Original Paper

Regression Analyses of Xiamen's Manufacturing Sector, China

CHEW, Soon Beng[1*] & IULDASHOV Nursultan[2]

[1] School of Humanities and Social Sciences, Nanyang Technological University, Singapore

[2] Economic Growth Centre, School of Social Sciences, Nanyang Technological University, Singapore

[*] CHEW, Soon Beng, School of Humanities and Social Sciences, Nanyang Technological University, Singapore

Abstract

This paper examines the impact of rising wages and falling product prices on the composition of Xiamen's manufacturing sector in China. Using annual labour surplus (LSR) (Note 1), we show that the pharmaceutical industry and the state owned enterprises are least affected by the twin squeezes (Note 2). We also show that the importance of state owned enterprises has increased at the expense of foreign owned firms in the Xiamen's manufacturing sector.

Keywords

labor surplus ratio, economic restructuring, state-holding enterprises

1. Introduction

As Chinese economy is growing it begins to face challenges of inevitable rise of the wages and increased overall productivity that in turn decreases prices of products in the manufacturing sector. Cumulative pressure from those two trends creates augmented squeeze on companies' surplus ratio through channels of labor cost and total revenue. Effects and possible complications of twin squeeze could not be underestimated taking into account China's quest for economic restructuring. Surplus ratio of industries is barometer of their survivability and relevance to given economic trends.

The spillover effect of this trend is not evenly distributed among different sectors, types of companies and their sizes in relation to market. Capital-intensive industries such as pharmaceutical industry are especially interesting as well as role of state-owned enterprises which at the same time constitute large market share of their respective sectors. The puzzling case of twin squeeze in modern China is not only of practical matter but also of theoretical inquiry because of unprecedented scale of state intervention policies and planning that mapped and led unique economic development of future's biggest economy. This study focused on detailed data obtained for Xiamen's manufacturing sector during crucial inflection point of economic reforms 2002-2015. Xiamen was recognized as first-tier city in 2016 (*CBN Weekly, China's leading business news magazine, on May 7th 2016*) together with other 15 cities embarking, embodying the shape of the emerging sectors that are no longer based on cheap labor.

The structure of this paper is as follows. Firstly, related literature was reviewed for historical, policy background and stylized facts regarding manufacturing sector in China. After that, data description and methodology was described in detail. Constructed regression models test effects of fundamental variables such as output, cumulative output (learning or complacent effect) and capital-intensity on labor surplus ratio. This research direction is not presented in current literature what makes this study

actual and relevant to encourage more intensive attention to complex dynamic and consequences behind twin squeezes and labor surplus ratio. Further, effects of type of ownership and company's size in relation to unevenly falling of labor surplus ratio was elaborated and analyzed. Possible intuition behind obtained results is proposed together with policy applications.

2. Literature Review

Many studies have been conducted to look at various aspects of the manufacturing sector in China. For instance, Hsieh and Klenow use micro data to quantify the potential extent of misallocation in the manufacturing sector of both China and India. They discover that if the two manufacturing sectors followed the capital and labour inputs are made to equalize the respective marginal products to the extent observed in the USA, they see TFP gains of 30%-50% for China and 40%-60% for India.

Cole, Elliott and Wu find that for China's manufacturing sector, an industry's emissions to be a positive function of its energy use and human capital intensity and a negative function of its productivity and R&D expenditure.

Brandt, Biesebrock and Zhang study the total factor productivity estimates at the firm level for China's manufacturing sector. They find that the weighted average annual productivity growth at the firm level is 2.85% for a gross output function and 7.96% for a value added production function over the period 1998-2007.

The purpose of this paper differs from these studies as we argue that, as labour cost rises, those with low productivity will be shut down first. Productivity in this paper is defined as annual surplus over total labour cost. This is known as annual labour ratio (LSR). If the ratio is as low as 20%, an increase in total labour cost can force many firms to shut down. Chew (2017) used ALR to analyze firm's survivability of firms in Singapore's manufacturing sector. The study demonstrated that many firms in Singapore's textile industry will would shut down as the ratio for the whole industry is barely 10%.

In another study by Liu, Wang and Chew et al., they use regression analysis to show importance of public policy in terms of helping firms to pay for labor cost and controlling LSR of Singapore's manufacturing sector. However, they conclude that it is value added per worker has been a consistent determinant of LSR for the manufacturing sector in Singapore.

No one has used LSR to assess the situation in countries other than Singapore. As China faces rising wages, this study has chosen to look at the performance of Xiamen manufacturing sector using the same methodology.

3. Data and Methodology

Annual surplus labor ratio is derived using Total Revenue (TR)—Total operation Cost (TC) Where TC consists of total labour cost and total non-labour cost. Total revenue is equal to the product price (P) times volume of sales (Q). When the price decreases, unless the price elasticity is very strong, both TR and TC will fall. This also means that annual surplus of the firm (LSR) will decrease too. Appendix A shows the historical dynamics of these indicators in Xiamen. Basically, the product price index has been declining and the wages have been rising. As a result, LSR for Xiamen's manufacturing sector has been declining too. We expect many firms will be forced to move to other locations where labour cost is more affordable to these firms. We also want to know which type of the manufacturing sector has been hit the most, among state enterprises, foreign firms and between large and small firms.

The data set with sufficient number of variables in the Xiamen's manufacturing sector for the period from 2002 to 2015 is taken from Xiamen Municipal Bureau of Statistics. The specific variables are

described in the Appendix B.

We constructed three different datasets for testing effects of various factors on LSR:

1) Panel dataset for period 2002-2015 covering 26 industries annually to see industry-specific effects and expand number of observations for modeling LSR by fundamental determinants.

2) Panel dataset for period 2002-2015 with firms divided into three groups-Small, Medium, and Large to see scale-specific effects on LSR. Definition criterion of size classification in terms of number of workers and operation revenue can be seen on Table 1 below.

Table 1. Firm's Size Classification

	Employment	Operation Revenue(million)
Large	$X \geq 1000$	$Y \geq 400$
Medium	$300 \leq X < 1000$	$20 \leq Y < 400$
Small	$X < 300$	$Y < 20$

Source: Xiamen Municipal Bureau of Statistics.

3) Panel dataset for period 2002-2015 with firms divided into four categories by type of ownership—Corporation Limited, Private-owned, State-holding, and Foreign-funded to see whether type of ownership affects LSR.

For the first main dataset we have total 364 observations and 42 and 56 observations for second and third correspondingly. Table 2 shows variables of interest such as LSR and number of companies (as rough indicator of market structure) for each category, year 2015 was chosen as it is most recent, actual data point (for other relevant data see Appendix F). For example, state owned holdings has the highest LSR in 2015, almost twice as high as other sectors. Surprisingly, for large, medium and small firms, their LSRs are about the same with small firms having the largest LSR. At the industry level, Pharmaceutical has the highest LSR which is close to the value of 5 while most of other industries stagnating between possibility to shut down or strive in the new economy.

Table 2. LSR for Xiamen's Manufacturing Sector by Category (2015)

Group	LSR	Number of companies
Corporation Limited	1.74	34
Private-owned	1.52	668
Foreign-funded	1.69	359
State-holding	3.26	70
Large	1.8	87
Medium	1.8	313
Small	2.07	1296
Agricultural products	1.44	66

Foods	1.61	46
Beverage	2.35	19
Textile	1.59	63
Wearing Apparel	2.3	121
Leather, Fur	1.13	41
Timber	1.6	5
Furniture	0.41	38
Paper	0.62	41
Printing	1.42	43
Culture, Fine Arts, Sports	1.13	70
Petroleum, Nuclear Fuel	1.34	2
Raw Chemical	0.87	64
Pharmaceutical	4.82	17
Chemical Fibers	1.84	7
Rubber and plastic	3.73	142
Ferrous Metals	1.6	10
Nonferrous Metals	1.97	20
Metal products	0.88	143
General purpose machinery	2.15	78
Special purpose machinery	1.33	85
Motor Vehicles	1.97	64
Electrical Machinery	1.56	184
Communication computers	2.34	206
Measuring instruments	2.08	36
Other Manufacture	1.46	44

Source: Xiamen Municipal Bureau of Statistics.

As expected from major economic restructuring process in China, total labor surplus ratio fell from 3.29 to 1.8 (2002-2015) while annual wages increased from average 17,977 RMB to 65,137 RMB. Surplus ratio meanwhile is falling across all industries due to twin squeezes as the yearly growth rates of surplus ratio and remuneration per worker are inversely correlated while prices of manufacturing product are falling (see Appendix C and Appendix D).

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4. Regression Models

For the first part of basic analysis of expanded dataset specified by sector, we propose to use the following model (Model 1) to estimate the impact of major variables associated with LSR:

$$Ratio = \alpha + \alpha_1 Q + \alpha_2 \sum Q + \alpha_3 \frac{K}{L} + C$$

Where:

Ratio=Annual LSR

- Q is output in millions RMB, intuitively $\alpha_1 > 0$ since there are economies of scale.
- $\sum Q$ is accumulative output in the period t in millions RMB, $\alpha_2 > 0$ implies learning effect of the sector that increases efficiency over time. However, if $\alpha_2 < 0$, this is complacent effect coming from companies that gained their respective niche and reluctant to expand or innovate.
- K/L is capital intensity ratio defined as ratio of Current Assets over Employment (see Appendix B). If $\alpha_3 > 0$ means labor surplus ratio is higher for firms with higher capital intensity which is intuitively a case for the restructuring economy.

Our second part is to check effect of type of ownership and market size on surplus ratio so we created dummies for corresponding datasets holding models in same specification as in basic equation. In case of companies' size, Medium firms are used as reference dummy to compare with Large and Small companies (Model 2). For the type of ownership, reference dummy is Private owned enterprises as they are obviously the most vulnerable category without state's support (Model 3).

As for methodology, we chose robust Pooled-OLS and Fixed-Effect since data and model don't have serious endogeneity problems and matches with our specific research objectives. To address heteroscedasticity across sectors we calculated robust standard errors. Fixed-Effect model is favored against between-effects because industry-specific effects come from within group rather than from cross-sectional dimension. Data was industry-panel declared before regression for sector specific data. For market size and type of ownership datasets we don't use Fixed-Effect since we already use dummies. We also have considerably less observations for later models. That's why OLS model was applied.

5. Results and Analysis

Key findings are same regardless econometric methodology for basic model with all variables being significant at 99% confidence interval. Fixed effect model is shown on first column of Table 3. Coefficient of Q has significant positive effect on surplus ratio as expected. If output increases by 100m RMB surplus ratio will increase by 0.016 points.

Table 3. Model 1. Fixed Effect vs Robust OLS

	Model 1 (FE)			Model 1 (OLS robust)		
Variable	B	SE B	Corr	B	SE B	Corr
Output(Q)	.0163***	.0033	.157	.0271***	.0069	.157
Accumulated Output ($\sum Q$)	-.00363***	.00039	.0059	-.00435***	.00099	.0059
Log of capital intensity(K/L ratio)	.753***	.214	.3695	1.311***	.154	.13**
R2	.2356			.3144		

Note. *p<.1   **p<.05   ***p<.01.

In contrast, the cumulative output depicting gained experience of industry is negative and resembles complacement effect. Instead of learning and improving efficiency, established businesses with a lot of accumulated production in the past enjoy stability but worsen surplus ratio. Given fact that most of Chinese sectors are still under-privatized we can conclude that complacement effect appears to be characteristic of large state-holding companies with high LSR. The coefficient is rather small though -0.0036 means that 100m RMB of more cumulative output will decrease LSR by 0.0036.

The capital intensity is significant factor affecting LSR as suggested by economic restructuring and wage growth process in China. Coefficient of 0.753 means if we increase capital to labor ratio by 1% than surplus ratio will increase by 0.00753 units or if by 10% than LSR is expected to level up by 0.0753 points. Corresponding coefficients for pooled OLS model are 0.0271, -0.00435 and 1.311 as shown on second column of Table 3.

In second part we tested the effect of type of ownership and market size of companies on LSR using dummies in frame of the same basic model. Bigger market size creates economies of scale that allow companies to enjoy higher LSR while small companies has lower LSR. On average large company implies higher LSR by 0.508 and for small companies and lower by 0.98 points as compared with medium enterprises (see Table 4).

Table 4. Model 2. Economies of Scale

Model 1 (OLS)			
Variable	B	SE B	Corr
Output(Q)	.0003636	.000352	.157
Accumulated Output (ΣQ)	-.000252***	.0000491	.0059
Log of capital intensity(K/L ratio)	1.602***	.4239	.3695
Large	.508***	.28	.48
Small	.98***	.77	-.45
R2	.6655		

Note. *p<.1   **p<.05   ***p<.01.

As for type of ownership, it is positively correlated with LSR for all types except private-owned companies (see Table 3). It is indeed logical since private-owned enterprises are more vulnerable to external changes. They don't enjoy economy of scale and lack resources for capital investments on eve of economic restructuring in China. Other possible reasons include higher efficiency which is arguable. More likely, state-holding companies have higher protection from government including financial rejection and legal support at expense of the rest of economy. Though they have more accumulated capital, it does not necessarily mean that capital is in its optimal level and used efficiently.

Table 5. Model 3. Protection from the Government

Model 1 (OLS)		
Variable	B	SE B
Output(Q)	.00054	.0005155
Accumulated Output (ΣQ)	-.0000848*	.0000491
Log of capital intensity(K/L ratio)	.749*	.429
Corporation Limited	1.879***	.3306

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State-holding	3.495***	.3798
Foreign-funded	2.789***	.281
R2	.83	

Note. *p<.1   **p<.05   ***p<.01.

6. Conclusion and Policy Implications

The pressure from twin squeezes is magnified by government's support of state-holding enterprises even in the labor intensive industries. Economic restructuring will inevitable shut down industries that fail to upgrade broader and efficient usage of capital. Although, one can easily notice that Chinese government allowed wages to rise too fast and probably too early for smooth restructuring transition as companies struggle with increased labor costs and falling prices on manufacturing products. Economic distress and higher unemployment are to be consequences in the short and midterm as sectors, companies and labor force gradually adjust to drastic changes. Chinese government needs to conduct policies upgrading labor force skills, privatizing sectors to remove inefficient, complacent state holdings and supporting emerging capital-intensive sectors as they will host both engine of future economic development and source of income for skilled middle-income class.

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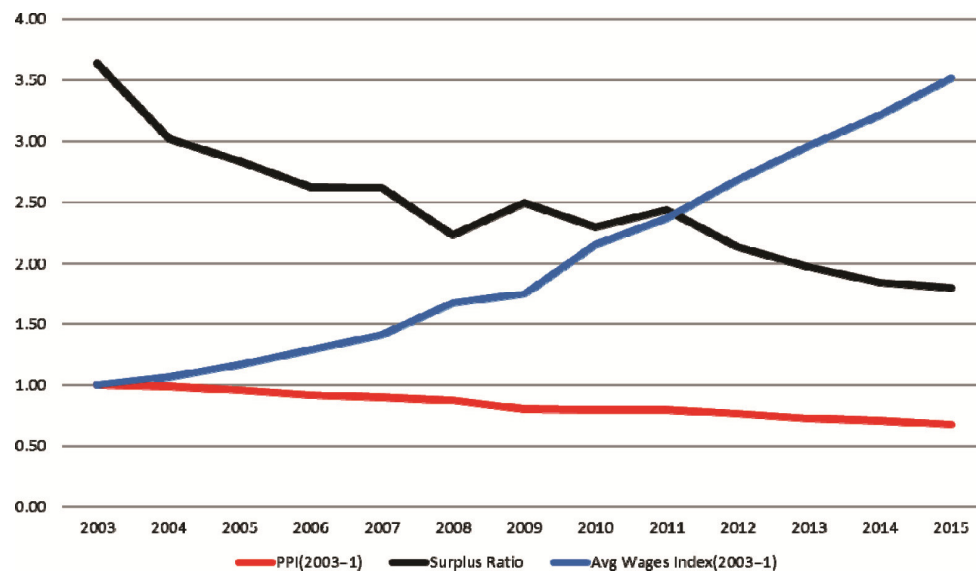
Notes

Note 1. LSR is derived from dividing Annual operating surplus on Total labor cost.

Note 2. Cumulative effect of simultaneous drastic falling of product prices (due to increased productivity) and rising wages.

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Appendixes

**Appendix A. Historical Dynamics of LSR, PPI and Wages**

Source: Xiamen Municipal Bureau of Statistics.

Appendix B. Description of the Variables

1) Remuneration—sum of salaries and benefit in kind by employer to employees at given year for particular industry, type of ownership and market size of firm.

2) Operating surplus—the difference between Total Revenue and Total operational Cost at given year for particular industry, type of ownership and market size of firm.

3) Output value—total value of generated revenue out of sales and other business activities at given year for particular industry, type of ownership and market size of firm

4) Current Assets—total value of all assets held by company at given year for particular industry, type of ownership and market size of firm.

5) Employment—number of employees working at given year for particular industry, type of ownership and market size of firm.

6) Number of companies—number of registered companies for given year for particular industry, type of ownership and market size of firm.

7) Cumulative output—value including the output value of given period plus output values of all periods before it for particular industry, type of ownership and market size of firm.

8) Capital intensity—the ratio of current assets over remuneration. Proxy to capital-to-labor proportion.

Appendix C. Growth Rates of LSR and Annual Salaries
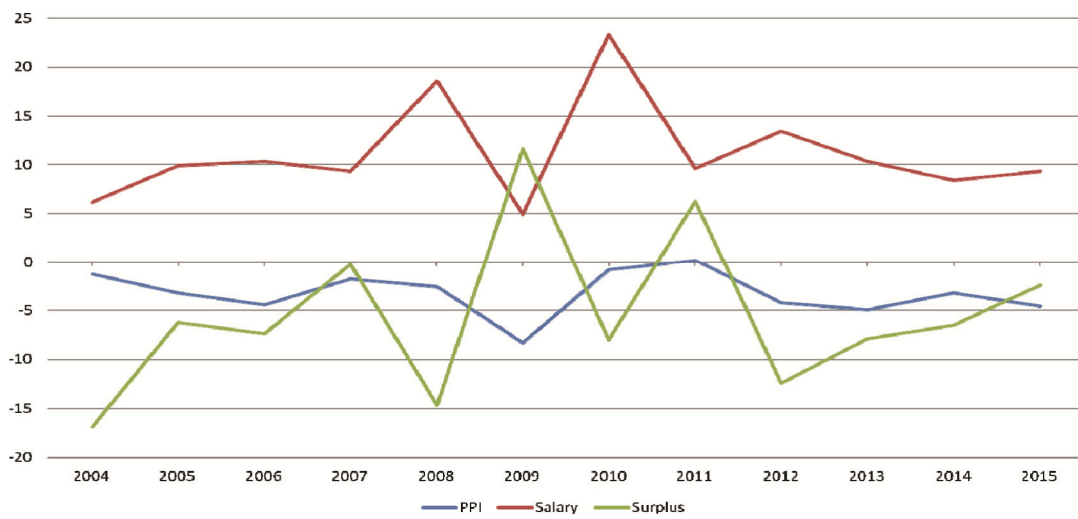
Source: Xiamen Municipal Bureau of Statistics.

Appendix D. LSR by Sector

Source: Authors's calculations.

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Appendix E. Detailed Meta-Data for LSR

2015	Number of Enterprises	Average Employment	Total Wages	Current Assets	Gross Industrial Output Value	Operation Surplus	Labor Surplus Ratio
Unit		Person	million yuan	million yuan	million yuan		
Total Manufacturing	1,766	623,004	40,580.64	289,263.48	50,286,788	72959.94	1.8
Corporation Limited	34	28,402	2,118.49	31,765.07	2,488,895	3685.04	1.74
Private-owned	668	106,151	5,464.72	34,559.52	6,080,774	8295.75	1.52
Foreign-funded	359	203,627	14,412.00	96,484.39	19,457,128	24392.57	1.69
State-holding	70	42,173	4,278.40	50,988.31	5,880,127	13938.17	3.26
Light Industry	857	273,495	16,265.74	97,600.91	15,810,042	29279.5	1.8
Heavy Industry	909	349,509	24,314.90	191,662.56	34,476,746	43680.44	1.8
Large	87	275,208	20,473.58	141,942.32	28,045,145	42280.84	2.07
Medium	313	175,994	10,560.52	66,390.01	10,226,330	15219.57	1.44
Small	1,296	165,909	9,436.75	75,326.74	11,592,523	15238.18	1.61
Agricultural Products	66	13,563	559.55	11,074.32	2,042,431	1312.42	2.35
Foods	46	11,619	594.35	3,757.60	544,382	944.71	1.59
Beverage	19	15,635	1,260.89	5,196.99	828,917	2900.01	2.3
Textile	63	15,760	852.06	5,287.54	730,215	966.27	1.13
Wearing Apparel	121	31,878	1,990.13	9,502.91	1,134,801	3184.54	1.6
Leather, Fur	41	17,293	804.8	2,221.03	416,058	332.99	0.41
Timber	5	834	33.91	154.81	23,605	21.07	0.62
Furniture	38	10,749	561.28	2,562.70	492,342	799.81	1.42
Paper	41	5,392	282.3	2,340.25	272,267	320.32	1.13
Printing	43	6,938	448.88	2,222.10	402,399	602.33	1.34
Culture, Fine Arts, Sports	70	27,250	1,465.04	5,676.16	929,092	1268.66	0.87
Petroleum, Nuclear Fuel	2	151	12.11	88.18	34,512	58.32	4.82
Raw Chemical	64	8,296	516	9,512.93	1,054,895	951.38	1.84
Medicines	17	6,602	556.91	3,548.05	406,790	2078.55	3.73
Chemical Fibers	7	3,249	191.59	1,862.30	509,842	162.44	0.85
Rubber and Plastics	142	47,837	2,752.34	11,226.03	2,490,454	4417.17	1.6
Non-metallic Mineral Products	71	12,036	749.89	8,284.99	963,240	1474.16	1.97
Ferrous Metals	10	1,185	54.9	790.81	139,252	48.51	0.88
Nonferrous	20	9,076	700.65	10,942.65	1,468,736	1508.56	2.15

Metals Metal Products	143	41,066	2,547.38	15,572.07	2,245,062	3381.48	1.33
General Purpose Machinery	78	26,966	1,652.01	11,107.55	1,374,388	3255.27	1.97
Special Purpose Machinery	85	18,125	1,248.08	14,132.10	1,073,841	1945.71	1.56
Motor Vehicles	64	26,118	2,150.64	21,474.25	3,004,423	5041.09	2.34
Electrical Machinery	184	56,947	3,897.59	27,200.72	3,670,234	8094.65	2.08
Communication Computers	206	167,292	10,901.05	76,600.47	19,240,016	15879.24	1.46
Measuring Instruments	36	13,883	757.52	2,833.13	471,968	798.9	1.05
Other Manufacture	44	7,831	410.99	1,904.40	264,584	319.73	0.78

Source: Xiamen Municipal Bureau of Statistics.

Appendix F. LSR by Size and Type of Ownership

	Employment	Labour Cost per worker	Annual Surplus (000,000')	Labor Surplus ratio
Large	275,208	74,393	42,280.84	2.07
Medium	175,994	60,005	15,219.57	1.44
Small	165,909	56,879	15,238.18	1.61
Corporation Limited	28,402	65137	3685.04	1.74
Private-owned	106,151	74589	8295.75	1.52
Foreign-funded	203,627	51481	24392.57	1.69
State-holding	42,173	70776	13938.17	3.26

Source: Xiamen Municipal Bureau of Statistics.