

RESEARCH ARTICLE

Little to Lose: Exit Options and Attitudes towards Automation in Chinese Manufacturing

Nicole Wu¹  and Zhongwei Sun²

¹Department of Politics and Public Administration, University of Hong Kong, Hong Kong SAR, China, and Department of Political Science, University of Toronto, Toronto, Canada, and ²School of Politics and Public Administration, South China Normal University, Guangzhou, China

Corresponding author: Zhongwei Sun; Email: sunzhwei@m.scnu.edu.cn

Abstract

Recent discussions on the future of work emphasize the negative effects of labour-replacing technology on employment and wages. However, original surveys and field research show that Chinese manufacturing workers currently consider themselves the beneficiaries of technological upgrading. This paper presents quantitative and qualitative evidence from two original surveys of over 2,400 workers and 600 companies in the manufacturing sector, interviews with firm managers and workers from 76 companies, and 34 factory visits in 19 cities in southern China. It finds that insofar as labourers experience automation anxiety, local workers are more likely than internal migrant workers to worry about technological displacement and are more pessimistic about their prospects of securing comparable employment after displacement. Owing to the features and consequences of the household registration system, internal migrants have a larger set of acceptable exit options that are no worse than their status quo, contributing to their lower anxiety about automation compared to locals. These findings suggest that automation susceptibility does not directly translate into automation opposition as previously assumed; institutions can shape technological receptiveness among people who face similar threats of automation by altering their exit options.

摘要

最近关于未来工作的研究大多强调机械化对工人就业和工资的负面影响。然而，本文的问卷调查和田野研究显示，中国制造业工人目前普遍认为自己是技术升级的受益者。我们综合并分析了两次问卷调查（受访者为 2400 多名制造业工人和 600 多家企业代表）、对 76 家企业管理人员和工人的访谈，以及对位于南方 19 个城市的 34 家工厂的实地观察。研究发现，就自动化焦虑而言，本地工人比非本地工人更担心被机器取代，更忧虑在失业后无法找到类似待遇的工作。由于户籍制度的规则及其后果，非本地工人通常有更多可接受的退出选项。因为非本地工人的退出选项大多不比他们当前的待遇及状况差，所以非本地工人对自动化导致失业的焦虑比本地工人为低。以往的研究多假设工人的工种或被机器取代的潜在威胁直接影响他们对自动化的观感，但本文针对工种相若的工人的研究显示，自动化的潜在威胁并不能完全解释工人对科技的态度。制度可以通过影响工种相似的工人的退出选项，从而调节他们对技术的接受度或反对程度。

Keywords: automation; manufacturing; labour; future of work; technology; automation anxiety

关键词: 自动化; 制造业; 劳动力; 未来工作; 科技; 自动化焦虑

Recent research on automation has emphasized the negative implications for wages and employment in industrialized economies.¹ There is a growing concern that technology will have an even greater impact on developing nations, where larger shares of jobs are susceptible to automation.

¹ Frey and Osborne 2017; Acemoglu and Restrepo 2020.

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One estimate suggests that it will be technically feasible to automate 77 per cent of jobs in China in the next few decades.² Furthermore, the Chinese government promotes an initiative to “replace humans with robots” (*jīqī huàn rén* 机器换人). Beijing emphasizes the necessity and urgency of boosting technological adoption in its “Made in China 2025” campaign, which aims to maintain China’s economic growth by shifting the economy away from low value-added manufacturing and towards high value-added production. To that end, various levels of Chinese government have made policy commitments, including subsidies to finance the production and adoption of robots, to modernize factories and to assist companies move up the global value chain.³

The seemingly dystopian slogan of “replace humans with robots” has been appearing in official government publications since 2012. The state media also boast about the effectiveness of the programme, highlighting the sizable labour savings that can be achieved through automation. Which types of manufacturing workers are more concerned about automation, and why? This paper presents findings based on semi-structured interviews with firm managers and manufacturing workers from 76 companies, 34 factory visits and two surveys of over 2,400 workers and 600 companies, covering 19 cities in southern coastal China. Such a combination of open-ended techniques and survey methods allows hypotheses to be refined and updated in the field and subsequently tested.⁴ We rely on both qualitative and quantitative data gathered in the field.

Contrary to the more pessimistic assessments of automation, most manufacturing workers in Guangdong – who are buffered by steady increases in demand and a chronic labour shortage – appear to be unfazed by technological change at present. During interviews, rather than dwell on wage or employment concerns, they more frequently emphasized the immediate and observable effects of technological improvements, such as lowered risks of injury, less monotonous work and improved product quality. These on-the-ground benefits of technological improvements play a critical role in shaping workers’ attitudes towards technology, but they are often overlooked in macroeconomic analyses of automation. Our observations build on and extend earlier findings covering a different and wider range of firms and localities.⁵

Paradoxically, insofar as labourers experience anxiety over the prospect of job automation, the survey finds that compared to migrant workers, local workers, who are better protected by local labour regulations, are more worried about technological displacement.⁶ Migrants with a non-local *hukou* 户口 (household registration) working in cities have little or no access to public services provided by local city governments and are typically less likely to be offered formal labour contracts.⁷

This important institution alters the cost of the technological displacement felt by local and non-local workers by affecting their relative ease of securing comparable employment or a satisfactory exit option following a layoff. The migrants’ undesirable circumstances – precarious positions, out-of-pocket expenses for essential public services that they are not eligible for, and the sometimes years of separation from their children – lower their expectations and make their jobs less painful to lose. As these jobs provide minimal benefit to migrant workers other than remuneration, interviewees expressed little concern about their chances of finding another job that was no worse than the status quo. Migrants are also generally more geographically mobile; they have already left their homes to pursue economic opportunities far away. Furthermore, the greater legal protection afforded to local workers (for example, higher mandated levels of employer contributions to insurance and retirement funds) ironically reduces their competitive edge as they are more expensive to

2 Frey and Osborne 2017; Citi GPS 2016.

3 Sharif and Huang 2019a; Huang and Sharif 2017.

4 Kapiszewski, MacLean and Read 2015.

5 He and Han 2019; Sharif and Huang 2019a; Lei 2022.

6 All workers in this study are Chinese. Internal migrant workers are those whose workplace or residence is different from that to which their *hukou* is registered. Strict internal migration controls have given rise to a dualistic labour market of local and non-local/migrant workers.

7 Song 2014.

hire than non-locals with the same levels of skill. While rural-to-urban migrants are less protected by labour regulations, many have hometown landholdings as a form of “self-insurance.”⁸ In the United States and United Kingdom,⁹ Mexico and Thailand,¹⁰ scholars have found that property or land ownership can affect attitudes regarding redistribution and social spending, migration preferences and voting behaviour. Land assets can offer a stock of wealth and a hedge against negative labour market risks, such as automation. Migrant workers have a harder time working away from home as they have limited access to subsidized services and housing, yet they almost always have the fallback option of returning home. Our survey shows that local workers who have fewer exit options comparable to the status quo are more worried about the threat of job automation.

This paper may be of interest to scholars of Chinese politics and comparative political economics. For the former, this work highlights the unintended labour consequences of an unequal welfare system that discriminates according to the *hukou* status people are assigned at birth. By allowing employers to opt for a lower, less generous tier of social insurance for their non-local employees, local governments inadvertently hurt the competitiveness of the group they seek to protect – local workers – if employers prefer migrant over local workers with the same level of skills. It also reveals a possible tension between local governments’ goals of promoting industrial upgrading via automation on the one hand and appeasing their local working-class constituents on the other. Unemployed migrant workers without a local *hukou* can return to their hometowns or move to a different city for opportunities, but local workers in coastal cities are less inclined to relocate. If local workers feel they are being negatively affected by automation, the aggressive pushes by local governments to modernize factories may create a politically tricky situation by irking their constituents, if not directly propelling them towards labour protests.¹¹

More generally, this paper offers a new perspective on technology attitudes which has implications that stretch beyond China. Existing research uses individuals’ educational attainment and job characteristics as a proxy for their susceptibility to automation.¹² While these factors are no doubt relevant to the analyses of mass attitudes, this paper additionally shows how institutions shape the technological receptiveness of people who face similar levels of risk regarding job automation. While the *hukou* system was intended to be a means of authoritarian control to restrict movement rather than a labour scheme,¹³ the current study may provide insights into how labour market institutions (for example, unions, employment protection legislation) may more broadly affect automation preferences. For example, in the United States, technological displacement may be more painful for unionized auto workers than for non-unionized retail workers, because the former will lose substantial income if they have to shift to a different industry or employment group (while losses are unlikely to be of the same magnitude for the latter). A well-compensated union job is harder to replace. Likewise, US manufacturing workers may be more opposed to automation than Chinese manufacturing workers, because comparable exit options for the former are few and far between. While education level affects a worker’s adaptability to technological change, existing levels of labour organization often affect the value of the job at stake. Antagonism towards technology may be more likely to originate from organized groups, but automation itself may also shift the balance of capital–labour bargaining.¹⁴

This paper joins a growing body of work that examines workers’ attitudes and beliefs regarding technology. It is important to study workers’ beliefs and attitudes towards workplace technological adoption, which may or may not differ from those of capital owners and policymakers. Manufacturing workers are often believed to be among the most negatively impacted. Our finding

8 Zou, Jing, Chen and Chen 2022; Carroll 1997.

9 Ansell 2014.

10 Van Wey 2005.

11 Liu and Zhang 2023.

12 Frey and Osborne 2017; Gallego and Kurer 2022.

13 Chan 1994.

14 Balázár 2022.

that Chinese industrial workers largely welcome technological change in some ways challenges a widely held idea that automation susceptibility directly translates into automation opposition. International competition aligns workers' interests with those of their employers, as suggested by our interviewees. At the same time, budding anxiety might eventually give rise to labour activism, even in an authoritarian setting, if workers fear obsolescence. By considering the views of those most negatively impacted, policymakers and employers might be better placed to devise appropriate responses (for example, training programmes) to address these apprehensions.

Understanding Automation in China

Research on technology's impact on workers is predominately based on the experience of advanced economies, with a few exceptions.¹⁵ The adoption of labour-replacing technology has been linked to job polarization, increasing inequality and unemployment.¹⁶ More recently, researchers argue that technology-induced anxiety might have fuelled anti-globalization attitudes¹⁷ and the rise of far-right populism in the developed world.¹⁸

Not all accounts of the effects of technological change on labour are strictly pessimistic. Technology can displace, reinstate or increase demand for labour. Labour is displaced if capital performs tasks previously performed by humans;¹⁹ labour is reinstated if technology-induced increases in productivity and output contribute to an increased demand for humans in non-automated roles or when technology creates new tasks that workers can take on.²⁰ Empirically, some recent research in Europe finds that the loss of routine jobs is offset by the creation of new jobs.²¹ Research based on Japanese industrial data shows that robot adoption increases industry-level employment.²² Experiences in France and Spain also show that robots are positive for adopters, as adopting firms experience positive output and employment effects.²³ In other words, workers might be better off if their company automates. Conversely, if the rest of the sector is automating but their firm is not, these workers are more likely to experience negative effects.

The effects of technology on Chinese workers so far look mixed and, occasionally, at odds with the canonical findings (for example, routine-biased technological change). While technological improvements have diminished the number of routine jobs elsewhere, Yang Du and Albert Park find an increase in routine-intensive occupations in China as the growing export-oriented sector specializes in less abstract and more routine tasks.²⁴ Others show that automation exposure has negative effects on wages and employment, particularly for state-owned sector, low-skilled, male and prime-age and older workers.²⁵ Through participant-observation in nine factories, also in Dongguan in 2015 and 2016, Naubahar Sharif and Yu Huang show instances of labour deskilling (typically through moving to a lower-paying department of the same company) and displacement, but also of upskilling (through additional training) as a result of technological upgrades.²⁶

15 Gallego and Kurer 2022.

16 Autor, Katz and Kearney 2006; Goos, Manning and Salomons 2014; Frey and Osborne 2017; Acemoglu and Restrepo 2020.

17 Wu 2022.

18 Milner 2021.

19 Routine-biased technological change describes the observation that technology is biased towards replacing workers in routine tasks (Goos, Manning and Salomons 2014). Advanced robotics and artificial intelligence threaten even workers who perform non-routine tasks.

20 Autor 2015; Bessen 2015; Acemoglu and Restrepo 2019.

21 Dauth et al. 2021.

22 Adachi, Kawaguchi and Saito 2024; Dekle 2020.

23 Koch, Manuylov and Smolka 2021; Acemoglu, Lelarge and Restrepo 2020.

24 Du and Park 2017.

25 Giuntella and Wang 2019; Li et al. 2020.

26 Sharif and Huang 2019b.

It is worthwhile to delve further into the changing and growing impact of technology on Chinese workers as existing theories about automation, which are derived from the Global North, may not readily apply to China or indeed other middle-income countries that rely heavily on the secondary sector or are still transitioning to a more service-dominated economy. Unlike much of the industrialized world, China represents a class of middle-income country where manufacturing work is less romanticized or held as a “good job” but employs a large segment of the population. This paper invites further investigation of these at-risk workers’ attitudes and trajectories.

Data sources and methods

To understand workers’ experiences with and opinions towards automation, we collected extensive and original qualitative and quantitative data. We secured access to government officials, firm managers and production line workers in 19 cities at various levels of development across Guangdong province. This region has traditionally been a site for policy experimentation and economic innovation. In 2014, the Dongguan 东莞 municipal government in Guangdong established a fund to help companies “replace humans with robots.” In addition, the southern region houses a significant portion of the country’s manufacturing activities and has thus been of great economic import to China. Guangdong province alone was responsible for 26 per cent of the country’s total value of exports in 2018.²⁷ Facing increasingly unfavourable policies (for example, environmental regulations) and market conditions (for example, soaring wages) for low-end, labour-intensive manufacturing, businesses in southern China were also among the earliest adopters of technology in the nation, making the region a particularly instructive case to examine the effects of automation. Millions of internal migrants have moved to Guangdong in pursuit of economic opportunities, making the province a particularly suitable field site through which to understand the potential differential impact of technology on different types of workers.

We sought to uncover a comprehensive picture of the impact of automation on manufacturing workers using a variety of strategies, including interviews, factory visits and original surveys. We fielded two original surveys of over 600 companies and covering 2,400 workers. As we had to rely on local departments of a bureau for survey distribution, some aspects of the sampling process were beyond our control. Our sampling method best approximated quota sampling. We first categorized cities into three tiers by their level of development (with 1 being the highest): (1) Dongguan 东莞, Guangzhou 广东 and Shenzhen 深圳; (2) Foshan 佛山, Jiangmen 江门, Huizhou 惠州, Shantou 汕头, Zhanjiang 湛江, Zhaoqing 肇庆, Zhongshan 中山 and Zhuhai 珠海; (3) Chaozhou 潮州, Heyuan 河源, Jieyang 揭阳, Meizhou 梅州, Shaoguan 韶关, Qingyuan 清远, Yunfu 云浮 and Yangjiang 阳江. Given the differences in the total output value of manufacturing industries and the number of large-scale enterprises in each prefecture-level city, we surveyed no fewer than 50, 30 and 20 firms in each city in tier 1 through to tier 3 respectively. Firms were then further selected based on certain characteristics, including industry, firm size and ownership type. The final sample covered eight main sectors: chemical, textile and apparel, electronics, metal fabrication, machinery, automobiles and other transportation equipment, beverages, and food processing. The firms were a mix of state-owned, privately held, foreign-owned, and jointly owned corporations. A representative of a firm was asked to answer the firm survey, while a minimum of four production line workers were selected from the sampled firms to complete the worker survey. About 70 per cent of the respondents had received some secondary (*gaozhong* 高中), vocational (*zhongzhuan* 中专) or technical education (*jixiao* 技校). In addition to enriching descriptive inference, the two surveys also allowed the subsequent testing of hypotheses, which were updated and refined in the field.²⁸ We provide detailed accounts of the sample in the Appendix.

27 Data retrieved from the National Bureau of Statistics, <http://data.stats.gov.cn/english/easyquery.htm?cn=E0103>. Accessed 15 June 2020.

28 Kapiszewski, MacLean and Read 2015.

Additionally, we conducted semi-structured interviews with firm managers and production line workers from 76 manufacturing companies. Unlike the survey, where we were seeking a broad representation of firms, for these interviews we were particularly interested in visiting firms that had already introduced automation. This move was intentional, as we were most interested in talking about the trend to workers who had already been exposed to automation. While we were not able to pick which line worker would sit down with us for an interview, we were free to talk to anyone on the factory floor more informally. Some researchers have used snowball or chain-referral sampling techniques to reach out to workers with fruitful results; our sample includes firms that are outside of electronics manufacturing and Dongguan.²⁹ The list of firms can be found in the Appendix. During interviews with workers, we probed their personal experiences with workplace technology and labour market concerns. In interviews with management, we inquired about motivations for and consequences of automation (i.e. profits, recruitment and retention). Over the course of four months, we also observed production line workers – mostly humans, but sometimes robots – in 34 production facilities. These visits enabled us to contextualize workers' responses and better understand the on-the-ground impact of automation on work.

Owing to China's political environment, there were significant and increasing constraints on our sampling and question scope, but these interviews and surveys still represent important data on attitudes regarding technology, especially now that accessing subjects in China has become increasingly difficult and dangerous.³⁰ Our quota sampling method precludes the possibility of representativeness in our surveys. However, surveys involving firms typically yield lower response rates (for example, the average response rate from organizational representatives was 35.7 per cent).³¹ Because of government involvement, we did not face issues with non-response when rolling out our surveys, or with requests for visits, and we were able to collect a dataset that captures a wide variety of firms across a number of dimensions. A negative trade-off of this access might involve concerns over intentional, unethical biases in the data. Directionally speaking, should there be any attempt to skew the data, the collaborating bureau would have had an incentive to play up the harm to workers wrought by automation – which is not what we ultimately find.

The state of automation in Chinese manufacturing

China has a relatively low stock of industrial robots per worker, ranking the last in robot density among G20 members (see Figure 1). It has, however, witnessed the largest growth in robot flow in recent years.³² Using the China Enterprise-Employee Survey (CEES), Hong Cheng and colleagues arrive at a lower robot density estimate than the International Federation of Robots (IFR) (39 compared to 68 robots per 10,000 workers in 2017).³³ Although the numeric estimates differ, both sources state that the density of robot usage is rapidly increasing but there is still a significant gap when compared to advanced countries.

The growth in robots in China has occurred against a backdrop of labour shortages and rising wages.³⁴ Additionally, Chinese industrial policies have also encouraged robot adoption and production.³⁵ In 2012 and 2013, the Ministry of Industry and Information Technology (MIIT) and the Ministry of Science and Technology (MST), both national-level development agencies, published guiding opinions on promoting automation. In 2014, lower-level governments started to offer financial assistance to companies to automate, generally in the form of a rebate of 10 to 30 per cent of the

29 Sharif and Huang 2019a; Lei 2022.

30 O'Brien 2018.

31 Baruch and Holtom 2008.

32 International Federation of Robotics 2019.

33 Cheng, Chen and Li 2018.

34 Cheng et al. 2019.

35 Ibid.

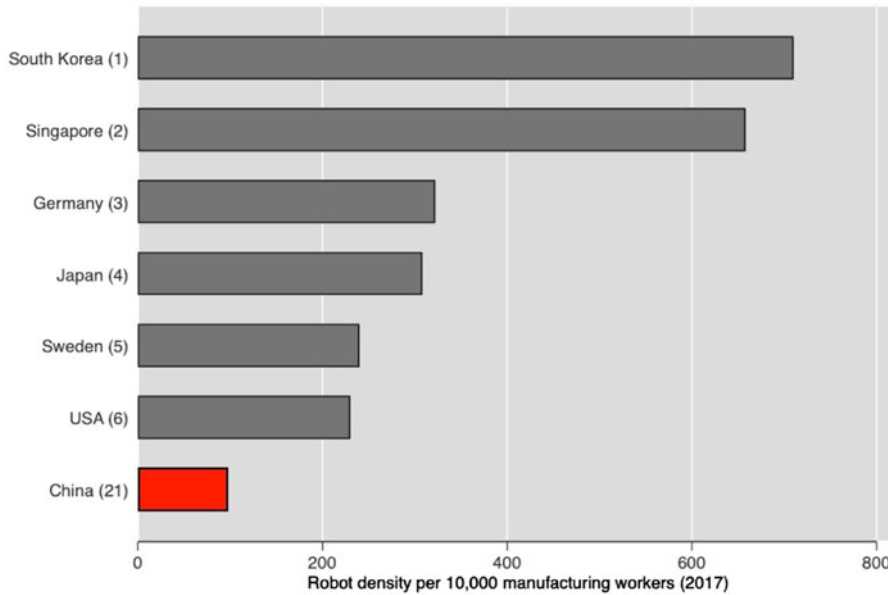


Figure 1. Robot Density per 10,000 Manufacturing Workers among the G20.

Source: Data from International Federation of Robotics 2019.

purchase price of qualifying equipment, depending on the locality. In 2015, Beijing reaffirmed these provincial- and municipal-level undertakings in its “Made in China 2025” campaign. Motivated to move China up the innovation value chain, the plan identified key development industries and promised support for manufacturing innovation centres.³⁶ A local government official we interviewed quipped that the programme had garnered too much negative attention from the United States and Europe,³⁷ and so officials now avoid using the provoking slogan and prefer to refer to the plan as “intelligent manufacturing” (*zhineng zhizao* 智能制造).³⁸ Although Premier Li Keqiang 李克强 did not refer to the “Made in China 2025” plan by name in his annual address to the National People’s Congress in March 2019, the policies remained.³⁹

The extent to which these policies accelerated technological adoption and innovation remains unclear. On one hand, Cheng and colleagues find that firms controlled by Communist Party members are more likely to adopt industrial robots: 15 per cent of the firms using robots in their sample reported that government industrial policies contributed to their adoption decisions.⁴⁰ On the other hand, Sharif and Huang note that government officials in Dongguan considered these subsidies merely as “icing on the cake.”⁴¹ Consistent with their observations, a human resource manager of a multinational corporation noted that the company “would have automated anyway” and that the subsidy amounted to “adding flowers to a brocade” (Company 32, Appendix). The owner of a privately owned machinery company did not apply for the subsidy to avoid “trouble” and “cumbersome paperwork” (Company 63). The general manager of a robotics company

36 The full text of the announcement is available at http://www.gov.cn/zhengce/content/2015-05/19/content_9784.htm. Accessed 15 June 2020.

37 For example, tariff increases specifically targeted at products identified in the Made in China 2025 plan by the United States.

38 Comment made to author.

39 For an excellent summary of automation and government policies in China see Feng, Xiaojun 2020.

40 Cheng et al. 2019.

41 Sharif and Huang 2019b.

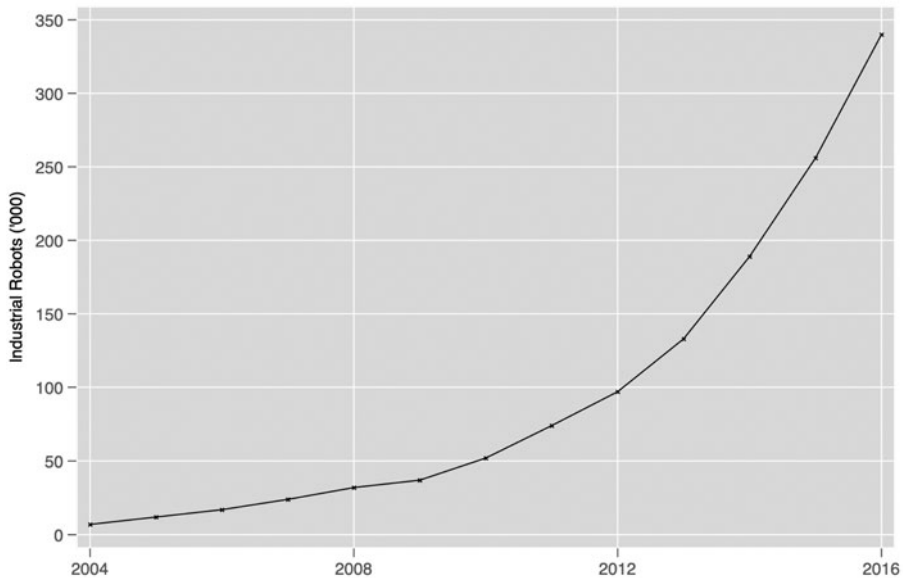


Figure 2. Industrial Robot Stock in China.

Source: Data from International Federation of Robotics 2019.

complained that state subsidies had hurt innovation and homegrown robotics development, as these financial incentives made once unaffordable German and Japanese robots attainable for their usual clientele (Company 3).⁴² More frequently, firm management attributed automation decisions to market forces – such as increasing output, responding to competition and alleviating labour shortages – rather than government incentives. Using CEES data and in terms of firm characteristics, adopters of industrial robots tend to be more capital-intensive, export-driven and are more likely to be foreign-owned or state-owned.⁴³ In other words, both market features and access to capital (via private or state sources) are associated with higher incidence of robot adoption.

Although it is difficult to determine the relative importance of these forces, both state- and market-based motivations to automate will likely persist in the years to come. Figure 2 shows that increases in robot stock in China preceded government policies to promote “intelligent manufacturing” and have greatly accelerated in pace in recent years. Rapid technological change was and is economically and socially disruptive. In England in the 1800s, the Luddites launched raids to destroy newly invented textile machines; in China at around the same time, craft guilds stopped the launch of a cotton-mill company in Shanghai, and native workers in Hong Kong, fearing for their jobs, wrecked sewing machines.⁴⁴ Historically, opposition to labour-saving technology has been the norm rather than the exception. Does the Chinese government today not fear the labour market – and possibly political – consequences of automation? How does technology affect Chinese workers and which types of workers are more concerned about automation?

Workers' Views Regarding Technology

We conducted a series of interviews to answer our research questions. At the beginning of every interview session, we introduced ourselves and explained the purpose of our visit, which was to

⁴² Note that some local governments require subsidies to be used on domestically produced robots. The rule varies across localities.

⁴³ Feng, Xiaojun 2020; Cheng et al. 2019.

⁴⁴ Frey 2019.

“understand the extent of automation at the production site; and how intelligent manufacturing has affected work, employment, and labour relations.” The majority of workers were cognizant of the technological improvements at their production sites, if indeed there were any. Many had already undergone training, had operated, maintained or at least seen these machines. In one case, a fully automated line was placed directly next to a human line that produced the exact same product (Company 44, Appendix). In our survey of manufacturing workers, about 36 per cent of the 2,445 respondents noted that their department had introduced industrial robots. In our survey of firms, 43 per cent reported having acquired new technology aimed at automation. The discrepancy between the two surveys may be attributable to the fact that we asked workers about technological improvements in their units, while we asked firm representatives if there had been such improvements firm wide. At the time of this research, industrial robots were seldom capable of completing all production procedures from start to finish; they merely took over certain tasks from humans. Production at most of these sites was semi-automatic at best.⁴⁵

When asked to share their experiences with technology at work, workers predominately focused on its practical implications on the factory floor rather than on wage or employment concerns. This response was contrary to our initial expectations, based on extant research in economics.⁴⁶ Among workers who reported experiencing automation, 45 per cent noted an improvement in work environment (whereas 4 per cent noted a deterioration). We observed that some technologies must operate in a dust-free environment and at a machine-friendly room temperature with proper ventilation. These upgrades benefited workers who operated or worked alongside these machines – climate-controlled rooms are especially appreciated during the long hot and humid southern Chinese summers. In addition, 54 per cent and 63 per cent of workers believed that technology had made their jobs less dangerous and less labour intensive respectively (whereas 7 per cent and 5 per cent reported an increase in injury risks and labour intensity respectively). During interviews, many workers cited automated guided vehicles (AGVs), including AGV forklifts and AGV pallet jacks, as greatly reducing fatigue and the risk of injury, as humans were no longer required to carry heavy articles themselves manually.

Technology has also been shown to shape the content of jobs, reducing the labour input for routine tasks and increasing the labour input for non-routine cognitive tasks. Owing to the wide variety of manufacturing tasks of the workers we interviewed, we did not specifically measure changes in job content; however, 35 per cent of those in production units with industrial robots reported that their jobs had become more stimulating owing to technological improvements, and 9 per cent reported that work had become more monotonous. Over half of our worker interviewees found that technology had made their jobs neither more interesting nor more mundane. A production line worker in a semiconductor factory (Company 35, Appendix) explained, “I used to have to complete all procedures by hand. I now press the same buttons over and over again according to the manual, but it is easier.” The ease of operation of these machines varies widely. In some instances, a few days of training sufficed; in others, training required long trips abroad, sometimes for months. In addition, workers also reported that technological improvements had increased interactions between their colleagues as well as enhanced their overall job satisfaction. Figure 3 summarizes workers’ evaluations of the impact of automation (ranges from 1 to 3). A higher average rating indicates a more positive evaluation.

As mentioned above, during the many interviews we conducted, respondents did not express concerns about wage cuts or technological unemployment unless directly probed on the issue, a finding which runs counter to recent macroeconomic research based on advanced economies in

45 Frey and Osborne (2017) describe such automation bottlenecks. Sometimes, companies choose not to automate even when they have the appropriate technology. This is more likely to be the case if the size of an order (usually of an unstandardized or custom product) is not sufficient to justify the time spent on experimenting and programming.

46 Autor, Katz and Kearney 2006; Goos, Manning and Salomons 2014; Frey and Osborne 2017.

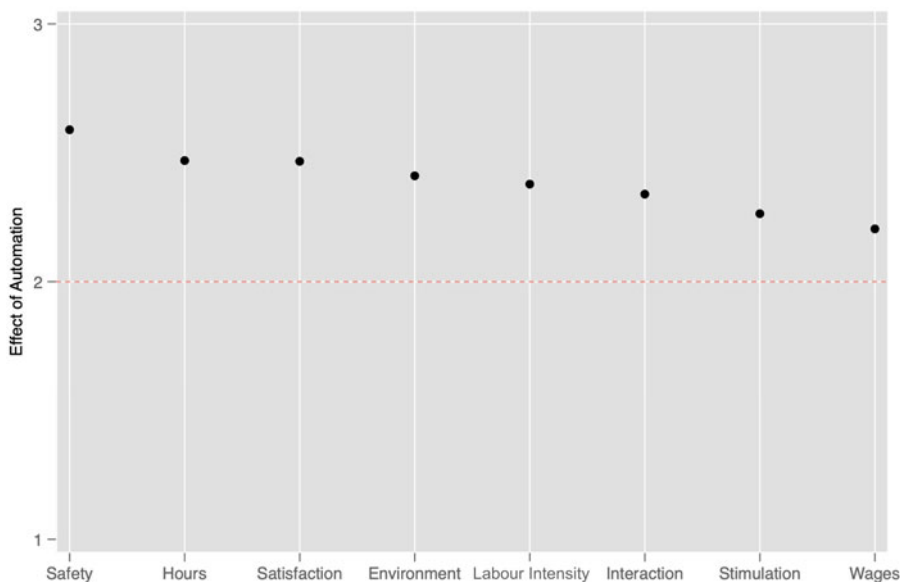


Figure 3. Self-reported Impact of Automation (mean).

Source: Data from original survey.

Notes: Rated by workers who reported experiencing automation. Mean values above the dotted line indicate positive appraisals overall. We ran ANOVA tests for each variable by ownership type. The results suggest that there are no significant differences between the group means.

the West. Our interviews and survey data provide some support, at least in part, to the view that technology is unlikely to put workers out of work rapidly and en masse in the short term.⁴⁷ Our survey asked Chinese workers if they had been laid off or reassigned to another position because of technological changes in the past two years; only 2 per cent said “yes.” Among those workers who had witnessed automation in their unit, only 7 per cent reported a decrease in salary (compared to 28 per cent who saw an increase). We acknowledge that inferences based on surveys and interviews of incumbent workers could potentially overlook the opinions of those permanently displaced by technology. We did not collect data from laid-off workers and so do not know how they would respond to our questions. However, we believe that survivorship bias or selection bias was unlikely to be significant for the study period. There were two major buffers for wage and employment shocks in the context of southern China at the time of this research that make permanent unemployment owing to technological displacement unlikely: an increase in demand and labour shortages, which were broadly lamented staffing issues along the coast.⁴⁸

Among the sampled firms, there was a continued increase in consumer demand. About 86 per cent of these firms service mainly domestic markets. According to World Bank data, final consumption expenditure in China rose steadily from US\$2.9 trillion in 2010 to US\$7.3 trillion in 2018.⁴⁹ Rather than leading to mass layoffs, automation helped firms to meet this increased demand. Second, there are chronic labour shortage and retention issues in the region.⁵⁰ About 93 per cent of surveyed firms reported experiencing recruitment challenges and nearly 90 per cent reported labour shortages. Noting the growing difficulties in recruitment, one human resources manager

47 Autor 2015; Bessen 2015.

48 The impact of the pandemic on Chinese manufacturing and automation remains to be seen. We offer a brief, preliminary note in the concluding section.

49 <https://data.worldbank.org/indicator/NE.CON.TOTL.CD>. Accessed on 29 June 2020

50 Meng 2012.

told a familiar story: “Speaking about City G, there has been a dramatic decline in labour supply, especially since 2015. The city government hosts a manufacturing job fair after the Chinese New Year every year in the sports arena. The venue used to be packed, but we had half the turnout in 2015, and then just another half of that in 2016.” He told us that he had “just returned from a month-long recruitment trip in the north-east” (Company 51, Appendix).

Recruitment, however, is often only half the battle. A majority of firms struggled to retain workers. The management of a state-owned automotive electronics company lamented that the company lost 50 to 60 per cent of its production workers every year: “it would be better if we could keep it under 30 per cent” (Company 33). Currently, the pressing challenge facing Chinese manufacturing on the southern coast is not joblessness but jobs left unfilled owing to excessive staff turnover. About 87 per cent of firms in the sample said no workers were laid off through automation.

Anxiety about the Future

The absence of massive layoffs does not, however, negate the disappearance of job opportunities in the future. Surveyed firms estimated that their modal industrial robotic system could theoretically replace 4.2 workers on average. Instead of laying off workers and risk triggering labour disputes, our interviewees revealed that some firms preferred to slow down recruitment or not re-hire after workers resign or complete their contracts. This implies that there may be fewer open positions across sectors in the future as Chinese firms continue to automate. In addition, recent research based on Spanish and French data shows that firm-level automation led to negative market-level employment outcomes; however, decreases in employment occurred not in the automating firm, but chiefly in competitor firms that did not automate.⁵¹ Despite Chinese workers’ positive evaluations of automation, they do not appear to be in denial of the possible effects of automation on future employment prospects. About 47 per cent of workers in the survey believed that their jobs could be automated in the next five to ten years.

Institutional effects on automation anxiety

We took an inductive approach to theorizing. Data from our interviews with manufacturing workers suggest that workers’ levels of technological anxiety may vary depending on workers’ exit options – that is, how easy it is to secure a comparable job or standard of living after a layoff. In their study of immigration attitudes, Sergi Pardos-Prado and Carla Xena argue that instead of focusing on the “employment threat” (supply of immigrants), it is helpful to consider the availability of jobs.⁵² In the case of automation, the threat from an increased adoption of robots may be inconsequential if workers believe there are adequate and satisfactory exit options. Individuals’ different beliefs about their exit options may in turn explain variations in automation anxiety even between individuals who face similar levels of automation threat (i.e. two workers with the same occupation).

When evaluating their menu of exit options, individuals’ current positions often serve as an anchor point for subsequent evaluations. Finding a substitute for a good job – for example, a stable, well-compensated, benefits-rich position – tends to be more difficult, making an individual more attached to their current job and displacement much more painful. In contrast, labour separations are likely to be less distressing if the spell of unemployment is short. It is generally much less challenging (and takes less time) to replace a job that provides little – for example, one that lacks a formal contract, pays low wages and provides no or limited benefits. A cashier at a grocery store can plausibly find another job at a convenience store reasonably quickly.

A 60-year-old institutional arrangement in China provides a unique opportunity to test this theory about exit options. Figure 4 summarizes the logic of the argument. The household registration

51 Koch, Manuylov and Smolka 2021; Acemoglu, Lelarge and Restrepo 2020.

52 Pardos-Prado and Xena 2019.

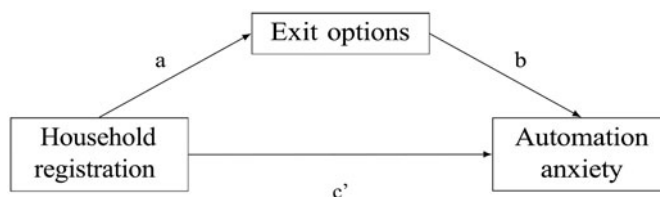


Figure 4. Hypothesized Effects of *Hukou* on Automation Anxiety.

(*hukou*) system shapes individuals' lifelong economic opportunities – and affects how they may be treated as workers – from birth. *Hukou* is passed on from one's parents. It determines an individual's official permanent residence. Hundreds of millions of Chinese workers have left their hometowns for cities in pursuit of economic opportunities, but transferring their *hukou* to a big city is notoriously difficult. Even though they are Chinese citizens, internal migrants are excluded from government-provided public services and welfare programmes at their migration destinations and thus incur higher out-of-pocket expenses and living expenses.⁵³ In addition, these internal migrant workers receive worse treatment in the labour market than their peers with a local *hukou*. In 2005, they were 2.6 times more likely than locals to be informally employed.⁵⁴ Informal employment is characterized by its temporality, the absence of a formal contract and limited social insurance benefits or labour protections. Moreover, sizable wage differentials exist between locals and migrants.⁵⁵ Although the 2008 Labour Contract Law sought to broaden protections for migrant workers, there are still significant gaps in implementation and enforcement, as well as social insurance coverage.⁵⁶ In other words, migrant workers with a non-local *hukou*, on average, receive worse treatment and have fewer social benefits than their local counterparts, even if they perform the same tasks within the same company. This is still true today, notwithstanding the shrinking wage gaps between rural migrant and urban workers in more recent years.⁵⁷

The systemic differences in access to public services and welfare have an enormous impact on workers' daily lives. These push factors decrease migrants' attachment to their current jobs and motivate an increasing number of them to return to their hometowns.⁵⁸ Most workers without a local *hukou* are not permitted to send their children to public schools in the city to which they have migrated, meaning that they must either pay for private (and often subpar) education or leave their children behind in their hometowns. According to one worker:

None of our children [without a local *hukou*] can attend [public schools]. They have to go to private schools. The quality of education is infinitely worse – it is even worse than public schools in my hometown, which cost 47 yuan per year. My child goes to the cheapest private school here and it costs 6,000 yuan per school term ... Workers without special skills typically make 5,000 to 6,000 yuan per month in this firm and the minimum wage in the city is 2,200 yuan. (Worker in Company 17, Appendix).

Moreover, other costs of living in cities also typically increase at a much faster pace than wages. The starting monthly salary for another interviewee's position grew 50 per cent, from 3,000 yuan in 2008 to 4,500 yuan in 2018, but housing costs doubled during the same period (Company 51, Appendix). To offset these costs, locals can apply for minimum living standard subsidies and subsidized housing, but non-local workers cannot.⁵⁹

⁵³ Song 2014.

⁵⁴ Gallagher, Lee and Kuruvilla 2011.

⁵⁵ Lee 2012.

⁵⁶ Gao, Yang and Li 2017.

⁵⁷ Ma, Li and Iwasaki 2023.

⁵⁸ Duan et al. 2020.

⁵⁹ Feng, Shuaizhang, Hu and Moffat 2017.

The greater legal protection afforded to local workers ironically makes it more costly for firms to hire them over non-local workers. For example, in Shenzhen, employers are required to provide medical insurance for contracted employees. They must purchase Tier 1 insurance for local employees and contribute 6 per cent of the worker's salary to the premium. On the other hand, employers are allowed to purchase Tier 2 or Tier 3 insurance for workers without a local *hukou*, which only costs them 0.5 per cent or 0.4 per cent of the worker's monthly salary, respectively.⁶⁰ The higher government-mandated benefits make local workers a greater financial burden to their employers than migrant workers in the same position.

On average, when compared to local workers, migrant workers have a wider menu of acceptable exit options. Their disadvantaged position also means that exit options no worse than their current position are comparatively more abundant. Given the plethora of imminent threats to their employment and family well-being, many migrant worker interviewees openly stated that technological displacement was not among their top concerns. What might migrants choose to do if they lost their job through automation? Interviewees frequently mentioned options outside of manufacturing, such as insurance sales, realty, ride-share driving and food delivery.

Non-local workers are also more likely to be geographically mobile. This is advantageous in the case of technological displacement. Robot adoption has been taking place at very different speeds across provinces.⁶¹ At the end of 2017, robot density was more than double in provinces like Guangdong and Jilin than in Hubei, for example.⁶² More geographically mobile workers may still find manufacturing work elsewhere, should they wish to do so, given the uneven distribution of technology across the country. In addition, many have landholdings in their hometown. Land ownership can be viewed as a form of "self-insurance."⁶³ Land assets can offer a stock of wealth and a hedge against negative labour market risks, including risks from automation.⁶⁴ The effectiveness of land as a hedge against hard times depends on the value of the land itself; in general, property increases the permanent income of owners and permits them to "smooth" their spending over labour market or other fluctuations.⁶⁵ Across a variety of country settings, land or residential wealth has been shown to reduce the need for support or government welfare, to alter migration preferences and to increase support for right-wing parties.⁶⁶ Opportunities elsewhere might reduce migrants' overall anxiety about automation in their workplace.

Empirical test

We test this theory using our original worker survey, which was fielded in 19 southern cities. The sampling procedures are discussed above. Additional information about the sample can be found in the Appendix. We collected responses from about 2,400 production workers in manufacturing. Our sample was 50 per cent male, the average respondent was 34 years of age, had attended either high school, vocational school or technical school, and had a local *hukou*. The respondents worked in a large variety of industries, with electronics and electrical appliances (23 per cent), clothing and textile (15 per cent), and machinery and equipment (8 per cent) best represented in the sample.

To test our theory (Figure 4), we conducted a mediation analysis (reported here) and OLS with robust standard errors adjusting for firm clustering (reported in the Appendix). The dependent

60 The full text of the Shenzhen Social Medical Insurance Law is available at http://sso.sz.gov.cn/pub/sbjmeta/zxbs/zdyw/cbyw/zcwj/201408/t20140830_2553100.htm. Accessed 15 June 2020.

61 Cheng et al. 2019.

62 Feng, Xiaojun 2020.

63 Zou, Jing, Chen and Chen 2022; Carroll 1997.

64 Ansell 2014.

65 Friedman 1957.

66 Ansell 2014; Van Wey 2005.

variable is the level of automation anxiety felt by workers. The survey asked respondents, “If your firm adopts industrial robots or automates production, how worried are you about losing your job?” Answers ranged from “not at all worried” to “very worried.” The independent variable (dummy) is an individuals’ *hukou* status – local or non-local. The mediator is a proxy of exit options. We conceptualize it as the ease of finding a comparable job. We asked respondents how easy or difficult it would be for them to find a job of similar compensation if they were to lose their job. Figure 4 can be operationalized as:

$$\text{ExitOption} = \beta_1 + a(\text{NonLocal}) + e_1$$

$$\text{AutoAnxiety} = \beta_2 + c'(\text{NonLocal}) + b(\text{ExitOption}) + e_2$$

$$\text{AutoAnxiety} = \beta_3 + c(\text{NonLocal}) + e_3$$

Additionally, we include a host of individual-level demographic and attitudinal covariates that may influence technological anxiety. We control for age, gender and the number of years an individual had served in their current firm (as a proxy of job stability). We also control for education, which may be correlated with individuals’ ability to adapt to and benefit from workplace technology⁶⁷ and how susceptible they are to automation.⁶⁸ The model also includes a firm-reported variable of whether the company had begun preparing workers for automation; preparation should be correlated with exposure to automation. In addition, the model accounts for any existing plans to leave the firm. Finally, we control for firm ownership (privately-owned, foreign-owned, state-owned), firm size (as measured by employment size), firm-level profit margin and industry type (for example, clothing and textiles, food and beverage). We include k-1 levels of the original variable for firm ownership and industry type.

Results

Results from the mediation analysis can be found in Table 1 below. We present bootstrapped standard errors and confidence intervals to avoid the assumption of the normality of $a*b$.⁶⁹ Overall, we find that residents with a non-local *hukou* believe it is easier for them to find a comparable job and are in turn less likely to be worried about technological displacement. The point estimate for path A linking the independent variable to the mediator is positive and the confidence interval does not contain zero. The point estimate for path B linking the mediator to the dependent variable is negative and the CI does not overlap with zero. A *hukou*’s statistically significant effects on exit options and technological anxiety are consistent with the predictions of the theory. The effect is substantively modest, but a *hukou*’s role is comparable to a common explanation of automation susceptibility: education. The additional achievement of an educational milestone increases the perceived availability of exit options and reduces individuals’ technological anxiety by roughly the same magnitude as having a non-local *hukou*. An additional question concerns the degree to which the effect of a local/non-local *hukou* on automation anxiety is mediated by the perceived availability of exit options. Using the method proposed by Xinshu Zhao and colleagues to test mediation, there is partial mediation.⁷⁰ According to this model, about 30 per cent of the effect of a non-local *hukou* is mediated by beliefs about exit options. The institutional arrangement has a moderate influence on automation anxiety by influencing how well respondents believe they will fare if they lose their jobs, even controlling for standard explanations like education, age and gender.

Some of the individual-level covariates also help to explain automation anxiety. The longer workers serve in a company, the less they are worried about being displaced by robots as seniority

67 Gallego, Kurer and Schöll 2022.

68 Frey and Osborne 2017.

69 Results are not meaningfully different from those derived from the Sobel or delta method.

70 Zhao, Lynch Jr and Chen 2010.

Table 1. Mediation Analysis (with percentile bootstrap CI; 10,000 resamples)

	Estimate	Std Err	z-value	<i>P</i> (> z)
Automation anxiety ~ non-local (c)	-0.085	0.033	-2.539	0.011
Exit option ~ non-local (a)	0.080	0.037	2.169	0.030
Education	0.086	0.019	4.508	0.000
Gender (Male=1)	-0.000	0.035	-0.007	0.994
Age	-0.001	0.003	-0.454	0.650
Years in firm	-0.007	0.004	-1.815	0.069
Firm-level automation training	0.004	0.017	0.233	0.816
Leave	0.005	0.046	0.106	0.916
Owner2: Private	0.254	0.090	2.816	0.005
Owner3: Foreign	0.297	0.092	3.240	0.001
Firm size	0.000	0.000	0.012	0.991
Profit	0.001	0.014	0.074	0.941
Industry1: Electronics	-0.034	0.059	-0.572	0.567
Industry2: Machinery	-0.079	0.077	-1.021	0.307
Industry3: Plastics	-0.058	0.090	-0.646	0.519
Industry5: Metalworking	-0.082	0.103	-0.799	0.424
Industry6: Furniture	0.118	0.077	1.542	0.123
Industry7: Automobile	-0.342	0.103	-3.333	0.001
Industry8: Food	-0.044	0.080	-0.545	0.586
Industry9: Others	-0.115	0.057	-2.032	0.042
Automation anxiety ~ exit option (b)	-0.425	0.026	-16.421	0.000
Education	-0.104	0.018	-5.836	0.000
Gender	0.002	0.033	0.064	0.949
Age	-0.003	0.003	-1.083	0.279
Years in firm	-0.015	0.004	-3.821	0.000
Firm-level automation training	0.002	0.016	0.094	0.925
Leave	0.128	0.043	2.967	0.003
Owner2: Private	0.063	0.093	0.682	0.495
Owner3: Foreign	0.085	0.096	0.890	0.374
Firm size	0.000	0.000	0.601	0.548
Profit	-0.009	0.013	-0.675	0.500
Industry1: Electronics	0.090	0.053	1.717	0.086
Industry2: Machinery	0.021	0.064	0.331	0.740
Industry3: Plastics	0.051	0.080	0.637	0.524
Industry5: Metalworking	-0.014	0.079	-0.175	0.861
Industry6: Furniture	0.002	0.071	0.021	0.983
Industry7: Automobile	0.047	0.082	0.570	0.569

(Continued)

Table 1. (Continued.)

	Estimate	Std Err	z-value	<i>P</i> (> <i>z</i>)
Industry8: Food	-0.138	0.077	-1.804	0.071
Industry9: Others	0.055	0.052	1.057	0.291
Defined Parameters:				
Indirect	-0.034	0.016	-2.132	0.033
Direct	-0.085	0.033	-2.539	0.011
Total	-0.119	0.037	-3.219	0.001

affords them a feeling of security, but this effect is not mediated by beliefs about exit options. Longer-serving employees believe they have fewer options beyond their current position, but they are less concerned about being a victim of technological displacement. However, age and gender have no impact on technological anxiety. We included firms' self-reported training of workers for automation in the model. This variable might affect automation anxiety in both directions: firms that prepare workers for automation might decrease their automation anxiety as workers who receive training are typically trained to be complementary to machines; however, the availability of training opportunities might mean a higher prevalence of machines in the workplace, increasing workers' anxiety. In our model, possibly owing to these opposing effects, automation training at the firm level is not predictive of attitudes regarding automation. We ran a different model including self-assessed risk of job automation (in Appendix).

Unsurprisingly, self-assessed risk of job automation in the next five to ten years is positively associated with technological anxiety overall. That said, those who feel optimistic about their prospects in the face of automation do not feel similarly optimistic about their exit options.

Firm- and industry-level indicators, on the other hand, are less reliable predictors than individual-level predictors of automation anxiety. Firm size (as measured by employment) and profit margin do not have a statistically significant effect on the dependent variable. In addition, workers in privately owned and foreign-owned companies are no more or less worried about being replaced by robots than workers in state-owned enterprises (SOEs), the baseline category, even though SOEs are less likely to automate.⁷¹ Interestingly, workers in private and foreign firms believe they have more exit options than those in SOEs. Different industry types, compared to the clothing and textiles industry baseline, appear to have no effect on anxiety. This is in line with expectations of scholarship which argues for a task-based approach rather than an industry-based approach to understand automation susceptibility.⁷² Industry type does not predict automation anxiety.

On the whole, these results are consistent with the proposed theory and support the findings derived from the semi-structured interviews conducted in the field. Paradoxically, insofar as Chinese manufacturing workers experience anxiety over prospective job automation, local workers are more worried than migrant workers with non-local *hukou* about technological displacement.

Discussion and Conclusion

This paper presents qualitative and quantitative accounts of Chinese manufacturing workers' reception of workplace automation based on semi-structured interviews, factory visits and two original surveys conducted in 19 cities. Contrary to the scholarship's more pessimistic accounts of

71 Cheng et al. 2019.
72 Acemoglu and Autor 2011; Frey and Osborne 2017.

automation, most manufacturing workers in southern China – buffered by steady increases in demand and chronic labour shortages – appear to be unconcerned about the impact of automation on employment and wages at present. Rather than focus on economic or material concerns, our worker interviewees emphasized the immediate and observable effects of technological improvements, such as the reduced risk of injury, less monotonous work, lower labour intensity, increased competitiveness and an improved working environment. This is in line with earlier work studying Chinese manufacturing and in contrast to some of the more doomsday portrayals of job automation. The on-the-ground benefits of technological improvements play an important role in influencing blue-collar workers' attitudes towards technology, but they are often overlooked in macroeconomic analyses and popular discourses regarding workplace automation. Workers' positive attitudes towards technology can help us to make sense of the state's push to automate, and even to some extent vindicate the bold slogan of "replace humans with robots." At least during our fieldwork, which was conducted just before the COVID-19 pandemic, workers' perceived benefits from technology seemed to outweigh their concerns over potential job losses.

On the other hand, our findings also point to the fact that manufacturing workers recognize the possible effects of automation on employment in the future. The habituation of the day-to-day benefits of technological adoption and an unexpected decline in the allure of maintaining industrial export dominance could push labour market concerns to the forefront. A sizable proportion – about half – of the surveyed workers believed that their jobs could be automated within the decade. Since the conclusion of our study, the arrival of COVID-19 introduced added economic uncertainty. During the first two months of 2020, investment and consumption fell by over 20 per cent year-on-year and the national unemployment rate rose.⁷³ Zooming in on manufacturing, stringent "zero-COVID" policies in 2020 and 2021 restricting labour mobility exacerbated labour shortages in coastal manufacturing enterprises. Enterprises clustered in Wuhan, Guangdong, Zhejiang and Jiangsu had to delay or suspend production due to a lack of manpower.⁷⁴ Pre-pandemic staffing and retention issues largely remain even today.⁷⁵ On the policy front, the Guangdong provincial government continues to attach great importance to automation and the digital transformation of manufacturing, viewing it as the most important means to enhance the international competitiveness of the industry. The 14th Guangdong Five-Year Plan in 2020 listed the intelligent robot industry cluster as one of the ten strategic emerging industry clusters. In November 2023, the People's Government of Guangdong Province issued a notice, "Several measures to accelerate technological transformation of industrial enterprises under the new situation in Guangdong province," announcing that no less than 100 billion yuan will be directed at the technological transformation of industrial enterprises from 2023 to 2027. Robot density will most likely increase. Even though the study was conducted before the pandemic, the trends highlighted in this paper appear unaltered.

If the pace of automation quickens, increasing numbers of workers may begin to feel anxious about technological displacement. Insofar as labourers experience automation anxiety, pre-pandemic survey results, controlling for a host of individual- and firm-level covariates, find that local workers are more worried than non-local workers about technological displacement. Results point to a mediation effect stemming from beliefs about one's exit options: even a sharp increase in robot adoption can be inconsequential if there are adequate alternatives and exit options in the labour market. This paper uses China's *hukou* system to test this theory about exit options. The *hukou* system determines an individual's official and only formal permanent residence at birth. Because it is difficult to transfer *hukou* even as people move around in search of economic

73 Zou, Peng, Huo and Li 2020.

74 Cai and Luo 2020.

75 One of the authors returned to the field in 2023. We surveyed 2,053 companies in Guangdong, with the manufacturing sector accounting for 51.93 per cent of the sample, and 71.6 per cent of manufacturing enterprises reported varying degrees of labour shortages.

opportunities, the system continues to shape individuals' opportunities, trajectories and treatment in the labour market. The undesirability of migrants' circumstances – out-of-pocket expenses for essential public services that they do not qualify for and sometimes years of separation from their children – makes their status quo less than ideal and thus jobs less painful to lose. Migrant workers face a plethora of imminent threats to their employment and family well-being, pushing technological displacement down their list of concerns. Their geographical mobility, openness to non-manufacturing jobs and hometown landholdings might also help to explain their lower levels of anxiety as they have a wider set of acceptable exit options. Conversely, the greater legal protections and costs associated with hiring local workers – stemming from more stringent labour legislation that is intended to help those workers – can potentially accelerate their job losses, relative to non-local workers. Once work becomes automatable, the history of industrial capitalism indicates that relative labour costs can play a significant role in affecting decisions to automate.⁷⁶

For researchers interested in Chinese politics, this work highlights the unintended labour consequences of an unequal welfare system that discriminates based on a status assigned to people at birth. By allowing systemic inequalities to persist (for example, permitting employers to opt for a less expensive tier of social insurance for their non-local employees), local governments inadvertently hurt the competitiveness of the group (i.e. the more expensive locals) they seek to protect. In addition, this project also reveals a possible tension between local governments' goal of facilitating industrial upgrading through incentivizing automation on the one hand and placating their local working-class constituents on the other. If local workers continue to feel more negatively affected by automation, local governments' aggressive push to modernize factories and promote "smart manufacturing" may create dissatisfaction among a group of constituents that is no stranger to contentious collective action.

Additionally, this paper offers an institutional explanation of automation anxiety that may have implications beyond China. While existing explanations of education and job characteristics are no doubt relevant to the analyses of technology attitudes, this paper shows how institutions can lead to different levels of technological receptiveness for people who face similar threats of job automation by altering the set of acceptable exit options (compared to the status quo). Although the *hukou* system was not intended to be a "labour market institution," the study invites new questions about these institutions (for example, unions, employment protection legislation) more broadly. In other countries, existing structures of labour organization often affect the value of the job at stake, especially for workers with lower educational attainment but well-remunerated jobs. If good exit options are far and few between, antagonism towards technology is more likely to originate from these organized groups, although it is not yet clear how automation may fundamentally shift the balance of capital–labour bargaining. Institutions of work affect what is at stake and the availability of exit options comparable to the worker's status quo. Future research would do well to consider how mechanisms creating stratification in other labour markets (for example, core and non-core employees in Japan, union and non-union workers in the United States) affect technology attitudes. If technological improvements are considered necessary to enhance economic growth and a nation's competitiveness, it is critical to understand the origins of technological anxiety and devise appropriate remedies to address these apprehensions.

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⁷⁶ Estlund 2021.

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References

- Acemoglu, Daron, and David Autor.** 2011. "Skills, tasks and technologies: implications for employment and earnings." *Handbook of Labor Economics* 4, 1043–1171.
- Acemoglu, Daron, Claire Lelarge and Pascual Restrepo.** 2020. "Competing with robots: firm-level evidence from France." *AEA Papers and Proceedings* 110, 383–388.
- Acemoglu, Daron, and Pascual Restrepo.** 2019. "Automation and new tasks: how technology displaces and reinstates labor." *Journal of Economic Perspectives* 33(2), 3–30.
- Acemoglu, Daron, and Pascual Restrepo.** 2020. "Robots and jobs: evidence from US labor markets." *Journal of Political Economy* 128(6), 2188–2244.
- Adachi, Daisuke, Daiji Kawaguchi and Y.U. Saito.** 2024. "Robots and employment: evidence from Japan, 1978–2017." *Journal of Labor Economics* 42(2), 591–634.
- Ansell, Ben.** 2014. "The political economy of ownership: housing markets and the welfare state." *American Political Science Review* 108(2), 383–402.
- Autor, David H.** 2015. "Why are there still so many jobs? The history and future of workplace automation." *Journal of Economic Perspectives* 29(3), 3–30.
- Autor, David H., Lawrence F. Katz and Melissa S. Kearney.** 2006. "The polarization of the US labor market." National Bureau of Economic Research Technical Report. *The American Economic Review* 96(2), 189–194.
- Balcázar, Carlos Felipe.** 2022. "Unions and robots: automation and the power of labor." SSRN 4360315, 7 September, <http://dx.doi.org/10.2139/ssrn.4360315>.
- Baruch, Yehuda, and Brooks C. Holtom.** 2008. "Survey response rate levels and trends in organizational research." *Human Relations* 61(8), 1139–60.
- Bessen, James.** 2015. "Toil and technology: innovative technology is displacing workers to new jobs rather than replacing them entirely." *Finance and Development* 52(001), 16–19.
- Cai, Min, and Jianwen Luo.** 2020. "Influence of COVID-19 on manufacturing industry and corresponding countermeasures from supply chain perspective." *Journal of Shanghai Jiaotong University (Science)* 25, 409–416.
- Carroll, Christopher D.** 1997. "Buffer-stock saving and the life cycle/permanent income hypothesis." *The Quarterly Journal of Economics* 112(1), 1–55.
- Chan, Kam Wing.** 1994. *Cities with Invisible Walls: Reinterpreting Urbanization in Post-1949 China*. Hong Kong: Oxford University Press.
- Cheng, Hong, Wen Jin Chen and Tang Li.** 2018. "Jiqiren zai Zhongguo: xianzhuang, weilai yu yingxiang – laizi Zhongguo qiye laidongli pipei diaocha (CEES) de jingyan zhengju" (Robots in China: status, future and impact – empirical evidence from the China employer–employee survey (CEES)). *Journal of Macro-Quality Research* 6(3), 1–21, <https://cees.whu.edu.cn/att/2018001.pdf>.
- Cheng, Hong, Ruixue Jia, Dandan Li and Hongbin Li.** 2019. "The rise of robots in China." *Journal of Economic Perspectives* 33(2), 71–88.
- Citi GPS.** 2016. "Technology at work v 2.0: the future is not what it used to be." Citi GPS: Global Perspectives and Solutions, 26 January, <https://www.oxfordmartin.ox.ac.uk/publications/technology-at-work-v2-0-the-future-is-not-what-it-used-to-be>.
- Dauth, Wolfgang, Sebastian Findeisen, Jens Suedekum and Nicole Woessner.** 2021. "The adjustment of labor markets to robots." *Journal of the European Economic Association* 19(6), 3104–53.
- Dekle, Robert.** 2020. "Robots and industrial labor: evidence from Japan." *Journal of the Japanese and International Economies* 58, 101108.
- Du, Yang, and Albert Park.** 2017. "Changing demand for tasks and skills in China." Background report for the World Bank Group (WBG)-Development Research Center under the State Council (DRC) on new drivers of growth in China.
- Duan, Jinyun, Juelin Yin, Yue Xu and Daoyou Wu.** 2020. "Should I stay or should I go? Job demands' push and entrepreneurial resources' pull in Chinese migrant workers' return-home entrepreneurial intention." *Entrepreneurship and Regional Development* 32(5–6), 429–448.
- Estlund, Cynthia.** 2021. *Automation Anxiety: Why and How to Save Work*. New York: Oxford University Press.
- Feng, Shuaizhang, Yingyao Hu and Robert Moffitt.** 2017. "Long run trends in unemployment and labor force participation in urban China." *Journal of Comparative Economics* 45(2), 304–324.

- Feng, Xiaojun. 2020. *The Labour Implications of Technological Upgrading in China*. Geneva: International Labour Organization.
- Frey, Carl Benedikt. 2019. *The Technology Trap: Capital, Labor, and Power in the Age of Automation*. Princeton, NJ: Princeton University Press.
- Frey, Carl Benedikt, and Michael A. Osborne. 2017. "The future of employment: how susceptible are jobs to computerisation?" *Technological Forecasting and Social Change* 114, 254–280.
- Friedman, Milton. 1957. *A Theory of the Consumption Function*. Princeton, NJ: Princeton University Press. <https://nber.org/books-and-chapters/theory-consumption-function>.
- Gallagher, Mary E., Ching Kwan Lee and Sarosh Kuruvilla. 2011. "Introduction and argument." In S. Kuruvilla, C.K. Lee and M.E. Gallagher (eds.), *From Iron Rice Bowl to Informalization: Markets, Workers, and the State in a Changing China*. Ithaca, NY: Cornell University Press.
- Gallego, Aina, and Thomas Kurer. 2022. "Automation, digitalization, and artificial intelligence in the workplace: implications for political behavior." *Annual Review of Political Science* 25(1), 463–484.
- Gallego, Aina, Thomas Kurer and Nikolas Schöll. 2022. "Neither left behind nor superstar: ordinary winners of digitalization at the ballot box." *The Journal of Politics* 84(1), 418–436.
- Gao, Qin, Sui Yang and Shi Li. 2017. "Social insurance for migrant workers in China: impact of the 2008 Labour Contract Law." *Economic and Political Studies* 5(3), 285–304.
- Giuntella, Osea, and Tianyi Wang. 2019. "Is an army of robots marching on Chinese jobs?" IZA Institute of Labour Economics Discussion Paper No. 12281, <https://ssrn.com/abstract=3390271>.
- Goos, Maarten, Alan Manning and Anna Salomons. 2014. "Explaining job polarization: routine-biased technological change and offshoring." *American Economic Review* 104(8), 2509–26.
- He, Zhanhong, and Baoguo Han. 2019. "Smart machines: study of adaptability on human replacement – a survey of traditional industrial workers in Foshan City." *Journal of Guangdong Industry Polytechnic* 1, 36–42.
- Huang, Yu, and Naubahar Sharif. 2017. "From 'labour dividend' to 'robot dividend': technological change and workers' power in south China." *Agrarian South: Journal of Political Economy* 6(1), 53–78.
- International Federation of Robotics. 2019. "US robot density now more than double that of China," <https://ifr.org/news/us-robot-density-now-more-than-double-that-of-china-ifr-says/#:~:text=Robot%20density%20in%20the%20US%20manufacturing%20industry%20reached%20200%20robots,robot%20installations%20in%20the%20US>.
- Kapiszewski, Diana, Lauren M. MacLean and Benjamin L. Read. 2015. *Field Research in Political Science: Practices and Principles*. Cambridge: Cambridge University Press.
- Koch, Michael, Ilya Manuylov and Marcel Smolka. 2021. "Robots and firms." *The Economic Journal* 131(638), 2553–84.
- Lee, Leng. 2012. "Decomposing wage differentials between migrant workers and urban workers in urban China's labor markets." *China Economic Review* 23(2), 461–470.
- Lei, Ya-Wen. 2022. "Upgrading China through automation: manufacturers, workers and the techno-developmental state." *Work, Employment and Society* 36(6), 1078–96.
- Li, Xun, Eddie Chi-man Hui, Wei Lang, Shali Zheng and Xiaozhen Qin. 2020. "Transition from factor-driven to innovation-driven urbanization in China: a study of manufacturing industry automation in Dongguan city." *China Economic Review* 59, 101382.
- Liu, Larry, and Han Zhang. 2023. "Robots and protest: does increased protest among Chinese workers result in more automation?" *Socio-Economic Review* 21(3), 1751–72.
- Ma, Xinxin, Yalan Li and Ichiro Iwasaki. 2023. "The hukou system and wage gap between urban and rural migrant workers in China: a meta-analysis." *Economics of Transition and Institutional Change* 32(4), 1105–36.
- Meng, Xin. 2012. "Labor market outcomes and reforms in China." *Journal of Economic Perspectives* 26(4), 75–102.
- Milner, Helen V. 2021. "Voting for populism in Europe: globalization, technological change, and the extreme right." *Comparative Political Studies* 54(13), 2286–2320.
- O'Brien, Kevin J. 2018. "Speaking to theory and speaking to the China field." *Issues and Studies* 54(04), 1840007.
- Pardos-Prado, Sergi, and Carla Xena. 2019. "Skill specificity and attitudes toward immigration." *American Journal of Political Science* 63(2), 286–304.
- Sharif, Naubahar, and Yu Huang. 2019a. "Achieving industrial upgrading through automation in Dongguan, China." *Science, Technology and Society* 24(2), 237–253.
- Sharif, Naubahar, and Yu Huang. 2019b. "Industrial automation in China's 'workshop of the world'." *The China Journal* 81(1), 1–22.
- Song, Yang. 2014. "What should economists know about the current Chinese hukou system?" *China Economic Review* 29, 200–212.
- Van Wey, Leah K. 2005. "Land ownership as a determinant of international and internal migration in Mexico and internal migration in Thailand 1." *International Migration Review* 39(1), 141–172.
- Wu, Nicole. 2022. "Misattributed blame? Attitudes toward globalization in the age of automation." *Political Science Research and Methods* 10(3), 470–487.

- Zhao, Xinshu, John G. Lynch Jr and Qimei Chen.** 2010. "Reconsidering Baron and Kenny: myths and truths about mediation analysis." *Journal of Consumer Research* 37(2), 197–206.
- Zou, Jing, Jie Chen and Yu Chen.** 2022. "Hometown landholdings and rural migrants' integration intention: the case of urban China." *Land Use Policy* 121, 106307.
- Zou, Peng, Di Huo and Meng Li.** 2020. "The impact of the COVID-19 pandemic on firms: a survey in Guangdong province, China." *Global Health Research and Policy* 5, 1–10.

Nicole WU is an assistant professor of politics and public administration at the University of Hong Kong.

Zhongwei SUN is professor of social security at South China Normal University's School of Politics and Public Administration.