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Integration in the Global Value Chain, Structural Change, and the Widening Gender Employment Gap in China

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Abstract: Despite the structural change toward services that are generally beneficial for female employment, China's gender employment gap (GEG) has widened by 9.64% in the past two decades, 2000–2020, indicated by the labor force participation rate (LFP) of males minus that of females. This study distinguishes domestic demand and different types of global value chain (GVC) related demand under the inter-country input–output framework, and propose a new gender gap decomposition model to explore the evolution of China's GEG from a demand-side perspective. Our results show that GVC-related activities contributed to the widening of China's GEG by less than 0.60% between 2000 and 2020. In contrast, increasing gender discrimination toward females and technological progress with a rapid decrease in employment when producing the same amount of output in most female-intensive sectors are the dominant reasons behind the widening of China's GEG. This study provides some implications for promoting high-quality employment development in China.

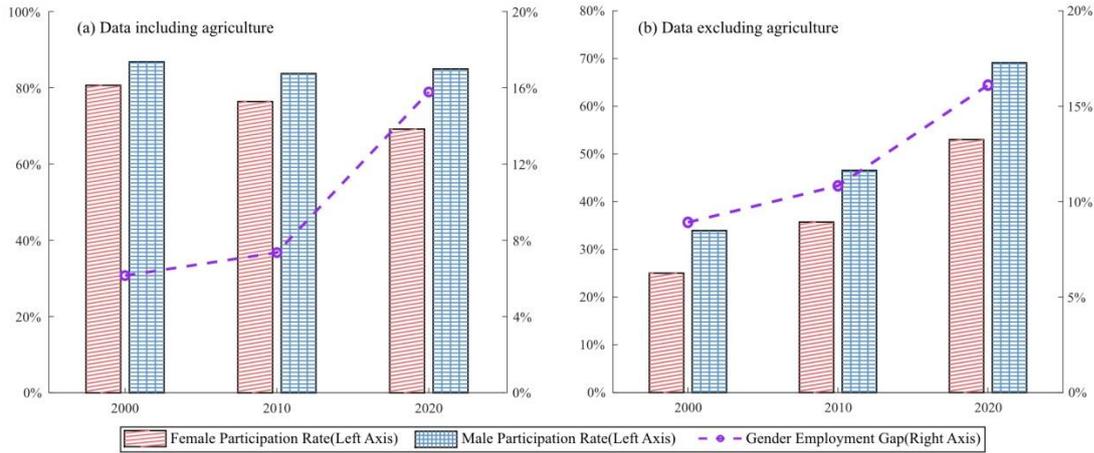**Keywords:** Gender Employment Gap, Labor Force Participation, Global Value Chain, China

Acknowledgements

1. Introduction

The gender gap transcends most of the world's cultures, religions, and income groups. The most recent "Global Gender Gap Report 2022" released by the World Economic Forum (WEF, 2022) shows that at the current rate of progress in 2022, it will take 132 years to reach full parity, which represents an over 30 year deterioration compared to the 2020 estimate (~100 years to parity). Among all economies, China ranked 102nd in the overall score of the global gender gap index, while its scores in the political empowerment, educational attainment, health, and survival sub-indices ranked lower than 120th out of 146 economies. Promoting high-quality employment has become one of the essential strategies to improve people's well-being, as shown in the report of the 20th National Congress of China's Communist Party released at the end of 2022.

Furthermore, in recent decades, China has witnessed a significant decrease in the female labor force participation (LFP) rate indicated by the female labor force divided by the total working-age female population. Specifically, if we measure the overall gender employment gap (GEG) in China in terms of male LFP minus female LFP, it has been continuously widening. According to data from China's population census, the overall GEG has increased from 6.26% in 2000 to 7.35% and 15.78% in 2010 and 2020, respectively, indicated by the gender difference in the LFP including the agricultural labor force (Fig. 1a), or increased from 9.22% in 2000 to 10.90% and 16.17% in 2010 and 2020, respectively, indicated by the gender difference in the LFP excluding the agricultural labor force (Fig. 1b). In other words, China's GEG is widening, regardless of the inclusion or exclusion of agriculture. The widening GEG, especially after 2010, is inconsistent with China's overall structural change, which shows a serious expansion of the tertiary industry in gross domestic products during the same period (Fig. 2 with dark blue solid lines); as the development of services is known to be more beneficial for female employment (e.g., Goldin, 2006; Taglioni and Winkler, 2016; Ngai and Petrongolo, 2017; Rendall, 2018).

Notes：The male/female participation rate is calculated as the labor force divided by the total working-age population by gender. The gender employment gap is calculated as the difference in the male and female participation rate. Data are taken from China's population census.

Figure 1. Labor force participation (LFP) rate by gender and gender employment gap (GEG) in China, 2000–2020

The literature has extensively discussed the reasons behind the GEG in China. For example, Chi and Li (2008, 2014) found that since the 1990s, female LFP has been decreasing, and the gap between male and female LFP has been increasing. Their further explorations suggest that personal education, experience, and family characteristics, such as marital status, the presence of a young child in the household, and spousal income led to the widening of the GEG. Their findings are confirmed in recent studies on China, such as Wang and Cheng (2021), Guo et al. (2022), and Liu et al. (2023). To a broader extent, their findings are similar to the vast body of research on gender gaps worldwide. The literature found that female gains in education and healthcare and the introduction of antidiscrimination legislation have narrowed and even reversed gender gaps worldwide (e.g., Goldin, 2006, 2016；Bertrand et al., 2015; Olivetti an Petrongolo, 2008, 2016), while the role of females as the primary providers of childcare and home production, and gender differences in attitudes toward risk, competition, and negotiation, may interfere with female performance in the labor market and increase the gender gap worldwide (e.g., Croson and Gnezy, 2009; Bertrand, 2011; Azmat and Petrongolo, 2014; Kleven et al., 2019).
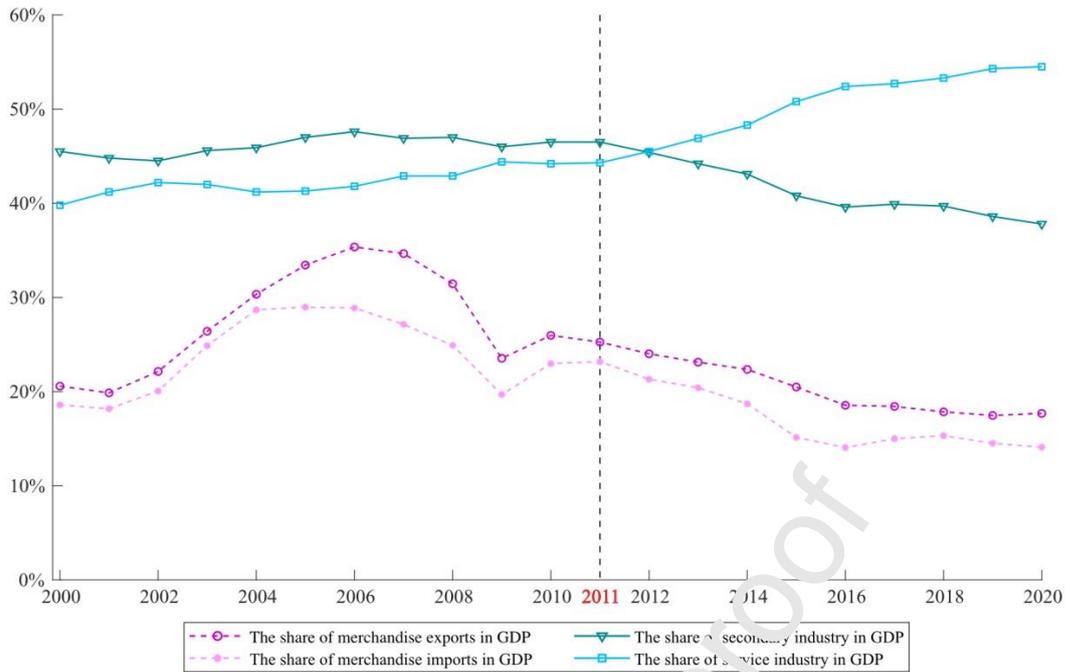
Notes: Data are taken from the official website of China's national statistical bureau (www.stats.gov.cn). GDP = Gross domestic product.

Figure 2. The pattern of Gross domestic product (GDP) composition in China, 2000–2020

Among all the factors, the integration in global trade (also indicated as global value chain (GVC) in recent studies) and its impact on the gender gap has attracted much attention against the background of growing economic integration worldwide and the spread of GVC. As shown in Fig. 2 with dashed lines, the rapid increase in the GEG since 2010 is accompanied by a rapid decrease in trade dependence in China. In the literature, the prominent role of female workers in export-oriented industries has led to claims that involvement in global trade results in development benefits for women and a narrowing of the gender gap in developing countries. Juhn et al. (2014), David and Tejani (2014), ILO (2015), and Gaddis and Pieters (2017), for example, suggested that global trade or offshoring have created new employment opportunities for women who are previously locked into a harsh and dependent existence with little opportunity to access employment, and thus reduced the gender employment and gender wage gap. It might be reasonable to link the gender gap increase and the backward integration in GVCs since 2010 in China.

However, many research findings show that integration in the global trade market (or GVC) increases both male and female employment and does not necessarily lead to positive social outcomes such as reducing the gender gap (Barrientos et al., 2011; Locke, 2013; Barrientos, 2014; Bøler et al., 2018) or even showing a positive relationship between involvement of global trade (or GVC) and the gender wage gap

(Berik et al., 2004; Domínguez-Villalobos and Brown-Grossman, 2010; UNCTAD, 2015; Nikulin and Wolszczak-Derlacz, 2022).

An important reason behind the mixed outcome of global trade on the gender gap is heterogeneity across sectors (Amiti and Davis, 2011; Yahmed, 2012; Wolszczak-Derlacz, 2013; Hummels et al., 2014, 2018). For example, Hummels et al. (2014, 2018) documented stylized facts about offshoring and the gender gap. They found that the net gender gap effects of trade vary substantially, conditional on labor skill type and task characteristics. Wolszczak-Derlacz (2013) found a negative impact of global trade on the growth of a high-skill gender wage gap in concentrated industries but a widening impact of trade on the growth of medium- and low-skill occupational gender wage gap in less competitive industries. Sectoral heterogeneity is significant for China. Yu et al. (2021) found that tariff reductions increased the GEG in China, contrary to the results of Gaddis and Pieters (2017), which found that tariff reductions decreased the gender gap in Brazil. Yu et al. (2021) suggested that the difference in the gender intensity of industries that experienced tariff decline highly explains the opposite gender-differential effects; that is, tariff reductions in Brazil are greater in male-intensive industries, while those in China are greater in female-intensive industries.

Therefore, it is imperative to distinguish the sectoral heterogeneity when discussing the outcome of integration in GVCs on the gender gap. Furthermore, there are different ways to integrate into GVCs at the sectoral levels (see Koopman et al., 2014, for classic decomposition). In this context, this paper investigates the impact of different integrating patterns in GVCs on the evolution of the overall GEG in China from a multisectoral perspective, with two significant contributions to the literature regarding theoretical and empirical aspects. Theoretically, we propose a new GEG decomposition model to investigate the evolution of the GEG by combining the measurements of different GVC-related activities (including direct exports, simplified GVC, and complex GVC) and a structural decomposition model under the inter-country input–output framework. This decomposition model can be extended to study the gender gap in wages, income, and wealth once corresponding data are available. From an empirical aspect, we tackle the paradox between the widening of the GEG and the structural change toward a services-based economy in China from a multisectoral perspective. That is, we explore how different ways of integrating GVCs influenced the pattern of composition and distribution of female employment across sectors and whether they led to the widening of the GEG during 2000–2020 in the hope of stimulating high-quality employment in China.

The structure of the paper is as follows. Section 2 introduces the methodology and data source employed, Section 3 provides decomposition results at both aggregate and sectoral levels, and Section 4 summarizes the results and concludes the paper.

2. Methodology

2.1 The gender employment gap in labor force participation

The gender gap could be reflected by the difference between men and women in economic, social, political, intellectual, or cultural attainments. This paper focuses on the gender employment gap (GEG) measured by the difference in men and women in China's LFP. That is,

$$GEG = LFP^m - LFP^f = \frac{E^m}{L^m} - \frac{E^f}{L^f} \tag{1}$$

where LFP^m is the male LFP defined as the number of male employment (E^m) divided by the number of the male labor force (i.e., the male population aged 16–60 in China, L^m), and LFP^f is the female LFP defined as the number of female employment (E^f) divided by the number of the female labor force (i.e., the female population aged 16–55 in China, L^f). All employment data include agriculture to reflect the overall structural change in China.

2.2 Decomposition of the gender employment gap: the first layer

We used the index decomposition to decompose the GEG from a multisectoral perspective. For the male LFP, we have,

$$LFP^m = \sum_{i=1}^{N} \frac{E_i^m}{L^m} = \sum_{i=1}^{N} \frac{E_i^m}{E_i} \cdot \frac{E_i}{E} \cdot \frac{E}{L} \cdot \frac{1}{L^m/L} = \sum_{i=1}^{N} GD_i \cdot IS_i \cdot ER \cdot \frac{1}{SL} \tag{2}$$

where GD_i denotes the extent of gender discrimination at the sectoral level, indicated by the share of male employment (E_i^m) in the total employment of sector i ($E_i, i = 1,2,...,N$); IS_i denotes the extent of the industrial structure, indicated by the share of employment of sector i (E_i) in the total employment (E); ER denotes the overall employment rate, indicated by the total labor participation rate, which is the total employment (E) divided by the total labor force (L); and SL denotes the structure of the labor force, indicated by the share of the male labor force (L^m) in the total labor force (L).

In this regard, the change in the male LFP from year t_0 to t_1 could be decomposed as the contributions of changes in these four factors. For n factors, there are $n!$ ways to decompose the contributions of each factor (Dietzenbacher and Los, 1998). In this paper, we follow the polar decomposition proposed by

Dietzenbacher and Los (1998) and de Boer and Rodrigues (2020) to decompose the change in male LFP from year t_0 to t_1. That is,

$$\Delta LFP^m = LFP^{m,t1} - LFP^{m,t0} = \sum_{i=1}^{N} GD_i^{t1} \cdot IS_i^{t1} \cdot ER^{t1} \cdot \frac{1}{SL^{t1}} - \sum_{i=1}^{N} GD_i^{t0} \cdot IS_i^{t0} \cdot ER^{t0} \cdot \frac{1}{SL^{t0}}$$

$$= \left[\sum_{i=1}^{N} (GD_i^{t1} - GD_i^{t0}) \cdot IS_i^{t0} \cdot ER^{t0} \cdot \frac{1}{SL^{t0}} + \sum_{i=1}^{N} (GD_i^{t1} - GD_i^{t0}) \cdot IS_i^{t1} \cdot ER^{t1} \cdot \frac{1}{SL^{t1}} \right] / 2 \qquad (3.a)$$

$$+ \left[\sum_{i=1}^{N} GD_i^{t1} \cdot (IS_i^{t1} - IS_i^{t0}) \cdot ER^{t0} \cdot \frac{1}{SL^{t0}} + \sum_{i=1}^{N} GD_i^{t0} \cdot (IS_i^{t1} - IS_i^{t0}) \cdot ER^{t1} \cdot \frac{1}{SL^{t1}} \right] / 2 \qquad (3.b)$$

$$+ \left[\sum_{i=1}^{N} GD_i^{t1} \cdot IS_i^{t1} \cdot (ER^{t1} - ER^{t0}) \cdot \frac{1}{SL^{t0}} + \sum_{i=1}^{N} GD_i^{t0} \cdot IS_i^{t0} \cdot (ER^{t1} - ER^{t0}) \cdot \frac{1}{SL^{t1}} \right] / 2 \qquad (3.c)$$

$$+ \left[\sum_{i=1}^{N} GD_i^{t1} \cdot IS_i^{t1} \cdot ER^{t1} \cdot (\frac{1}{SL^{t1}} - \frac{1}{SL^{t0}}) + \sum_{i=1}^{N} GD_i^{t0} \cdot IS_i^{t0} \cdot ER^{t0} \cdot (\frac{1}{SL^{t1}} - \frac{1}{SL^{t0}}) \right] / 2 \qquad (3.d)$$

$$= \underbrace{m\_\Delta GD}_{(3.a)} + \underbrace{m\_\Delta IS}_{(3.b)} + \underbrace{m\_\Delta ER}_{(3.c)} + \underbrace{m\_\Delta SL}_{(3.d)} \qquad (3)$$

where Eq. (3.a) denotes the contribution of changes in the share of male employment in total employment across all sectors, i.e., the contribution of changes in gender discrimination at the sectoral level ($m\_\Delta GD$); Eq. (3.b) denotes the contribution of changes in the share of sectoral employment in total employment, that is the contribution of change in industrial structure ($m\_\Delta IS$); Eq. (3.c) denotes the contribution of changes in overall LFP without gender distinction, i.e., the contribution of change in employment rate ($m\_\Delta ER$); and Eq. (3.d) denotes the contribution of changes in the share of the male labor force in the total labor force, i.e., the contribution of change in the structure of the labor force ($m\_\Delta SL$).

In a similar vein, the change in the female LFP from year t_0 to t_1 can be decomposed into the contributions of these four factors as follows:

$$\Delta LFP^f = LFP^{f,t1} - LFP^{f,t0}$$

$$= \sum_{i=1}^{N} (1 - GD_i^{t1}) \cdot IS_i^{t1} \cdot ER^{t1} \cdot \frac{1}{(1-SL^{t1})} - \sum_{i=1}^{N} (1 - GD_i^{t0}) \cdot IS_i^{t0} \cdot ER^{t0} \cdot \frac{1}{(1-SL^{t0})}$$

$$= \left[\sum_{i=1}^{N} (GD_i^{t0} - GD_i^{t1}) \cdot IS_i^{t0} \cdot ER^{t0} \cdot \frac{1}{1-SL^{t0}} + \sum_{i=1}^{N} (GD_i^{t0} - GD_i^{t1}) \cdot IS_i^{t1} \cdot ER^{t1} \cdot \frac{1}{1-SL^{t1}} \right] / 2 \qquad (4.a)$$

$$+ \left[\sum_{i=1}^{N} (1 - GD_i^{t1}) \cdot (IS_i^{t1} - IS_i^{t0}) \cdot ER^{t0} \cdot \frac{1}{1-SL^{t0}} + \sum_{i=1}^{N} (1 - GD_i^{t0}) \cdot (IS_i^{t1} - IS_i^{t0}) \cdot ER^{t1} \cdot \frac{1}{1-SL^{t1}} \right] / 2$$

(4.b)

$$+ \left[\sum_{i=1}^{N} (1 - GD_i^{t1}) \cdot IS_i^{t1} \cdot (ER^{t1} - ER^{t0}) \cdot \frac{1}{1-SL^{t0}} + \sum_{i=1}^{N} (1 - GD_i^{t0}) \cdot IS_i^{t0} \cdot (ER^{t1} - ER^{t0}) \cdot \frac{1}{1-SL^{t1}} \right] / 2$$

(4.c)

$$+ \left[\sum_{i=1}^{N} (1 - GD_i^{t1}) \cdot IS_i^{t1} \cdot ER^{t1} \cdot (\frac{1}{1-SL^{t1}} - \frac{1}{1-SL^{t0}}) + \sum_{i=1}^{N} (1 - GD_i^{t0}) \cdot IS_i^{t0} \cdot ER^{t0} \cdot (\frac{1}{1-SL^{t1}} - \frac{1}{1-SL^{t0}}) \right] / 2$$

(4.d)

$$= \underbrace{f\_\Delta GD}_{(4.a)} + \underbrace{f\_\Delta IS}_{(4.b)} + \underbrace{f\_\Delta ER}_{(4.c)} + \underbrace{f\_\Delta SL}_{(4.d)} \tag{4}$$

where Eqs. (4.a)–(4.d) denote the contribution of each factor to the change in female LFP, as Eqs. (3.a)–(3.d) denote the change in male LFP.

Consequently, the change in the GEG from year t_0 to t_1 can be decomposed into the contributions of four factors, gender discrimination (as shown in Eq. 5a), industrial structure (as shown in Eq. 5b), employment rate (as shown in Eq. 5c), and the structure of the labor force by gender (as shown in Eq. 5d). That is,

$$\Delta GEG = (LFP^{m,t1} - LFP^{f,t1}) - (LFP^{m,t0} - LFP^{f,t0})$$

$$= (LFP^{m,t1} - LFP^{m,t0}) - (LFP^{f,t1} - LFP^{f,t0}) \tag{5}$$

$$= \underbrace{(m\_\Delta GD - f\_\Delta GD)}_{(5.a)} + \underbrace{(m\_\Delta IS - f\_\Delta IS)}_{(5.b)} + \underbrace{(m\_\Delta ER - f\_\Delta ER)}_{(5.c)} + \underbrace{(m\_\Delta SL - f\_\Delta SL)}_{(5.d)}$$

2.3 Decomposition of the gender employment gap from a demand-side perspective

Among the four factors of the first layer of decomposition, the role of industrial structure in Eq. (5b) is of particular concern, as China's structural change toward services (Fig. 2), which is beneficial for female employment, deviated from the increasing trend of GEG in the past decades of China (Fig. 1). The industrial structural change is, however, driven by the change in various demands of households, governments, and foreign consumers and production linkages across sectors. In this section, we introduce an inter-country input–output framework to explore further the reasons behind the change in industrial structure from the demand-side perspective. Inter-country input–output tables have been widely accepted to distinguish GVC-related and domestic demand-related activities from a multisectoral perspective (Koopman et al., 2014; Duan et al., 2021; Chen et al., 2022). Following Koopman et al. (2014) and Wang et al. (2017, 2021), we distinguish the employment generations at the sectoral level into four types of final demand, domestic demand (DD), direct exports (EX), simplified GVC (SG), and complex GVC (CG), for which the latter three types belong to GVC-related activities. Without loss generality, let us consider a

world economy with M countries and N sectors. Defining $A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1,MN} \\ a_{21} & a_{22} & \cdots & a_{2,MN} \\ \vdots & \vdots & \ddots & \vdots \\ a_{MN,1} & a_{MN,2} & \cdots & a_{MN,MN} \end{bmatrix}$ as a

MN × MN matrix of input coefficients, $A^D = \begin{bmatrix} a_{11} & 0 & \cdots & 0 \\ 0 & a_{22} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & a_{MN,MN} \end{bmatrix}$ as a MN × MN diagonal block

matrix of domestic input coefficients, $A^F = A - A^D$ as a MN × MN off-diagonal block matrix of

imported input coefficients, $B = (I - A)^{-1}$ as the overall Leontief inverse, $B^D = (I - A^D)^{-1}$ as the

domestic Leontief inverse, $F^D = \begin{bmatrix} f_{11} \\ f_{22} \\ \vdots \\ f_{MM} \end{bmatrix}$ as a MN × 1 vector of final products that are consumed by

domestic consumers (incl. households and governments), $F^F = F - F^D$ as a MN × 1 vector of final

products consumed by foreign consumers, and Y as the total output, the row equilibrium can be written as

follows:

$$Y = B^D \cdot (F^D + E) = B^D \cdot F^D + B^D \cdot F^F + B^D \cdot A^F X = \sum_{k=1}^{4} B^D \cdot F^k = \sum_{k=1}^{4} Y^k$$

$$= \underbrace{B^D \cdot F^D}_{domestic\ demand} + \underbrace{B^D \cdot F^F}_{direct\ exports} + \underbrace{B^D \cdot A^F \cdot B^D \cdot F^D}_{simplified\ GVC} + \underbrace{B^D \cdot A^F \cdot (B \cdot F - B^D \cdot F^D)}_{complex\ GVC} \quad (6)$$

where the first term $B^D \cdot F^D$ corresponds to the output Y^1 driven by domestic demand (*DD*); second term

$B^D \cdot F^F$ corresponds to the outputs Y^2 driven by direct exports (*EX*); third term $B^D \cdot A^F \cdot B^D \cdot F^D$

corresponds to the outputs Y^3 driven by simplified GVC (*SG*), that is, intermediate exports/imports used by

a direct importing country to produce products that are absorbed in the country; and the fourth term

$B^D \cdot A^F \cdot (B \cdot F - B^D \cdot F^D)$ corresponds to the outputs Y^4 driven by complex GVC (*CG*), that is,

intermediate exports/imports used by the partner country to produce exports (intermediate or final) for

other countries. The first term belongs to domestic demand-related activities, whereas the second, third,

and fourth terms belong to GVC-related activities.

Let $E = \begin{bmatrix} E_1 \\ E_2 \\ \vdots \\ E_N \end{bmatrix}$ denotes the MN × 1 vectors of employment by country and sector, $EC = E\hat{Y}^{-1}$

denotes the MN × 1 vectors of employment coefficients per unit of output by country and sector, and the

employment generation can be decomposed into four types of final demand (E^k, *k*=1, 2, 3, 4):

$$E = \sum_{k=1}^{4} E^k = \sum_{k=1}^{4} \widehat{EC} \cdot Y^k$$

$$= \underbrace{\widehat{EC} \cdot B^D \cdot F^D}_{domestic\ demand} + \underbrace{\widehat{EC} \cdot B^D \cdot F^F}_{direct\ exports} + \underbrace{\widehat{EC} \cdot B^D \cdot A^F \cdot B^D \cdot F^D}_{simplified\ GVC} + \underbrace{\widehat{EC} \cdot B^D \cdot A^F \cdot (B \cdot F - B^D \cdot F^D)}_{complex\ GVC}$$

$$(7)$$

Recalling that the factor "Gender Discrimination" (*GD_i*) denotes the share of male employment (E_i^m)

in the total employment of sector i (E_i) and assuming that the share GD_i would be identical regardless of the type of demand, the male and female employment driven by four types of final demand can be written as follows:

$$E^m = \sum_{k=1}^{4} E^{mk} = \sum_{k=1}^{4} \widehat{GD} \cdot E^k = \sum_{k=1}^{4} \widehat{GD} \cdot \widehat{EC} \cdot Y^k$$

$$= \underbrace{\widehat{GD} \cdot \widehat{EC} \cdot B^D \cdot F^D}_{domestic\ demand} + \underbrace{\widehat{GD} \cdot \widehat{EC} \cdot B^D \cdot F^F}_{direct\ exports}$$

$$+ \underbrace{\widehat{GD} \cdot \widehat{EC} \cdot B^D \cdot A^F \cdot B^D \cdot F^D}_{simplified\ GVC} + \underbrace{\widehat{GD} \cdot \widehat{EC} \cdot B^D \cdot A^F \cdot (B \cdot F - B^D \cdot F^D)}_{complex\ GVC} \qquad (8.a)$$

$$E^f = \sum_{k=1}^{4} E^{fk} = \sum_{k=1}^{4} (1 - \widehat{GD}) \cdot E^k = \sum_{k=1}^{4} (1 - \widehat{GD}) \cdot \widehat{EC} \cdot Y^k$$

$$= \underbrace{(1 - \widehat{GD}) \cdot \widehat{EC} \cdot B^D \cdot F^D}_{domestic\ demand} + \underbrace{(1 - \widehat{GD}) \cdot \widehat{EC} \cdot B^D \cdot F^F}_{direct\ exports}$$

$$+ \underbrace{(1 - \widehat{GD}) \cdot \widehat{EC} \cdot B^D \cdot A^F \cdot B^D \cdot F^D}_{simplified\ GVC} + \underbrace{(1 - \widehat{GD}) \cdot \widehat{EC} \cdot B^D \cdot A^F \cdot (B \cdot F - B^D \cdot F^D)}_{complex\ GVC} \quad (8.b)$$

With the distinction of employment driven by gender and different demand types, the contribution of *IS* to change in the GEG, as shown in Eq. (5.b), can be further decomposed from the demand-side perspective. We start with the decomposition of the crucial change $\Delta IS_i = IS_i^{t1} - IS_i^{t0}$ from a demand-side perspective. That is,

$$\Delta IS_i = IS_i^{t1} - IS_i^{t0} = \frac{E_i^{t1}}{E^{t1}} - \frac{E_i^{t0}}{E^{t0}} = \frac{\sum_{k=1}^{4} E_{ki}^{t1}}{\sum_{i=1}^{N} \sum_{k=1}^{4} E_{ki}^{t1}} - \frac{\sum_{k=1}^{4} E_{ki}^{t0}}{\sum_{i=1}^{N} \sum_{k=1}^{4} E_{ki}^{t1}}$$

$$= \frac{\sum_{k=1}^{4} EC_i^{t1} \cdot B^{D,t1} \cdot (Y^{t1} \otimes FT^{k,t1} \otimes FS^{k,t1})}{\sum_{k=1}^{4} \sum_{i=1}^{N} EC_i^{t1} \cdot B^{D,t1} \cdot (Y^{t1} \otimes FT^{k,t1} \otimes FS^{k,t1})} - \frac{\sum_{k=1}^{4} EC_i^{t0} \cdot B^{D,t0} \cdot (Y^{t0} \otimes FT^{k,t0} \otimes FS^{k,t0})}{\sum_{k=1}^{4} \sum_{i=1}^{N} EC_i^{t0} \cdot B^{D,t0} \cdot (Y^{t0} \otimes FT^{k,t0} \otimes FS^{k,t0})}$$

$$= \frac{\sum_{k=1}^{4} EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t1})}{\sum_{k=1}^{4} \sum_{i=1}^{N} EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t1})} - \frac{\sum_{k=1}^{4} EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t0})}{\sum_{k=1}^{4} \sum_{i=1}^{N} EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t0})}$$

$$= IS\_\Delta EC + IS\_\Delta BD + IS\_\Delta FT + IS\_\Delta FS$$

$$= IS_i\_\Delta EC + IS_i\_\Delta BD + \sum_{k=1}^{4} IS_i\_\Delta FT^k + \sum_{k=1}^{4} IS_i\_\Delta FS^k \qquad (9)$$

where EC and B^D still represent the employment coefficients per unit of output at the sectoral level and the domestic Leontief inverse, respectively. The final demand by type k is further calculated as $F^k = FD \otimes FT^k \otimes FS^k$, with FD representing the total amount of the final demand including all types and sectors; FT^k represents the share of demand type k in the total final demand Y; and FS^k represents the share of the sectoral demand in the total demand by each type k. The amount of final demand FD^{t1}/FD^{t0} is reduced as the common factor of the numerator and denominator in Eq. (9), suggesting that the total amount of final demand FD^{t1}/FD^{t0} does not influence the structural change. In this regard, the change ΔIS_i can be decomposed into the contributions of changes in employment coefficients ($IS_i\_\Delta EC$), domestic Leontief inverse ($IS_i\_\Delta BD$), share of demand type k ($IS_i\_\Delta FT^k$), and structure of demand type k

$(IS_i\_\Delta FS^k)$. In Appendix A, we provide detailed decomposition formulas.

Combining Eqs. (9) and (3b), the change of ΔIS_i, which drives the contributions $m\_\Delta IS$ shown in Eq. (3b) can be further decomposed into the contributions of changes from the demand-side perspective, including employment coefficients $(m\_\Delta EC)$, production recipe indicated by the domestic Leontief inverse $(m\_\Delta BD)$, the share of demand of each type in the total final demand $(m\_\Delta FT^k)$, and the share of sectoral demand in the total demand by each type structure $(m\_\Delta FS^k)$.

$$m\_\Delta IS = \left[\sum_{i=1}^{N} GD_i^{t1} \cdot (IS_i^{t1} - IS_i^{t0}) \cdot ER^{t0} \cdot \frac{1}{SL^{t0}} + \sum_{i=1}^{N} GD_i^{t0} \cdot (IS_i^{t1} - IS_i^{t0}) \cdot ER^{t1} \cdot \frac{1}{SL^{t1}}\right]/2$$

$$= m\_\Delta EC + m\_\Delta BD + \sum_{k=1}^{4} m\_\Delta FT^k + \sum_{k=1}^{4} m\_\Delta FS^k \tag{10}$$

Similarly, the change ΔIS_i that drives the contributions $f\_\Delta IS$ shown in Eq. (4b) can be further decomposed from a supply-side perspective as follows:

$$f\_\Delta IS = \left[\sum_{i=1}^{N}(1 - GD_i^{t1}) \cdot (IS_i^{t1} - IS_i^{t0}) \cdot ER^{t0} \cdot \frac{1}{1-SL^{t0}} + \sum_{i=1}^{N}(1 - GD_i^{t0}) \cdot (IS_i^{t1} - IS_i^{t0}) \cdot ER^{t1} \cdot$$

$$\frac{1}{1-SL^{t1}}\right]/2$$

$$= f\_\Delta EC + f\_\Delta BD + \sum_{k=1}^{4} f\_\Delta FT^k + \sum_{k=1}^{4} f\_\Delta FS^k \tag{11}$$

Therefore, the change in the GEG from year t_0 to t_1 can be decomposed from a demand-side perspective as follows:

$$\Delta GEG = (LFP^{m,t1} - LFP^{m,t0}) - (LFP^{f,t1} - LFP^{f,t0})$$

$$= \underbrace{(m\_\Delta GD - f\_\Delta GD)}_{(5.a)} + \underbrace{(m\_\Delta IS - f\_\Delta IS)}_{(5.b)} + \underbrace{(m\_\Delta ER - f\_\Delta ER)}_{(5.c)} + \underbrace{(m\_\Delta SL - f\_\Delta SL)}_{(5.d)}$$

$$= \underbrace{(m\_\Delta GD - f\_\Delta GD)}_{(5.a)} + \underbrace{(m\_\Delta EC - f\_\Delta EC)}_{(12.a)} + \underbrace{(m\_\Delta BD - f\_\Delta BD)}_{(12.b)} + \underbrace{(m\_\Delta FT^k - f\_\Delta FT^k)}_{(12.c)}$$

$$+ \underbrace{(m\_\Delta FS^k - f\_\Delta FS^k)}_{(12.d)} + \underbrace{(m\_\Delta ER - f\_\Delta ER)}_{(5.c)} + \underbrace{(m\_\Delta SL - f\_\Delta SL)}_{(5.d)} \tag{12}$$

In Appendix A, we provide detailed decomposition formulas for each factor in Eq. (12). In total, three out of all the factors, gender discrimination (GD), the employment rate (ER), and structure of labor (SL), remain the same in contributing to the change in the GEG based on first-layer decomposition (Eq. 5), based on demand-side decomposition (Eq. 12). The only difference between the demand-side and the first-layer decomposition lies in the further decomposition of industrial structure (IS) from the demand-side perspective, as shown in Eqs. (12a)–(12d). Noteworthy, the total employment (E) in the employment rate (ER) is determined by the final demand, including both amount and structure. However, as the employment rate (ER) is a well-known indicator reflecting the prosperity of the overall economy, and the total employment (E) has been decomposed as the denominator of IS, in this paper we only decompose the

contribution of *IS* from the demand-side perspective. In Fig. 3, we summarize our *GEG* decompositions, where the first layer of decomposition distinguishes the role of four factors, as shown in Eqs. (3)–(5), and the further layer of demand-side decomposition distinguishes the role of employment coefficients (*EC*), domestic Leontief inverse (*BD*), final demand share (*FT^k*), and final demand structures (*FS^k*), as shown in Eq. (11).
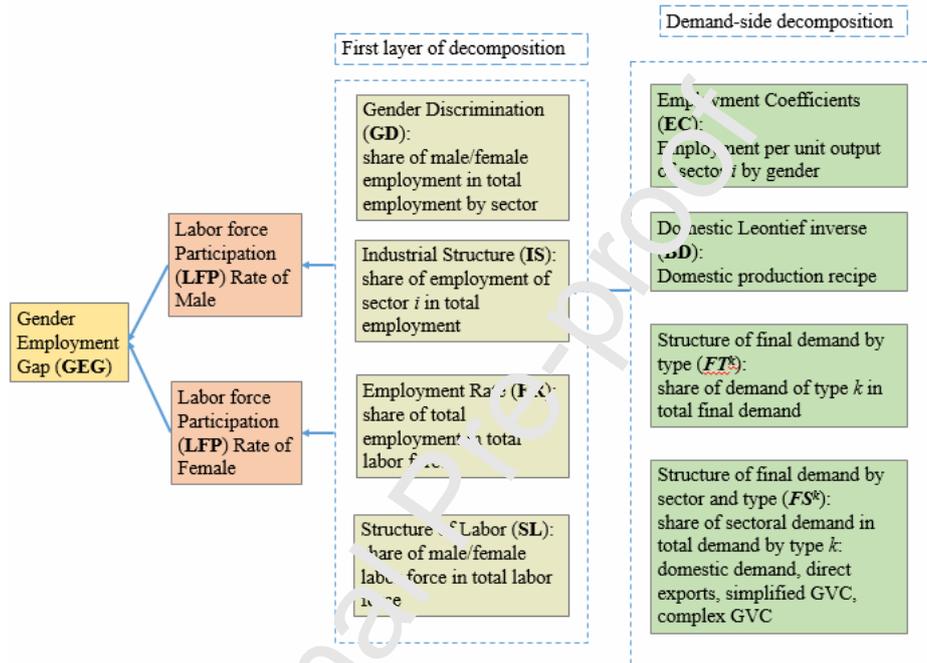
Figure 3. The outline of the decompositions of the Gender Employment Gap (GEG)

2.4 Data

Many international organizations have released inter-country input–output databases, including the World Input–Output Database research group, United Nations Conference on Trade and Development (UNCTAD), Organization for Economic Co-operation and Development, Institute of Developing Economies of Japan External Trade Organization, Asian Development Bank (ADB), and Global Trade Analysis Project (refer to Inomata and Owen, 2014 for a thorough review). In this study, we employed the multi-regional input–output tables (MRIO) released by the ADB to measure the contributions of changes related to the GVC and DD in China's LFP and GEG. Compared to other databases, the ADB-MRIO has been updated to 2020 and, therefore, can reflect a relatively long-term change in China. It covers 63 major economies (including China) and 35 sectors, and we used the version of the MRIO tables in constant prices

of 2010.

China's gender gap statistics is limited, especially from a multisectoral perspective. In general, there are two macro-statistics of employment by sector and gender, population census and economic census. Since the population census conducts a comprehensive survey with household-by-household registration, the employment data based on the population census is generally higher than that based on the economic census. For example, the total amount of non-agriculture employment released by the 2018 economic census was 354.8 million, while that released by the 2020 population census was 514.9 million, including considerable employment in small and microenterprises. Therefore, this study relies on the national population census data of 2000, 2010, and 2020 to obtain employment data by gender and sector. However, the sector classifications of the population census are inconsistent with the ADB-MRIO table. The population census distinguished 92, 95, and 98 sectors in 2000, 2010, and 2020. The sector "c35-Private households with employed persons" yielded output at 0 in China according to the ADB-MRIO, and the population census did not distinguish the sector "c19-Sale, maintenance, and repair of motor vehicles and motorcycles; retail sale of fuel" from the sector "c20-Retail trade, except motor vehicles and motorcycles; repair of household goods." Therefore, we combined them in the MRIO tables and obtained 33 sectors for China. Please refer to Appendix B for the reconciliation table between different sector classifications under the Chinese population census and the ADB-MRIO table. Furthermore, since the population census lacks wage data by gender, we restricted our study of the gender gap in LFP to explore the change and reasons behind the GEG in China.

3. Decomposition Results

3.1 The decomposition results of the gender employment gap (GEG) in the first layer

3.1.1 The decomposition results of the gender employment gap (GEG) at the aggregate level, the first layer

Table 1 summarizes the decomposition results of the first layer based on Eqs. (3)–(5) without distinction of sector. The number of each row represents the factor's contribution to the change in the corresponding indicators. For example, the "−2.67%" in the first row and column represents that the impact of the change in gender discrimination (GD) on the change in the GEG during 2000–2010 was −2.67%, while the total change in the GEG during the same period 2000–2010 was 1.21% indicated in the

first row and last column.

Table 1 suggests that the GEG increased by 8.43% during the subperiod 2010–2020, much faster than that during the subperiod 2000–2010, and the reasons for the GEG's growth during the two subperiods 2000–2010 and 2010–2020 differ. From 2000 to 2010, the LFP of males and females decreased by −3.08% and −4.29%, respectively. The decrease in male LFP is smaller than that of female LFP, leading to a slight increase in the GEG by 1.21%. From 2010 to 2020, the LFP of males slightly increased by 1.22%, and that of females decreased seriously by −7.21%, leading to a widening of the GEG by 8.43%. Among all four factors, the employment rate (*ER*) and the structure of the labor force (*SL*) produced negative contributions to changes in the GEG, ranging from 0.30% to 3.58%. Further explorations show that China's overall *ER* decreased from 83.91% in 2000 to 80.28% in 2010 and 77.73% in 2020. The share of the male labor force (*SL*) continued to increase from 52.80% in 2000 to 53.06% in 2010 and 54.21% in 2020. Therefore, it seems reasonable that the overall decrease in *ER* reduced the *LFP* of males and females. As male employment accounts for over half of the total employment, the overall decrease in *ER* influenced the male LFP more seriously than the female LFP, narrowing the GEG. Meanwhile, the increasing share of the male labor force (*SL*) from 2000 to 2020 naturally led to a lower LFP of males and a higher LFP of females, narrowing the GEG from 2000 to 2020.

Table 1. The decomposition results of the first layer

Change	Indicator	Impact of each factor on the change in indicator				Total
		Gender Discrimination (GD)	Industrial Structure (IS)	Employment Rate (ER)	Structure of Labor (SL)	
2000-2010	GEG	-2.67%	5.03%	-0.30%	-0.86%	1.21%
	LFP of male	-1.26%	2.37%	-3.77%	-0.42%	-3.08%
	LFP of female	1.41%	-2.66%	-3.47%	0.44%	-4.29%
2010-2020	GEG	3.81%	8.57%	-0.38%	-3.58%	8.43%

					1.22
LFP of male	1.78%	3.97%	-2.73%	-1.79%	%
LFP of female	-2.03%	-4.61%	-2.35%	1.79%	-7.21 %

Notes: Data were calculated by the authors. LFP represents the labor force participation rate indicated by the labor force divided by the total working-age population by gender. GEG represents the LFP of males minus the LFP of females.

Gender discrimination (*GD*) shows a U-turn impact on the change in the GEG. During 2000–2010, the change of degree in *GD* would lower the GEG by 2.67% if no other changes existed; but during 2010–2020, the change of degree in *GD* would increase the GEG by 3.81% if no other changes existed. This suggests that sectors generally employed a higher proportion of female employment between 2000 and 2010, but employed a lower proportion of female employment between 2010 and 2020. In contrast, industrial structure (*IS*) dominated the change in the GEG, with positive contributions to the widening GEG at 5.03% and 8.57%, respectively, during the two subperiods. Our results differ from those of Yu et al. (2021) as they only focused on the impact of changes in tariff reductions by sector on China's GEG. In contrast, we focused on the impact of *IS* (indicated by the share of each sector in GDP) on China's GEG.

3.1.2 The decomposition results of the gender employment gap at the sectoral level, the first layer

It is thus interesting to explore in which sectors the proportions of employment (*IS_i*) as well as the proportion of female employment (i.e., *GD_i*) have changed the most significantly during 2000–2020. Fig. 4 provides detailed decomposition results at the sectoral level. We summarize our results into 10 sectors to simplify our analysis (refer to Appendix B for the reconciliation table between different sector classifications)[1]. From 2000 to 2010, the changes in construction, transportation, high-tech industry, and heavy industry led to the widening of the GEG. In contrast, the changes in consumer services, producer services, agriculture, and the light industry led to the narrowing of the GEG. At the aggregate level, different sectors' positive and negative contributions are partly offset and only led to a slight increase of the GEG by 1.21%. From 2010 to 2020, the changes in all sectors led to a widening of the GEG, with only two exceptions, consumer services and the mining industry, which showed relatively small negative

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[1] The detailed results at the further disaggregated sectoral level are available upon request.

contributions. As a result, the GEG significantly increased by 8.43%.
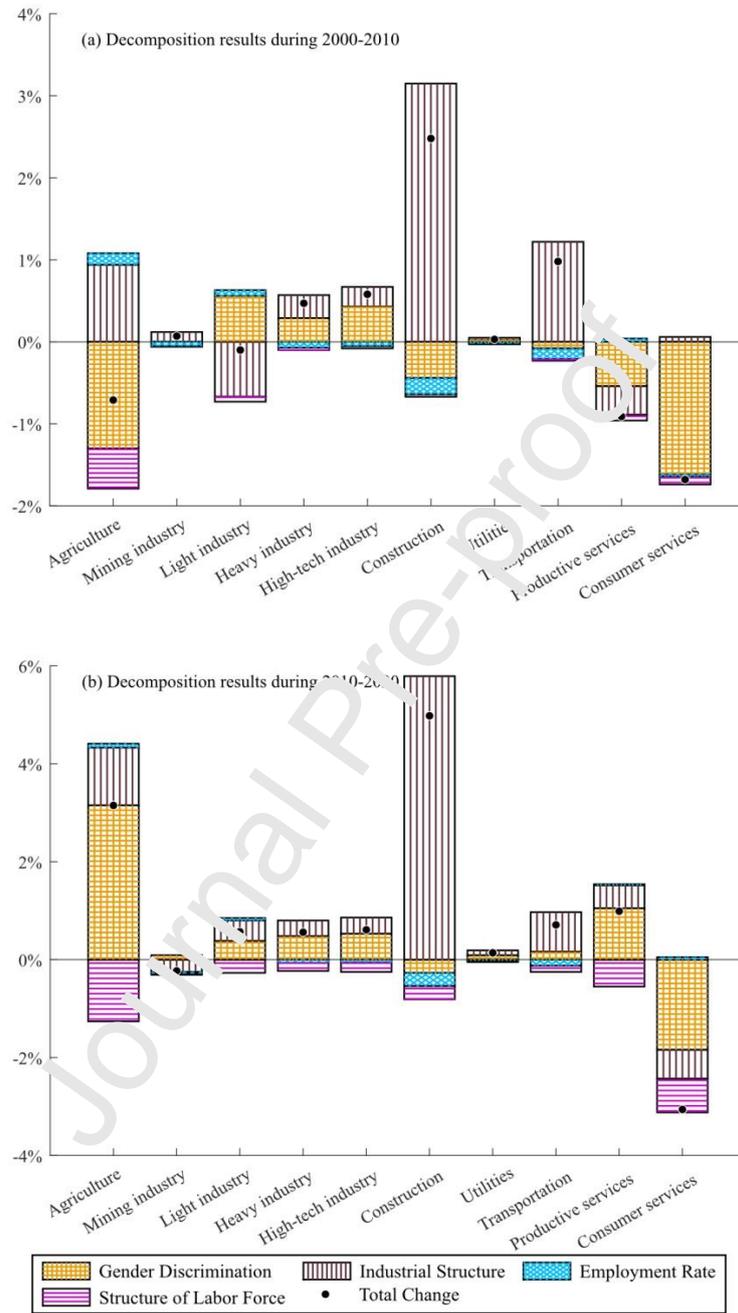
Notes: Data were calculated by the authors. The bars represent the absolute contributions of changes in each factor (including gender discrimination, industrial structure, employment rate, and labor force structure) to the total change in China's gender employment gap (GEG).

Figure 4. The decomposition results of China's gender employment gap (GEG) at the first layer, by sector

Among the four factors, the employment rate (*ER*) and structure of the labor force (*SL*) generally have

negligible impacts on the change in the GEG. In contrast, industrial structure (*IS*) and gender discrimination (*GD*) dominated the changes in the GEG at the sectoral level, as they did at the aggregate level. Specifically, if the other factors did not change, the change in *GD* would increase the GEG of all manufacturing industries (including light, heavy, and high-tech industries) during 2000–2010, suggesting that manufacturing industries employed a smaller proportion of females in 2010 compared with that in 2000. In contrast, the change in *GD* would decrease the GEG of all services (including producer and consumer services), construction, and agriculture during 2000–2010, suggesting that these industries employed a greater proportion of females in 2010 compared with that in 2000. Both positive and negative contributions led by the change in *GD* at different sectors were partly offset and slightly decreased the GEG by 2.67%. However, from 2010 to 2020, the change in *GD* would increase the GEG in all sectors except for consumer services and construction. This finding suggests that most sectors were inclined to employ fewer proportions of females in 2020 compared to 2010. Consequently, *GD* positively contributed to the increase in the GEG during 2010–2020 by 3.31% at the aggregate level. These findings are confirmed in Fig. 5, which describes the trend of the share of female employment by sector (i.e., *GD*) along the Y-axis, showing the heterogeneity of *GD* across sectors during 2000–2010 and overall decreases in *GD* for most sectors during 2010–2020.
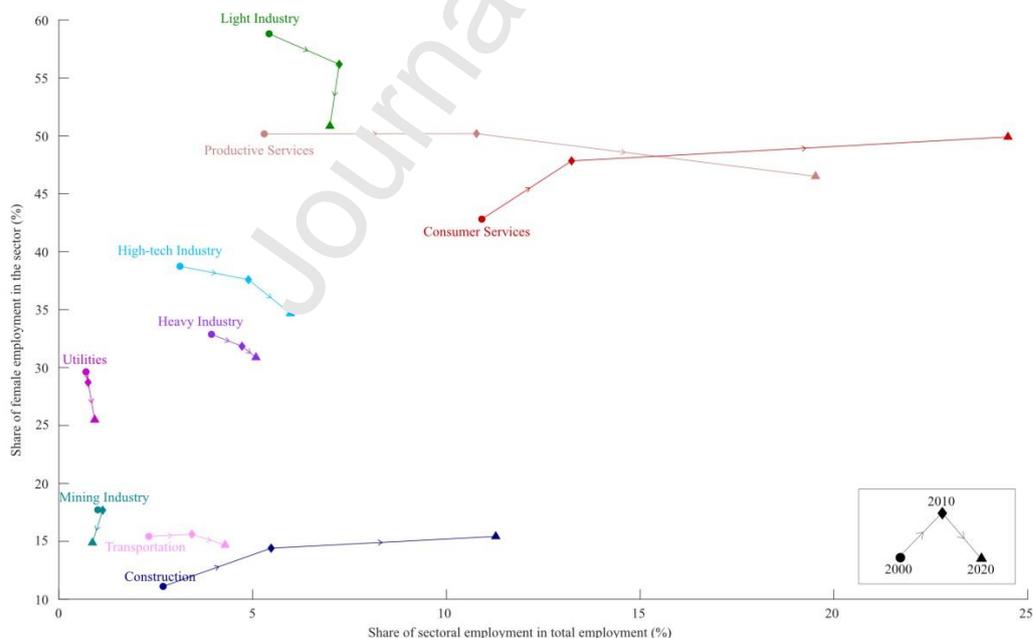
Notes: Data were taken from the Chinese population census. The change in industrial structure (*IS*) is indicated by the share of sectoral employment in total employment along the X-axis. The change in gender discrimination (*GD*) is indicated by the share of female employees in the sector along the Y-axis.

Figure 5. Changes in gender discrimination (*GD*) and industrial structure (*IS*), by sector, 2000–2020

The contributions of *IS* also yield heterogeneity across sectors for the subperiod 2000–2010. From 2000 to 2010, if the other factors did not change, the change of *IS* would increase the GEG of construction, agriculture, and transportation. However, it would decrease the GEG of the light industry, producer services, and consumer services, and positive and negative contributions were partially offset during 2000–2010. From 2010 to 2020, if the other factors did not change, the change in *IS* would increase the GEG of all sectors except the mining industry and consumer services. This partly explains the much higher increase in GEG during 2010–2020 than that during 2000–2010.

Moreover, decomposition at the sectoral level helps to understand the puzzle between China's structural change toward a service-based economy and the widening of the GEG since 2010, against the fact that services are generally beneficial to female employment. In brief, the structural change within manufacturing and services, rather than the structural change from manufacturing to service, is the dominant factor behind the composition and distribution of employment by gender. As shown in Fig. 5, both producer and consumer services considerably expanded in the Chinese economy during 2010–2020, indicated by an increasing share of their sectoral employment in total employment along the X-axis. However, their degrees of *GD* (i.e., the share of female employment along the Y-axis) show a completely different trend of changes, leading to positive contributions of *IS* ($m\_\Delta IS - f\_\Delta IS$) in producer services but negative contributions of *IS* ($m\_\Delta IS - f\_\Delta IS$) in consumer services. As a result, the service industry as a whole only led to an insignificant change in the GEG. Meanwhile, heavy industry, high-tech industry, transportation, and utilities experienced an increase in the share of sectoral employment along the X-axis and an increase in the degree of *GD* toward females, indicated by a decreasing share of sectoral female employment along the Y-axis (Fig. 5). The contributions of *IS* in these industries are positive, and consequently, the overall changes of *IS* led to the widening of China's GEG to a large extent during 2010–2020. In other words, if we only focus on the structural change from manufacturing to service, the conclusions about the effect of structural change on GEG could be highly misleading. The structural changes within manufacturing and services play a dominant role in the widening of China's GEG.

3.2 The decomposition results of the gender employment gap from a demand-side perspective

3.2.1 The decomposition results of the gender employment gap at the aggregate level from a

demand-side perspective

Now, we turn our attention to the demand-side decomposition to better understand the change in the GEG. At the aggregate level, the contributions of factors—gender discrimination, employment rate, and structure of labor force remain the same as those in the first layer. Therefore, in this section, we only focus on the decomposition of the changes in the industrial structure (*IS*) that dominated the change in the GEG. Specifically, the contribution of the change in *IS* on the change of the GEG ($m\_\Delta IS - f\_\Delta IS$) is decomposed into the contributions of the change in employment coefficients (*EC*) as shown in Eq. (12a), domestic Leontief inverse (B^D) as shown in Eq. (12b), the share of domestic demand in total demand (*FT-DD*), the share of GVC-related demand (including direct exports, simplified GVC, and complex GVC) in total demand (*FT-GVC*) as shown in Eq. (12c), the structure of domestic demand (*FS-DD*) and the structure of GVC-related demand (*FS-GVC*) as shown in Eq. (12d).

Table 2. The decomposition of the contribution of industrial structure (IS) from a demand-side perspective

	Indicator	Impact of each factor on the change in indicator						Total
		EC	B^D	Share of demand by type		Structure of demand by type		
				FT-DD	*FT-GVC*	*FS-DD*	*FS-GVC*	
2000-2010	GEG	-3.04%	2.29%	-0.41%	0.09%	5.39%	0.72%	5.03%
	LFP of male	-1.43%	1.08%	-4.59%	4.44%	1.60%	1.27%	2.37%
	LFP of female	1.61%	-1.21%	-4.18%	4.35%	-3.79%	0.55%	-2.66%
2010-2020	GEG	11.40%	-3.52%	0.93%	-0.33%	0.01%	0.09%	8.57%
	LFP of male	5.29%	-1.64%	5.66%	-5.38%	-1.29%	1.33%	3.97%
	LFP of female	-6.12%	1.88%	4.73%	-5.05%	-1.30%	1.25%	-4.61%

Notes: LFP = labor force participation rate, GEG = gender employment gap, *EC* = employment coefficients, B^D = domestic Leontief inverse, *FT* = share of demand by type, *FS* = structure of demand by type; *DD* = domestic demand, *GVC* = global value chain–related demand.

In Table 2, we provide the decomposition results at the aggregate level, and the numbers in each row

represent the factor's contribution to the change in the corresponding indicators. For example, the "−3.04%" in the first row and column denotes that the impact of the change in employment coefficients (*EC*) on the change in the gender employment gap (GEG) during 2000–2010 was −3.04%, while the "Total: 5.03%" indicated in the first row and last column is the contribution of the change in *IS* to the change in the GEG during 2000–2010, as shown in Table 1.

According to Table 2, most factors produce U-shaped or inverse U-shaped effects on the change in LFP and GEG during the two subperiods. If no other changes existed, the change in employment coefficients (*EC*) would decrease the GEG by 3.04% during 2000–2010 but increase the GEG by 11.40% during 2010–2020. Similarly, the change in the Leontief inverse (B^D) would increase the GEG by 2.29% during 2000–2010 but decrease the GEG by 3.52% during 2010–2020. The U-shape or inverse U-shape effects also hold for the change in LFP by gender. From 2000 to 2010, the change in *EC* would decrease male LFP but increase female LFP, whereas it would increase male LFP but decrease female LFP from 2010 to 2020. Due to rapid technological progress, China's overall employment per unit of output in constant prices of 2010 continued to decrease from 205 persons/million US$ in 2000 to 40 persons/million US$ in 2010 and 17 persons/million US$ in 2020. The contrary contributions of changes in *EC* on LFP of males and females thus imply considerable heterogeneity across sectors. During 2010–2020, for example, the change in *EC* increased the male LFP by 5.29%. It decreased the female LFP by 6.12%, suggesting that the sectors that employ more males may experience a lower decrease in *EC* or even a growth of *EC*, while the sectors that employ more females may experience a rapid decrease in *EC*. We will return to this issue in the next section.

The contributions of changes in the Leontief inverse (B^D) also generated contrary effects on the LFP of males and females; however, their degrees are much smaller than those of *EC*. During 2000–2010, the change in B^D would increase the LFP of males by 1.08% and decrease the LFP of females by 1.21%, suggesting that the entire economy is inclined to consume the intermediates of sectors that employ more males than females (e.g., manufacturing) from 2000 to 2010. From 2010 to 2020, the change in B^D would increase the LFP of females by 1.88% and decrease that of males by 1.64%, suggesting that the entire economy is inclined to consume more intermediates of sectors that employ more females than males (e.g., services) during the same subperiod. This result aligns with the trend of overall structural change toward services in China (Fig. 2).

Now, we turn to the role of final demand. First, we summarize the final demand into two types, domestic and GVC-related demand. The sum of the share of domestic demand (*FT-DD*) and the share of GVC-related activities (*FT-GVC*) equals 1. Thus, *FT-DD* and *FT-GVC* would generate opposite effects on the change in LFP. According to the ADB-MRIO tables, from 2000 to 2010, the share of GVC-related demand in total demand expanded from 17.59% to 24.18; therefore, the change in *FT-GVC* led to increases in the LFP of males and females by 4.44% and 4.35%, respectively, while the shrinkage of DD (i.e., change in *FT-DD*) decreased the LFP of both males and females by 4.59% and 4.18%, respectively. However, from 2010 to 2020, the share of DD expanded from 75.82% to 82.92%. Thus, the change in *FT-DD* led to increases in the LFP of males and females by 5.66% and 4.73%, respectively, and the change in *FT-GVC* led to decreases in the LFP of both males and females by 5.38% and 5.05 %, respectively. Regarding structure, the change in *DD* stimulated the LFP of males but decreased that of females during 2000–2010, leading to a widening of the GEG. From 2010 to 2020, the change in *DD* decreased the LFP of both males and females by −1.29% and −1.30%, respectively. In contrast, changes in the structure of GVC-related demand stimulated the employment of both males and females for the period 2000–2010, with the effects on LFP ranging from 0.55% to 1.33%. In addition, no clear gender difference exists in terms of employment generations and LFP by GVC-related demand, as changes in the share and structure of GVC-related demand (including *FT-GVC* and *FS-GVC*) only have negligible impacts on the change in the GEG at the aggregate level during the period 2000–2020.

Thus, a question arises of whether different GVC-related activities yield heterogeneity. In Table 3, we further distinguish three types of GVC-related demand: direct exports (*EX*), simplified GVC (*SG*), and complex GVC (*CG*), and compare their contributions to the change in LFP by gender and GEG.

According to Table 3, GVC-related demand considerably stimulated the LFP of males and females during 2000–2010, regardless of the type. This is because all GVC-related demands experienced expansion during 2000–2010. Further explorations based on ADB-MRIO tables show that the share of direct exports (*EX*) increased from 9.84% to 12.99%, the share of simplified GVC (*SG*) increased from 4.80% to 6.66%, and the share of complex GVC (*CG*) increased from 2.95% to 4.53% during 2000–2010. The entry into the World Trade Organization in 2001 substantially stimulated economic growth and employment in China. From 2010 to 2010, the share of GVC-related demand turned from expanding to shrinking. With a series of "Black swan" incidents, such as the international financial crisis, Britain's exit from the European Union, the China–U.S. trade conflict, and the dependence of the Chinese economy on trade, GVC-related

activities decreased during 2010–2020. Further explorations based on ADB-MRIO tables show that the share of direct exports (*EX*) decreased from 12.99% to 9.43%, the share of simplified GVC (*CG*) decreased from 6.66% to 4.31%, and the share of complex GVC (*CG*) decreased from 4.53% to 3.35% during 2010–2020. This finding also aligns with the decreasing dependence of the Chinese economy on trade during 2000–2020, as shown in Fig. 2. As a result, the change in the share of GVC-related demand considerably decreased the LFP of both males and females. Moreover, the effects of GVC-related demand on LFP showed no gender difference, thus at the aggregate level, the change in the share of GVC-related demand (*FT-GVC*) only slightly changed the GEG by less than 0.5% during the entire period 2000–2020.

Table 3. The decomposition of the contributions of GVC-related demand

	Indicators	Shares of demand by GVC type			Structure of demand by GVC type			Total
		FT-EX	*FT-SG*	*FT-CG*	*FS-EX*	*FS-SG*	*FS-CG*	
2000-2010	GEG	-0.08%	0.10%	0.07%	0.45%	0.14%	0.12%	0.81%
	LFP of male	2.27%	1.22%	0.95%	0.70%	0.37%	0.20%	5.71%
	LFP of female	2.35%	1.12%	0.88%	0.25%	0.23%	0.08%	4.90%
2010-2020	GEG	-0.05%	-0.19%	-0.09%	0.07%	0.02%	-0.01%	-0.24%
	LFP of male	-2.82%	-1.73%	-0.83%	0.79%	0.28%	0.27%	-4.05%
	LFP of female	-2.77%	-1.54%	-0.74%	0.72%	0.26%	0.27%	-3.81%

Notes: LFP = labor force participation rate, GEG = gender employment gap, *EX* = direct exports, *SG* = simplified GVC, *CG* = complex GVC.

Regarding the structure of GVC-related demand, their changes generally stimulated LFP, regardless of gender and type of demand, but only with negligible positive effects ranging from 0.08% to 0.79% during 2000–2020. At the aggregate level, the contributions of changes in different types of GVC-related demand on the GEG are also negligible, with a positive contribution of 0.81% during 2000–2010 and a negative contribution of −0.24% during 2010–2020. In summary, the patterns of changes in different GVC-related demands are negligible and quite similar across types.

3.2.2 The decomposition results of the gender employment gap at the sectoral level from a demand-side perspective

The decomposition results at the aggregate level may mask the differences between sectors. This section focuses on the results at a disaggregated sectoral level. As 33 sectors are too much to be presented, we present the sectors with absolute effects on the GEG that exceed 0.2% in Fig. 6. These sectors account for the majority of changes in the GEG. From 2000 to 2010, 13 out of 33 sectors showed absolute effects greater than 0.2%, with a total effect of 1.48%, accounting for 122% of the total change in the GEG. From 2010 to 2020, 15 out of 33 sectors showed absolute effects greater than 0.2%, with a total effect of 7.45%, accounting for 88% of the total change in the GEG.
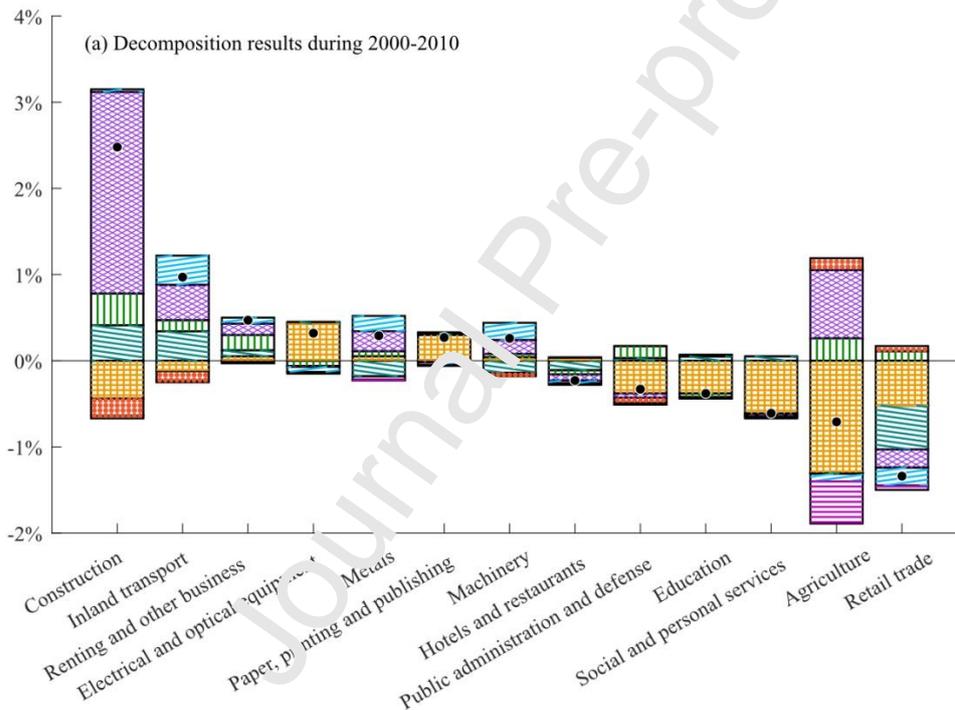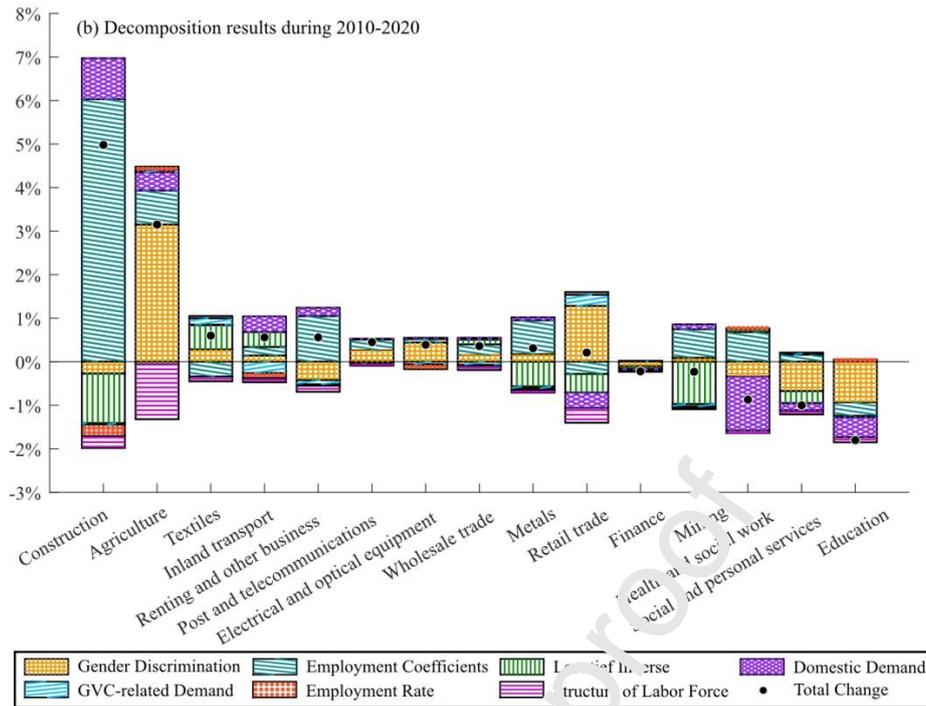
(a) Decomposition results during 2000-2010

Notes: Data were calculated by the authors. The bars represent the absolute contributions of changes in each factor (including gender discrimination, employment coefficients, Leontief inverse, GVC-related and domestic demand, employment rate, and labor force structure) to the total change in the gender employment gap in China.

Figure 6. The decomposition results from the demand-side perspective by sector, 2000–2010

From 2000 to 2010, the top five sectors positively affecting the GEG are construction, inland transport, renting and other businesses, electrical and optical equipment, and metals; together, they led to a widening of the GEG by 4.53%. Meanwhile, the top five sectors with negative effects on the GEG are retail trade, agriculture, social and personal services, education, and public administration and defense; together, they led to a narrowing of the GEG by 3.36%. In general, considerable heterogeneity exists across the manufacturing and service sectors. In contrast, the positive and negative effects on the GEG are offset to a large extent and at the aggregate level. The GEG only slightly increased by 1.21% during 2000–2010.

Among all factors, changes in domestic demand (*DD*) and GVC-related demand (*GVC*) in construction, inland transport, metal machinery, and agriculture positively contributed to the change in the GEG. In contrast, changes in gender discrimination (*GD*) in inland transport, public administration and defense, education, and social and personal services negatively contributed to the change in the GEG. Fig. 7 shows the trend of GD_i and EC_i at the sectoral level from 2000 to 2020. Inland transport, public administration and defense, education, and social and personal services experienced an increasing share of

female employment during 2000–2010, leading to the negative effects of *GD* on the GEG. The changes in employment coefficients (*EC*) show heterogeneity, with positive contributions in construction, inland transport, education, renting, and other businesses and negative contributions in metals, machinery, and retail trade. At the sectoral level, the positive and negative contributions of different factors were also compensated, leading to a small overall change in the GEG.

From 2010 to 2020, sectors show high similarity, and most sectors positively affect the GEG. Specifically, the top five sectors with positive effects on the GEG are construction, agriculture, inland transport, renting and other business services, and post and telecommunications; together, they led to a widening of the GEG by 9.84%. Meanwhile, the top five sectors with negative effects on the GEG are education, social and personal services, health and social work, and mining and finance; together, they led to a narrowing of the GEG by 4.12%. Therefore, the GEG generally increased to a greater extent by 8.43% during 2010–2020.

Notes: The change in gender discrimination (GD) is indicated by the share of female employment along the X-axis, and the change of employment coefficients (*EC*) is indicated by the number of employments per million US$ of output along the Y-axis.

Figure 7. Changes in employment coefficients (*EC*) and gender discrimination (*GD*) by sector, 2000–2020

Among all factors, the changes in employment coefficients (*EC*) and gender discrimination (*GD*) dominated the changes in the GEG at the sectoral level, as they did at the aggregate level. In general, the sectors that employ more males than females, such as construction, mining, metals, renting, and other business, experienced a relatively low decrease in *EC* during 2010–2020, leading to positive contributions of change in *EC* on the GEG. In contrast, sectors that employ more females than males, such as textile, retail trade, and education, experienced a rapid decrease in *EC*, leading to negative contributions of change in *EC* on the GEG (Fig. 7). Therefore, at the aggregate level, the changes in *EC* significantly increased the GEG by 11.40% during 2010–2020. Concerning the change in *GD*, the sectors with expanding demand (including domestic demand and GVC-related demand), such as agriculture, textile, and retail trade, generally experienced increasing *GD* with decreasing share of female employment along the X-axis (Fig. 7). As a result, the changes in *GD*, *DD*, and *GVC* together positively contributed to the change in the GEG in these sectors. In comparison, the sectors that employed more females than males with increasing *GD* toward females along the X-axis (Fig. 7), such as education, health, and social work, generally experienced a shrinkage of demand. Consequently, the changes in *GD*, *DD*, and *GVC* negatively contributed to the change in the GEG in these sectors.

In summary, from 2010 to 2020, the female-intensive sectors, such as textile, retail trade, and education, experienced rapid technological progress indicated by a significant decrease in *EC* and an increase in *GD* toward females indicated by the decreasing share of female employment. In addition, some sectors, such as education, experienced a shrinkage in the final demand. In contrast, the male-intensive sectors, such as construction, mining, metals, renting, and other business, experienced relatedly low technological progress, indicated by a small decrease in *EC*. Together these led to a higher LFP of males and a lower LFP of females in 2020 compared to 2010, and at the aggregate level, the GEG significantly increased by 8.43% during the subperiod 2010–2020.

4. Conclusions

The prominent role that female workers play in export-oriented industries integrated into the GVC has led to claims that integration into the GVC results in development benefits for women and a narrowing of the gender gap in developing countries. However, China's national population census data shows a widening GEG indicated by the male LFP minus the female LFP during 2000–2020, with increases of 1.21%

and 8.43%, respectively, during two subperiods, 2000–2010 and 2010–2020. This finding contradicts China's growing involvement in GVCs in recent decades and the increasing proportion of services industry in the Chinese economy that is known to be beneficial for female employment. In this context, this study combines the measurements of different GVC activities and a structural decomposition model under the framework of inter-country input–output analysis. It proposes a new GEG decomposition model to investigate the impact of integrating patterns in GVCs (including direct exports, simplified GVC, and complex GVC) on the evolution of the GEG in China from 2000 to 2020. In the process, the role of structural change is considered, as input–output analysis could provide demand-side decompositions from a multisectoral perspective. The subperiod 2010–2020 is of particular concern, as it shows a significant increase in the GEG compared with 2000–2010.

Our decomposition results suggest that the structural change in employment distribution across sectors is the dominant factor for GEG changes, leading to GEG increases of 5.03% and 8.57% for the two subperiods, 2000–2010 and 2010–2020, respectively. Gender discrimination experienced a U-shaped change in terms of effects on the GEG, leading to a decrease in the GEG by 2.67% during 2000–2010 and an increase in the GEG by 3.81% during 2010–2020. Further explorations at the sectoral level show that structural changes within the manufacturing and services industry, rather than the overall structural change from the manufacturing-based economy to the services-based economy, plays a crucial role in the positive contributions of IS in the GEG. Furthermore, from 2010 to 2020, although service industries generally experienced an increasing share of employment (IS_i), their trend of changes in gender discrimination (GD) toward females completely differs, leading to an overall offset of negative and positive contributions from IS and GD. In contrast, heavy industry, high-tech industry, transportation, and utilities that were experiencing an increase in IS_i also experienced an increase in GD toward females during 2010–2020. The positive contributions of IS and GD in these sectors significantly increased the GEG from 2010 to 2020.

Furthermore, we employed an inter-country input–output framework to understand the change in IS from a demand-side perspective. Our results suggest that GVC-related demand contributes to an overall increase in China's GEG; however, the degree of contributions is insignificant with less than 0.7% for the entire period 2000–2020. No apparent difference exists in the effects of GVC-related demand on male and female employment. In addition, no clear difference exists across different ways of integrating into GVC: China's increasing involvement in direct exports, simplified GVC, and complex GVC contributed to widening the GEG by 0.39%, 0.08%, and 0.10%, respectively, for the period 2000–2020. In contrast, the

technological progress indicated by the change in employment coefficients per unit of output (*EC*), together with the changing pattern of *GD*, explained the change in *IS* to a large extent. In particular, from 2010 to 2020, the female-intensive sectors, such as textile, retail trade, and education, generally experienced rapid technological progress, indicated by a significant decrease in *EC*. Simultaneously, they also experienced increased *GD* toward females, indicated by a lower share of female employment. In comparison, the male-intensive sectors, such as construction, mining, metals, renting, and other business, experienced relatively low technological progress, indicated by a slight decrease in *EC*. Together they led to a higher LFP of males and a lower LFP of females in 2020 compared to 2010, and at the aggregate level, the GEG significantly increased by 8.43% during the subperiod 2010–2020.

Technological progress is irreversible since new technologies such as robotics, artificial intelligence, and smart production, are continuously reshaping employment. In other words, the employment required to produce the same output will be further reduced, which may bring more serious negative effects in female-intensive sectors than in male-intensive sectors. Meanwhile, the overall gender desrimination toward females may continue to increase in China given the fertility policy adjustments. These factors seem to suggest a continuing widening gender gap in China. Therefore, it is crucial to stimulate the LFP of females, both on the sides of employers and employees, for high-quality employment in China. From employers' perspective, the increasing access of females to education and training and affordable and convenient care for children and older adults are necessary. From the perspective of employees, policies to encourage gender equality, including law, public opinion, and tax incentives, may help to improve the chances of employing females. This study also contributes to the literature on the gender gap using analytical and theoretical tools of input–output analysis from the demand-side perspective, for which the structural change is further decomposed. Although the decomposition model only targets the GEG, it can be easily extended to study the gender wage gap and gender income gap when wage or income data are available by gender and sector. We hope that our study sheds some light on reducing the gender gap and improving high-quality employment in China.

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Appendix A. The decomposition formulas from demand-side perspective

According to Eq. (12) in the main manuscript, the change of GEG from year t_0 to year t_1 can be decomposed from the demand-side perspective into contributions of changes in 7 factors. Since the contributions of changes in gender discrimination (GD), employment rate (ER) and structure of labor force (SL) are as the same as that in Eq. (5), here we only provide formulas for the contributions of changes in other four factors: employment coefficients (EC), domestic Leontief inverse (B^D), share of final demand by type (FT^k), and structure of final demand by type (FS^k).

First, we have the decomposition of the crucial change ΔIS_i as follows:

$$\Delta IS_i = IS_i^{t1} - IS_i^{t0} = \frac{E_i^{t1}}{\sum_{i=1}^N E_i^{t1}} - \frac{E_i^{t0}}{\sum_{i=1}^N E_i^{t0}}$$

$$= \frac{\sum_{k=1}^4 EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t1})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t1})} - \frac{\sum_{k=1}^4 EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t0})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t0})}$$

$$= \left\{ \left[\frac{\sum_{k=1}^4 EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t1})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t1})} - \frac{\sum_{k=1}^4 EC_i^{t0} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t1})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t0} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t1})} \right] + \left[\frac{\sum_{k=1}^4 EC_i^{t1} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t0})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t1} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t0})} - \right.\right.$$

$$\left.\left. \frac{\sum_{k=1}^4 EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t0})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t0})} \right] \right\} / 2 \qquad (A.1a)$$

$$+ \left\{ \left[\frac{\sum_{k=1}^4 EC_i^{t0} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t1})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t0} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t1})} - \frac{\sum_{k=1}^4 EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t1} \otimes FS^{k,t1})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t1} \otimes FS^{k,t1})} \right] + \left[\frac{\sum_{k=1}^4 EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t0} \otimes FS^{k,t0})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t0} \otimes FS^{k,t0})} - \right.\right.$$

$$\left.\left. \frac{\sum_{k=1}^4 EC_i^{t1} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t0})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t1} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t0})} \right] \right\} / 2 \qquad (A.1b)$$

$$+ \left\{ \left[\frac{\sum_{k=1}^4 EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t1} \otimes FS^{k,t1})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t1} \otimes FS^{k,t1})} - \frac{\sum_{k=1}^4 EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t1})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t1})} \right] + \left[\frac{\sum_{k=1}^4 EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t0})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t0})} - \right.\right.$$

$$\left.\left. \frac{\sum_{k=1}^4 EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t0} \otimes FS^{k,t0})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t0} \otimes FS^{k,t0})} \right] \right\} / 2 \qquad (A.1c)$$

$$+ \left\{ \left[\frac{\sum_{k=1}^4 EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t1})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t1})} - \frac{\sum_{k=1}^4 EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t0})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t0} \cdot B^{D,t0} \cdot (FT^{k,t0} \otimes FS^{k,t0})} \right] + \left[\frac{\sum_{k=1}^4 EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t1})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t1})} - \right.\right.$$

$$\left.\left. \frac{\sum_{k=1}^4 EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t0})}{\sum_{k=1}^4 \sum_{i=1}^N EC_i^{t1} \cdot B^{D,t1} \cdot (FT^{k,t1} \otimes FS^{k,t0})} \right] \right\} / 2 \qquad (A.1d)$$

$$= \underbrace{IS_{i\_}\Delta EC}_{(A.1a)} + \underbrace{IS_{i\_}\Delta BD}_{(A.1b)} + \underbrace{\sum_{k=1}^4 IS_{i\_}\Delta FT^k}_{(A.1c)} + \underbrace{\sum_{k=1}^4 IS_{i\_}\Delta FS^k}_{(A.1d)} \qquad (A.1)$$

Second, the decomposition of $m\_\Delta IS$ can be written as:

$$m\_\Delta IS = \left[\sum_{i=1}^N GD_i^{t1} \cdot (IS_i^{t1} - IS_i^{t0}) \cdot ER^{t0} \cdot \frac{1}{SL^{t0}} + \sum_{i=1}^N GD_i^{t0} \cdot (IS_i^{t1} - IS_i^{t0}) \cdot ER^{t1} \cdot \frac{1}{SL^{t1}} \right] / 2$$

$$= \left[\sum_{i=1}^N GD_i^{t1} \cdot (IS_{i\_}\Delta EC + IS_{i\_}\Delta BD + \sum_{k=1}^4 IS_{i\_}\Delta FT^k + \sum_{k=1}^4 IS_{i\_}\Delta FS^k) \cdot ER^{t0} \cdot \frac{1}{SL^{t0}} + \sum_{i=1}^N GD_i^{t0} \cdot \right.$$

$$\left. (IS_{i\_}\Delta EC + IS_{i\_}\Delta BD + \sum_{k=1}^4 IS_{i\_}\Delta FT^k + \sum_{k=1}^4 IS_{i\_}\Delta FS^k) \cdot ER^{t1} \cdot \frac{1}{SL^{t1}} \right] / 2$$

$$= \left[\sum_{i=1}^N GD_i^{t1} \cdot IS_{i\_}\Delta EC \cdot ER^{t0} \cdot \frac{1}{SL^{t0}} + \sum_{i=1}^N GD_i^{t0} \cdot IS_{i\_}\Delta EC \cdot ER^{t1} \cdot \frac{1}{SL^{t1}} \right] / 2 \qquad (A.2a)$$

$$+ \left[\sum_{i=1}^{N} GD_i^{t1} \cdot IS_i\_\Delta BD \cdot ER^{t0} \cdot \frac{1}{SL^{t0}} + \sum_{i=1}^{N} GD_i^{t0} \cdot IS_i\_\Delta BD \cdot ER^{t1} \cdot \frac{1}{SL^{t1}} \right] / 2 \qquad \text{(A.2b)}$$

$$+ \left[\sum_{i=1}^{N} GD_i^{t1} \cdot \sum_{k=1}^{4} IS_i\_\Delta FT^k \cdot ER^{t0} \cdot \frac{1}{SL^{t0}} + \sum_{i=1}^{N} GD_i^{t0} \cdot \sum_{k=1}^{4} IS_i\_\Delta FT^k \cdot ER^{t1} \cdot \frac{1}{SL^{t1}} \right] / 2 \quad \text{(A.2c)}$$

$$+ \left[\sum_{i=1}^{N} GD_i^{t1} \cdot \sum_{k=1}^{4} IS_i\_\Delta FS^k \cdot ER^{t0} \cdot \frac{1}{SL^{t0}} + \sum_{i=1}^{N} GD_i^{t0} \cdot \sum_{k=1}^{4} IS_i\_\Delta FS^k \cdot ER^{t1} \cdot \frac{1}{SL^{t1}} \right] / 2 \quad \text{(A.2d)}$$

$$= \underbrace{m\_\Delta EC}_{(A.2a)} + \underbrace{m\_\Delta BD}_{(A.2b)} + \underbrace{\sum_{k=1}^{4} m\_\Delta FT^k}_{(A.2c)} + \underbrace{\sum_{k=1}^{4} m\_\Delta FS^k}_{(A.2d)} \qquad \text{(A.2)}$$

Similarly, the decomposition of $f\_\Delta IS$ can be written as:

$$f\_\Delta IS = \left[\sum_{i=1}^{N} (1 - GD_i^{t1}) \cdot (IS_i^{t1} - IS_i^{t0}) \cdot ER^{t0} \cdot \frac{1}{1 - SL^{t0}} + \sum_{i=1}^{N} (1 - GD_i^{t0}) \cdot (IS_i^{t1} - IS_i^{t0}) \cdot ER^{t1} \cdot \right.$$

$$\left. \frac{1}{1 - SL^{t1}} \right] / 2$$

$$= \left[\sum_{i=1}^{N} (1 - GD_i^{t1}) \cdot (IS_i\_\Delta EC + IS_i\_\Delta BD + \sum_{k=1}^{4} IS_i\_\Delta FT^k + \sum_{k=1} IS_i\_\Delta FS^k) \cdot ER^{t0} \cdot \frac{1}{1 - SL^{t0}} + \right.$$

$$\left. \sum_{i=1}^{N} (1 - GD_i^{t0}) \cdot (IS_i\_\Delta EC + IS_i\_\Delta BD + \sum_{k=1}^{4} IS_i\_\Delta FT^k + \sum_{k=1}^{4} IS_i\_\Delta FS^k) \cdot ER^{t1} \cdot \frac{1}{1 - SL^{t1}} \right] / 2$$

$$= \left[\sum_{i=1}^{N} (1 - GD_i^{t1}) \cdot IS_i\_\Delta EC \cdot ER^{t0} \cdot \frac{1}{1 - SL^{t0}} + \sum_{i=1}^{N} (1 - GD_i^{t0}) \cdot IS_i\_\Delta EC \cdot ER^{t1} \cdot \frac{1}{1 - SL^{t1}} \right] / 2$$

$$\text{(A.3a)}$$

$$+ \left[\sum_{i=1}^{N} (1 - GD_i^{t1}) \cdot IS_i\_\Delta BD \cdot ER^{t0} \cdot \frac{1}{1 - SL^{t0}} + \sum_{i=1}^{N} (1 - GD_i^{t0}) \cdot IS_i\_\Delta BD \cdot ER^{t1} \cdot \frac{1}{1 - SL^{t1}} \right] / 2 \quad \text{(A.3b)}$$

$$+ \left[\sum_{i=1}^{N} (1 - GD_i^{t1}) \cdot \sum_{k=1}^{4} IS_i\_\Delta FT^k \cdot ER^{t0} \cdot \frac{1}{1 - SL^{t0}} + \sum_{i=1}^{N} (1 - GD_i^{t0}) \cdot \sum_{k=1}^{4} IS_i\_\Delta FT^k \cdot ER^{t1} \cdot \frac{1}{1 - SL^{t1}} \right] / 2$$

$$\text{(A.3c)}$$

$$+ \left[\sum_{i=1}^{N} (1 - GD_i^{t1}) \cdot \sum_{k=1}^{4} IS_i\_\Delta FS^k \cdot ER^{t0} \cdot \frac{1}{1 - SL^{t0}} + \sum_{i=1}^{N} (1 - GD_i^{t0}) \cdot \sum_{k=1}^{4} IS_i\_\Delta FS^k \cdot ER^{t1} \cdot \frac{1}{1 - SL^{t1}} \right] / 2$$

$$\text{(A.3d)}$$

$$= \underbrace{f\_\Delta EC}_{(A.3a)} + \underbrace{f\_\Delta BD}_{(A.3b)} + \underbrace{\sum_{k=1}^{4} f\_\Delta FT^k}_{(A.3c)} + \underbrace{\sum_{k=1}^{4} f\_\Delta FS^k}_{(A.3d)} \qquad \text{(A.3)}$$

With the decomposition of $m\_\Delta IS$ and $f\_\Delta IS$, the change in LFP of male ΔLFP^m and LFP of female ΔLFP^f can be written as:

$$\Delta LFP^m = m\_\Delta GD + m\_\Delta IS + m\_\Delta ER + m\_\Delta SL$$

$$= m\_\Delta GD + \underbrace{(m\_\Delta EC + m\_\Delta BD + \sum_{k=1}^{4} m\_\Delta FT^k + \sum_{k=1}^{4} m\_\Delta FS^k)}_{(A.3)} + m\_\Delta ER + m\_\Delta S$$

$$\text{(A.4a)}$$

$$\Delta LFP^f = f\_\Delta GD + f\_\Delta IS + f\_\Delta ER + f\_\Delta SL$$

$$= f\_\Delta GD + \underbrace{(f\_\Delta EC + f\_\Delta BD + \sum_{k=1}^{4} f\_\Delta FT^k + \sum_{k=1}^{4} f\_\Delta FS^k)}_{(A.4)} + f\_\Delta ER + f\_\Delta SL$$

$$\text{(A.4b)}$$

In the end, the change of GEG from year t_0 to year t_1 can be decomposed from the demand-side perspective as:

$\Delta GEG = (LFP^{m,t1} - LFP^{m,t0}) - (LFP^{f,t1} - LFP^{f,t0})$

$= (m\_\Delta GD + m\_\Delta IS + m\_\Delta ER + m\_\Delta SL) - (f\_\Delta GD + f\_\Delta IS + f\_\Delta ER + f\_\Delta SL)$

$= \left[m\_\Delta GD + \left(m\_\Delta EC + m\_\Delta BD + \sum_{k=1}^{4} m\_\Delta FT^k + \sum_{k=1}^{4} m\_\Delta FS^k \right) + m\_\Delta ER + m\_\Delta SL \right]$

$\quad - \left[f\_\Delta GD + \left(f\_\Delta EC + f\_\Delta BD + \sum_{k=1}^{4} f\_\Delta FT^k + \sum_{k=1}^{4} f\_\Delta FS^k \right) + f\_\Delta ER + f\_\Delta SL \right]$

$= (m\_\Delta GD - f\_\Delta GD) + (m\_\Delta IS - f\_\Delta IS) + (m\_\Delta ER - f\_\Delta ER) + (m\_\Delta SL - f\_\Delta SL)$

$= (m\_\Delta GD - f\_\Delta GD) + (m\_\Delta EC - f\_\Delta EC) + (m\_\Delta BD - f\_\Delta BD) + (m\_\Delta FT^k - f\_\Delta FT^k)$

$+ (m\_\Delta FS^k - f\_\Delta FS^k) + (m\_\Delta ER - f\_\Delta ER) + (m\_\Delta SL - f\_\Delta SL) \qquad (A.5)$

Appendix B. The reconciliation between different sector classifications

In this section, we provide reconciliation tables between different sector classifications under Chinese population census and multi-regional input-output table released by Asian Development Bank (ADB-MRIO).

Table B.1 The reconciliation table of sector classification between the Population Census of China in 2000 and the ADB-MRIO table

Population Census in 2000	ADB MRIO table
Farming	Agriculture, hunting, forestry, and fishing
Forestry	
Animal husbandry	
Fishery	
Services in Support of Agriculture, Forestry, Animal Husbandry and Fishery	
Logging and Transport of Timber and Bamboo	
Coal Mining and Dressing	Mining and quarrying
Petroleum and Natural Gas Extraction	
Ferrous Metals Mining and Dressing	
Nonferrous Metals Mining and Dressing	
Nonmetal Minerals Mining and Dressing	
Other Minerals Mining and Dressing	
Food Processing	Food, beverages, and tobacco
Food Production	
Beverage Production	
Tobacco Processing	
Textile Industry	Textiles and textile products
Garments and Other Fiber Products	
Leather, Furs, Down and Related Products	Leather, leather products, and footwear
Timber Processing, Bamboo, Cane, Palm Fiber and Straw Products	Wood and products of wood and cork
Furniture Manufacturing	
Papermaking and Paper Products	Pulp, paper, paper products, printing, and publishing
Printing and Record Medium Reproduction	
Cultural, Educational and Sports Goods	
Petroleum Processing and Coking	Coke, refined petroleum, and nuclear fuel
Raw Chemical Materials and Chemical Products	Chemicals and chemical products
Medical and Pharmaceutical Products	
Chemical Fiber	
Rubber Products	Rubber and plastics
Plastic Products	
Nonmetal Mineral Products	Other nonmetallic minerals
Smelting and Pressing of Ferrous Metals	Basic metals and fabricated metal
Smelting and Pressing of Nonferrous Metals	

Metal Products	
Ordinary Machinery Manufacturing	Machinery, nec
For Special Purposes Equipment Manufacturing	
Weapons and Ammunition Manufacturing	
Electric Equipment and Machinery	Electrical and optical equipment
Electronic and Telecommunications Equipment	
Instruments,Meters,Cultural and Office Machinery	
Transport Equipment Manufacturing	Transport equipment
Other Manufacturing	Manufacturing, nec; recycling
Production and Supply of Electric Power, Steam and Hot Water	Electricity, gas, and water supply
Production and Supply of Gas	
Production and Supply of Tap Water	
Water Management	
Civil Engineering	Construction
Pipes, Lines and Equipment Installation	
Building Decoration	
Wholesale of Food, Beverages, Tobaccos and Household products	Wholesale trade and commission trade, except of motor vehicles and motorcycles
Wholesale of Energy, Materials and Electronic Equipments	
Other Wholesale Industry	
Business Economics and Agency Industry	
Retail Trade	Retail trade
Catering Industry	Hotels and restaurants
Hotel Industry	
Railway Transport	Inland transport
Highway Transport	
Pipeline Transport	
Other Transportation	
Water Transport	Water transport
Air Transport	Air transport
Transport Supporting and Auxiliary Services	Other supporting and auxiliary transport activities; activities of travel agencies
Storage Industry	
Post and Telecommunication Services	Post and telecommunications
Financial Industry	Financial intermediation
Underwriting	
Real Estate Development and Operation	Real estate activities
Real Estate Management Industry	
Real Estate Agency and Economic Industry	
Geologic Examination Industry	Renting of M&Eq and other business activities
Leasing Service	
Tourism	
Information, Consulting Service	
Computer Application Service	

Other Social Service	
Scientific Research Industry	
Integrated Technical Service	
Social Welfare Security Industry	Public administration and defense; compulsory social security
State Organs	
Party and Government Agencies	
Grass Roots Self-management Organizations	
Education	Education
Public Health	Health and social work
Public Service	Other community, social, and personal services	Private households with employed persons
Neighborhood Services Industry	
Entertainment Service	
Sports	
Culture and Art Industry	
Radio, Film and TV Industry	
Social Group	

Table B.2 The reconciliation table of sector classification between the Population Census of China in 2010 and the ADB-MRIO table

Population Census in 2010	ADB MRIO Table
Farming	Agriculture, hunting, forestry, and fishing
Forestry	
Animal husbandry	
Fishery	
Services in Support of Agriculture, Forestry, Animal Husbandry and Fishery	
Mining and Washing of Coal	Mining and quarrying
Extraction of Petroleum and Natural Gas	
Mining and Processing of Ferrous Metal Ores	
Mining and Processing of Non-Ferrous Metal Ores	
Mining and Processing of Nonmetal Ores	
Mining of Other Ores	
Processing of Food from Agricultural Products	Food, beverages, and tobacco
Manufacture of Foods	
Manufacture of Beverages	
Manufacture of Tobacco	
Manufacture of Textile	Textiles and textile products
Manufacture of Textile Wearing Apparel, Footware and Caps	
Manufacture of Leather, Fur, Feather and Related Products	Leather, leather products, and footwear
Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm and Straw Products	Wood and products of wood and cork
Manufacture of Furniture	

Manufacture of Paper and Paper Products	
Printing,Reproduction of Recording Media	Pulp, paper, paper products, printing, and publishing
Manufacture of Articles For Culture, Education and Sport Activities	
Processing of Petroleum, Coking, Processing of Nuclear Fuel	Coke, refined petroleum, and nuclear fuel
Manufacture of Raw Chemical Materials and Chemical Products	
Manufacture of Medicines	Chemicals and chemical products
Manufacture of Chemical Fibers	
Manufacture of Rubber	Rubber and plastics
Manufacture of Plastics	
Manufacture of Non-metallic Mineral Products	Other nonmetallic minerals
Smelting and Pressing of Ferrous Metals	
Smelting and Pressing of Non-ferrous Metals	Basic metals and fabricated metal
Manufacture of Metal Products	
Manufacture of General Purpose Machinery	Machinery, nec
Manufacture of Special Purpose Machinery	
Manufacture of Electrical Machinery and Equipment	
Manufacture of Communication Equipment, Computers and Other Electronic Equipment	Electrical and optical equipment
Manufacture of Measuring Instruments and Machinery for Cultural Activity and Office Work	
Manufacture of Transport Equipment	Transport equipment
Manufacture of Artwork and Other Manufacturing	Manufacturing, nec; recycling
Recycling and Disposal of Waste	
Production and Supply of Electric Power and Heat Power	
Production and Supply of Gas	Electricity, gas, and water supply
Production and Supply of Water	
Water Management	
Building and Civil Engineering	
Construction Installation	Construction
Construction Decoration	
Other Construction	
Wholesale Trade	Wholesale trade and commission trade, except of motor vehicles and motorcycles
Retail Trade	Retail trade
Hotel Services	Hotels and restaurants
Catering Services	
Railway Transport	Inland transport
Road Transport	

Urban Public Transport	
Pipeline Transport	
Water Transport	Water transport
Air Transport	Air transport
Loading, Unloading and Other Transport Services	Other supporting and auxiliary transport activities; activities of travel agencies
Storage industry	
Posts	Post and telecommunications
Telecommunications and Other Information Transmission Services	
Banking	Financial intermediation
Securities Business	
Underwriting	
Other Finance Operations	
Real Estate	Real estate activities
Computer Service Industry	Renting of M&Eq and other business activities
Software Industry	
Leasing Industry	
Commerce Service Industry	
Development of Researches and Tests	
Profession Skill Service Industry	
Both Scientific and Technological Communication and Generalization	
Geologic Examination Industry	
Other Service Industries	
Social Security Industry	Public administration and defense; compulsory social security
CCP Organ	
Organs of State	
The Political Consultative Conference and Democratic Parties	
Grass Roots Self-management Organizations	
Education	Education
Public Health	Health and social work
Social Welfare Industry	
Environmental Management	Other community, social, and personal services | Private households with employed persons
Public Facility Management	
Neighborhood Services Industry	
Journalism Industry	
Radio, TV, Film and Audiovisual Product Industry	
Culture and Art Industry	
Sports	
Entertainment Industry	
Mass Organizations, Social Communities and Religion Organizations	

Table B.3 The reconciliation table of sector classification between the Population Census of China in 2020 and the ADB-MRIO table

Population Census in 2020	ADB MRIO Table
Agriculture	Agriculture, hunting, forestry, and fishing
Forestry	
Animal husbandry	
Fishery	
Professional and Support Activities for Agriculture, Forestry, Animal Husbandry and Fishery	
Mining and Washing of Coal	Mining and quarrying
Extraction of Petroleum and Natural Gas	
Mining and Processing of Ferrous Metal Ores	
Mining and Processing of Non-Ferrous Metal Ores	
Mining and Processing of Nonmetal Ores	
Professional and Support Activities for Mining	
Mining of Other Ores	
Processing of Food from Agricultural Products	Food, beverages, and tobacco
Manufacture of Foods	
Manufacture of Liquor, Beverage and Refined Tea	
Manufacture of Tobacco	
Manufacture of Textile	Textiles and textile products
Manufacture of Textile, Wearing Apparel and Accessories	
Manufacture of Leather, Fur, Feather and Related Products and Footwaer	Leather, leather products, and footwear
Processing of Timbers, Manufacture of Wood, Bamboo, Rattan, Palm, and Straw Products	Wood and products of wood and cork
Manufacture of Furniture	
Manufacture of Paper and Paper Products	Pulp, paper, paper products, printing, and publishing
Printing, Reproduction of Recording Media	
Manufacture of Articles for Culture, Education, Arts and Crafts, Sport and Entertainment Activity	
Processing of Petroleum, Coal and Other Fuels	Coke, refined petroleum, and nuclear fuel
Manufacture of Raw Chemical Materials and Chemical Products	Chemicals and chemical products
Manufacture of Medicines	
Manufacture of Chemical Fibres	
Manufacture of Rubber and Plastics Products	Rubber and plastics
Manufacture of Non-Metallic Mineral Products	Other nonmetallic minerals
Smelting and Pressing of Ferrous Metals	Basic metals and fabricated metal
Smelting and Pressing of Non-Ferrous Metals	
Manufacture of Metal Products	
Manufacture of General Purpose Machinery	Machinery, nec
Manufacture of Special Purpose Machinery	
Repair Service of Metal Products, Machinery and Equipment	

Manufacture of Electrical Machinery and Apparatus	Electrical and optical equipment
Manufacture of Computer, Communication and Other Electronic Equipment	
Manufacture of Measuring Instruments and Machinery	
Manufacture of Automobiles	Transport equipment
Manufacture of Railway, Ship, Aerospace and Other Transportation Equipments	
Other Manufacture	Manufacturing, nec; recycling
Utilization of Waste Resources	
Production and Supply of Electric Power and Heat Power	Electricity, gas, and water supply
Production and Supply of Gas	
Production and Supply of Water	
Water Management	
Construction of Buildings	Construction
Civil Engineering	
Construction Installation	
Building Decoration and Other Construction	
Wholesale Trade	Wholesale trade and commission trade, except of motor vehicles and motorcycles
Retail Trade	Retail trade
Motor Vehicles, Electronic Products and Daily Use Products Repair Industry	
Hotel Services	Hotels and restaurants
Catering Services	
Railway Transport	Inland transport
Road Transport	
Pipeline Transport	
Water Transport	Water transport
Air Transport	Air transport
Intermodality and Forwarding Agency	Other supporting and auxiliary transport activities; activities of travel agencies
Loading, Unloading and Storage	
Post	Post and telecommunications
Telecommunication, Radio and Television Satellite Transmission Service	
Monetary Financial Service	Financial intermediation
Capital Market Service	
Underwriting	
Other Financial Service	
Real Estate	Real estate activities
Land Management Service	

Internet and Related Service	Renting of M&Eq and other business activities
Software and Information Technology Service	
Leasing industry	
Commerce Service Industry	
Development of Researches and Tests	
Profession Skill Service Industry	
Both Scientific and Technological Communications and Generalization	
Other Service Industries	
CCP Organ	Public administration and defense; compulsory social security
Organs of State	
The Political Consultative Conference and Democratic Parties	
Social Security	
Grass Roots Self-management Organizations	
Education	Education
Public Health	Health and social work
Social Service	
Ecological Protection and Environmental Management	Other community, social, and personal services | Private households with employed persons
Neighborhood Services Industry	
Radio, TV, Film and Audiovisual Product Industry	
Culture and Art Industry	
Sports	
Entertainment Industry	
Mass Organizations, Social Communities and Other Menber Organizations	
Journalism and Publishing	
Management on Public Facilities	

Table B.4 Sectoral aggregation of the ADB-MRIO table

10 Sectors (Aggregated)	33 Sectors (Original classification)
Agriculture	Agriculture, hunting, forestry, and fishing
Mining Industry	Mining and quarrying
Light Industry	Food, beverages, and tobacco
	Textiles and textile products
	Leather, leather products, and footwear
	Wood and products of wood and cork
	Pulp, paper, paper products, printing, and publishing
Heavy Industry	Coke, refined petroleum, and nuclear fuel
	Chemicals and chemical products
	Rubber and plastics
	Other nonmetallic minerals
	Basic metals and fabricated metal
High-tech	Machinery, nec

Industry	Electrical and optical equipment
	Transport equipment
Heavy industry*	Manufacturing, nec; recycling
Construction	Construction
Utilities	Electricity, gas, and water supply
Transportation	Inland transport
	Water transport
	Air transport
	Other supporting and auxiliary transport activities; activities of travel agencies
Producer Services	Sale, maintenance, and repair of motor vehicles and motorcycles; retail sale of fuel | Retail trade, except of motor vehicles and motorcycles; repair of household goods
	Post and telecommunications
	Financial intermediation
	Renting of M&Eq and other business activities
Consumer Services	Wholesale trade and commission trade, except of motor vehicles and motorcycles
	Hotels and restaurants
	Real estate activities
	Public administration and defense; compulsory social security
	Education
	Health and social work
	Other community, social, and personal services | Private households with employed persons

* There are two sub-sector, "manufacturing, nec" and "recycling", in this sector. While the sub-sector "manufacturing, nec" belongs to the light industry, the sub-sector "recycling" belongs to the heavy industry. Among the two sub-sectors, the output of "recycling" is higher. According to the national input-output tables of 2017 officially released by national bureau of statistics of China, for example, the output of the sub-sector "manufacturing, nec" was 374,475 million RMB, while the output of the sub-sector "recycling" was 660,135 million RMB in 2017. Therefore, in the paper we allocate the sector "Manufacturing, nec; recycling" into heavy industry. As our defense, this is generally a very small sector, accounting for less than 0.5% of GDP in China, and this allocation would not seriously mislead the outcomes.

Integration in the Global Value Chain, Structural Change, and the Widening

Gender Employment Gap in China

Highlights

1. The gender employment gap (GEG) increased by 9.64% in China from 2000 to 2020.

2. Integration in GVC contributed to a widening of the GEG by ~0.60% during 2000-2020.

3. Increasing gender descrimination contributed to GEG by +1.?'% during 2000-2020.

4. Shrinkage of female-intensive sectors contributed to GEG ιv +ι.36% during 2000-2020.