

# **Technology Development and Job Creation in China's Manufacturing Sector**

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## **Abstract**

This paper examines how Science and Technology (S&T) contributes to job creation in the Chinese manufacturing sector. The ambition of transforming China to an innovation-oriented nation and the emphasis on indigenous innovation capacity building has placed Science and Technology (S&T) high on the Chinese policy agenda. At the same time, the need for job creation is pressing, both to absorb the huge supply of underemployed people, and to enable the annual 20 million new labor market entrants to find employment. We analyse the relationship between S&T and job growth in Chinese industry. S&T can be expected to have both positive and negative effects on employment. For instance, new technology might increase competitiveness and enable Chinese firms to expand their labor force. On the other hand, new technology might be labor-saving, enabling Chinese firms to produce more output with fewer employees. Based on a large sample of manufacturing firms in China between 1998 and 2004, we analyse how S&T affects the probability of firm survival and how it affects the growth of employment in surviving firms. Our results suggest that S&T activities have a positive impact on firms' survival but no effect on job creation.

**Keywords:** China, Science and Technology, Job-Creation

## **INTRODUCTION**

New technology is important for economic development: it raises national income by increasing output for a given amount of production factors. It is safe to say that no country has ever

industrialized and developed without substantial technology change. This might be one reason why policy makers around the world tend to spend considerable attention to technology development. China is one such country.

Science and Technology (S&T) has over the last few years become one of the most promoted areas in Chinese economic policy (Lundin et al, 2006). The recently released National Guidelines for Medium- and Long-term Plans for Science and Technology Development of China (2006-2020) stresses the importance of technology change in general, and of indigenous technology change in particular (Chinese Ministry of Science & Technology, 2006). The official rhetoric is paralleled by a strong increase in S&T by Chinese firms, and China is today one of the world's largest performer of S&T (OECD, 2005).

It is widely expected among Chinese policy makers that increased S&T efforts will improve upon competitiveness and growth of the Chinese economy. Less debated is the role of S&T on job creation. This is unfortunate considering the serious lack of jobs in the formal sector. There is a large number of unemployed people in China and an even larger amount seeking an existence in the informal sector. Moreover, the rapidly declining state owned enterprises have not been matched by a sufficient expansion of the private sector, putting additional stress on the need to create new jobs.

S&T might affect the degree of job-creation. However, it is not obvious if the effect is positive or negative. On one hand, it might increase competitiveness and thereby the demand for labor. On the other hand, S&T might lead to relatively skill intensive or capital intensive production and thereby a reduced demand for labor. Which mechanism that dominates is an open question.

We contribute to the literature on job-creation in developing countries by examining the relationship between S&T and employment. Our analysis is based on a large data set on all large and medium sized enterprises in Chinese industry between 1998 and 2004. One methodological problem is that we can only observe employment in surviving firms and survival might be affected by S&T. The results on how S&T affects employment could therefore be biased. We try to control for this potential bias by applying a Heckman two-step estimation procedure. Our analysis shows that S&T has a positive effect on firm survival. However, there is no positive effect on job-creation even after controlling for the higher survival rate of firms engaged in S&T. We conclude the paper by arguing that there might be many advantages with S&T development but it does not seem to solve one of the major policy issues in China, insufficient job-creation.

## **S&T AND JOB CREATION – A CONCEPTUAL FRAMEWORK AND PREVIOUS STUDIES**

### **The Chinese Context**

The Chinese labour force is predicted to grow at an annual rate of 1.3 percent over the next decades (Chow et al., 1999, p.483). Moreover, there is a large pool of Chinese underemployed workers or

workers in the informal sector. For instance, around 65 percent of China's 131 million internal migrants are without *hukou* (household registration) and therefore excluded from the formal job markets (Cai et al., 2005). Taken together, this growth of the labor force and the large number of workers outside of the formal labor market underlines the need for substantial job creation in China. Unfortunately, some reports suggest that job growth has come to a halt. As a consequence, registered unemployment increased from around 4 to 6 percent of the labour force between 1995-2000 and labour force participation decreased over the same period from around 73 percent to 62 percent (Cai, 2004).

Which firms will then be likely to provide the new jobs? There is strong evidence that firm ownership is important for job creation. For instance, the main reason to an insufficient job creation in China is that the private sector, including foreign owned multinationals and joint-ventures, has difficulties to absorb the same number of workers that are laid off from SOEs. This is shown in manufacturing employment which has declined from about 98 millions in 1996 to about 83 millions in 2002, largely because increased private sector employment has been out-weighted by declining employment in manufacturing SOEs from 32 millions in 1996 to less than ten millions in 2002 (National Bureau of Statistics, 2005, Tables 1-6 and 1-16). Hence, SOEs are relatively less likely to generate jobs and private domestic and foreign firms relatively more likely.

Referring to our issue of the impact of technology on job creation, there is hardly any previous studies that can be consulted. It has been shown that large firms (many employees) conduct more S&T than small firms (few employees) (Lundin et al., 2006) but we can not draw any conclusions from this stylized fact regarding the causality between S&T and employment growth. In other words, it might be that large firms tend to be more willing to invest in S&T and not a causal effect from S&T to employment growth.

## **DATA AND DESCRIPTIVE STATISTICS**

### **Data**

#### *Content*

The data in this paper is on large- and medium-sized enterprises in the Chinese industrial sector over the period 1998-2004 and is compiled by the National Bureau of Statistics of China. The classification of large- and medium sized firms is based on a combined firm-size indicator, in which employment, turnover and fixed asset are taken into account.<sup>1</sup>

The included variables are from two different sources. The first one is balance sheets of firms from the Chinese industrial statistics, which is very similar to the same type of data used in previous studies on a range of different countries. The other source is S&T statistics. Merging these two datasets and using unique firm identification codes, we obtain a dataset containing variables, which can be divided into two categories: 1) Firm-level economic variables, such as employment, wages, sales, value-added, profit, exports, fixed assets, time of establishment and ownership 2) Technology related variables including S&T and R&D expenditures, human resource inputs such as S&T personnel and R&D personnel, and purchase of foreign technology.

## Descriptive Statistics

The main constraint with the above analysis is obvious: job growth and firm survival are affected by a host of factors other than the ones included in the tables. If such characteristics differ between firms with and without S&T, it is a risk that our comparison is biased. Indeed, Table 5 shows that there are large differences between firms with and without S&T, in all sectors and in all time periods. More specifically, firms with S&T tend to be relatively large, capital intensive firms with high profits, productivity, and wages, and with a large amount of import of technologies. Firms with no S&T tend to have a substantially higher amount of export.

To control for various factors that affect employment and to allow all Chinese firms to be included in the data, and thereby allow us to make more well founded conclusions on the relationship between S&T and job growth, requires an econometric approach to which we now turn.

## ECONOMETRIC MODEL AND RESULTS

### Model

To assess the impact of S&T on job-creation, we use a Heckman two-step estimator to control for the sample selection problem caused by attrition (firms dropping out from the data set) (Puhani, 2000). This aims to control for the effect of firm survival before we estimate the impact of S&T on job creation. In the first step we estimate a probit model for firm exit. We experiment with using different sets of controls, ranging from S&T status dummy only, to the most comprehensive model, which includes firm size, age, profit, ownership skill- and capital intensities and a set of dummy variables to control for export- and import status, as well as for year- and industry-specific effects. We use the most comprehensive model to calculate the inverse Mills ratio. In the second step the inverse Mills ratio is added as an explanatory variable to the model of employment growth. The employment growth model is specified as follows<sup>2</sup>:

$$\Delta X_i = \ln X_{it} - \ln X_{it-1} = \alpha + \beta_{st} S\&T\_share_{i,t-n} + \lambda Firm_{it} + \sum \beta_w Ownership_i + dIndustry_j + \sum b_t Year\_dummy + \sum \beta_{ind} Ind\_dummy_j + \sum b_R Reg\_dummy + \varepsilon_{it} \quad (1)$$

where  $i$  is index for firms,  $j$  is index for industries and  $t$  is index for year. The model is estimated by applying OLS and fixed effect estimators on the full dataset as well as on sub-samples by ownership and by industry sector. The variables included in the specification are defined as:

$X_{it}$  : Employment

$S\&T\_share_{i,t-n}$  : The ratio of S&T expenditures to sales, where  $n$  is the number of lags.

$Firm_{it}$  : A vector of firm characteristics such as size, age, skill intensity, capital intensity and labour productivity.

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<sup>1</sup> See Appendix A for the detailed classification.

<sup>2</sup> See Appendix A3 for detailed definitions of the control variables at the firm- and industry level.

*Ownership<sub>i</sub>*: Ownership dummy variable indicating SOE, collective, joint venture with firms from Taiwan, Hong Kong and Macau, joint venture with firms from other foreign countries, wholly foreign-owned, private and other domestic firms.

*Industry<sub>it</sub>*: A vector of control variables at the 4-digit industry-level, such as S&T share, export to sales ratio and technology import to sales ratio, FDI intensity and Herfindal index as a measure for industrial concentration ratio.

*Year<sub>t</sub>*: Year dummy variable.

*Industry<sub>j</sub>*: Industry dummy variables at the 4-digit level.

*Reg \_ dummy*: Regional dummy variables at the province-level.

## Results

In our final estimations, we divide the sample in high-tech industries and other industries.<sup>3</sup> It does not seem to be the degree of technology sophistication of the sector that matters for the effect of S&T on job-growth. The effect of S&T is positive and statistically significant in both groups of industries but with marginal economic significance.

## CONCLUDING REMARKS

China is making large strives to upgrade its technological capability. Public guidelines on transforming China to an innovation driven economy is paralleled by sharp increases in expenditures on S&T. The idea of technological leapfrogging is a commonly expressed hope among policy makers, not least in developing countries, but is a policy with its own costs. It is without doubt necessary for countries who want to maintain a high and sustainable economic growth to constantly improve upon technology but such upgrading can take place through several channels, such as purchase of existing technologies or development of new technologies. Chinese public policies seem to aim for the latter. However, indigenous technology development is costly and, as witnessed in many other developing countries, often inefficient. The question to ask for Chinese policy makers is if resources could be spent better if being spent differently.

This is of course a very difficult question to answer and depends on what is being identified as the main economic challenge for China. We argue in this paper that job creation is at least one of the most pressing economic issues in China: the pool of underemployed people is huge and Chinese industry does not seem to absorb a sufficiently large number of workers. We continue and ask the question if S&T might affect job-growth in Chinese industry. One can think of both positive and negative effects of S&T on employment: positive if it enables the firm to survive and expand, and negative if labor is substituted for capital.

Our analysis of Chinese industry between 1998 and 2004 shows that the number of large and medium sized firms has increased by about 24 percent but employment only by about 4 percent. More importantly, most expansion has been in firms without any S&T: the number of firms

without S&T has increased more rapidly than the number with S&T, and employment in firms without S&T has grown more rapidly than employment in firms with S&T. Our econometric analysis aims at answering if S&T causes the comparable low job-growth, or if performance is caused by some other observed or unobserved firm characteristics. One econometric problem is that we only observe job-growth in firms that remain in the sample (survivals) and this survival might be a function of S&T. We try to control for this potential bias by using a Heckman two-step procedure where we include the inverse Mills ratio from a probit analysis on exit into the regression analysis. This approach seems important in light of a strong positive impact of S&T on the firm's likelihood to stay in the sample. We are inclined to interpret this result as a positive effect of S&T on firm survival but realize that the effect could also be caused by a lower probability of firms with S&T to be acquired, or a lower probability that these firms fall under the size threshold for being included in the large and medium sized category. Controlling for survival has little impact on the result for job-growth: S&T has no or even a negative effect on job-growth. The result is stable to inclusion of a host of various variables that might affect job-growth and to estimations in different industries and in different ownership groups.

Our conclusion is that S&T might be important in China for a number of reasons. It is not, however, likely to solve the large problem of job-creation in large and medium sized enterprises. To address this concern requires different policies than ones focusing on technology development.

## References