES, we had to adjust the WES strategy measures to focus on whether product or process innovation were considered important. With this industry-level variation in the strategy measure over the 2001–2012 period, we estimated changes in the share of firms that considered process or product innovation important for their strategy was affected by Chinese competition.[1] Similarly, we construct measures of the share of firms with a product or process innovation in the last 3 years and aggregate to the industry level to investigate whether Chinese competition continued to have a significant impact on innovation outcomes past 2005.

[Table A5]

Table A5 documents the results. First, process and product innovation strategies both appear to have declined, with process innovation strategy falling almost twice as much with a decline that is

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[1] For this long-run specification, we used three non-overlapping time differences from 2001–2005, 2005–2009, and 2009–2012 and estimated effects with industry and year fixed effects.

statistically significant at the 10% level. These results are consistent with strategic orientation changing through selection, including entrants adjusting their strategy optimally, while incumbent firms might have trouble changing strategies. At the same time, columns 3 and 4 confirm that process innovations are significantly declining on the industry level, even controlling for long-run industry level trends.

Appendix G: Innovation and strategy responses, excluding foreign-owned firms

In this section we investigate whether some of our innovation results are driven by foreign owned firms. In particular, it might be the case that subsidiaries of multinational firms innovate less process innovations in response to Chinese competition because they can access process innovations of their parent companies[2].

[Table A6]

Around 16% of Canadian manufacturing establishments in our sample are foreign-owned, mostly with corporate parents in the US. Since we have access to ownership share information, we exclude establishments with majority foreign ownership from our analysis. Table A6 shows results of the impact of Chinese competition on innovation and business strategy excluding foreign-owned establishments. Results are qualitatively similar to our baseline results in table 4. Even as the reduction in the number of process innovation is slightly weaker than before, the negative innovation incentive effects stays highly statistically significant. Furthermore, the increase in number of exclusive production innovations and the coefficient on product innovation strategy is

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[2] We thank an anonymous referee for raising this issue.

almost unchanged. The results excluding foreign firms therefore remain consistent with our baseline theory.
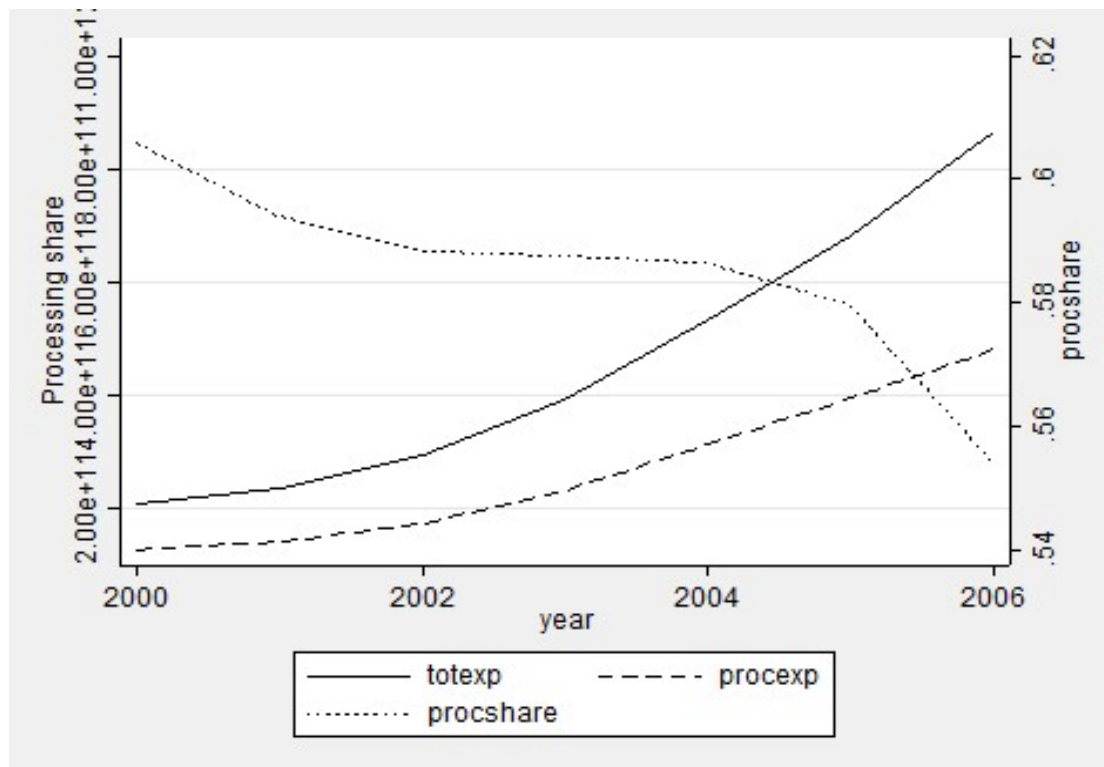
Figure A1: Time series of total Chinese exports to Canada, processing exports and the share of processing trade from 2000 to 2006.

Table A1: Industry-level Summary Statistics (SIBS 3/4-digit NAICS aggregation)

NAICS	Category Name	Chinese import share		Innovation outcomes (share of firms)		Innovation strategies (share of firms)	
		Change 1999-2005	1999	Product	Process	Product	Process
3341	Computer and peripheral equipment manufacturing	0.275	0.036	0.653	0.386	0.5	0.534
3333	Ventilation, heating, air-conditioning, and commercial refrigeration	0.266	0.073	0.691	0.521	0.547	0.513
3152	Cut and sew clothing manufacturing	0.248	0.216	0.306	0.125	0.212	0.208
337	Furniture and related product manufacturing	0.208	0.088	0.378	0.44	0.429	0.407
334R	Computer and electronic product manufacturing	0.182	0.088	0.488	0.503	0.321	0.901
315R	Clothing manufacturing	0.181	0.286	0.553	0.481	0.375	0.286
3342	Communications equipment manufacturing	0.167	0.041	0.676	0.342	0.696	0.595
339R	Miscellaneous manufacturing	0.154	0.201	0.445	0.537	0.373	0.518
314	Textile product mills	0.151	0.087	0.404	0.444	0.343	0.332
3352	Household appliance manufacturing	0.144	0.098	0.726	0.636	0.725	0.543
3351	Electric lighting equipment manufacturing	0.142	0.231	0.748	0.583	0.656	0.245
316	Leather and allied product manufacturing	0.129	0.301	0.617	0.452	0.447	0.339
3219	Other wood product manufacturing	0.113	0.060	0.382	0.53	0.201	0.359
3117	Seafood product preparation and packaging	0.104	0.023	0.098	0.358	0.195	0.346
3323	Architectural and structural metals manufacturing	0.095	0.014	0.306	0.445	0.21	0.432
327	Non-metallic mineral product manufacturing	0.083	0.057	0.376	0.468	0.26	0.419
3344	Semiconductor and other electronic component manufacturing	0.083	0.018	0.589	0.589	0.496	0.47
3212	Veneer, plywood and engineered wood product manufacturing	0.083	0.005	0.256	0.496	0.341	0.353
3211	Sawmills and wood preservation	0.079	0.007	0.316	0.5	0.282	0.322
332X	Other fabricated metal product manufacturing	0.076	0.036	0.417	0.522	0.346	0.557
331R	Primary metal manufacturing	0.074	0.038	0.387	0.602	0.234	0.447
3359	Other electrical equipment and component manufacturing	0.065	0.026	0.527	0.574	0.465	0.547
3334	Metalworking machinery manufacturing	0.064	0.008	0.525	0.696	0.273	0.525
3391	Medical equipment and supplies manufacturing	0.063	0.034	0.701	0.64	0.49	0.512
3324	Boiler, tank and shipping container manufacturing	0.051	0.011	0.422	0.517	0.422	0.573
326R	Plastics and rubber products manufacturing	0.049	0.043	0.599	0.597	0.459	0.451
3369	Other transportation equipment manufacturing	0.047	0.072	0.438	0.5	0.438	0.625
313	Textile mills	0.046	0.045	0.553	0.603	0.483	0.396
323	Printing and related support activities	0.046	0.024	0.291	0.521	0.34	0.462
3122	Tobacco manufacturing	0.045	0.001	NA	NA	NA	NA
3262	Rubber product manufacturing	0.045	0.014	0.422	0.532	0.495	0.656
3313	Alumina and aluminum production and processing	0.042	0.003	0.366	0.59	0.229	0.321
331X	Other metal production and processing	0.040	0.010	0.461	0.522	0.269	0.328
3345	Navigational, measuring, medical and control instruments	0.039	0.020	0.622	0.527	0.572	0.523
3327	Machine shops, turned product, and screw, nut and bolt	0.037	0.012	0.192	0.605	0.214	0.406
3353	Electrical equipment manufacturing	0.036	0.018	0.474	0.514	0.439	0.508
3222	Converted paper product manufacturing	0.036	0.028	0.315	0.547	0.333	0.425
333R	Machinery manufacturing	0.027	0.006	0.568	0.485	0.529	0.479
3114	Fruit and vegetable preserving and specialty food manufacturing	0.026	0.022	0.513	0.512	0.245	0.584
3363	Motor vehicle parts manufacturing	0.018	0.007	0.393	0.599	0.397	0.491
325X	Other chemical product manufacturing	0.013	0.004	0.472	0.521	0.402	0.435
3365	Railroad rolling stock manufacturing	0.013	0.002	0.545	0.455	0.364	0.273
3111	Animal food manufacturing	0.009	0.008	0.429	0.434	0.315	0.533
3251	Basic chemical manufacturing	0.008	0.013	0.432	0.414	0.296	0.402
3221	Pulp, paper and paperboard mills	0.007	0.001	0.441	0.33	0.26	0.356
3252	Resin, synthetic rubber, and artificial and synthetic fibres and filaments	0.005	0.001	0.47	0.669	0.536	0.64
311R	Food manufacturing	0.005	0.013	0.519	0.635	0.254	0.584
3118	Bakeries and tortilla manufacturing	0.004	0.008	0.353	0.348	0.42	0.334
324	Petroleum and coal product manufacturing	0.004	0.001	0.501	0.269	0.27	0.462
3116	Meat product manufacturing	0.002	0.001	0.297	0.407	0.187	0.307
3255	Paint, coating and adhesive manufacturing	0.002	0.001	0.579	0.421	0.594	0.488
3364	Aerospace product and parts manufacturing	0.002	0.001	0.484	0.611	0.413	0.608
3362	Motor vehicle body and trailer manufacturing	0.002	0.001	0.479	0.415	0.344	0.364
3254	Pharmaceutical and medicine manufacturing	0.001	0.007	0.59	0.503	0.521	0.503
3361	Motor vehicle manufacturing	0.000	0.000	0.444	0.722	0.333	0.611
3121	Beverage manufacturing	0.000	0.001	0.581	0.559	0.114	0.348
3115	Dairy product manufacturing	0.000	0.003	0.448	0.494	0.331	0.48
3366	Ship and boat building	-0.001	-0.006	0.435	0.406	0.163	0.324
3328	Coating, engraving, heat treating and allied activities	NA	NA	0.151	0.388	0.122	0.245
	Unweighted mean across industries	0.068	0.043	0.463	0.501	0.371	0.452
	Unweighted median across industries	0.045	0.014	0.455	0.513	0.345	0.457
	Correlation with change in Chinese import share		0.635	0.175	-0.236	0.231	-0.029
	Correlation (innovation outcome, strategy)			0.702	0.395		
	Correlation between different innovation outcomes/strategies				0.262		0.363

Notes : We report trade flows and innovation measures using the 3/4-digit NAICS aggregation (59 industries) from the 2009 Survey of Innovation and Business Strategy (SIBS) public-release data. Innovation outcomes are self-reported by firms as introducing "New or significantly improved goods" or "New or significantly improved method of manufacturing or production" over the last 3 years. Innovation strategies are self-reported by firms as "Introduce new or significantly improved goods or services regularly" and "Introduce new or significantly improved business activities or processes to its operations for the long term" in response to questions about the strategic focus of the enterprise with respect to its "goods or services" or "operations or business activities." The omitted categories for strategies are "maintain or expand the sales of existing goods or services" and "maintain or optimize current operations and business activities for the long term".

Table A2: Autor-Dorn-Hanson IV

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Change in Chinese competition		Change in perceived non-US competition	Number of Process Innov.	Number of Product Innov.	Number of exclusive Process Innov.	Number of exclusive Product Innov.	Change in Strategy: Process innovation	Change in Strategy: Product innovation	Future Exit	Change in Profits
Dependent variable	IV First Stage	IV First Stage	IV	IV	IV	IV	IV	IV	IV	IV	IV
Change in Chinese competition			5.169	-12.741	-2.949	-1.288	3.706	0.358	0.511	0.807	-1.096
			(1.905)	(4.013)	(4.050)	(0.721)	(1.295)	(0.401)	(0.321)	(0.320)	(0.915)
Initial Chinese import share X aggregate change in Chinese imports **to Europe**	0.662	0.665									
	(0.085)	(0.052)									
Population sampling weights	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	859	1,354	863	908	908	908	908	863	863	1,354	859
R-squared	0.492	0.625	0.035	0.021	0.008	-0.001	0.002	0.005	0.007	0.007	-0.000

Notes: Column (1) displays IV first stage for firms that survive until 2005, while column (2) is the IV first stage for all initial firms in 1999. Column (3) uses a 1-5 Likert scale, measuring the intensity of perceived non-US international competition. Columns (4) and (5) use number of innovations, which are counts of the number of years that firms reported either process or product innovations (summing across "new" and "improved"). Columns (6) and (7) use exclusive number of innovations include either only process or only product innovations, excluding innovations that occurred in years with both product and process innovations. Colimns (8) and (9) use process or product innovation strategy, measured as relative priority of product or process innovation for business strategy in survey responses. Column (10) uses future exit, which measures either firm bankruptcy or plant shutdown in the years after 1999 but neither survey attrition nor M&A activity. Profits in colum (11) are defined as operating revenue minus operating cost relative to initial profits. All regressions use population sampling weights, which make estimates representative of approximately 57,000 Canadian manufacturing firms. Robust standard errors in parentheses are clustered by 4-digit NAICS industry.

Table A3: Innovation outcomes controlling for initial industry differences

	(1)	(2)	(3)	(4)
	Number of Product Innov.	Number of Process Innov.	Number of exclusive Product Innov.	Number of exclusive Process Innov.
Dependent variable	IV	IV	IV	IV
Change in Chinese Competition	3.096	-9.503	5.102	-1.364
	(5.353)	(3.396)	(1.600)	(0.787)
Share of firms with product innovation in 1999	1.807		0.454	
	(0.544)		(0.144)	
revenue	0.449	0.491	-0.051	0.057
	(0.140)	(0.121)	(0.034)	(0.033)
Share of firms with process innovation in 1999		0.502		-0.102
		(0.738)		(0.115)
Observations	886	886	886	886
R-squared	0.067	0.081	0.019	0.015

Notes: Number of innovations are counts of the number of years that firms reported either process or product innovations (summing across "new" and "improved"). Exclusive number of innovations is the number of years in which there were product or process innovations (new or improved) but excluding years in which both types of innovations occurred. Process or product innovation strategy is measured as relative priority of product or process innovation for business strategy in survey responses. All regressions use population sampling weights, which make estimates representative of approximately 57,000 Canadian manufacturing firms. Robust standard errors in parentheses are clustered by 4-digit NAICS industry.

Table A4: Initial strategies and perceived non-US international competition

Dependent variable	Initial perceived non-US, international competition (in 1999) (1)	Change in perceived non-US, international competition (1999-2005) (2)	Future perceived non-US, international competition (in 2005) (3)
Proc. Innovation strategy (in 1999)	0.510	0.199	0.322
	(0.301)	(0.348)	(0.275)
Prod. Innovation strategy (in 1999)	0.058	-0.126	-0.023
	(0.275)	(0.313)	(0.226)
Low cost strategy (in 1999)	-0.077	0.229	0.150
	(0.126)	(0.194)	(0.114)
Observations	1,359	863	863
R-squared	0.016	0.004	0.390

Notes: The dependent variable in column (1) measures firm-level perceived intensity of non-US international competition on a Likert scale from 1-5 in 1999. Column (2) measures the change in the firm-level perceived intensity of non-US international competition from 1999 to 2005. Column (3) is measured by using the change in non-US international competition and controlling for initial perception of non-US international competition.

Table A5: Long run industry-level responses

Dependent variable	Strategic responses		Innovation responses	
	2001-2012		2001-2012	
	Share of firms with Process innovation strategy	Share of firms with Product innovation strategy	Share of firms with Process innovations in last 3 years	Share of firms with Product innovations in last 3 years
	(1)	(2)	(3)	(4)
	IV	IV	IV	IV
Change in Chinese Competition	-1.677	-0.950	-1.594	-0.021
	(0.936)	(0.623)	(0.498)	(0.411)
Observations	151	151	151	151
R-squared	0.012	-0.007	0.003	0.000

Notes: Sample combines data from the WES and the SIBS. Results are at approximately the NAICS 4-digit industry-level with industry and year fixed effects included in all specifications. The overall time horizon is 2001 to 2012 with non-overlapping sample periods of 2001-2005, 2005-2009, 2009-2012. Variables and samples are defined to be common across data sets. Innovation strategy is based on whether the firm records the strategy as important. The innovation variable is based on any reported innovation in the past 3 years. Robust standard errors in parentheses are clustered by 4-digit NAICS industry. ***, **, * mark significance at the 1, 5, and 10 percent level, respectively.

Table A6: Average innovation and strategy responses, excluding foreign-owned firms

Dependent variable	(1) Change in number of Process innov. IV	(2) Change in number of Product innov. IV	(3) Change in number of exclusive Process Innov. IV	(4) Change in number of exclusive Product Innov. IV	(5) Change in Strategy: Process innovation IV	(6) Change in Strategy: Product innovation IV
Chinese competition	-9.482	2.051	-1.467	4.687	0.290	0.444
	(3.085)	(4.717)	(0.759)	(1.477)	(0.379)	(0.275)
Population sampling weights	YES	YES	YES	YES	YES	YES
Observations	740	740	740	740	704	704
R-squared	0.024	-0.009	-0.002	-0.012	0.005	0.006

Notes: Number of innovations are counts of the number of years that firms reported either process or product innovations (summing across "new" and "improved"). Exclusive number of innovations include either only process or only product innovations, excluding innovations that include both product and process innovations. Process or product innovation strategy is measured as relative priority of product or process innovation for business strategy in survey responses. All regressions use population sampling weights, which make estimates representative of approximately 57,000 Canadian manufacturing firms. Robust standard errors in parentheses are clustered by 4-digit NAICS industry.