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The impact of the US-China trade war on China’s semiconductor industry

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1 Introduction

Critical to economic competitiveness and national security in a digitalised world, the semiconductor industry has rapidly expanded, evidenced by 39 fabrication plants announced globally in 2021 and substantial government incentives, including Europe’s $30-50B Chips Act and Korea’s $452B commitment (Varas, et al. 2020) (SIA 2022). China was projected to overtake the US to become the leading semiconductor manufacturer by increasing capacity by ~38% by 2030 (PwC 2017). However, in June 2018, the US imposed a 25% tariff on semiconductor imports from China, ostensibly aiming to “protect national industries and counter unfair trade practices” (USTR 2018). This fuelled the ongoing US-China trade war, impacting $450B+ imports.

Therefore, this paper investigates an important question: “How have US tariffs under Section 301 (list 1) impacted exports and wages in China's semiconductor industry?”. Given the US was China’s third-largest semiconductor export partner pre-2018, understanding these effects is essential as tariffs are widely used, often faced with retaliation, and used to benchmark other trade policies (International Trade Centre 2023) (Gardner and Kimbrough 1992). This paper examines existing literature, economic theory, and empirical data using novel descriptive statistics and econometrics, to determine that the tariff had no significant effect on China’s global export growth but correlated with transient wage reduction.

2 Literature review

2.1 The effect of tariffs on foreign prices

Extending Lerner's two-commodity tariff analysis, Baldwin (1960) posits foreign prices may fall post-tariff if demand elasticity is below unity (vice versa). For semiconductors, considered normal goods due to downstream consumption of electronics (McKinsey & Company 2011), Baldwin’s model would predict higher prices in China post-US-301 tariffs. Conversely, Chowdhury’s (2012) two-stage, two-country, demand-supply model showed that EU specific tariffs on agricultural products raised domestic prices and lowered foreign prices, reducing EU imports and Sub-Saharan Africa’s supply. This had a disproportionally negative welfare effect on Sub-Saharan Africa.

2.2 The effect of tariffs on wages

Galiani and Porto’s (2010) study on Argentina’s trade liberalisation policies (1974 – 2001), including reducing ad-valorem import tariffs, showed domestic wages decreased, ceteris paribus. However, their model combining non-competitive union wage-setting with factor abundance, found liberalisation increased unskilled wages (reduced the skill premium), supporting the Stolper-Samuelson theorem. Similarly, Lang’s (1998) research on New Zealand's 1980s trade liberalisation using quasi-reduced computable-general-equilibrium models with labour mobility and market condition variables, showed decreased employment and significantly lowered wages in previously protected industries. It follows, therefore, that US-301 tariffs could decrease foreign (Chinese) wages.

2.3 The US-China trade war

Using partial equilibrium models and regression, Amiti, Redding and Weinst (2019) determined that the US-China trade war raised US import prices by 10-30%, reduced import quantities by 25-30%, and created a $23.8B deadweight loss with near-complete pass-through to US consumers. Fajgelbaum and Khandelwal (2022) extended this analysis using the standard trade model and general equilibrium models (including static computable and dynamic stochastic models), revealing long-term effects including a ~1% GDP decrease in both countries and dispersed real wage impacts in the tradeable sector, averaging a 1% decline with significant standard deviation (0.5%).

2.4 Review of literature

Existing literature, whilst robust, reveals evolving views on tariffs' impact on foreign prices, analyses trade liberalisation's domestic wage effects, and predominantly studies the US-China trade war from an aggregate, US-centric perspective. This paper aims to bridge the gaps by exploring the price and wage effects of protectionist policies from China's perspective and conducting sector-specific analysis.

3 Theoretical analysis

3.1 Ad-valorem tariff model

Building on Baldwin and Chowdhury's analysis, we model an ad valorem tariff on China's exports, assuming (1) the US is the only importer and (2) countries exporting to the US are China or 'not China'. The US' semiconductor imports, y, from China, x, is

$$q_{xy} = a_{dxy} p_{xy}^{-\sigma_y},$$

and China's semiconductor exports to the US is

$$q_{xy} = a_{sxy} p_{xy}^{s_y},$$

where $x \in$ {all exporters}, $y \in$ {electronics tariff lines}, σ_y is the US' own price semiconductor import demand elasticity, s_y is the rest of world's own price semiconductor export supply elasticity, and a_{dxy} and a_{sxy} are shift parameters corresponding to import demand and export supply, respectively (Figure 1).

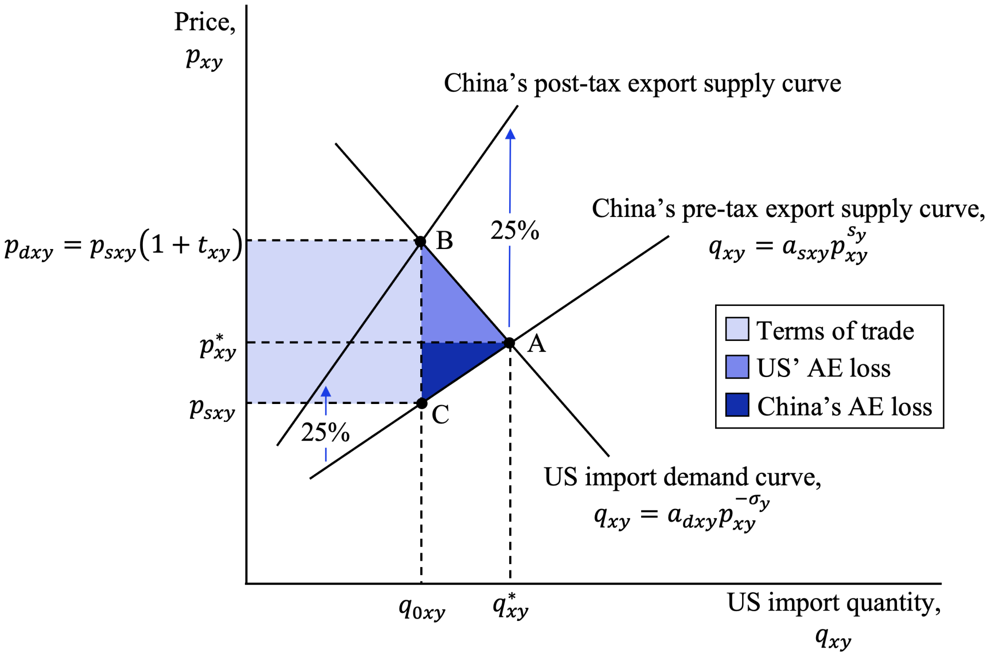

Figure 1: Ad-valorem tariff on US imports of China's semiconductors

p_{xy}^* is the free trade world price and q_{xy}^* is the US import quantity (equilibrium at A). The ad valorem tariff means Chinese shippers only export semiconductors to the US if the US price exceeds China's by at least 25%, t[1], causing a leftward, pivoted shift of the export supply curve. Movement along the import demand curve from A to B increases the domestic price to p_{dxy} and decreases the world price to p_{sxy} (determined at C), where

$$p_{dxy} = p_{sxy}(1 + t_{xy}).$$

The 'post-tariff' import quantity is q_{0xy}. The US gains from the new terms of trade (TOT) but faces allocative efficiency (AE) loss due to the higher domestic price and lower imports. China faces AE loss and TOT loss due to lower export prices (Krugman, Obstfeld and Melitz 2023). Adapting Chowdhury's approach, the US' net welfare loss is derived as

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[1] Given an ad valorem tariff, t is a variable dependent on p.

$$= \sum\nolimits_x \sum\nolimits_x q_{0xy} p_{sxy} \underbrace{\left[\frac{1}{\sigma_y - 1}\left(1 + t_{xy}\right)^{\frac{\sigma_y(1+s_y)}{\sigma_y+s_y}} - \frac{\sigma_y}{\sigma_y - 1}\left(1 + t_{xy}\right) + \left(1 + t_{xy}\right)^{\frac{\sigma_y}{\sigma_y+s_y}}\right]}_{AE\ loss}$$

$$-\sum\nolimits_x \sum\nolimits_y q_{0xy} p_{sxy} \underbrace{\left[\left(1 + t_{xy}\right)^{\frac{\sigma_y}{\sigma_y+s_y}} - 1\right]}_{TOT\ loss},$$

and China's net welfare loss is derived as

$$= \sum\nolimits_y q_{0xy} p_{sxy} \underbrace{\left[\frac{s_y}{\left(s_{y+1}\right)} + \frac{1}{\left(s_y + 1\right)}\left(1 + t_{xy}\right)^{\frac{\sigma_y(s_y+1)}{s_y+\sigma_y}} - \left(1 + t_{xy}\right)^{\frac{\sigma_y}{\sigma_y+s_y}}\right]}_{AE\ loss}$$

$$+\sum_y q_{0xy} p_{sxy} \underbrace{\left[\left(1 + t_{xy}\right)^{\frac{\sigma_y}{\sigma_y+s_y}} - 1\right]}_{TOT\ loss}.$$ [2]

This aligns with existing US-China literature where there is a decrease in foreign prices and a net welfare loss in both countries (Fajgelbaum and Khandelwal 2022) (Chowdhury 2012). Subsequent research could use this derivation to calculate both countries' welfare losses.

3.2 Specific factors model (SFM)

Applying constraints to Galiani and Porto's model, we modify the SFM to examine the effect of lower semiconductor prices in China on its domestic employment and wages. We assume (1) China only produces semiconductors, y, and 'other' goods, o, (2) there are three factors of production where labour (L) is mobile, and capital (K) and land (T) are specific, (3) the neoclassical production functions,

$$Q_y = Q_y\left(K, L_y\right), \text{ and } Q_O = Q_O(T, L_O),$$

exist with diminishing marginal products and constant returns, (4) the economy operates at full employment with perfectly competitive markets (Jones 1971). Figure 2 depicts a

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[2] Full derivation in Appendix, 7.1

downward shift in the semiconductor labour demand curve following a fall in China's semiconductor prices from P_y^1 to P_y^2, causing the equilibrium to move from 1 to 2.

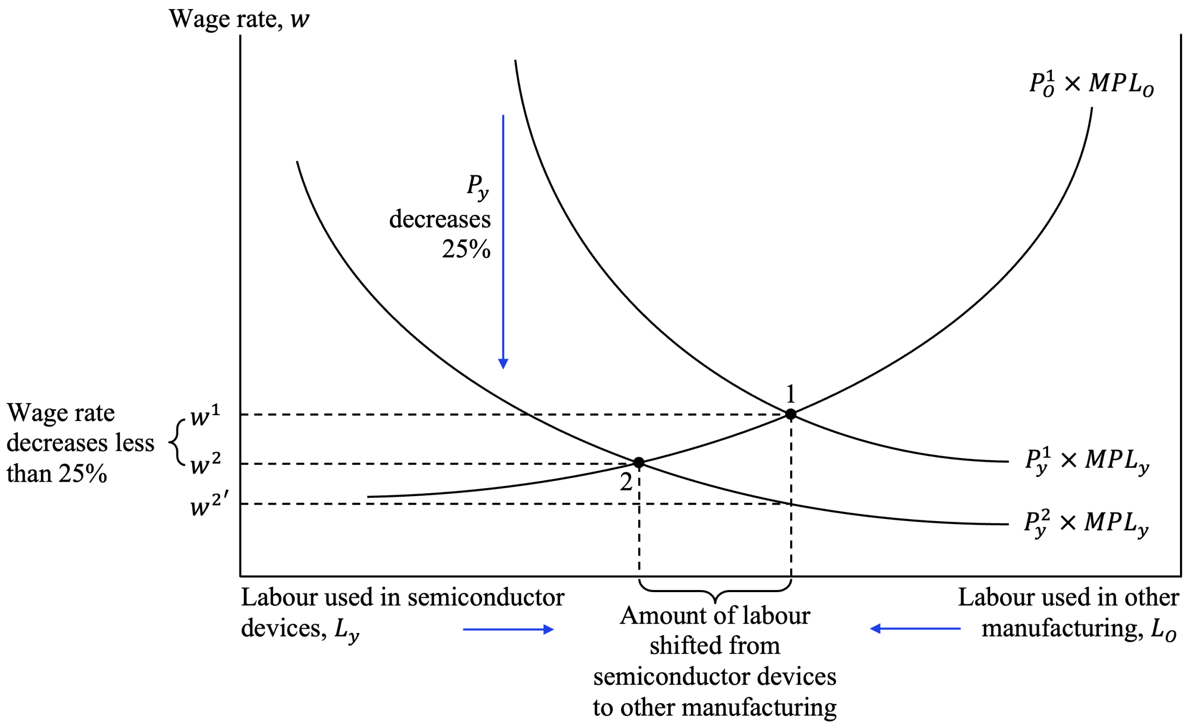

Figure 2: Specific factors model for China's domestic manufacturing industry

Here, wages decrease by less than 25%, from w_1 to w_2 ($w^{2'}$ indicates a wage decrease in the same proportion), and labour, being a mobile factor, shifts towards other manufacturing as semiconductors become less profitable. Therefore, under the specified assumptions, decreased prices in China result in a less-than-proportional fall in wages and a decrease in employment.

4 Empirical analysis

4.1 Impact on exports

Consistent with the theory, data shows China's US semiconductor exports decreased post-tariff, from \$1.3B in 2017 to \$0.7B in 2018 and have remained below \$1B. This reflects a 42.4% decline (Figure 3).

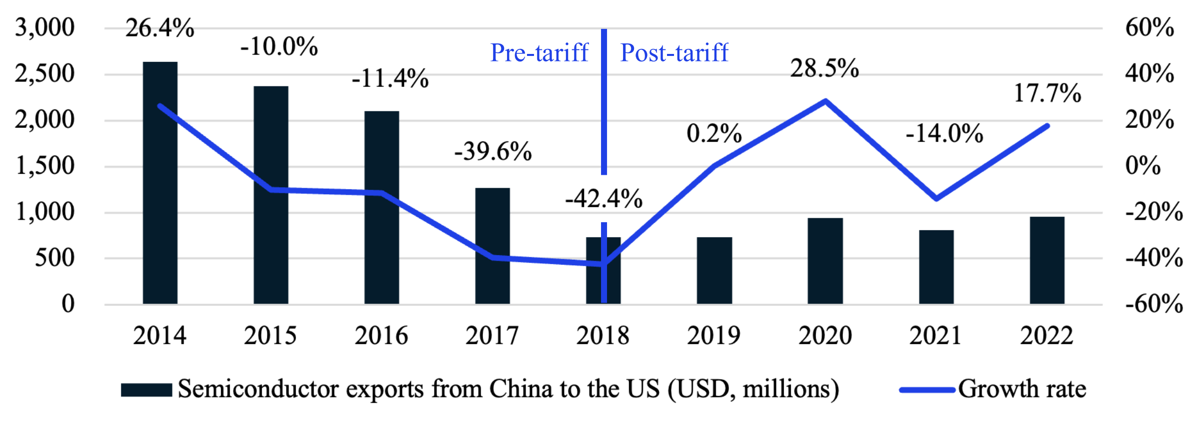

Figure 4: Value of China's exports of semiconductor devices to the US (USD, millions)
Source: International Trade Centre (Appendix, 7.2)

However, the US share of China's semiconductor exports (4.7% in 2017 and 2.5% in 2018), declined by 47.0%. Since the nominal value decreased less-than-proportionally to percentage share, despite the tariff, China's global semiconductor exports must have increased. Figure 4 depicts this insight showing China's global exports increased 8.5% from $26.8B in 2017 to $29.1B in 2018 and continued growing at a 23% CAGR:

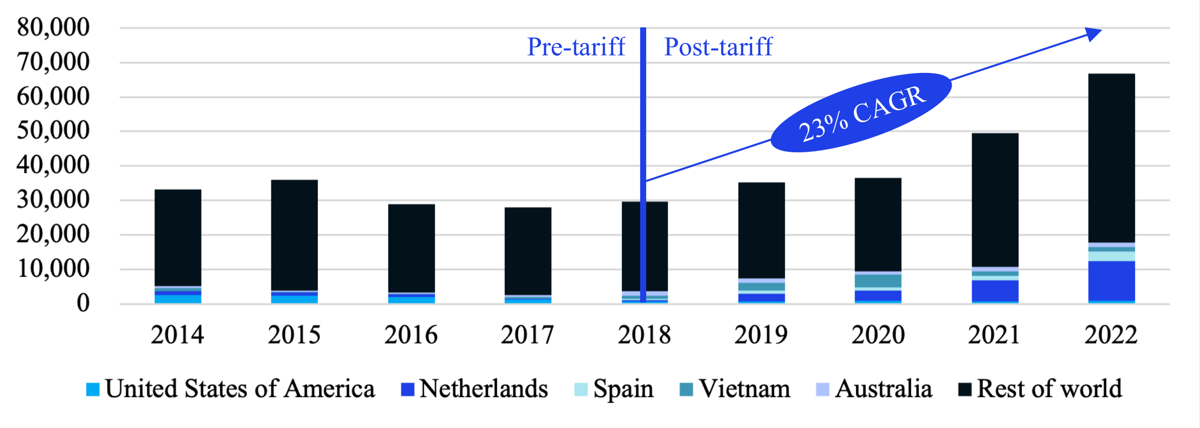

Figure 3: Value of China's global exports of semiconductor devices by country (USD, millions)
Source: International Trade Centre (Appendix, 7.3)

Given China's trade with 220 countries, this can be explained by trade diversion from the US to other importing countries (Nicita 2019). For example, Figure 4 shows the Netherlands, Spain, Vietnam, and Australia increasing from a combined $1.4B (5.4% share) in 2017 to $2.9B (10.1% share) in 2018, reflecting a 103.9% increase.

4.2 Impact on wages

Due to the unavailability of wage data, this paper uses alternative semiconductor-specific data sets from China's Ministry of Industry and Information Technology to estimate the average annual wage per employee. The data's accuracy was verified through comparison with average private-sector wages, electronics industry wages and manufacturing wages from The National Bureau of Statistics of China.

First, we calculate the total cost of wages to all registered semiconductor firms within China:

$$\begin{aligned}&\text{Total cost of wages}\\&\qquad = \text{revenue} - \text{cost of sales} - \text{selling and distribution cost} - \text{total tax} - \text{profit}.\end{aligned}$$

Then, we determine annual wages per employee:

$$\begin{aligned}&\text{Annual wage per employee (RNB)}\\&= \frac{\text{total cost of wages}}{\text{total number of registered enterprises} \times \text{average number of employees per enterprise}}.\end{aligned}$$

Finally, we convert RNB to USD (WSJ Markets 2023):

$$\text{Annual wage per employee (USD)} = \frac{\text{average wage per employee (RNB)}}{\text{average yearly closing exchange rate}}.$$

Therefore, we obtain:

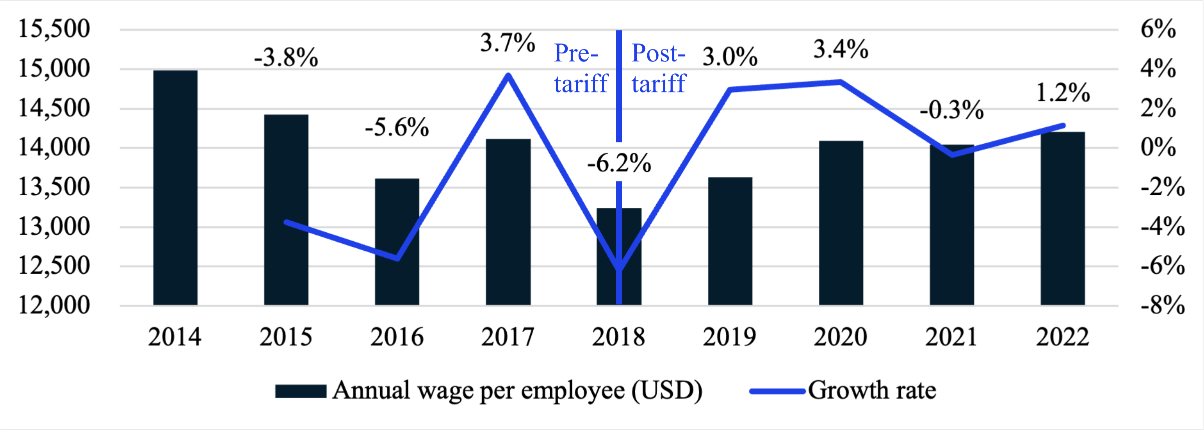

Figure 5: Annual wages of employees in China's semiconductor devices manufacturing industry (USD)
Source: Author's analysis using China's MIIT and WSJ Markets data (Appendix, 7.4/7.5)

Figure 5 illustrates wages decreasing 6.2% from $14,117 in 2017 to $13,242 in 2018. This is consistent with the SFM prediction that foreign wages should decrease by less than 25%. Despite strong export growth, wages took two years to recover, with relatively stagnant growth between 2020 and 2022, potentially due to COVID-19-related supply chain disruptions.

4.3 Regression analysis

Difference-in-difference estimators would ideally be used to measure post-tariff effects, but retaliatory tariffs, trade diversion, and industry-wide tariffs preclude establishing a control group consistent with parallel trend assumptions. Therefore, we build an OLS model regressing semiconductor wages (USD) on China's US exports (USD, thousands),

$$\ln \text{wages} = \beta_0 + \beta_1(\text{export value}) + \delta + \varepsilon_i,$$

where δ contains five variables to control for endogeneity. The results (excluding controls) are:

ln wages	**Coefficient**	**Robust std. err.**	**t**	**P>|t|**	**[95% conf. interval]**	
Export value	0.00041671	0.00019586	2.12765116	0.0709157	-0.00004641	0.00087983
Constant	13457.4735	307.352681	43.7851182	8.464E-10	12730.6999	14184.2471

This shows that a $1,000 increase in China's US semiconductor exports increases China's semiconductor wages by 0.042%, ceteris paribus. Hence, reduced exports due to the tariff negatively impacted China's domestic wages.

5 Conclusion

US tariffs on China's imports had a relatively insignificant impact on China's semiconductor industry but the results are crucial for policymakers. Whilst China's US exports decreased 42.4%, remaining below $1B, its global semiconductor exports grew at a 23% CAGR since 2018. This challenges the conventional perception of tariffs as effective economic levers, revealing the complex interdependencies in global supply chains. This necessitates further research into trade policies' long-term strategic value, the diversion effects of tariffs to countries like the Netherlands and Vietnam, and the extent of tariffs as political rather than economic instruments. The tariff also correlated with foreign wages falling 6.5%, aligning with our model predictions.

5.1 Limitations

Firstly, the tariff model assumes the US is the only semiconductor importer, and the SFM oversimplifies to a two-good economy, ignoring the potential effects of trade diversion, retaliatory tariffs, and external factors like exchange rates, regulation, and consumer preferences. Secondly, our extrapolated wage data is subject to inaccuracies. Finally, our OLS model has limited observations and solely focuses on export effects, thereby subjecting it to omitted variable bias; such variables include semiconductor prices, government policy, and inflation.

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7 Appendix

7.1 Welfare loss derivation

From Figure 1, ignoring the subscripts,

$$p_d = p_s(1+t) \tag{1}$$
$$q_0 = a_d p_d^{-\sigma} = a_s p_s^s. \tag{2}$$

From (1) and (2),

$$\begin{aligned} a_d p_s^{-\sigma}(1+t)^{-\sigma} &= a_s p_s^s \\ \rightarrow \frac{a_d}{a_s} &= (1+t)^{\sigma} p_s^{s+\sigma}. \end{aligned} \tag{3}$$

From Figure 1,

$$\begin{aligned} q^* &= a_d p^{*-\sigma} = a_s p^{*s} \\ \rightarrow \frac{a_d}{a_s} &= p^{*(s+\sigma)}. \end{aligned} \tag{4}$$

Combining (3) and (4),

$$\begin{aligned} (1+t)^{\sigma} p_s^{s+\sigma} &= p^{*(s+\sigma)} \\ \rightarrow p^* &= p_s(1+t)^{\frac{\sigma}{\sigma+s}}. \end{aligned} \tag{5}$$

From (2), (4) and (5),

$$q^* = q_0(1+t)^{\frac{\sigma s}{\sigma+s}}. \tag{6}$$

From Figure 1, AE loss in the US

$$\begin{aligned} &= \int_{q_0}^{q^*} p(q_d)dq - (q^* - q_0)p^* \\ &= \int_{q_0}^{q^*} \left(\frac{q}{a_d}\right)^{-\frac{1}{\sigma}} dq - (q^* - q_0)p^* \end{aligned}$$

$$
\begin{aligned}
&= (a_d)^{\frac{1}{\sigma}} \left| \frac{q^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} \right|_{q_0}^{q^*} - (q^* - q_0)p^* \\
&= \frac{\sigma}{\sigma-1}(a_d)^{\frac{1}{\sigma}} \left[q^{*\frac{\sigma-1}{\sigma}} - q_0^{\frac{\sigma-1}{\sigma}} \right] - (q^* - q_0)p^*.
\end{aligned}
$$

Substituting p^* and $q^*$from (5) and (6) respectively, AE loss in the US

$$
\begin{aligned}
&= \frac{\sigma}{\sigma-1}(q_0 p_d^{\sigma})^{\frac{1}{\sigma}} \left(q_0^{\frac{\sigma-1}{\sigma}} \right) \left[(1+t)^{\frac{s(\sigma-1)}{\sigma(\sigma+s)}} - 1 \right] - q_0 \left[(1+t)^{\frac{\sigma s}{\sigma+s}} - 1 \right] p_s (1+t)^{\frac{\sigma}{\sigma+s}} \\
&= \frac{\sigma}{\sigma-1} p_s (1+t) q_0 \left[(1+t)^{\frac{s(\sigma-1)}{\sigma(\sigma+s)}} - 1 \right] - q_0 p_s (1+t)^{\frac{\sigma(1+s)}{\sigma+s}} + q_0 p_s (1+t)^{\frac{\sigma}{\sigma+s}} \qquad (7) \\
&= p_s q_0 \left[\frac{1}{\sigma-1}(1+t)^{\frac{\sigma(1+s)}{\sigma+s}} - \frac{\sigma}{\sigma-1}(1+t) + (1+t)^{\frac{\sigma}{\sigma+s}} \right].
\end{aligned}
$$

From Figure 1, AE loss in China

$$
\begin{aligned}
&= (q^* - q_0)p^* - \int_{q_0}^{q^*} p(q_s)dq \\
&= (q^* - q_0)p^* - \int_{q_0}^{q^*} \left(\frac{q_s}{a_s} \right)^{\frac{1}{s}} dq \\
&= (q^* - q_0)p^* - \frac{s}{s+1} a_s^{-\frac{1}{s}} \left[q^{*\frac{s+1}{s}} - q_0^{\frac{s+1}{s}} \right].
\end{aligned}
$$

Substituting p^* and q^* from (5) and (6) respectively, AE loss in China

$$
\begin{aligned}
&= q_0 \left((1+t)^{\frac{\sigma s}{\sigma+s}} - 1 \right) p_s (1+t)^{\frac{\sigma}{\sigma+s}} - \frac{s}{s+1} a_s^{-\frac{1}{s}} \left[q_0^{\frac{s+1}{s}} (1+t)^{\frac{\sigma(1+s)}{\sigma+s}} - q_0^{\frac{s+1}{s}} \right] \\
&= p_s q_0 \left[\frac{s}{s+1} - (1+t)^{\frac{\sigma}{\sigma+s}} + \frac{1}{s+1}(1+t)^{\frac{\sigma(1+s)}{\sigma+s}} \right]. \qquad (8)
\end{aligned}
$$

TOT gain in the US/loss in China

$$= (p^* - p_s)q_0.$$

Substituting p^* from (5), we get TOT gain in the EU/loss in China

$$= p_s q_0 \left[(1+t)^{\frac{\sigma}{\sigma+s}} - 1 \right].$$

Finally, we have the net welfare loss in the US

$$= \sum_x \sum_x q_{0xy} p_{sxy} \underbrace{\left[\frac{1}{\sigma_y - 1} \left(1 + t_{xy}\right)^{\frac{\sigma_y(1+s_y)}{\sigma_y + s_y}} - \frac{\sigma_y}{\sigma_y - 1} \left(1 + t_{xy}\right) + \left(1 + t_{xy}\right)^{\frac{\sigma_y}{\sigma_y + s_y}} \right]}_{AE\ loss}$$

$$- \sum_x \sum_y q_{0xy} p_{sxy} \underbrace{\left[\left(1 + t_{xy}\right)^{\frac{\sigma_y}{\sigma_y + s_y}} - 1 \right]}_{TOT\ loss},$$

and the net welfare loss in China

$$= \sum_y q_{0xy} p_{sxy} \underbrace{\left[\frac{s_y}{\left(s_{y+1}\right)} + \frac{1}{\left(s_y + 1\right)} \left(1 + t_{xy}\right)^{\frac{\sigma_y(s_y+1)}{s_y + \sigma_y}} - \left(1 + t_{xy}\right)^{\frac{\sigma_y}{\sigma_y + s_y}} \right]}_{AE\ loss}$$

$$+ \sum_y q_{0xy} p_{sxy} \underbrace{\left[\left(1 + t_{xy}\right)^{\frac{\sigma_y}{\sigma_y + s_y}} - 1 \right]}_{TOT\ loss}.$$

Source: Chowdhury 2012

7.2 China's exports of semiconductor devices to the US

Importers	**2013**	**2014**	**2015**	**2016**	**2017**
United States of America	2,087,271	2,638,749	2,375,081	2,103,705	1,270,397
Growth rate	--	*26.4%*	*-10.0%*	*-11.4%*	*-39.6%*

Importers	**2018**	**2019**	**2020**	**2021**	**2022**
United States of America	731,212	732,569	941,045	809,719	952,878
Growth rate	*-42.4%*	*0.2%*	*28.5%*	*-14.0%*	*17.7%*

Source: International Trade Centre 2023

7.3 China's global exports of semiconductor devices

	2014	2015	2016	2017	2018
World	30,637,370	33,556,647	26,930,143	26,774,699	29,054,830
United States of America	2,638,749	2,375,081	2,103,705	1,270,397	731,212
US share	*8.6%*	*7.1%*	*7.8%*	*4.7%*	*2.5%*
Rate of change of US share	--	*-17.8%*	*10.4%*	*-39.3%*	*-47.0%*
Netherlands	1,125,765	979,140	631,047	325,694	497,553
Spain	30,987	21,048	15,303	14,966	296,628
Vietnam	918,020	203,790	259,358	404,789	838,525
Australia	427,053	392,990	366,589	696,448	1,306,837
Sum of other countries	2,501,825	1,596,968	1,272,297	1,441,897	2,939,543
Other countries share	*8.2%*	*4.8%*	*4.7%*	*5.4%*	*10.1%*
Growth rate	--	*-36.2%*	*-20.3%*	*13.3%*	*103.9%*
Rest of world	28,135,545	31,959,679	25,657,846	25,332,802	26,115,287

	2019	2020	2021	2022
World	34,562,900	35,655,866	48,792,510	65,880,033
United States of America	732,569	941,045	809,719	952,878
US share	*2.1%*	*2.6%*	*1.7%*	*1.4%*
Rate of change of US share	*-15.8%*	*24.5%*	*-37.1%*	*-12.8%*
Netherlands	2,317,549	3,042,761	6,145,890	11,432,923
Spain	952,112	879,316	1,260,858	2,913,488
Vietnam	2,174,344	3,629,660	1,212,679	1,196,501
Australia	1,249,305	997,143	1,294,079	1,338,454
Sum of other countries	6,693,310	8,548,880	9,913,506	16,881,366
Other countries share	*19.4%*	*24.0%*	*20.3%*	*25.6%*
Growth rate	*127.7%*	*27.7%*	*16.0%*	*70.3%*
Rest of world	27,869,590	27,106,986	38,879,004	48,998,667

Source: International Trade Centre 2023

7.4 Wage derivation from income statement items

(RNB)	2014	2015	2016	2017	2018
Revenue	**83,346,470,000**	**94,275,030,000**	**110,900,000,000**	**124,830,000,000**	**142,850,297,724**
Cost of Sales	72,521,410,000	81,924,370,000	97,100,000,000	108,340,000,000	123,923,716,501
Selling and Distribution Cost	1,371,000,000	1,510,460,000	1,700,000,000	2,150,000,000	2,838,987,183
EBT / Profit before tax	5,567,570,000	6,820,180,000	7,866,667,000	9,986,667,000	12,196,315,424
Total Tax	1,443,240,000	1,671,720,000	1,966,667,000	2,496,667,000	3,049,079,161
Profit	4,124,330,000	5,148,460,000	5,900,000,000	7,490,000,000	9,147,236,263
Implied cost of wages	**3,886,490,000**	**4,020,020,000**	**4,233,333,000**	**4,353,333,000**	**3,891,278,615**
Total number of enterprises	319	324	334	343	349
Average number of employees per enterprise	132	137	140	133	127
Annual wage per employee (RNB)	**92,298**	**90,565**	**90,533**	**95,428**	**87,794**
Average exchange rate (RNB to USD)	6.16	6.28	6.65	6.76	6.63
Annual wage per employee (USD)	**14,983**	**14,421**	**13,614**	**14,117**	**13,242**
Growth rate	--	*-3.8%*	*-5.6%*	*3.7%*	*-6.2%*

(RNB)	2019	2020	2021	2022
Revenue	**159,992,333,451**	**180,791,336,799**	**186,215,076,903**	**219,733,790,746**
Cost of Sales	137,890,607,357	155,153,334,531	156,987,754,317	185,830,096,546
Selling and Distribution Cost	3,094,241,653	3,999,528,354	4,851,735,549	6,119,616,803
EBT / Profit before tax	14,635,578,509	16,830,915,286	19,692,170,884	22,449,074,808
Total Tax	3,658,894,994	4,207,729,243	4,923,043,214	5,612,269,264
Profit	10,976,683,516	12,623,186,043	14,769,127,670	16,836,805,544
Implied cost of wages	**4,371,905,931**	**4,807,558,629**	**4,683,416,153**	**5,335,002,589**
Total number of enterprises	357	369	383	393
Average number of employees per enterprise	130	134	135	142
Annual wage per employee (RNB)	**94,202**	**97,228**	**90,580**	**95,599**
Average exchange rate (RNB to USD)	6.91	6.90	6.45	6.73
Annual wage per employee (USD)	**13,633**	**14,091**	**14,043**	**14,205**
Growth rate	*3.0%*	*3.4%*	*-0.3%*	*1.2%*

Source: MIIT 2023

7.5 USD to RNB historical exchange rates

Year	Average closing price	Year Open	Year High	Year Low	Year Close	Annual % change
2023	7.07	6.9	7.34	6.7	7.17	3.94%
2022	6.73	6.36	7.3	6.31	6.9	8.53%
2021	6.45	6.53	6.57	6.34	6.36	-2.71%
2020	6.9	6.96	7.17	6.52	6.53	-6.18%
2019	6.91	6.88	7.18	6.69	6.96	1.23%
2018	6.63	6.49	6.98	6.26	6.88	5.72%
2017	6.76	6.96	6.96	6.49	6.51	-6.32%
2016	6.65	6.53	6.96	6.45	6.95	7.18%
2015	6.28	6.2	6.49	6.19	6.48	4.52%
2014	6.16	6.05	6.26	6.04	6.2	2.48%

Source: WSJ Markets 2023

7.6 STATA output (excluding controls)

```
     Source |       SS         df        MS             Number of obs   =           9
------------+------------------------------------       F (1, 7)        =  4.52689944
      Model | 807251.73952      1   807251.73952        Prob > F        =  0.07091574
   Residual | 1248263.2429      7   178323.32041        R-squared       =        0.39
------------+------------------------------------       Root MSE        =   0.6266776
      Total | 2055514.9824      8        --

-------------------------------------------------------------------------------------------
                                 Robust
    lnwages |  Coefficient     std. err.        t          P>|t|     [95% conf. interval]
------------+------------------------------------------------------------------------------
exportvalue |  0.00041671     0.00019586   2.12765116   0.0709157   -0.00004641   0.00087983
      _cons |  13457.4735     307.352681   43.7851182   8.464E-10    12730.6999   14184.2471
-------------------------------------------------------------------------------------------
```