NBER WORKING PAPER SERIES

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Working Paper 32547
http://www.nber.org/papers/w32547

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2024, Revised October 2025

This paper has benefited from comments and suggestions from Elisa Operti, Nilanjana Dutt, Minyuan Zhao, Svenja Friess and Ina Ganguli. We thank participants of the 7th Geography of Innovation Conference (GeoInno) at Manchester University, Workshop of UK Digital Economics at University of Cambridge, SPJIMR- Chicago Booth Quantitative Marketing Conference at SPJIMR Mumbai, EU-SPRI Annual Conference at University of Sussex, Institute of Public Goods & Policies, CSIC - Madrid, Libera Università Internazionale degli Studi Sociali (LUISS), Brunel University, University of Surrey, British Academy of Management (BAM) Conference at University of Sussex and XVIII International Conference on Public Policy & Management at IIM Bangalore for useful discussions. Funding from Hoover Institution Visiting Fellowship and University of Sussex Business School is acknowledged. Authors also acknowledge support from the Levy-Rosenblum Institute, Freeman School of Business, Tulane University. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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June 2024, Revised October 2025
JEL No. J16, O34

ABSTRACT

Do stronger intellectual property rights (IPR) incentivize women's participation in innovation? We provide new causal evidence on this question using the USPTO's Artificial Intelligence Patent Dataset. Our identification strategy exploits China's WTO TRIPS accession, which led to a substantial strengthening of IPR in 2002. Our results show that post-WTO accession, the number of patents with at least one female inventor in China rose by 95%, and the number of individual female inventors increased by 111%, relative to other countries. We also find significant improvement in patent quality measured by forward citations, strategic importance, and patent impact scores. Heterogeneity analysis shows that gains were concentrated in less complex AI technologies such as computer vision and knowledge processing, with smaller increases in frontier areas like machine learning and evolutionary computation. Our results are robust to alternative control groups, synthetic controls, coarsened exact matching, and randomized inference tests. We identify three mechanisms underlying this surge in female innovation. First, the share of domestic female inventors on patenting teams rose sharply. Second, patents with female inventors increasingly originated from private firms rather than state-owned enterprises, reflecting market liberalization effects. Third, systematic investment in women's higher education expanded the pool of qualified female researchers. Together, these findings suggest that while China's WTO accession provided an exogenous policy shock, complementary institutional reforms were essential in enabling women's participation in the innovation economy. Overall, the results highlight that stronger intellectual property rights when embedded in supportive institutional contexts can foster both technological progress and gender inclusion.

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1. Introduction

Is there a relationship between stronger intellectual property rights (IPR) and the labor market for inventors? Trade-offs associated with IPRs are central to innovation policy debates across the world (Arrow, 2015; Nordhaus, 1969). Advocates argue that stronger IPR stimulates technology transfer and leads to efficiency gains (Branstetter, Fisman, & Foley, 2006), while critics warn of static inefficiencies and risk of crowding out domestic innovation in less-developed countries (Lanjouw, 1998; McCalman, 2001; Motari et al., 2021). Yet the distributive consequences of IPR reforms - who participates in innovation, not just how much innovation occurs - remain less understood (Bhattacharya, Chakraborty, & Chatterjee, 2022; Kline, Petkova, Williams, & Zidar, 2019).

Some existing evidence shows that stronger IPR spurs innovation (Brown, Martinsson, & Petersen, 2017; Hu, 2010; Intarakumnerd & Charoenporn, 2015; Maskus, Milani, & Neumann, 2019), but whether these effects extend equally across different groups is unclear. We examine this question through a gendered lens. Structural barriers mean that women often face unequal access to resources, finance, knowledge, training, and network ties (Aneja, Reshef, & Subramani, 2022; Biscione, Boccanfuso, Caruso, & de Felice, 2021; Del Carpio & Guadalupe, 2022; Frietsch, Haller, Funken-Vrohlings, & Grupp, 2009; Pairolero, Toole, DeGrazia, Teodorescu, & Pappas, 2022). Yet, when endowed with a supportive innovation environment, women's contribution can be as strong or even more than men's (Marvel, Lee, & Wolfe, 2015; Mendonça & Reis, 2020; Wu, Dbouk, Hasan, Kobeissi, & Zheng, 2021). This suggests that structural changes may differentially affect inventor participation.

We investigate how stronger IPR influenced women's participation in innovation activity by exploiting a major institutional reform in China. China's accession to the World Trade Organization (WTO) in 2001 marked a major structural reform that tightened the IPR enforcement and reshaped incentives for inventors (Li, 2002). This setting provides a quasi-natural experiment to causally test whether stronger IPR can reduce barriers for women's participation in artificial intelligence patenting technology. Our hypothesis builds on Becker's model of discrimination (Becker, 2010), which predicts that stronger competition- induced by trade and market liberalization erodes discriminatory practices. Prior work has shown that trade shocks reduce gender wage gaps and improve female occupational outcomes (Black & Brainerd, 2004; Black & Strahan, 2001; Ederington, Minier, & Troske, 2009); we extend this framework to inventive labor in AI, a field where women remain particularly underrepresented (Aneja, Reshef, & Subramani, 2024; Bell, Chetty, Jaravel, Petkova, & Van Reenen, 2019; Hunt, Garant, Herman, & Munroe, 2012).

Descriptive evidence shows that after WTO accession share of AI patents in China rose sharply compared to rest of the world (ROW) (see Figure 1, Panel a), consistent with the 1400% surge in Chinese patenting documented by Fisch, Block, and Sandner (2016).[1] More strikingly, the share of female AI inventors increased relative to ROW (Figure 1, Panel b). We check if a similar pattern is observed in other major economies such as Japan, the United States, Canada, Germany, or India post their WTO accession. As shown in Figure 2, none of them show a rise in female inventors except China. These two figures (Figure 1 and Figure 2) taken together show two things. First, an increase in overall innovation may not always mean an increase in female-led innovation. Second, China seems like a standout case that deserves a deeper investigation which we attempt in this study.

To quantify these effects causally, we use the USPTO's Artificial Intelligence Patent Dataset (AIPD)[2], which classifies patents across eight AI technology classes for 123 countries from 1997–2011. Linking these patents to inventor-level data, we measure whether stronger IPR reforms facilitated greater gender inclusion. Our focus on AI patents is motivated by both context and literature. While the role of women in innovation has been studied in the broader patenting literature (Aneja et al., 2024; Bell et al., 2019; Hunt et al., 2012), AI patenting among women has received relatively little attention despite its current prominence and transformative potential. The late 1990s to mid-2000s marked a formative phase for the field, with foundational advances in statistical learning, natural language processing, speech recognition, and computer vision (Tait & Wilks, 2019; Zou, Chen, Shi, Guo, & Ye, 2023). Studying this "pre-takeoff" period is analytically valuable. It reveals whether institutional reforms opened opportunities

[1]We also empirically evaluate change in total number of patents in China post 2002 compared to ROW. Results are shown in Table A1.

[2]See website - https://www.uspto.gov/ip-policy/economic-research/research-datasets/artificial-intelligence-patent-dataset

for women precisely as a general-purpose technology was crystallizing, before later waves of capital and data accelerated adoption.

Importantly, women were especially underrepresented in AI relative to other technological domains. AI patents list on average only 0.63 female inventors compared to 2.00 for non-AI patents[3], making AI a stringent test-bed for gender inclusion mechanisms to be studied at the innovation margin (see Table A2). By tracing the historical trajectory of women's entry into AI innovation, we provide insights that can better inform today's debates on gender inclusivity in transformative technologies.

Using a difference-in-differences framework, we estimate the average treatment effect of the IPR policy shock post-2002 on women's AI patenting in China compared to the rest of the world. Our findings suggest that the number of AI patents with female inventors increased by 116.1% after 2002, and the participation of female inventors on these patents increased by 186.3% as compared to the rest of the world.[4] Our results resonate directly with the classic prediction from Becker's model of discrimination: when competition intensifies, the "taste for discrimination" becomes costlier and is competed away, raising the relative demand for previously under-utilized groups. China's WTO/TRIPS-linked strengthening of IPRs plausibly raised returns to high-quality inventive effort and increased market contestability. If discrimination had been constraining women's participation, we should observe elastic female entry into innovation, which is precisely the pattern we document.

We find three important mechanisms to explain why there is a surge in female participation in AI inventive activity in China post 2002. First, we find significant evidence of an increase in the share of domestic female inventors on patent teams in China.[5] Second, we find that after 2002, there was a surge in patents with female inventors filed by private firms compared to state-owned entities. Third, we observe a systematic effort from the Chinese government to promote

[3] We obtain non-AI patents also from USPTO and merged them with the gendered algorithm to get gender distribution within them

[4] These results remain robust, controlling for unobserved heterogeneity at the country, technology class, and over time. We also conduct multiple robustness checks, including coarsened exact matching (Iacus, King, & Porro, 2012), randomized inference testing (Rosenbaum, 2002), and synthetic controls (Abadie, Diamond, & Hainmueller, 2010); our benchmark findings remain consistent. Our results also hold when we use two alternative sets of control groups - emerging and developed nations. Refer to section 5 for more details.

[5] By design, this likely understates domestic participation gains that might be detectable in Chinese local patenting database like State Intellectual Property Office (SIPO) or China National Intellectual Property Administration (CNIPA), once high-fidelity gender attribution becomes feasible.

women in higher education, as documented by a sharp increase in the percentage of female enrollment in Ph.D. programs in scientific research institutes and an increase in gender parity for enrollment in tertiary education in China compared to the ROW. All these mechanisms show that while the opening up of the market post-2002 was an important exogenous shock, underlying complementary structural reforms provided support for the rise in female inventors.

Our results relate directly to Claudia Goldin's influential work on how institutional rules shape women's economic participation, and with evidence from labor markets showing that competition curbs discriminatory rents (Goldin, 2006). Additionally, Black and Brainerd (2004) find that rising import competition narrowed the U.S. gender wage gap, and Banerjee, Peñarrieta, and Chakraborty (2025) show that a trade liberalization in Chile raised the female share of white-collar employment in exporting firms. Our results extend these insights to the domain of technological innovation, highlighting how liberalizing markets and pro-appropriability reforms can alter who innovates, not just how much innovation occurs.

Finally, a growing literature shows that greater female participation improves inventive quality i.e. firms with female CTOs generate more highly cited patents (Wu et al., 2021), gender-diverse ownership is associated with higher innovativeness (Tonoyan & Boudreaux, 2023), and mixed-gender inventor teams produce higher-quality patents. Past work (Griffin, Li, & Xu, 2021; Kou et al., 2020; Le Loarne-Lemaire, Bertrand, Razgallah, Maalaoui, & Kallmuenzer, 2021; Ritter-Hayashi, Vermeulen, & Knoben, 2019) has found that more females within the technological innovation value chain and in boardrooms impact the adoption of efficient innovation processes, greater productivity, and better results. While studies have measured the value of Chinese patents between the period 2000-2011 across types of patents (Chen & Zhang, 2019), industrial ownership (Fisch, Sandner, & Regner, 2017; Liu, Cao, & Song, 2014; Thoma, 2013), financial incentives (Dang & Motohashi, 2015), and research universities (Fisch et al., 2016), there exists a gap in understanding these heterogeneities from a gender perspective. In this light, we find that the quality of innovation generated by female inventors in China increased positively and significantly after China became a member of the WTO.[6]

Our evidence that stronger IPR institutions induced sharp increases in women's participa-

[6]We utilize the Derwent Innovation database to measure the quality of patents using the number of forward citations, strategic importance, and impact of the patent in its field of publication.

tion in AI innovation underscores the broader welfare implications: reducing discriminatory frictions can unlock under-utilized human capital and enhance innovation efficiency.

The rest of the paper proceeds as follows. Section 2 provides the institutional background of China related to stronger IPR. Section 3 discusses the data. Our empirical strategy is outlined in Section 4. In Section 5, we discuss our findings along with robustness checks and mechanisms. Section 6 concludes with managerial and policy implications.

2. Impact of China Joining the WTO

2.1. Institutional Changes

After fifteen years of negotiations (since 1986), China formally joined the World Trade Organization (WTO) on December 11, 2001. WTO accession required China to undertake extensive legal and regulatory reforms to facilitate integration into the global market. In particular, China was expected to enhance transparency standards, curb trade-distorting subsidies, and strengthen IPR protection.

To meet these obligations, China implemented a series of sweeping and long-lasting reforms to its patent and trade laws between 2000 and 2002 (see Appendix Table A3). In 2000, the Chinese government amended its Patent Law to bring it into compliance with the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS).[7] TRIPS, a core component of WTO trade rules, mandates that member countries "enact substantive legislation to protect against counterfeiting and ensure that critical enforcement procedures are available in each member country to safeguard IP" (Evans, 2002; Stoianoff, 2012; Thomas, 2017).[8] By aligning its domestic framework with TRIPS, China not only signaled to developed economies its commitment to protecting innovators' rights but also began to reshape domestic perceptions of intellectual property and innovation. This institutional shift likely broadened the labor market for inventors and enhanced the social legitimacy of innovative activity (Evans, 2002; Giuliani

[7]The amendments spanned three key areas: (a) judicial and administrative procedures, (b) the patent application process, and (c) the enforcement mechanism.

[8]TRIPS covers the full spectrum of intellectual property protection, including patents, trademarks, and copyrights, as well as the adjudication of related disputes.

& Macchi, 2014; Stoianoff, 2012).

While the changes to patent law set the stage for innovators to be incentivized by new ideas, accession to the WTO along with a series of new laws in 2002 ensured patent holders of their IP rights (Li, 2002; Representative, 2002). Regulations on administration, registration, and prohibition of imports or exports of technologies, along with amendments to computer software protection, came into force on January 1, 2002. Rules related to creative innovation combining publications, motion pictures, sound, and video recordings came into effect on February 1, 2002. The implementation of regulations for copyright law and trademark law started on September 15, 2002. Finally, trademark examination guidelines were revised in October 2002 (Thomas, 2017). There were multiple IPR reforms in China post 2002, as shown in Table A4. We pick up 2002 as the intervention year, as it was the start of the series of policy reforms and is fundamental to understanding how it caused the baseline results to be only enhanced by subsequent policies.

Before WTO membership, China's science and technology policies primarily focused on promoting state-owned enterprises (SOEs), which, despite significant investment and periodic revitalization efforts, achieved limited progress (Prime, 2002). To foster innovation more effectively, China shifted from being a provider to a promoter of innovation—encouraging the growth of private enterprises, research universities, and a skilled human capital base. According to the Patent Rights Index (Park, 2008), China's ranking rose from 69th in 1995 to 34th in 2005 among 123 countries, reflecting a substantial strengthening of its patent protection regime. Combined with liberalized market regulations, a stronger domestic knowledge base, and a more pro-patent legal framework, these reforms catalyzed an unprecedented surge in innovative activity (Eberhardt, Helmers, & Yu, 2016; Prud'homme & Zhang, 2019).

2.2. *Innovation Environment of China*

In addition to examining gender participation in innovation, an important related question concerns the role of institutional reforms. We argue that China's evolving innovation environment, shaped by these legal and structural changes was instrumental in transforming its economy into a global technological leader, particularly in the development and adoption of artificial intelligence. Central to this transformation is the promotion of gender diversity, which not only broadens the pool of innovative talent but also enhances the inclusiveness and sustainability of technological progress. A 2016 WIPO report mentions that "The Republic of Korea (50%) and China (49%) had the greatest gender equality in international patenting via the PCT in 2015, whereas the greatest gender gaps among the top PCT countries of origin are found in Germany (19%), Japan (19%), Italy (18%) and South Africa (16%)".[9] Clearly, much therefore remains to be understood on what institutional environment drives these findings around the co-evolution of female inventors in the national innovation ecosystem.

Extant work has explored the role of financial support, such as subsidies, attracting FDI, and R&D support that may have led to the patent explosion in China. Chen and Zhang (2019) provides a perspective on this effect by disentangling the heterogeneity by patent types. They find that although financial benefits increase the number of applications filed in China, there is heterogeneity in quality. Along similar lines, other researchers suggest that R&D explains only a fraction of the growth in patenting. Eberhardt et al. (2016), Guan and Yam (2015) & Hu and Jefferson (2009) attribute the explosion to state incentives, such as the second amendment of Chinese patent law in 2000 and the exit of state-owned enterprises, which led to the entry of non-state entities. Dang and Motohashi (2015), Lei, Sun, and Wright (2012) & Li (2012) credit patent subsidies across regions as a positive policy shock-inducing firms and individuals to innovate more. Finally, Tiwari, Anjum, Chand, and Phuyal (2017) & Lundvall and Rikap (2022) show that significant investments in human capital, education, and research universities may explain the evolution of innovation in China.

There is also a strand of literature that questions institutional homogeneity and gives evidence of spatial variation in innovation across regions and industries in China. Innovation is found to be restricted to a few locations with higher populations and more industrialization (Crescenzi, Rodríguez-Pose, & Storper, 2012; Prud'homme & Zhang, 2019). There also seems to be a skew towards a few clusters of active industries with better technological capabilities (Eberhardt et al., 2016; Guan & Yam, 2015; Prud'homme & Zhang, 2019) and to regions with positive knowledge spillovers generating agglomeration externalities (Kafouros, Wang, Piper-

[9] See https://www.wipo.int/pressroom/en/articles/2016/article0015.html

opoulos, & Zhang, 2015; Li, 2009; Ma, Lee, & Chen, 2009; Shang, Poon, & Yue, 2012).

Overall, while micro-policy and industrial changes may have played a role (Hu & Jefferson, 2009), the question of whether structural changes like stronger IPR incentivize female participation in innovation remains under investigated.[10] Relatedly, whether stronger IPR also relates to an increase in the quality of patents with female participation in innovation also needs to be addressed. Our study provides some of the first evidence on these two important questions.

3. Data

We obtained data on inventors participating in patenting activity between 1997 and 2011 using PatentsView, a publicly available repository of the United States Patent and Trademark Office (USPTO).[11] The raw USPTO data files are widely used for conducting studies related to patenting activity and innovation. These files offer researchers several advantages. First, the PatentsView data aggregation process incorporates a built in algorithm that predicts an inventor's gender. It builds on prior gender classification methods using country-specific names associated with males and females (Caviggioli & Forthmann, 2022; Giczy, Pairolero, & Toole, 2024). Second, it also deals with problems from misspellings and other errors found in raw text fields (Toole, Jones, & Madhavan, 2021). These nuances and attention to detail make the attribution results more accurate and reliable.[12] Using this database, we identify the inventors participating in patenting activity over our study period across 123 countries, such as China,

[10] In this regard, to check for the specificity of IPR as the key driving factor we also analyse other structural reforms before 2002 that could explain the observed rise in women's participation in innovation. The first is the 1992 amendment to China's Patent Law, which was the first major change to the patent law in China. This amendment broadened patentable subject matter, clarified patent rights, and enhanced the scope of legal protection. The second is the 1998 higher education reform, which substantially expanded university enrollments and sought to modernize China's tertiary education system. To this end, we test their impact using our baseline model. The results show no evidence of an increase in female-led patenting or the number of women inventors (see Table A5). This evidence speaks more generally to the point that if female inventors were able to thrive under any policy improvement, we would expect to see similar increases for 1992 and the 1998 reforms. Thus, the absence of such effects reinforces that the post-2002 increase is specifically linked to the substantial strengthening of IPR associated with WTO accession.

[11] https://patentsview.org/download/data-download-dictionary

[12] Gender inference for Chinese names after Romanization to Pinyin is error-prone; a medical-informatics study evaluating NamSor, Gender API, and Wiki-Gendersort on 20,000 Chinese given names in Pinyin reported misclassification rates of 43–94%, even after excluding unisex names (Sebo, 2022). Such error rates materially bias gender-disaggregated measures of inventive activity. For these reasons, the USPTO provides a more consistent, reliable and conservative test for our baseline question.

Japan, the USA, South Korea, the UK, and India.[13] Further, we rely on USPTO patents for two main reasons: international comparability and selectivity. Patents filed at the USPTO are typically of higher economic and technological significance, as they seek protection in one of the world's largest and most competitive markets. By focusing on this subset, we capture internationally relevant Chinese innovations and reduce noise from minor or low-value filings. This approach strengthens the external validity of our analysis and follows prior literature that uses USPTO data to benchmark global innovation trends.[14]

To identify the patents that our sample of inventors have worked on, we merge the inventor data with the artificial intelligence patent database (AIPD) published by the USPTO (Fang, Gu, Yan, & Zhu, 2025). This crossover data gives us an understanding of the participation of inventors in patents granted between 1997 to 2011 that had a component of AI. The AIPD data allows us to identify each patent's AI component across eight technology classes, including machine learning, natural language processing, evolution, knowledge reasoning, hardware, planning, speech, and vision technologies (Giczy, Pairolero, & Toole, 2022). Through a machine learning algorithm based on patent text, claims, and citations, each patent is given a probability score between 0.0 and 1.0, indicating the degree of presence of the eight AI components. The AI probability scores are translated into binary variables taking the value of one if the score is greater than or equal to 0.50 and zero otherwise. This allows us to categorize each patent according to its dominant technology component.

Using patent and gender information, we generate a panel at the country, technology class, and year level from 1997-2011. Table 1 describes the construction and definition of the main variables used in our study. There are two main dependent variables assessing female participation in innovation activity. First is the number of patents with female inventors, defined as the total number of patents in a country in a given year in each technology class with at least one female inventor on the patenting team.[15] Second is the total number of female inventors partic-

[13] We used the patent-inventor crosswalk dataset containing identifying location id, inventor id, and patent id to map the inventor information (such as name, gender, patent, country of residence, or inventor location).

[14] In contrast, domestic rather than filings at China's State Intellectual Property Office (SIPO/CNIPA) filings pose several challenges: the sheer volume of filings includes many strategic or low-quality patents, and inventor name disambiguation is considerably more difficult.

[15] A patent can be classified into a technology-year category for more than one country due to international collaborations.

ipating in innovation activity at the country-technology-year level.[16] For both these dependent variables, we also create share variables by dividing the patents with female inventors by the total number of patents and the number of female inventors by the total number of inventors.

From our crossover dataset, we identify the patents for each year in a country across technology classes that had non-zero female inventors. We take this information and collapse mean values at the country-technology-year level to calculate patent quality. We use the information on citations, strategic importance, and patent impact from the Derwent Innovation Database to understand the quality of innovation activity. The number of citations or forward citations refers to "the number of times a patent has been cited by subsequent patents, indicating that these newer patents are technologically built upon the cited (previously filed) patent" (Fisch et al., 2017)[17]. Patent citation has been among the most frequently used measures to assess patent quality (Lanjouw & Schankerman, 2004; Schmitt, 2025), technological output (Hall, Jaffe, & Trajtenberg, 2000), and information flow (Jaffe & Trajtenberg, 2002).[18]

However, there has also been criticism of the use of citations as a measure of quality of patents (Moser, Ohmstedt, & Rhode, 2018). To overcome this debate, we add two more measures of quality - strategic importance and patent impact. These are unique scores generated by Derwent Innovation based on machine learning algorithms for every patent to obtain its effectiveness. Strategic importance indicates a patent's ability to enable firms to make crucial business decisions, monitor technology trends, or identify market opportunities. Patent Impact indicates the overall technological or competitive footprint of an invention. Table 2 presents the summary statistics for the main variables in our study.[19]

[16]Since we cannot capture the level of contribution of a female inventor in each technology component of a patent distinctively, we consider a female as an inventor across multiple technology classes if a patent falls under this ambit. For example, if patent xyz invented by a Chinese female in 2001 had three AI components (ML=0.3, NLP=0.7, Vision=0.6), this female inventor will be included as an AI inventor of ML, NLP, and Vision equally.

[17]The citation time window is from the date of publication to March 2022 when we accessed the data.

[18]The measure of the quality of innovation has been at the center of debate in research involving patents. Measures such as patent claims (Harhoff & Wagner, 2009; Régibeau & Rockett, 2010; Tong & Frame, 1994), forward citations (Gambardella, Harhoff, & Verspagen, 2008; Hagedoorn & Cloodt, 2003; Harhoff, Scherer, & Vopel, 2003), citation lag (Fisch et al., 2017; Gay, Le Bas, Patel, & Touach, 2005) and patent renewals (Bessen, 2008; Chen & Zhang, 2019; Liu et al., 2014) have all been used in the extant literature.

[19]As a comparison exercise, which reiterates the importance of analysing AI innovation, we present the descriptive estimates for non-AI patents in Table A2. The mean log number of patents with at least one female inventor is 1.68 for non-AI patents, whereas it is 0.46 for AI patents. Similarly, on average, there are 2 female inventors of non-AI patents but only 0.63 for AI patents. These patterns suggest that female representation is substantially lower in AI innovation than in other technological domains, underscoring the importance of studying this case in particular.

Table 3 provides descriptive estimates from a simple difference-in-differences framework related to the impact of China joining the WTO. The table highlights the mean value of the log of patents with female inventors and the log of female inventors in the pre- and post-period for China and the ROW. We define 1997-2001 as the pre-shock period and 2002-2011 as the post-shock period. The estimates from first difference indicate a significant increase for both outcome variables as China strengthened its intellectual property regime after its accession to the WTO.

Table 3 also highlights the difference-in-differences estimate (first minus second difference) of raw means. We find a significant increase in both of our main dependent variables. We also find similar results for both the share variables. The t-test and the p-values confirm the significance of the mean difference. These preliminary results from the simple difference-in-differences setup are merely suggestive and non-parametric and require the inclusion of fixed effects and robustness checks to establish a stronger causal inference.

4. Empirical Specification

We evaluate the average treatment effect of China's membership in the WTO on the participation of female inventive labor and their patenting activity by using difference-in-differences as our identification strategy. To study the causal relation, we use the following regression specification

$$\mathbf{y_{ity}} = \beta_0 + \beta_1 \mathbf{China_i} \times \mathbf{Post2002_y} + \theta_i + \theta_t + \theta_y + \nu_{it} + \phi_{ty} + \epsilon_{ity} \tag{1}$$

where y_{ity} is the outcome variable measured at the country (i)- technology (t)- year(y) level. y_{ity} is used as the number of patents with at least one female inventor and the number of female inventors in two separate estimates (in the log). $China_i$ corresponds to a dummy for our treatment group, which equals one when country i is China and zero for the ROW (control group). $Post2002_t$ equals one if the year is after 2002, zero otherwise. θ_i, θ_t ,θ_y represent country, technology class, and year dummies respectively. ν_{it} & ϕ_{ty} represent paired dummies of country-technology and technology-year respectively. These allow us to control for simultaneous events such as the SkyNet[20] and Smart Cities[21] projects launched in China during the sample period, which may confound our results otherwise. Standard errors are clustered at the country level.

The main coefficient of interest in our study is β_1. This estimate captures the effect of China's membership in the WTO on the participation of females in innovation activity at the technology level, as compared to the ROW exogenous to the regulation. In other words, it measures the change in female inventors and their patenting activity due to Chinese accession to the WTO, net of change post-2002, and net of possible permanent difference across the ROW.[22]

Our control group comprises 123 countries, which are termed the ROW in this study. The preferred counterfactual would have been to identify an exact country with a similar institutional innovation regime and characteristics as China to act as the suitable control group. We recognize that the ROW may not be the perfect comparison group to test the validity of the policy change; hence, we satisfy the assumption for parallel trends and run numerous validation checks.

Additionally, we run our regression specifications with an alternative control group that has only developed countries and emerging economies in two separate specifications. We perform robustness checks using coarsened exact matching for estimating the true effects of treatment and conduct randomized inference tests to ensure that our results are not obtained by a matter of chance. Finally, we use a data-driven procedure to identify a comparison group based on synthetic controls by Abadie and Gardeazabal (2003).

[20]Launched to ensure public security by rolling out technology(such as facial recognition) to monitor anti-social behavior.

[21]Central government-funded project, encouraged firms to build new technology-integration with facial recognition, big data, and AI to monitor anti-social behavior.

[22]Equation 1 represents the reduced form estimation. We test for effects at the first stage using the same specification with total patents as the dependent variable. The results from this estimation have been summarized in Table A1. The positive and significant coefficient in column (3) suggests that after the strengthening of IPR in 2002, the total number of patents in China increased by 82% compared to the ROW. This specification is inclusive of country-technology and year-fixed effects.

5. Findings

5.1. *Increasing Female Led Innovation in China After WTO Accession*

5.1.1. *Baseline Findings*

Table 4 presents our baseline results by estimating Equation 1. The dependent variable in Panel A is the log of the number of patents with at least one female inventor, and in Panel B is the log of the number of female inventors. In both panels, column (1) shows baseline estimation without any fixed effects. Column (2) includes the fixed effects at the country and technology level, and in column (3), we introduce year fixed effects and an interaction dummy for country-technology and technology-year, along with the existing fixed effects. Standard errors in all estimations are clustered at the country level.[23]

The interaction coefficients in Table 4 represent the impact of China becoming a WTO member on its female inventors and their involvement in AI patenting activity (compared to the ROW). We use column (3) for interpretation since they are the most conservative with all fixed effects. In column (3) of Panel A, where we consider patents with at least one female inventor, we find a positive and significant interaction coefficient (β = 1.161). This indicates that China's WTO accession caused an increase in the number of patents with at least one female inventor by 116% as compared to the ROW.[24] Similarly, findings in column (3) of Panel B, where we consider the number of female inventors, indicate a positive and significant interaction coefficient (β = 1.836). This indicates that the number of female inventors in China increased by 183.6% compared to the ROW after 2002.[25] [26]

[23]Estimations with standard errors clustered at the country-technology level also follow the same sign and significance as our baseline results. Results are shown in Table A6.

[24]Our positive and significant results are in line with the existing literature. Seminal papers exploiting trade shocks show an increase in female employment and a reduction in the gender wage gap. Specifically, Banerjee et al. (2025) find that the share of female white-collar workers increased by 10% among new exporters to Mexico as a result of the Chile–Mexico FTA. Similarly, Black and Brainerd (2004) find that the average increase in import share in concentrated industries in the US accounts for a decline in the residual gender wage gap in the manufacturing sector of approximately 0.034 log points.

[25]We also find an increase in male inventors during the same time using the same regression model, but the coefficient is much smaller.

[26]The dependent variables in the analysis are defined as log(1+X), where X represents either the number of patents with female inventors or the number of female inventors in a country. However, (Cohn, Liu, & Wardlaw, 2022) has shown that using this transformation in linear regressions can lead to incorrect expected signs. To address this concern, we re-estimate the baseline results using a Poisson model. Estimates are shown in Table A7.

There could be a concern that these results are obtained because of an overall increase in patenting activity, and an increase in female innovators is just part of the overall growth in innovation in China. To overcome this concern, in Table 5, we present results on the share of patents with female inventors and the overall share of female inventors using Equation 1. We find that across model specifications, the interaction coefficient remains positive and significant. This indicates that with China joining the WTO, the share of female inventors involved in AI-based innovation increased compared to the ROW.[27]

Another concern could be the use of 2002 as a singular shock when China had multiple policy reforms after 2002 (as outlined in Table A4). Given that these reforms could also have an impact on innovation activity, we use each of them as separate intervention points. We re-estimated our baseline specification by interacting China x Post-Reform Year. Beyond the baseline effect of 2002, these coefficient estimates are positive and significant (see Table A9). The result is consistent with the notion that successive policy improvements reinforced female participation in innovation.[28] Using the first reform as the primary shock allows us to avoid contamination from overlapping policy changes and to isolate the initial impact of strengthened IPR.

5.1.2. Alternate Control Group

We next perform robustness checks by altering our control group (i.e., the ROW). The purpose of these checks is to ensure that our results are not from an arbitrary selection of ROW as a control group and that the treatment effect holds for our outcome variables in China after the policy shock. Following the IMF's classification of countries, we divide our control group sample into developed and emerging economies. We compute this estimation to ensure that

All results hold. We thank the anonymous reviewer for this suggestion.

[27]We also re-estimate our baseline specification for all patents (AI +non-AI) and separately for non-AI patents (see Table A8. The results are consistent across samples; there is a positive and significant increase in the number of patents with at least one female inventor and female inventors in China post 2002. However, in both cases, the effect on the share of female inventors and patents with at least one female inventor is insignificant and close to zero. This suggests that while absolute participation of women increased sharply, their relative share within the pool of inventors remained unchanged for non-AI (and all) patents. In contrast to this, there is a positive and significant increase in the share of female inventors and patents with female inventors for AI patents, highlighting the impact on AI innovation.

[28]Given these policy shocks impact the entire unit and the exposure to shock is not measurable due to data limitations, implementing a staggered design is not feasible.

our results are not driven by a control group comprising a pooled set of diverse countries. We repeat our analysis using these two separate control groups and present our findings in columns (4) and (5) of Table 4.[29]

The coefficient of interest remains significant and positive for both outcomes of interest in column (4) of Panels A and B (Table 4), where the control group comprises only emerging economies. These results suggest that as China joined the WTO in 2002, its innovation environment became more friendly for female-led innovation when compared to the group of other emerging economies. By analyzing the gendered perspective, these findings not only support but contribute to the literature that studies the factors and policies that led to differences in the evolution of innovation between emerging economies (Crescenzi & Rodríguez-Pose, 2012; Crescenzi et al., 2012; Tiwari et al., 2017).

Next, we estimate the same regression specification by changing the control group to developed countries. The findings in column (5) of Panels A and B (Table 4) reveal that the percentage of patents with at least one female inventor and the percentage of female inventors in China increased by 110% and 168.7%, respectively. This is suggestive of an increase in innovation by female inventors in China after 2002 compared to developed countries. Overall, the effect in China is stronger when compared against emerging economies as opposed to developed ones.

5.1.3. Coarsened Exact Matching (CEM)

We also use the non-parametric technique of coarsened exact matching (CEM) to reduce imbalances between the treatment and the control group. The basic idea of CEM is to coarsen each variable by re-coding so that substantively indistinguishable values are grouped and assigned the same numerical value (Iacus et al., 2012). We match the treatment and control groups based on different innovation-related, macroeconomic, and policy-related factors, such as the total number of inventors, patents in a country in a year, GDP per capita, current account balance (% of GDP), government expenditure (% of GDP), R&D Expenditure, and Corruption Rating of a

[29] We also use as a control group those countries that joined the WTO after 2002 and were classified as emerging countries. All our results hold and are available upon request.

country.[30] In matching weights, we lose 120 observations from the control group that remain unmatched units. The gain, however, is in the reduction of imbalance as the multivariate L1 statistic changes from 1 to 0.375.[31]

CEM has gained attention as a robustness check for the validity of the control group in a causal estimate framework due to its multitude of advantages (Chen, Zaiyan, & Xie, 2022; Fry, 2021; Galasso & Simcoe, 2011; Iacus, King, & Porro, 2011; Wang & Zheng, 2022; Zervas, Proserpio, & Byers, 2017). For example, it can reduce estimation error, bias, model dependence, and imbalances between the treatment and the control group. Moreover, it is easily automated and has improved statistical properties (Blackwell, Iacus, King, & Porro, 2009; Rathi, Chakrabarti, Chatterjee, & Hegde, 2022).

Column (6) of Panels A and B in Table 4 gives the estimates from the CEM technique. Our coefficient of interest remains significant and positive for both outcome variables. We observe that there is a slight drop in the number of observations as compared to our baseline analysis. However, the results show that post-CEM, with proper matching, our baseline results for both outcome variables improve. We find a 118.2% increase in the AI patenting activity, including female inventors, and a 199.9% increase in participation by female inventors in China after 2002.

5.1.4. Alternate Sample - Extended Period

Our baseline analysis period is 1997 to 2011, which is five years before the policy shock in China. There were two reasons for the selection of this time frame. First, we intend to have enough years in the pre-intervention period for observing pre-trends. Second, this period was marked by the onset of changes in the IPR regime within China. Now, to ensure that our results are not driven by selecting a particular time frame, we extend the pre-period of our analysis. As a part of this robustness check we estimate the results for our baseline model with the extended period from 1990 to 2011.

The results obtained from the regression analysis are presented in column (7) of Panels A

[30] This data has been obtained from the World Bank open database (https://data.worldbank.org/)

[31] L1 statistic measures the overall imbalance in the joint distribution of covariates between the treatment and control groups, indicating the degree of imbalance. It functions like an R-squared value for model fit: a lower L1 statistic signifies greater balance, while a higher value indicates more imbalance.

and B in Table 4. The coefficient for the number of patents with female inventors (in log) and the number of female inventors (in log) remains positive and significant. After the strengthening of the IPR regime in China, we find that patents with at least one female inventor and the number of female inventors increased by 101% and 178%, respectively. These estimates further support and strengthen our baseline findings.

5.1.5. *Non Existent Pre-Trends*

To validate the assumption of parallel trends, we plot the coefficients using an event study design. This test implies that in the absence of treatment, the changes in outcome for the treatment group would be similar to the changes in the outcome in the control group. In other words, without the policy shock, outcomes for China and the ROW should follow parallel trajectories over time. The estimation is based on the following specification:

$$\mathbf{y_{ity}} = \beta_0 + \sum_{\mathbf{y=1998}}^{\mathbf{2011}} \beta_{\mathbf{y}}(\mathbf{China_i}) + \theta_i + \theta_t + \theta_y + \nu_{it} + \phi_{ty} + \epsilon_{ity} \tag{2}$$

where $Year_y$ ranges from 1998 to 2011, with 1997 as the base year. We plot the coefficients obtained from Equation 2 for both outcome variables: (1) log of the number of patents with at least one female inventor and (2) the log of the number of female inventors. Insignificant coefficients in the pre-period (until 2001) would satisfy the assumption of parallel trends between the treatment and control groups in our estimated results.

In Panel (a) of Figure 4, where the dependent variable is the log of the number of patents with at least one female inventor, we find that the coefficients in the pre-treatment period are near zero and insignificant. This indicates that in the absence of the treatment, the outcome for the control group and the treatment group follows a parallel trend. Importantly, the figure shows significant and positive coefficients for the year following the policy shock in 2002. This suggests that there was an increase in innovation involving female inventors following the strengthening of IPR in China.

Next, in Panel (b) of Figure 4, we show event study results where the dependent variable is the log of the number of female inventors. We find that, except for 2001, all interaction coefficients in the pre-period are insignificant. Panel (b) also shows a significant jump starting in 2003, indicating an increase in female inventors in China after WTO accession.[32]

5.1.6. *Synthetic Control*

The ideal counterfactual for our identification strategy would be to observe the outcome for China in the absence of treatment. To obtain a control group that resembles China, we create a synthetic China by using the estimation strategy outlined by Abadie and Gardeazabal (2003). We use a data-driven procedure that reduces the researcher's discretion in choosing a comparison group. We use the synthetic control method to obtain an artificial control group through the weighted average of the available control units. This provides a better comparison for the unit exposed to the intervention.

This approach creates a combination of comparison units matched to the characteristics of the treated group in the pre-treatment period. This data-driven technique has become more widespread due to its advantages (Adbi, Chatterjee, Drev, & Mishra, 2019; Aggarwal, Chakrabarti, Chatterjee, & Higgins, 2021; Billmeier & Nannicini, 2013; Green, Heywood, & Navarro, 2014), as it highlights two things. First is the percentage of contribution of each control unit to the counterfactual and its similarity with the treated group. Second, the sum of the weights is one and is restricted to be positive (Abadie et al., 2010). Hence, the synthetic control method saves from extrapolation (Abadie et al., 2010).

We create synthetic China by matching the treatment and control groups based on different innovation-related, macroeconomic, and policy-related factors, such as the total number of inventors, patents in a country in a year, GDP per capita, current account balance (% of GDP), government expenditure (% of GDP), R&D Expenditure, and Corruption Rating of a country. Using this approach for identifying a valid counterfactual, weights are assigned to the countries from the ROW to create an artificially matched sample of China.

Figure 5 shows the plots for both of our dependent variables between 1997 and 2011. The figure shows that our benchmark findings hold when the control group is substituted with synthetic China. As with the non-parametric analysis, the number of patents with at least one female inventor and the number of female inventors follow similar trends in the pre-intervention

[32]We corroborate these findings of the pre-period empirically in Table A10.

period. This shows that synthetic China provides a sensible approximation for female inventor participation in inventive labor and their patenting activity. Immediately after the policy shock in 2002, the two trends diverge noticeably. Thus, China's joining the WTO changes the trajectory of the outcome variables for the treated group in a positive and significant direction, thereby confirming and providing further support for our baseline results.

5.1.7. Randomized Inference

Next, we utilize a randomized inference (RI) test to assess if the treatment effects are just a matter of chance. Originally developed by Fisher (1936) and taken forward by Rosenbaum (2002) to perform exact tests for experiments, RI is increasingly being applied to non-experimental data (Bharadwaj, Johnsen, & Løken, 2014; Chakrabarti, Kishore, & Roy, 2018; Nagler, Piopiunik, & West, 2020). The RI test can also be considered a falsification exercise. We use the 'ritest' command developed by Heß (2017) in STATA to conduct the RI test.

We compare the coefficients from our baseline specification shown in column (1) and column (3) of Table 4 to a distribution of coefficients. We follow a three-step process. First, we reallocate a country-technology-year combination of the two groups (treatment and control) randomly, ensuring that the sample sizes match that of our baseline model. Second, we use the baseline specification Equation 1 to estimate the treatment effect using these new treatment and control groups. Third, we repeat this exercise 10000 times. The idea is to compare the coefficients we obtain from this random reorganization to those from our baseline specification. The p-values obtained from RI, clustered at the country level, are shown in Table 6. The p-values suggest that the effects of China's joining the WTO on the increase in female-supported innovation are unlikely to be observed simply by chance.

5.1.8. Heterogenities Across AI Technology Sub-Classes

Finally, it would be important to explore if there are any underlying heterogeneities at the technology sub-class level that may explain our results. Thus, we split the sample across the eight AI technology sub-classes as defined by Giczy et al. (2022) in the AIPD dataset. The purpose of this exercise is to observe if, within AI, there are specific technologies that may be favoured by female inventors. To evaluate this, we use Equation 1 without technology-fixed effects and generate estimates on technology-based sub-samples. Table 7 presents our results for both of our dependent variables. The dependent variable in Panel (a) is the log of the number of patents with at least one female inventor, and in Panel (b) it is the log of the number of female inventors. In both the panels, columns (1)-(8) show sub-sample analysis across different AI technology sub-classes. All models include year, country, country-technology, and technology-year fixed effects. Standard errors in all estimations are clustered at the country level.

We find that the interaction coefficient, in all sub-samples, for both dependent variables is positive and significant. There are, however, stark differences in the involvement of female inventors in different technologies. As per our findings, female inventors' participation has grown most prominently in relatively established and application-oriented domains such as computer vision and knowledge processing, whereas the increase is more modest in emerging, research-intensive areas such as machine learning and evolutionary computation. This pattern suggests that women may be more actively engaged in subfields where entry barriers are lower, technical skills are more transferable from existing scientific disciplines, and collaboration opportunities are greater. In such established areas, research often relies on applied problem-solving and interdisciplinary collaboration, which may allow female scientists trained in related fields (e.g., information science, cognitive science, or data analytics) to transition more easily into inventive roles.[33]

In contrast, frontier technologies such as machine learning and evolutionary computation often require advanced mathematical modelling, programming, and algorithmic expertise—skills that have historically exhibited high gender segregation in educational and occupational pipelines. These subfields also tend to be characterized by competitive research environments, concentrated institutional networks, and higher levels of venture capital and entrepreneurial activity, all of which may reproduce gendered gatekeeping and limit entry opportunities for women. Moreover, gendered differences in mentorship access, professional visibility, and patenting incentives within research teams may further reinforce these patterns. Overall, our findings suggest that the surge in female innovation in China has been selective

[33]Our informal discussions with professors at Nankai University and Tianjin University in China also revealed the same.

rather than uniform, concentrated in domains that align more closely with existing skill endowments and collaborative structures.

5.2. *Mechanisms*

We believe three mechanisms led to the increasing participation of female inventors in the inventive labor market in China. First, there is an increase in the share of domestic female inventors on patent-inventor teams in China compared to the control group countries in our analysis. Given the heterogeneity in inventor teams and increasing international collaborations, this mechanism allows us to obtain a coherent picture of the promotion of female inventors within a country's innovation environment. Second, human capital improved after China's ascension to the WTO. This human capital channel provides us an insight into the technological skills that females in China were developing through participation in higher education. Our findings provide suggestive evidence of the growing complementarity between females pursuing higher education and subsequently participating in the innovation environment of China. Third, there is an increase in female inventors and patents with females filed by private firms after WTO accession. We study how increased competition amongst private firms after 2002 acts as a mechanism that ensures fair gendered allocation of labor in innovation.

5.2.1. *Share of Domestic Female Inventors*

To assess the change in the participation of females in the Chinese innovation environment, we obtained information on the assignee (the organization to which a patent was granted) of patents between 1997 and 2011 from the PatentsView repository of the USPTO. This data file allows us to identify the assignee organization and the assignee country of the patents.[34] After using the patent ID as the unique identifier, we match the patents to their inventors and their respective locations. We then obtain the number of female inventors in each patent-inventor team. Next, using inventor location, we identify the number of domestic and international female inventors. Finally, we calculate the share of domestic female inventors on the patent team as the number of domestic female inventors divided by the total number of female inventors on each patent-

[34]The type of organization allows us to identify if a patent was assigned to a country's government, a country's private firm, a public-private partnership of a country, or an international agency each year.

inventor team. We estimate the impact of accession to the WTO on the share of domestic female inventors in China compared to the ROW, using the following equation:

$$\mathbf{y_{iy}} = \beta_0 + \beta_1 \mathbf{China_i} + \beta_2 \mathbf{Post2002_t} + \beta_3 \mathbf{China_i} \times \mathbf{Post2002_y} + \theta_i + \theta_y + \epsilon_{it} \tag{3}$$

where y_{iy} is the share of domestic female inventors (in the log) measured at the country-year level. The rest of the parameters remain the same as our baseline equation.

The results from our regression estimates are presented in Table 8. In column (1), we observe a 65.7% increase in the share of domestic female inventors on patent teams in China after the strengthening of IPR compared to the ROW. Columns (2) to (4) give the coefficients obtained for $Post2002_y$ from a before and after estimation, following Equation 3. This specification does not include fixed effects for time and country. In column (2), the coefficient for $Post2002_y$ is positive and significant, suggesting a 63.2% increase in the share of domestic female inventors in China. The coefficient in columns (3) and (4) includes the estimates for developed economies and the ROW, respectively. The share of domestic female inventors on patent teams decreases by 3.3% for developed economies (column 3) and 3.4% for the ROW (column 4).

Our findings complement Tang and Zhang (2021). They find that gender discrimination was reduced in domestic Chinese firms due to cultural transfers generated by multinational firms.[35] While their findings apply to manufacturing firms, our study provides suggestive evidence for the innovation market, specifically AI. With the accession to the WTO, the strengthening of the intellectual property regime enabled non-state entities to access the innovation market of China. In response to this new competition (in line with Becker's model of discrimination) and cultural spillovers, the share of female inventors in domestic firms increased.

5.2.2. Increased Enrollment of Women in Higher Education

Several studies focused on the gender gap in innovation suggest that increasing representation in science and engineering fields (Hunt, Garant, Herman, & Munroe, 2013), collaboration ties

[35] A recent study by Crescenzi, Dyèvre, and Neffke (2022) also signals the role of multinational firms in boosting innovation and growth.

(Meng, 2016), and education level (Marvel et al., 2015; Mendonça & Reis, 2020) may increase the probability of patenting for female inventors. This positive impact holds even when gender equality is lower in developing countries (Attah-Boakye, Adams, Kimani, & Ullah, 2020). We find that there is a systematic investment in female higher education in China during our sample period. We provide two pieces of evidence to support our claim.

First, we obtain data on the number of females in higher technical education from the Ministry of Education of the People's Republic of China.[36] We obtain the percentage of females in higher technical education by dividing the number of females enrolled in a Ph.D. program by the total number of students enrolled in Ph.D. programs in China. Figure 3 depicts the percentage of female Ph.D. enrollment in scientific research institutions from 1997 to 2011. We observe a sudden increase in the percentage of female enrollment from 2004 onwards. Importantly, this increase remains persistent and never returns to the pre-WTO era. This increasing trend indicates a progression in China that supports female interest in higher technical education.

Second, we also use openly available World Bank data and analyze the variable of "gender parity for enrollment in tertiary education". This indicator is calculated by dividing the female gross enrollment ratio in tertiary education by the male gross enrollment ratio in tertiary education. In China, tertiary education refers to all formal post-secondary education, including universities, colleges, and vocational institutions that offer academic degrees or professional certifications, following upper secondary school. It is important to unpack these mechanism of supply of human capital to understand the plausible antecedents of our results (Bostwick & Weinberg, 2022; Fisher et al., 2019). Using this variable, we do regression analysis similar to our baseline, where we look for change post 2002. As shown in Table A11, we find a positive and significant increase in gender parity in tertiary education in China compared to the rest of the world. This result obtained from publicly available data provides strength to our reasoning that increased investment in female education is the means by which the sudden transition that we see took place.

[36] See: http://www.moe.gov.cn/jyb_sjzl/moe_560

5.2.3. *Firm Characteristics*

In China, accession to the WTO led to liberalization and openness. The regime change required China to recognize the property rights of inventors. This allowed entry of private and foreign firms into innovation-focused industries, which were previously concentrated by state-owned enterprises. Figure 6 shows the gradual increase in the number of patents owned by firms other than the state-owned enterprises from 1997 to 2011. The figure suggests an increase in competition in the Chinese innovation environment.

Based on the Becker model, we postulate that increased competition will increase the cost of discrimination against female inventors. When competition increases, new firms entering the market without a taste for discrimination hire the profit-maximizing number of female inventors. Whereas firms with a strong taste for discrimination end up paying more by not hiring female inventors, thus losing potential profits. As a result, competition drives out discriminatory firms as they will earn less than normal profits from the innovation market. This, in turn, should increase the participation of female inventors in the long run.

Accession to the WTO opened up the innovation environment for private firms in China (Figure 6). With this increased competition, private firms were bound to balance their gendered allocation. As shown in Figure 7, we see a clear jump in the number of patents with female inventors and the number of female inventors amongst those who are part of a multi-national corporation. Interestingly, these same two variables show negligible change for state-owned enterprises.

We empirically evaluate the magnitude of this mechanism by creating a panel at the firm type-country-year level. We identify the assignee type of the patent and code it as private if the patent is filed by a multi-national corporation. We categorise a firm as an MNC if it is classified as part foreign company or corporation, part US company or corporation, foreign company or corporation and US company or corporation by the USPTO. Similarly, if a patent is filed by a state-owned enterprise (firms classified as foreign government and part foreign government by USPTO), we code it as a government-filed patent. We present the results for the analysis with our two dependent variables in Table 9. Columns (1) and (3) show the baseline effect, and columns (2) and (4) include firm, country, and year-fixed effects to control for unobserved heterogeneity. As shown in column (2), we find a 95% increase in the number of Chinese patents with at least one female inventor. Similarly, as shown in column (4), compared to state-owned enterprises, the number of female inventors in private firms increased by 111.2 % after 2002. These findings justify our theoretical motivation that increased competition in China after 2002 led to reduced discrimination against female inventors. Private firms appear to have led this effect.

5.3. Impact on Quality of Innovation

Thus far, our results have provided evidence that the number of female inventors and the number of patents with female inventors increased after China's accession into the WTO. A logical next question is whether the quality of innovation was impacted by the increased presence of female inventors. Patent quality is important because it generates returns for inventive firms (Boeing, Mueller, & Sandner, 2016). However, the increasing propensity of inventive labor to patent has brought the quality of these patents into question. The evidence in the literature is mixed. On one hand, a number of studies (Chen & Zhang, 2019; Dang & Motohashi, 2015; Fisch et al., 2017) suggest that the quality of patents in China did not converge in increased patenting. On the other hand, several studies find that institutional policies promoting domestic innovation (attracting FDI, R&D) and reducing the cost of innovation (patent application fee subsidy) led to lower-quality patents (Fisch et al., 2016; Liu et al., 2014; Thoma, 2013).

To assess the value of innovation generated by female inventors in China, we evaluate the quality of patents using the number of patent citations, the strategic importance of patents, and patent impact. The last two are variables drawn from the Derwent database using machine learning methods, as discussed earlier, as a robustness check, given the debate around using citations for the quality of patents. The estimates are drawn from the following regression specification:

$$\mathbf{y_{ity}} = \beta_0 + \beta_1 \mathbf{China_i} \times \mathbf{Post2002_y} + \theta_t + \theta_y + \epsilon_{ity} \tag{4}$$

where y_{ity} is measured at the country-technology-year level. y_{ity} is either the number of citations, strategic importance, or patent impact (in the log). $China_i$ corresponds to when country i is China (one for our treatment group) or the ROW (zero for our control group). $Post2002_t$ equals one if the year is after 2002, zero otherwise. θ_t, θ_y represent technology and year dummies respectively. Standard errors are clustered at the country level.

Table 10 shows the results from Equation 4. Columns (1) and (2) have the log of the number of citations as the dependent variable, columns (3) and (4) have the log of strategic importance as the dependent variable, and columns (5) and (6) have the log of patent impact as the dependent variable. Columns (1), (3), and (5) report the baseline estimation without any fixed effects. Columns (2), (4), and (6) include the fixed effects at the year and technology level to deal with heterogeneity.

The interaction coefficient in Table 10 indicates the impact of China's WTO accession on the quality of patents with female inventors. We find that across columns (1) to (6), the interaction term $China \times Post2002$ is positive and significant. We focus on columns (2), (4), and (6) for interpretation since they are the most conservative, as they include all fixed effects. In Column (2), we find that the quality of AI patents measured by forward citations that involved Chinese female inventors increased by 109.8% compared to our control group. In Column (4), we find that the strategic importance of the patents involving female inventors increased by 39.5% compared to our control group. Similarly, in column (6), we find the patent impact involving female inventors to increase by 17.4%. These results suggest that as female inventor participation increased, so did the quality, importance, and impact of the patents (innovation) they worked on. Our findings are consistent with Ain, Yuan, and Javaid (2021), and Xie and Zhang (2015) who also show gender effects on the quality of innovation. Our findings support the literature, which emphasizes the improvement in the quality of innovation involving women.

6. Discussion

Innovation is a public good that drives economic and social progress, yet its creation is often constrained by institutional and market barriers. Inventors require not only encouragement but also legal protection and economic incentives to generate knowledge that can be effectively diffused throughout society. Intellectual property rights (IPR) play a central role in this process by rewarding creativity while regulating ownership through criteria of novelty, inventiveness, and practical applicability. A long-standing policy debate concerns whether developing countries should strengthen their IPR regimes. While IPR may incentivize domestic invention, it can also restrict access to existing technologies. Our results suggest that, for China as an emerging economy, the strengthening of IPR yielded overall benefits, most notably by enabling greater participation of women in innovation.

Our findings reveal that compared to the ROW, there is a significant increase in the number of patents with female inventors and the number of female inventors in China after 2002. Our findings undergo a battery of robustness checks, including alternate control groups, coarsened exact matching, randomized inference testing, and synthetic controls. Critically, not only do we find increases in patent activity by female inventors, but we also observe that the quality of patents with female inventors improved. To triangulate 'out-of-sample' trends after 2011, recent evidence signals continuing (though incomplete) gains in women's patent participation, specifically within AI invention communities. USPTO's Progress & Potential updates show rising female inventor shares into 2019; and Fang et al. (2025) using AIPD find women's growing roles in both university and commercial AI invention (Toole et al., 2021). These external benchmarks imply that if anything, our 1997–2011 elasticities understate the longer-run effect sizes as AI scaled.

To our knowledge, this is the first study to examine gender divisions in inventive labor with explicit attention to heterogeneity across technology classes and countries. We identify three mechanisms underpinning the post-2002 surge in female innovation in China. First, there was a marked rise in the share of domestic female inventors on patenting teams. Second, patents with female inventors increasingly originated from private firms rather than state-owned enterprises, signaling a shift in innovation dynamics following market liberalization. Third, sustained government investment in women's higher education—evident in the sharp increase in female enrollment in Ph.D. programs and gender parity in tertiary education expanded the pool of skilled female researchers. Together, these mechanisms suggest that while China's

WTO accession and strengthened IPR regime provided an exogenous catalyst, deeper structural reforms created the foundation for women's growing participation in inventive activity.

By linking institutional change to gendered innovation outcomes, our findings contribute to the broader debate on whether stronger intellectual property protection can foster both technological progress and gender inclusion. The results are especially relevant in the context of China's transition from an imitation-based to an innovation-driven economy, offering a valuable reference point for other emerging economies seeking to build more equitable innovation systems. Moreover, China's convergence with leading technological nations such as the United States, Japan, and South Korea is not merely temporal; its sustained innovation trajectory increasingly positions it as a global leader in artificial intelligence (Lundvall & Rikap, 2022).

As with all empirical studies, ours has some limitations that open avenues for future research. First, we do not examine patent family relationships, which could shed light on cross-country collaborations and the diffusion of female-led innovation across technology classes. Future work could explore networks and also understand heterogeneity across patent types to better understand where female inventors contribute most. Second, our analysis focuses on granted patents. Extending the scope to include pre-grant applications would allow researchers to assess whether gender differences emerge earlier in the innovation process particularly, in the translation of creative ideas into granted patents. Third, our results point towards heterogeneity in female participation across different technology sub-classes. However, at this stage, we are unable to causally test the mechanisms that may be driving these differences and only provide anectdotal discussion. Future work could conduct RCTs or surveys with organizations engaged in heterogeneous innovation to explore the possible underlying effects. Such extensions would not only refine our understanding of the mechanisms driving gender gaps in innovation but also help design policies that support women's participation at every stage of the inventive pipeline.

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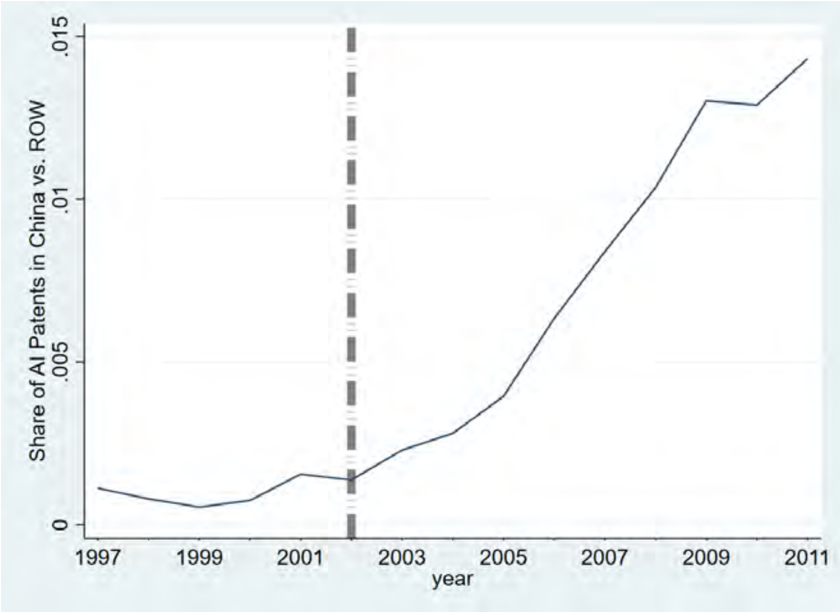
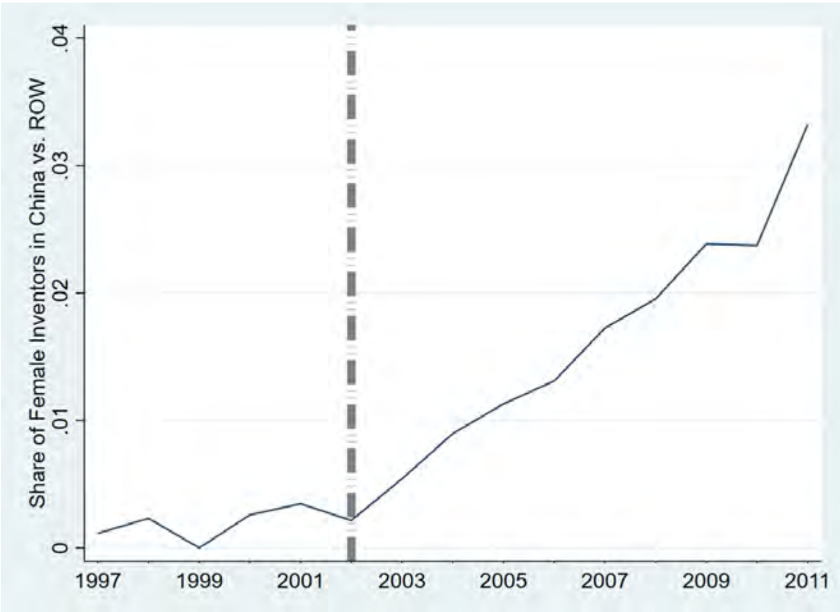
Figure 1: Descriptive Plots: Innovation in China. In Panel (a), we present the share of AI patents in China, which is calculated as the total number of Chinese AI patents across eight technology classes divided by the total number of AI patents in the ROW. In Panel (b), we present the share of female inventors in China, which is calculated as the total number of Chinese female inventors across eight technology classes divided by the total number of female inventors in the ROW.



(a) Share of AI Patents in China.



(b) Share of Female Inventors in China.

Figure 2: Inventors Across Countries This figure includes graphs for nine countries, indicating the trend lines for the total number of inventors (dashed line in blue) and the total number of female inventors (solid line in red). The reference line indicates the year when the respective country joined the WTO. We can see that for all countries, there is an increase in the total number of inventors post joining the WTO, but female inventors increase only for China.

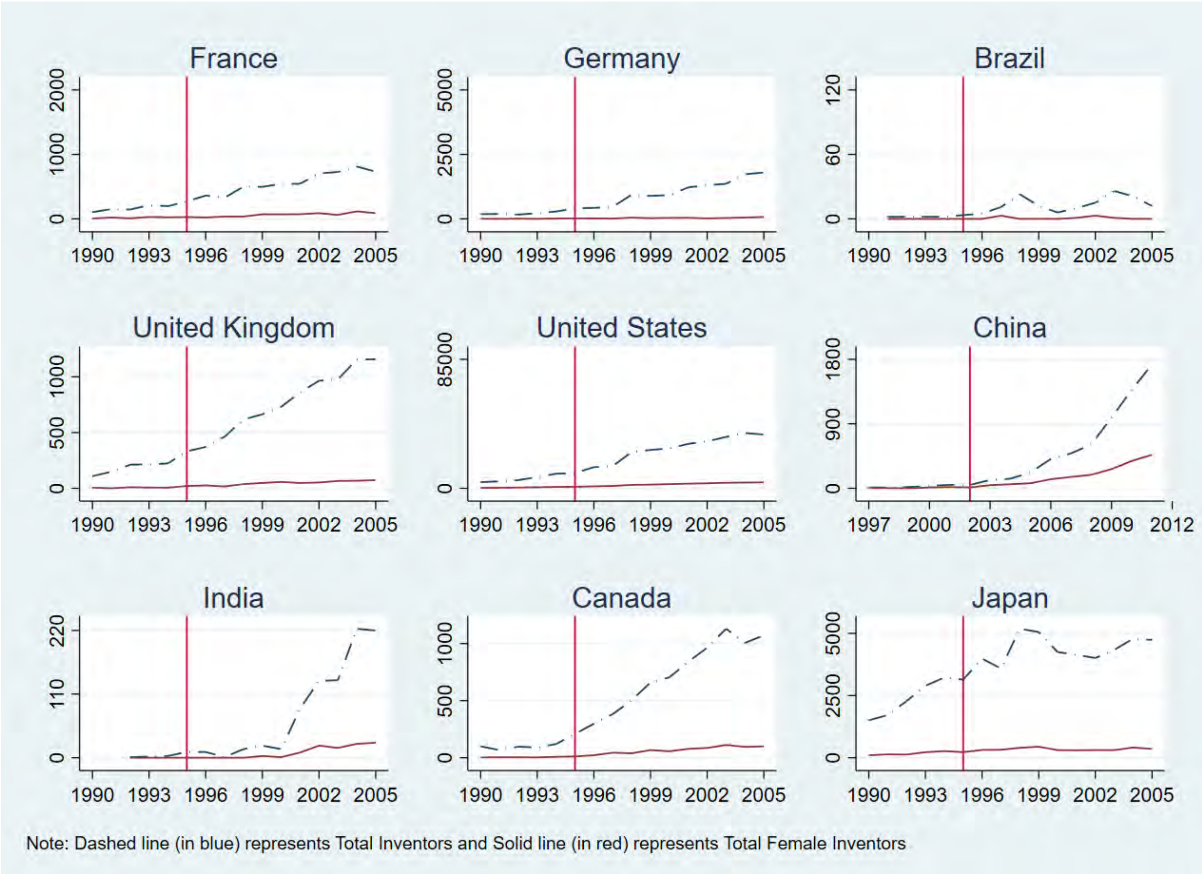


Figure 3: Females in Higher Education. The plot shows the percentage of female Ph.D. enrollment in scientific research institutions from 1997 to 2011. Data for the years 2002 and 2003 were not available and have been interpolated. We observe a sudden increase in female enrollment from 2004. These trends imply an increasing interest by females in higher technical education. Source: Ministry of Education of the People's Republic of China - http://www.moe.gov.cn/jyb_sjzl/moe_560.

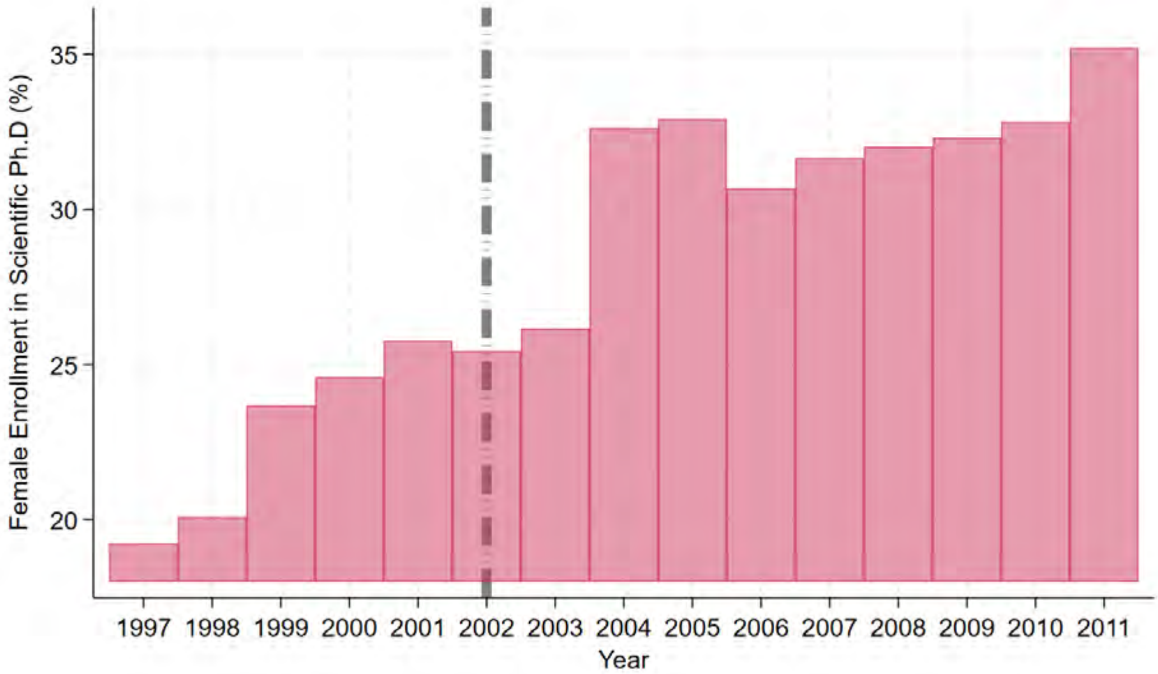
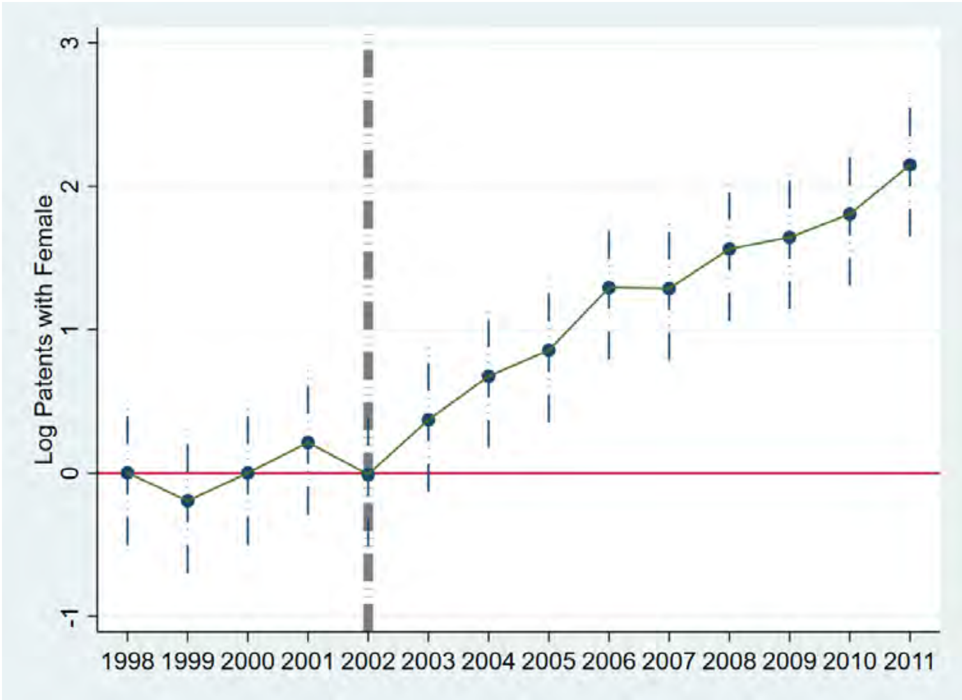
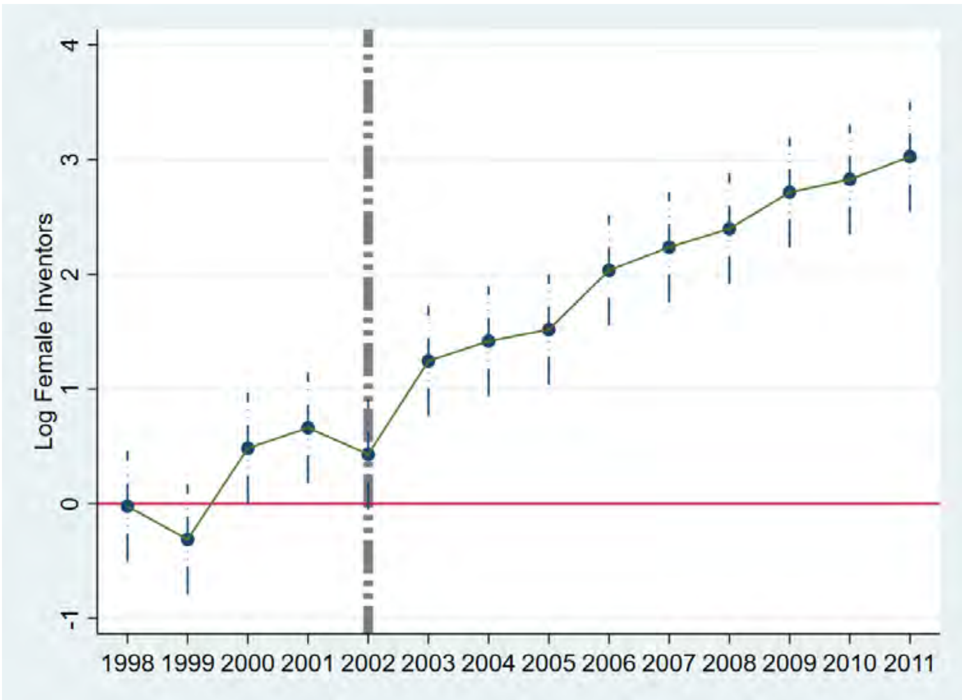


Figure 4: Event Study Design. The point estimates are coefficients for the country-technology class dummy for every year from 1998 to 2011 (1997 is taken as the base year) for our main outcome variables - Log Patents with Female in Panel (a) and Log Female Inventors in Panel (b). The dashed vertical line for each point estimate indicates the 95% confidence interval. The dashed-dotted reference line indicates the year of the policy shock (i.e., 2002). The horizontal red line at 0 indicates no significant difference between the treated and control groups.

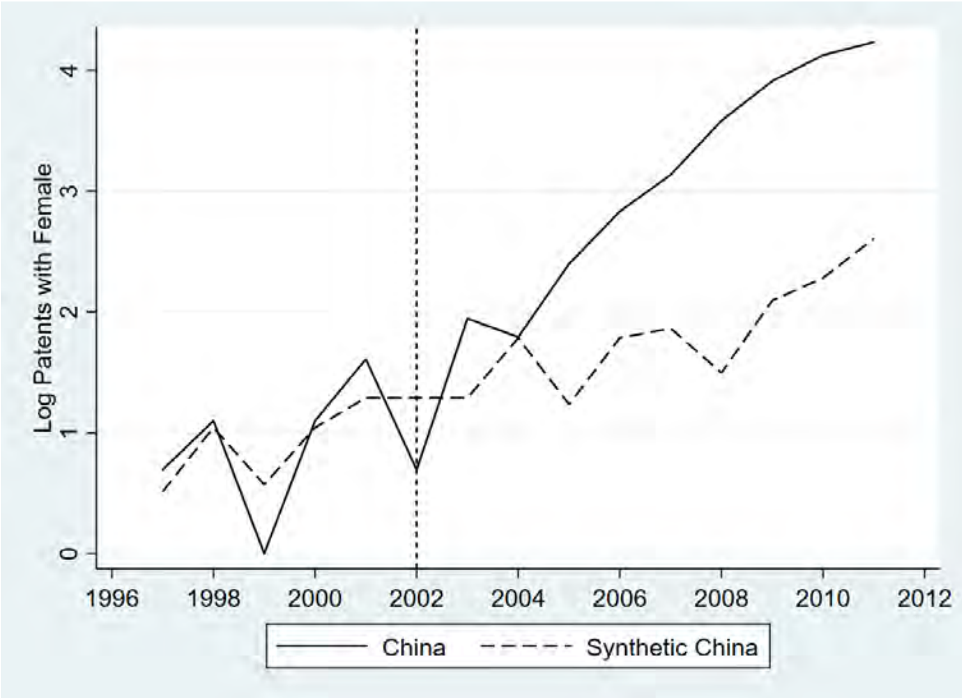


(a) Number of Patents with At Least One Female Inventor

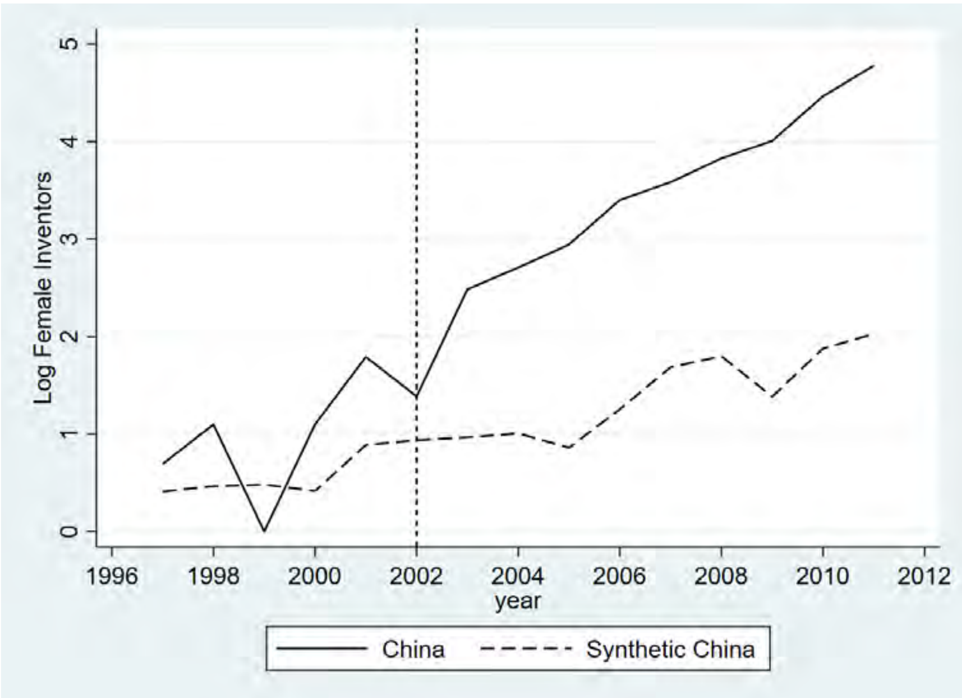


(b) Number of Female Inventors

Figure 5: Synthetic Control. Panel (a) plots the log of the number of patents with at least one female inventor, and Panel (b) plots the log of the number of female inventors between the period 1997 and 2011. The dotted line is the trend for synthetic China, and the solid line follows the trajectory of our outcome variables for China.



(a) Number of Patents with At Least One Female Inventor



(b) Number of Female Inventors

Figure 6: Innovation Environment in China. The figure includes the total number of patents assigned to non-state entities between 1997 to 2011 in China. We observe a gradual increase in the innovative activity of non-state firms after accession to the WTO. This suggests an increase in competition in innovative industries in China.

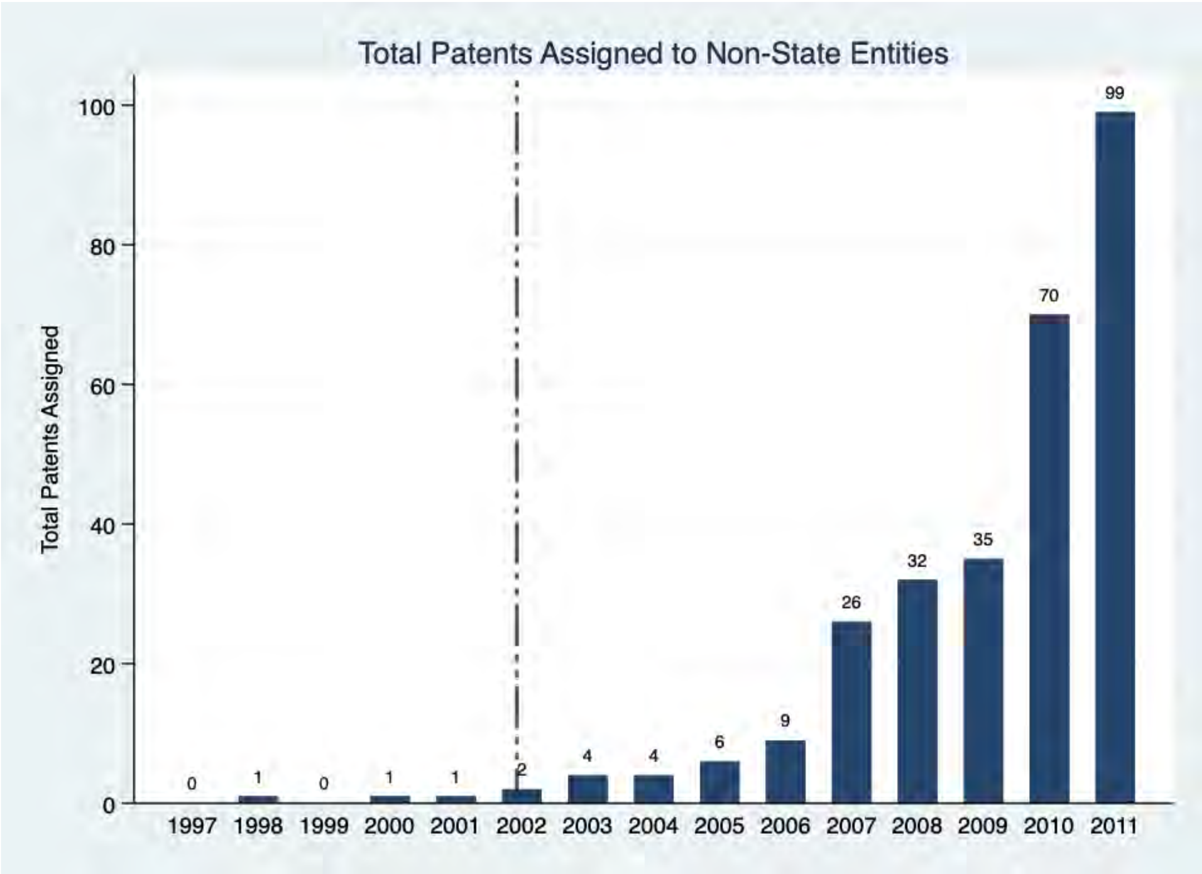
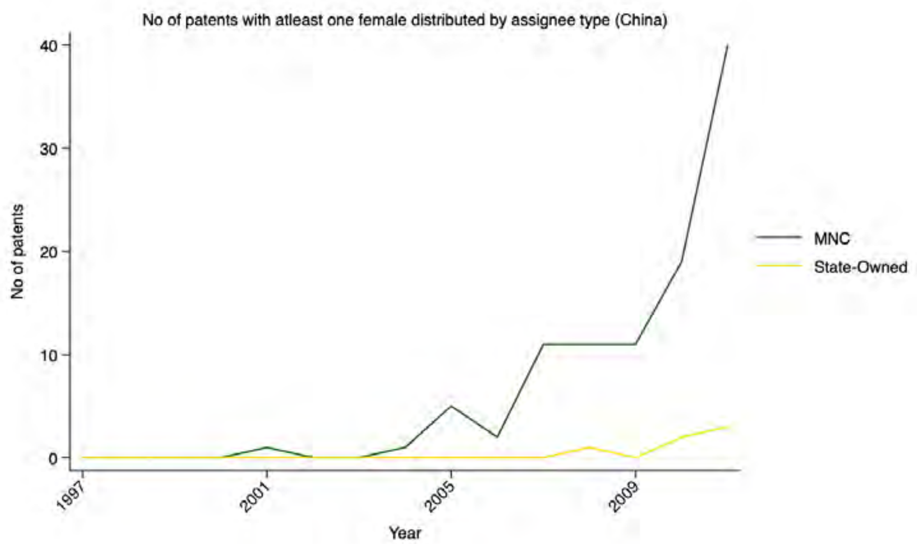
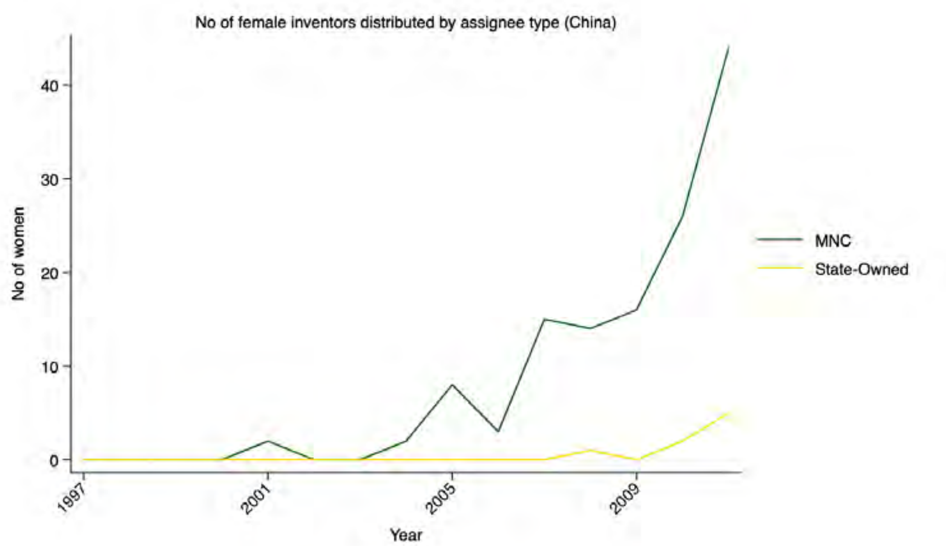


Figure 7: Firm Effect. Panel (a) plots the log of the number of patents with at least one female inventor, and Panel (b) plots the log of the number of female inventors between the period 1997 and 2011. Two trends are shown: (1) multinational companies and (2) state-owned enterprises.



(a) Number of Patents with At Least One Female Inventor



(b) Number of Female Inventors

Table 1: Variable Description

Dependent Variables	**Definition and Construction**
Log Patents with Female	Logarithm of (1 + number of patents that have at least one female inventor)
Log Female Inventors	Logarithm of (1 + number of female inventors in a country in a year)
Log Number of Citations	Logarithm of number of citings of the patent obtained from Derwent database
Log Strategic Importance	Logarithm of strategic importance score of the patent. This score is obtained from Derwent based on machine learning and indicates a patent's ability to enable firms to make crucial business decisions, monitor technology trends, or identify market opportunities
Log Patent Impact	Logarithm of patent impact score of the patent. This score is obtained from Derwent based on machine learning and indicates the overall technological or competitive footprint of an invention
Log Share of Patents with Female	Logarithm of (1 + share of patents with at least one female out of total patents)
Log Share of Female Inventors	Logarithm of (1 + number of female inventors out of total inventors in a country in a year)
Independent Variables	**Definition and Construction**
China	Coded as one if the country is China, zero for other countries
Post 2002	Coded as one if the country-year pair is from 2002, zero otherwise

Table 2: Summary Statistics

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
Log Patents with Female	6624	0.46	1.012	0	7.53
Log Female Inventors	6624	0.625	1.214	0	8.071
Log Number of Citations	1715	1.503	1.040	0	5.811
Log Strategic Importance	1715	0.739	0.708	0	4.485
Log Patent Impact	1715	2.170	0.748	0.307	4.605
Log Share Patents with Female	6624	0.048	0.163	0	4.5
Log Share of Female Inventors	6624	0.046	0.099	0	0.693
Log Total Patents	6624	0.713	1.367	0	8.834
Log Total Inventors	6624	1.804	1.975	0	10.17

Table 3: Descriptive Estimates in Difference-in-Differences Framework

	China		Rest of World		Difference-in-Differences		
Variable	Pre	Post	Pre	Post	Diff.	t-stat	p-value
Log Patents with Female	0.181	1.563	0.382	0.473	1.291	6.580	0.000***
Log Female Inventors	0.453	2.611	0.493	0.642	2.009	8.610	0.000***
Log Share of Patents with Female	0.060	0.162	0.043	0.048	0.097	3.060	0.002***
Log Share of Female Inventors	0.131	0.26	0.036	0.044	0.121	6.430	0.002***

Notes: The table represents the initial summary statistics in the difference-in-differences framework. We show mean values of our dependent variables pre and post 2002 and calculate difference-in-differences values along with respective t-stat and p-values. The post-period includes years from 2002 to 2011, and the pre-period includes years from 1997 to 2001. For all four variables, we find a difference-in-difference (first difference - second difference) value to be positive and significant.

Table 4: Change in Number of Patents with Females and Number of Female Inventors

Panel A

DV: Log Patent with Female	Baseline Results			Alternate Control Group Emerging	Developed	CEM	Extended Time Period
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
China x Post 2002	1.291***	1.161***	1.161***	1.299***	1.100***	1.182***	1.011***
	[0.039]	[0.038]	[0.038]	[0.053]	[0.048]	[0.045]	[0.064]
Post 2002	0.091**	0.486***					
	[0.039]	[0.079]					
China	-0.201*						
	[0.114]						
Country Dummies	No	Yes	Yes	Yes	Yes	Yes	Yes
Technology Dummies	No	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	No	No	Yes	Yes	Yes	Yes	Yes
Country - Technology Dummies	No	No	Yes	Yes	Yes	Yes	Yes
Technology - Year Dummies	No	No	Yes	Yes	Yes	Yes	Yes
R-squared	0.017	0.742	0.898	0.652	0.913	0.918	0.852
Observations	6,624	6,624	6,624	2,776	3,432	6,504	8,376

Panel B

DV: Log Female Inventors	Baseline Results			Alternate Control Group Emerging	Developed	CEM	Extended Time Period
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
China x Post 2002	2.009***	1.836***	1.836***	1.996***	1.687***	1.999***	1.780***
	[0.056]	[0.056]	[0.056]	[0.097]	[0.071]	[0.073]	[0.085]
Post 2002	0.149***	0.671***					
	[0.056]	[0.109]					
China	-0.040						
	[0.147]						
Country Dummies	No	Yes	Yes	Yes	Yes	Yes	Yes
Technology Dummies	No	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	No	No	Yes	Yes	Yes	Yes	Yes
Country - Technology Dummies	No	No	Yes	Yes	Yes	Yes	Yes
Technology - Year Dummies	No	No	Yes	Yes	Yes	Yes	Yes
R-squared	0.036	0.841	0.906	0.736	0.921	0.927	0.869
Observations	6,624	6,624	6,624	2,776	3,432	6,504	8,376

Notes: The dependent variable in Panel A is the log of the number of patents with at least one female inventor, and in Panel B is the log of the number of female inventors. Columns (1) to (3) in both panels showcase our baseline results. Columns (4) to (7) represent different robustness checks over the baseline specification. Across model specifications, we see that the interaction term is positive and statistically significant. Thus, there is a significant increase in female innovation in China after accession to the WTO. The time horizon is from 1997 to 2011. Robust standard errors, clustered at the country level, are presented in the parentheses.'***','**','*' indicate significance at the 1%, 5%, and 10% respectively.

Table 5: Change in Share of Patents with Females and Share of Female Inventors

	(1)	(2)	(3)	(4)	(5)	(6)
	Log Share of Patents with Female			Log Share of Female Inventors		
China x Post 2002	0.097***	0.086***	0.086***	0.121***	0.114***	0.114***
	[0.004]	[0.003]	[0.003]	[0.004]	[0.004]	[0.004]
Post 2002	0.004	0.031***		0.009*	0.031***	
	[0.004]	[0.010]		[0.004]	[0.010]	
China	0.017**			0.095***		
	[0.008]			[0.006]		
Country Dummies	No	Yes	Yes	No	Yes	Yes
Technology Dummies	No	Yes	Yes	No	Yes	Yes
Year Dummies	No	No	Yes	No	No	Yes
Country - Technology Dummies	No	No	Yes	No	No	Yes
Technology - Year Dummies	No	No	Yes	No	No	Yes
R-squared	0.006	0.185	0.348	0.064	0.237	0.337
Observations	6,624	6,624	6,624	6,624	6,624	6,624

Notes: The dependent variable in columns (1) to (3) is the log of the share of the number of patents with at least one female inventor, and in columns (4) to (6) is the log of the share of the number of female inventors. Across model specifications, we see that the interaction term is positive and statistically significant. Thus, there is a significant increase in female innovation in China after accession to the WTO. The time horizon is from 1997 to 2011. Robust standard errors, clustered at the country level, are presented in the parentheses.'***','**','*' indicate significance at the 1%, 5%, and 10% respectively.

Table 6: Falsification Check: Randomized Inference

Log Patents with Female (T obs)	c	N	p = c/N	SE(p)	95% confidence interval
1.291	124	10000	**0.0124**	0.0011	0.0103 - 0.0147

Log Female Inventors (T obs)	c	N	p = c/N	SE(p)	95% confidence interval
2.009	382	10000	**0.0382**	0.0019	0.0345 - 0.0421

Notes: This table presents results from randomization inference (RI) tests of the DID model shown in Equation 1. Coefficient of the interaction term T(obs) is our test statistic as obtained in columns (1) and (4) of Table 4. We obtain the distribution of the test statistic under the null hypothesis that accession of China to the WTO does not affect female inventors in China, and use 10,000 re-randomizations. The p-value of the test statistic (as shown in column 4) suggests that we reject the null-hypothesis. These results suggest that our baseline results are robust and have not been obtained by chance. We conducted the RI tests using the "ritest" command in Stata, developed by (Heß, 2017).

Table 7: Heterogeneity Across AI Technology Sub-class

Panel A

DV: Log Patent with Female	(1) Computer Vision	(2) Knowledge Processing	(3) Planning	(4) NLP	(5) Speech	(6) Hardware	(7) ML	(8) Evolutionary Computation
China x Post 2002	1.885***	1.860***	1.324***	1.138***	1.120***	0.996***	0.829***	0.136***
	[0.066]	[0.068]	[0.074]	[0.027]	[0.028]	[0.051]	[0.039]	[0.017]
Observations	828	828	828	828	828	828	828	828
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country - Technology Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Technology - Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Panel B

DV: Log Female Inventors	(1) Computer Vision	(2) Knowledge Processing	(3) Hardware	(4) NLP	(5) Speech	(6) Planning	(7) ML	(8) Evolutionary Computation
China x Post 2002	2.270***	2.248***	2.023***	1.929***	1.802***	1.748***	1.635***	1.036***
	[0.065]	[0.076]	[0.071]	[0.059]	[0.039]	[0.078]	[0.062]	[0.050]
Observations	828	828	828	828	828	828	828	828
Country Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country - Technology Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Technology - Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

In panel (a), the dependent variable in all columns is the log of the number of patents with female inventors, and in panel (b), the dependent variable is the log of the number of female inventors. The table represents a split-sample analysis across 8 different sub-technologies of AI. Across specifications, we see that although the interaction term is positive and statistically significant, there is heterogeneity across different sub-technologies. The time horizon is from 1997 to 2011. Robust standard errors, clustered at the country level, are presented in the parentheses.'***','**','*' indicate significance at the 1%, 5%, and 10% respectively.

Table 8: Increase in Share of Domestic Female Inventors on Patent Teams

DV: Share of Domestic Female Inventors	(1) All Countries	(2) China	(3) Developed	(4) ROW
China x Post 2002	0.661***			
	[0.019]			
Post 2002		0.632***	-0.033***	-0.034***
		[0.019]	[0.003]	[0.003]
Year Dummies	Yes	No	No	No
Country Dummies	Yes	No	No	No
R-squared	0.132	0.083	0.003	0.003
Observations	41,125	114	40,799	41,023

Notes: The dependent variable in all columns is the share of domestic female inventors on patent teams. The estimates in column (1) take the ROW as the control group. Columns (2) - (4) are a sub-sample analysis where we see a change in the share of domestic female inventors after 2002 in China, developed countries, and the ROW, respectively. The time horizon is from 1997 to 2011. Robust standard errors, '***','**','*' indicate significance at the 1%, 5%, and 10% respectively.

Table 9: Effect of Firm Characteristics: Identification by Assignee Type

	(1)	(2)	(3)	(4)
	Log Patents with Atleast One Female		Log Female Inventors	
China x Post 2002 x MNC	1.396***	0.958***	1.606***	1.112***
	[0.076]	[0.119]	[0.080]	[0.124]
Observations	2,640	2,640	2,640	2,640
R-squared	0.006	0.545	0.007	0.546
Year Fixed Effects	No	Yes	No	Yes
Country Fixed Effects	No	Yes	No	Yes
Firm Type Fixed Effect	No	Yes	No	Yes

Notes: The dependent variable in columns (1) and (2) is the log of the number of patents with at least one female inventor, and columns (3) and (4) represent the log of the number of female inventors. Across model specifications, we see that the interaction term is positive and statistically significant. The time horizon is from 1997 to 2011. Robust standard errors, clustered at the country level, are presented in the parentheses.'***','**','*' indicate significance at the 1%, 5%, and 10% respectively.

Table 10: Improvement in Quality of Innovation

	(1)	(2)	(3)	(4)	(5)	(6)
	Log Number of Citations		Log Strategic Importance		Log Patent Impact	
China x Post 2002	1.096***	1.098***	0.325***	0.395***	0.156***	0.174***
	[0.079]	[0.064]	[0.030]	[0.046]	[0.059]	[0.061]
Post 2002	0.218***	0.605***	0.492***	0.906***	0.530***	0.858***
	[0.079]	[0.127]	[0.030]	[0.098]	[0.059]	[0.106]
China	-1.000***	-0.891***	-0.206***	-0.189***	-0.017	0.020
	[0.102]	[0.092]	[0.056]	[0.061]	[0.084]	[0.090]
Technology Dummies	No	Yes	No	Yes	No	Yes
Year Dummies	No	Yes	No	Yes	No	Yes
R-squared	0.014	0.149	0.089	0.186	0.091	0.198
Observations	1,715	1,715	1,715	1,715	1,715	1,715

Notes: The dependent variable in columns (1) and (2) is the log of the number of citations of patents with female inventors, in columns (3) and (4) is the log of the strategic importance of patents with female inventors, and in columns (5) and (6) is the log of patent impact. Across all specifications, we see that the interaction term is positive and statistically significant, suggesting that there is an improvement in the quality of patents in China after its accession to the WTO. The time horizon is from 1997 to 2011. Robust standard errors, clustered at the country level, are presented in the parentheses.'***','**','*' indicate significance at the 1%, 5%, and 10% respectively.

Appendix

Table A1: First Stage: Change in Total Number of Patents

DV: Log Total Patents	(1)	(2)	(3)
China x Post 2002	0.706***	0.824***	0.824***
	[0.103]	[0.030]	[0.030]
Observations	6,736	6,736	6,624
R-squared	0.003	0.630	0.946
Year Fixed Effects	No	Yes	Yes
Country Fixed Effects	No	Yes	Yes
Technology Fixed Effects	No	Yes	Yes
Country x Technology Fixed Effects	No	No	Yes
Technology x Year Fixed Effects	No	No	Yes

Notes: The dependent variable in columns (1) to (3) is the log of the total number of patents. Across all specifications, we see that the interaction term is positive and statistically significant. This suggests that there is a significant increase in the number of patents in China after its accession to the WTO. The time horizon is from 1997 to 2011. Robust standard errors, clustered at the country level, are presented in the parentheses.'***','**','*' indicate significance at the 1%, 5%, and 10% respectively.

Table A2: Summary Statistics of Non-AI Patents

Variable	Count	Mean	Std. Dev.	Min	Max
Log Patents with Female	1,514	1.68	2.10	0	8.98
Log Female Inventors	1,514	2.00	2.29	0	9.56
Log Share of Patents with Female	1,514	0.11	0.16	0	0.69
Log Share of Female Inventors	1,500	0.12	0.15	0	0.69
Log Total Patents	1,514	3.35	2.61	0.69	11.41
Log Total Inventors	1,500	3.60	2.74	0.69	11.78

Table A3: IP Regime Change

S. No.	Mechanisms of Change	Description
1	Article 11 of China's Patent Law	Article 11 gave exclusive rights to patent holders to advertise and sell their products while prohibiting any third party from moving the market before seeking permission from the owner.
2	Article 60 of China's Patent Law	Article 60 was amended to include a specific amount of compensation that a patent holder will receive in case of illegal infringement by a third party, depending on the loss of the owner or the profits of the infringer.
3	Article 57 of China's Patent Law	Article 57 establishes a more transparent mechanism to deal with patent infringement. It requires the third party to provide solid evidence to the patent holder and to the judicial body instead of merely stating ignorance as a defense.
4	Article 52 and 53 of China's Patent Law	In accordance with TRIPS, the duration and scope of compulsory licenses was modified, with increased access to legal and judicial bodies, guaranteeing the protection of IPR for original patent owners.
5	State Intellectual Property Office's (SIPO) Initiative of 2004	To protect from illegal infringement, SIPO launched the "Work Program on Strengthening Enforcement of the Laws on Intellectual Property Rights and Launching a Special Law Enforcement Campaign"
6	Protection of Intellectual Property Rights against Crimes forum	To improve three-way communication and coordination between IPR proprietors, foreign companies and government, the Ministry of Public Security held regular forums from 2002 to table, discuss and address any IPR
7	Import and Export of Technology	Regulations and amendments were made on administration, registration and prohibition of imports or exports of technologies along with amendments to computer software protection.
8	Copyright and Trademark Laws	Amendments to the existing laws on copyrights and trademark rules were made in 2002.

Notes: The table includes policies, laws, and amendments that China launched between 2000-2002 to strengthen its intellectual property regime.

Table A4: IPR related policy reforms post-2002 in China

Name of the Reform	Implementation Year	Nature / Description of the Reform
Collective Copyright Management Regulations	2004	Introduced rules for collective management of copyrights, including rights transfer and licensing.
Network Dissemination Rights Regulation	2006	Extended copyright to online and digital dissemination; strengthened digital enforcement.
National Intellectual Property Strategy (NIPS)	2008	Comprehensive cross-sector IP strategy: focused on innovation, enforcement, and public awareness.
The Third Amendment to the Patent Law	2009	introduced absolute novelty, stronger penalties, pretrial preservation, and compulsory licensing rules.
Updated Implementation Regulations	2010	Operationalized 2009 Patent Law changes; clarified administrative procedures and enforcement.

Notes: The table documents the major IPR-related reforms implemented after 2002.

Table A5: Impact of policy reforms pre-2002

	(1)	(2)	(3)	(4)
DV (in log)	Patents with Atleast One Female		Female Inventor	
Intervention Year	1992-First Patent Reform	1998-Higher Education Reform	1992-First Patent Reform	1998-Higher Education Reform
China x Post	-0.208***	-0.123**	-0.124	0.019
	[0.057]	[0.054]	[0.076]	[0.066]
Observations	3,480	3,480	3,480	3,480
R-squared	0.876	0.876	0.899	0.899
Year Fixed Effects	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes
Technology Fixed Effects	Yes	Yes	Yes	Yes
Country x Technology Fixed Effects	Yes	Yes	Yes	Yes
Technology x Year Fixed Effects	Yes	Yes	Yes	Yes

Notes: The dependent variable in columns (1) and (2) is the log of the number of patents with at least one female inventor, and columns (3) and (4) represent the log of the number of female inventors. We examine two major policy reforms in China before WTO accession in 2002. The first is the 1992 amendment to China's Patent Law, which was the first major change to the patent law in China (as highlighted in Columns 1 and 3). This amendment broadened patentable subject matter, clarified patent rights, and enhanced the scope of legal protection. The second is the 1998 higher education reform, which substantially expanded university enrollments and sought to modernize China's tertiary education system (as highlighted in Columns 2 and 4). The sample is restricted to pre-2002, and these two interventions are used as policy shocks to re-estimate the baseline equation. The results highlighted show no evidence that these reforms triggered an increase in female-led patenting; instead, the coefficients are negative for both types of reform. Similarly, these policy shocks have an insignificant effect on the number of female inventors in China. Robust standard errors, clustered at the country level, are presented in the parentheses.'***','**','*' indicate significance at the 1%, 5%, and 10% respectively.

Table A6: Baseline Results with Standard Errors Clustered at Country-Technology Level

	(1)	(2)	(3)	(4)	(5)	(6)
	Log Patent with Female			Log Female Inventors		
China x Post 2002	1.291***	1.161***	1.161***	2.009***	1.836***	1.836***
	[0.234]	[0.236]	[0.186]	[0.160]	[0.162]	[0.132]
Post 2002	0.091***	0.486***		0.149***	0.671***	
	[0.017]	[0.041]		[0.022]	[0.046]	
China	-0.201***			-0.040		
	[0.067]			[0.096]		
Country Dummies	No	Yes	Yes	No	Yes	Yes
Technology Dummies	No	Yes	Yes	No	Yes	Yes
Year Dummies	No	No	Yes	No	No	Yes
Country - Technology Dummies	No	No	Yes	No	No	Yes
Technology - Year Dummies	No	No	Yes	No	No	Yes
R-squared	0.017	0.742	0.898	0.036	0.841	0.906
Observations	6,624	6,624	6,624	6,624	6,624	6,624

Notes: The dependent variable in columns (1) - (3) is the log of the number of patents with female inventors. Columns (4) - (6) are the log of the number of female inventors. Across all specifications, we see that the interaction term is positive and statistically significant, suggesting that our results hold even when we cluster at the country-technology level. The time horizon is from 1997 to 2011. Robust standard errors, clustered at the country level, are presented in the parentheses.'***','**','*' indicate significance at the 1%, 5%, and 10% respectively.

Table A7: Robustness Check: Poisson Specification

	(1)	(2)	(3)	(4)
	Log Patent with Female		Log Female Inventors	
China x Post 2002	1.687***	1.687***	1.237***	1.238***
	[0.384]	[0.384]	[0.248]	[0.248]
Post 2002	0.465***		0.513***	
	[0.044]		[0.038]	
China	-0.023		0.631	
	[2.033]		[2.195]	
Technology Dummies	No	Yes	No	Yes
Year Dummies	No	Yes	No	Yes
Lg Likelihood	-3730.53	-3115.85	-4153.16	-3754.81
Observations	6,624	6,624	6,624	6,624

Notes: The dependent variable in columns (1) and (2) is the log of the number of patents with at least one female inventor, and in columns (4) and (5) is the log of the number of female inventors. Across model specifications, we see that the interaction term is positive and statistically significant. Thus, even with Poisson estimation, there is a significant increase in female innovation in China after accession to the WTO. The time horizon is from 1997 to 2011. '***','**','*' indicate significance at the 1%, 5% and 10% respectively.

Table A8: Baseline results for all patent types (AI and non-AI)

	(1)	(2)	(3)	(4)
Panel A: Baseline estimates for all patents (AI+Non-AI)				
DV (in log)	Female Inventor	Patents with Atleast One Female	Share of Female Inventor	Share of Patents with Atleast One Female
China x Post 2002	1.392***	1.492***	0.000	-0.007
	[0.045]	[0.044]	[0.009]	[0.009]
Post 2002	0.821***	0.744***	0.016	0.016
	[0.093]	[0.090]	[0.017]	[0.019]
China	4.449***	4.189***	0.243***	0.254***
	[0.042]	[0.042]	[0.010]	[0.010]
Country Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
R squared	0.9667	0.9635	0.3641	0.3735
Observations	1,535	1,535	1,535	1,522
Panel B: Baseline estimates for Non-AI Patents				
DV (in log)	Female Inventor	Patents with Atleast One Female	Share of Female Inventor	Share of Patents with Atleast One Female
China x Post 2002	1.349***	1.474***	-0.001	-0.010
	[0.044]	[0.040]	[0.009]	[0.009]
Post 2002	0.778***	0.655***	0.011	0.007
	[0.093]	[0.087]	[0.020]	[0.020]
China	4.385***	4.097***	0.241***	0.251***
	[0.042]	[0.038]	[0.011]	[0.010]
Country Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
R squared	0.9664	0.9654	0.3418	0.3692
Observations	1,514	1,514	1,514	1,500

Notes: The dependent variable in columns (1) and (2) is the log of the number of patents with at least one female inventor and the log of the number of female inventors, columns (3) and (4) represent the share of the respective variables. Panel A represents the estimates for all patents (AI and non-AI), whereas Panel B represents the estimates for non-AI patents only. The coefficient estimates highlight a positive and significant effect for the first two outcomes, but represent an insignificant effect for the share of patents with female and female inventors. This represents that while the absolute numbers changed, the overall share remains unchanged for all patents, which is in contrast to baseline estimates for AI patents. Robust standard errors, clustered at the country level, are presented in the parentheses.'***','**','*' indicate significance at the 1%, 5%, and 10% respectively.

Table A9: Impact of policy reforms post-2002

	(1)	(2)	(3)	(4)	(5)
DV	Panel A: Log Patents with Atleast One Female				
Intervention Year	2004:Copyright	2006:Network Dissemination	2008:NIPS	2009:Third Amendment	2010:Updated Implementation
China x Post	1.356***	1.414***	1.382***	1.359***	1.382***
	[0.040]	[0.040]	[0.039]	[0.040]	[0.042]
Observations	6,624	6,624	6,624	6,624	6,624
R-squared	0.901	0.901	0.899	0.898	0.897
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Technology Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country x Technology Fixed Effects	Yes	Yes	Yes	Yes	Yes
Technology x Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
DV	Panel B: Log Female Inventor				
Intervention Year	2004:Copyright	2006:Network Dissemination	2008:NIPS	2009:Third Amendment	2010:Updated Implementation
China x Post	1.929***	1.951***	1.873***	1.859***	1.800***
	[0.056]	[0.055]	[0.054]	[0.056]	[0.058]
Observations	6,624	6,624	6,624	6,624	6,624
R-squared	0.908	0.908	0.905	0.904	0.902
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Technology Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country x Technology Fixed Effects	Yes	Yes	Yes	Yes	Yes
Technology x Year Fixed Effects	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable in panel A is the log of the number of patents with at least one female inventor, and columns (3) and (4) represent the log of the number of female inventors. We examine five major policy reforms in China post-WTO accession in 2002 that altered the IPR policies. These policies are listed in detail in table A8. Robust standard errors, clustered at the country level, are presented in the parentheses.'***','**','*' indicate significance at the 1%, 5%, and 10% respectively.

Table A10: Non-Existent Pre-Trends

	(1) Log Patents with Female	(2) Log Female Inventors
China x Year 1998	-0.012	-0.026
	[0.293]	[0.272]
China x Year 1999	-0.196	-0.309
	[0.293]	[0.272]
China x Year 2000	0.002	0.486*
	[0.292]	[0.272]
China x Year 2001	0.203	0.669**
	[0.292]	[0.272]
China x Year 2002	-0.011	0.438
	[0.292]	[0.272]
Observations	6,624	6,624
R-squared	0.679	0.807

Notes: The dependent variable in column (1) is the log of the number of patents with female inventors. In column (2) is the log of the number of female inventors. We see that the interaction term is mostly insignificant, suggesting that there was no significant difference between the treatment and control groups in the pre-treatment period. Robust standard errors, clustered at the country level, are presented in the parentheses.'***','**','*' indicate significance at the 1%, 5%, and 10% respectively.

Table A11: Increased Enrollment in Tertiary Education in China Post-2002 (Source: World Bank Open Data)

DV: Gender Parity in Tertiary Enrollment	(1)	(2)	(3)
China x Post 2002	0.236***	0.233***	0.233***
	[0.006]	[0.006]	[0.006]
Post 2002	0.068***	0.140***	
	[0.006]	[0.011]	
China	-0.279***		
	[0.024]		
Year Dummies	No	Yes	Yes
Country Dummies	No	No	Yes
R-squared	0.010	0.014	0.964
Observations	2,388	2,388	2,388

Notes: The dependent variable in columns (1) to (3) is Gender Parity in Tertiary Enrollment. Across all specifications, we see that the interaction term is positive and statistically significant. This suggests that there is a significant increase in the enrollment of females in tertiary education in China after its accession to the WTO in 2002. The time horizon is from 1997 to 2011. Robust standard errors, clustered at the country level, are presented in the parentheses.'***','**','*' indicate significance at the 1%, 5%, and 10% respectively.