SINGAPORE'S ADJUSTED GENDER PAY GAP

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1. INTRODUCTION

1.1 The gender pay gap is a commonly used figure to measure income inequality between men and women. It essentially captures how much less women earn compared to men. The extent of the gender pay gap across countries and at different points in time has long been an active area of research. **A commonly used measure is the "Unadjusted Median Gender Pay Gap", which is often used for international comparisons of the extent of gender inequality across countries.**

1.2 The Unadjusted Median Gender Pay Gap[1] compares the median pay of working women relative to that of men. However, as this measure **captures gender differences in productive characteristics between men and women** such as age, education, occupation, industry, years of work experience, discrimination etc, it is at best a broad measure, and does not offer the most like for like comparison. In 2018, Singapore's unadjusted median gender pay gap of full-time employed residents is 12.5%.[2]

1.3 "Equal pay for equal work" is a concept that individuals performing the same work should be given equal pay. This is an important concept for consideration in the measurement of the gender pay gap. To better measure whether women are paid as per their male peers who are doing similar work[3], a study was done to determine the "**Adjusted Gender Pay Gap"** in Singapore. The adjusted gender pay gap provides a more like-for-like comparison by measuring the gender pay gap of men and women with the same characteristics in terms of age, education, occupation, industry, and usual hours worked.

1.4 This paper reviews the extent and trends in female participation in the labour market, with focus on the adjusted gender pay gap. The data are from the Ministry of Manpower's Comprehensive Labour Force Survey (CLFS) conducted by the Manpower Research and Statistics Department (MOM, MRSD).

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[1] The unadjusted median gender pay gap (GPG) is, calculated as:

$$1 - \frac{Median\ income\ of\ women}{Median\ income\ of\ men} \times 100\%$$

[2] The unadjusted gender pay gap narrows further to 9.7% in 2018 when we compare the median income from work of full-time employed men and women in similar occupational groups (1-digit SSOC).

[3] While it was the aim to capture individuals performing "equal work", practically it was not yet possible to capture individuals doing exactly the same work (e.g. Same workload, job role, within and across firms and industry).

1.5 The analysis focuses on the gross monthly income (including employer CPF contributions) of full-time resident employees in the prime-working ages of 25 to 54 years. This is to ensure comparison of men and women with similarly strong labour market attachment:

- Full-time employees form the majority of all workers and tend to be subjected to existing pay packages, unlike the self-employed who are likely to have a different labour market and wage experience as compared to employees.
- The analysis excludes part-timers as they face a different wage structure, with lower earnings and lower labour market attachment.
- The age restriction ensures that trends are less impacted by young entrants who may still be in school and older workers who may be retiring from the labour force.

The key findings are:

1.6 First, current cohorts of women in Singapore have higher educational attainment and increased labour market participation compared to past cohorts of women.

- In 2002, only 36% of women has at least a diploma qualification. By 2018, the proportion almost doubled, 71% of women with at least a diploma qualification.
- The LFPR of prime working age women in Singapore has increased from 65.2% in 2002 to 80.8% in 2018.
- Women's share rose across the broad occupational groups, with the largest increase observed among professionals, managers, executives and technicians (PMETs). However, women continue to be over-represented in traditionally female occupations (such as nurse, accountant and administration manager). Average earnings in these "female" occupations tend to be lower than earnings in occupations with higher male shares.

1.7 Second, the adjusted GPG has narrowed over time.

- The adjusted gender pay gap in 2018 is 6.0%. This is the unexplained component from the decomposition, which is the remaining gender pay gap between men and women employees after adjusting for both human capital and labour market factors where data was available. It has narrowed from 8.8% in 2002.
- The adjusted gender pay gap of 6.0% is lower when compared with results for similar studies done for USA (8.0%), Canada (7.7% - 8.3%) and China (18.3%).
- **Labour market factors were found to have a bigger impact** on narrowing the gender pay gap. In particular, **occupational differences between the genders** was the most significant factor across time, suggesting that there is increasing **occupational segregation.**

1.8 The importance of occupational differences in accounting for the GPG raises the question of why occupational segregation continues to persist. We discuss several factors that could influence women's choice of occupation and their career progression leading on to occupational segregation:

- Gender differences in personality traits and skills,
- Psychological traits,
- Value placed on workplace flexibility and social norms in gender roles within families.

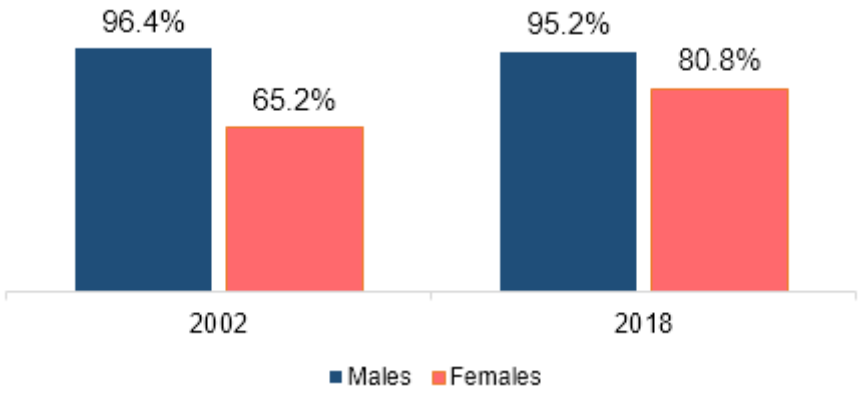
Lastly, there remains **the unexplained component (6.0% adjusted gender pay gap) which the model was not yet able to account for at this stage of the study.** Some of the factors that may explain these 6% difference could be **unmeasured employment characteristics (e.g. type of firms, position within firm, and work experience), caregiving responsibilities, parenthood, and labour market discrimination.**

2. WOMEN IN THE LABOUR MARKET

2.1 Women today, particularly those in advanced economies, have higher educational attainment and increased labour market attachment than women of the past. This is also true for women in Singapore.

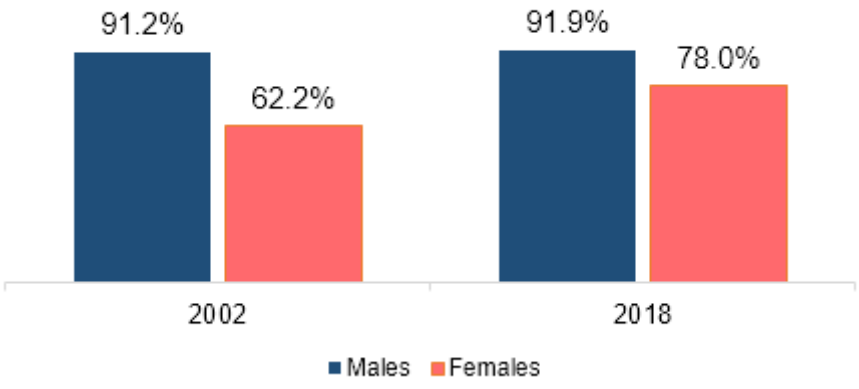
2.2 The female labour force participation rate (LFPR) rose strongly from 2002 to 2018 (Chart 1). As to be expected, women's employment rate also rose strongly over the same period (Chart 2). These trends were largely driven by the entry of women into full-time work. The full-time employment rate rose from 58% in 2002 to 72% in 2018 (Chart 3).

Chart 1: Labour Force Participation Rate of Residents Aged 25 to 54



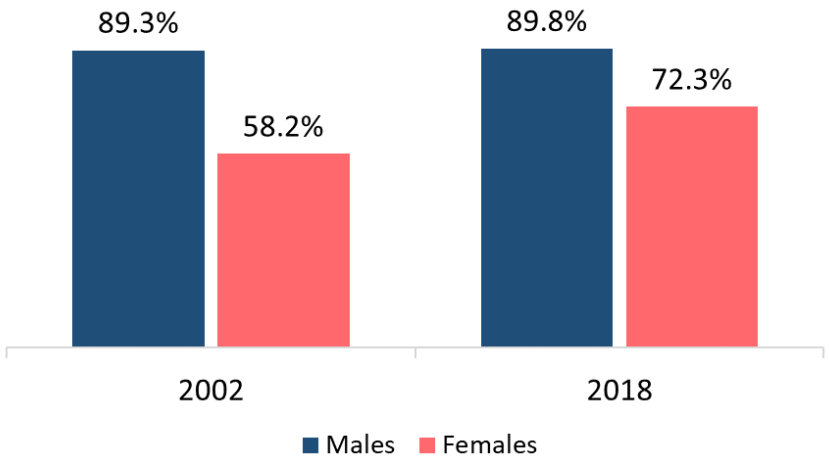
Source: Comprehensive Labour Force Survey

Chart 2: Employment Rate of Residents Aged 25 to 54



Source: Comprehensive Labour Force Survey

Chart 3: Full-Time Employment Rate of Residents Aged 25 to 54

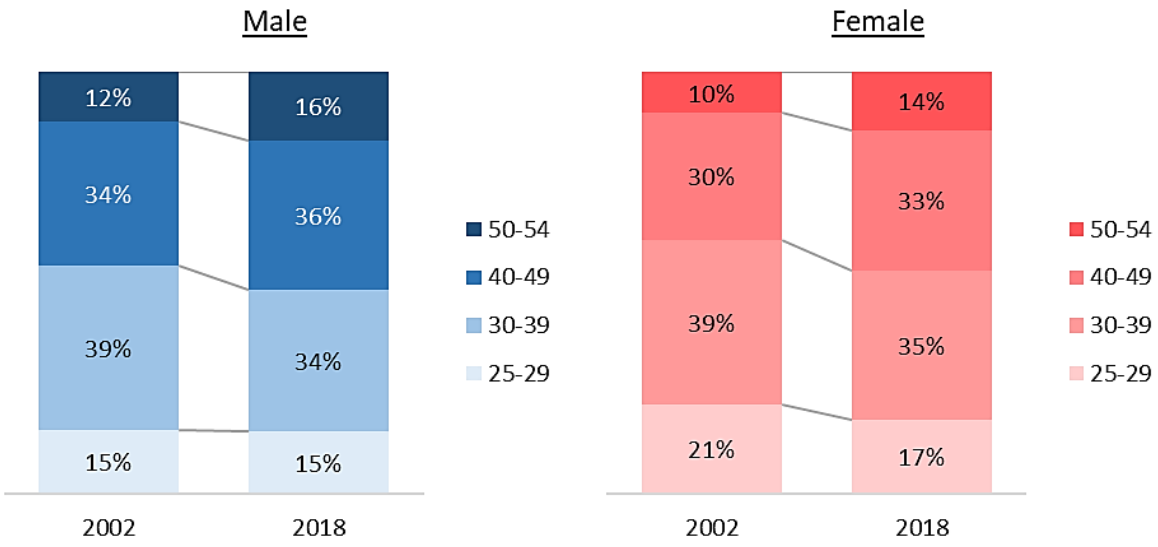


Source: Comprehensive Labour Force Survey

Note: To facilitate international comparison, Singapore's full-time employment rate data refers to those employed with usual hours worked of at least 30 hours a week as a percentage of the population

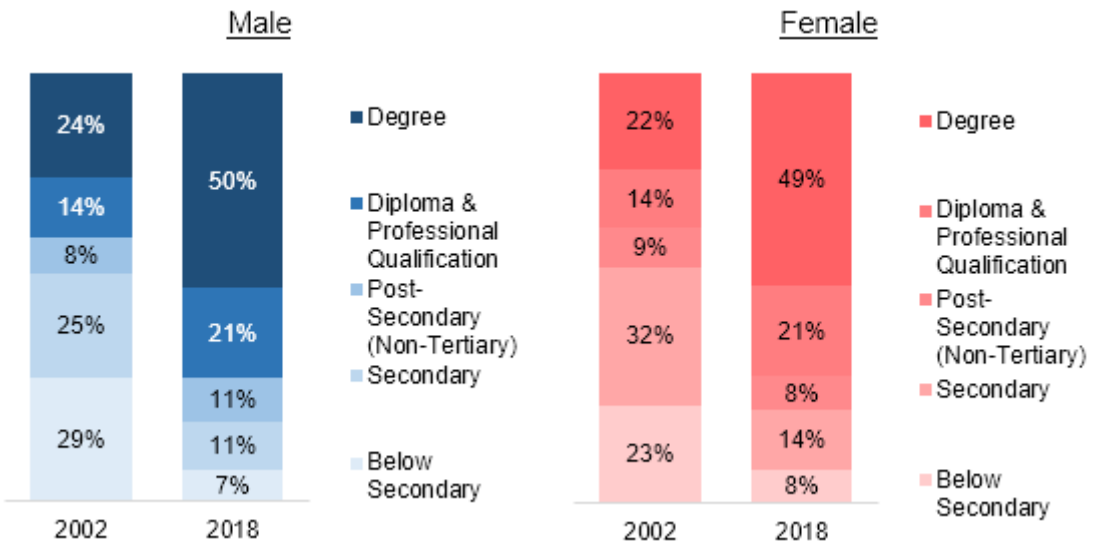
2.3 Among full-time resident employees aged 25 to 54 years old, male and female age profiles were similar (Chart 4). The education profile of both men and women improved from 2002. Female employees' educational profile continue to be on par with that of men (Chart 5).

Chart 4: Age Profile of Full-Time Resident Employee Aged 25 to 54



Source: Comprehensive Labour Force Survey

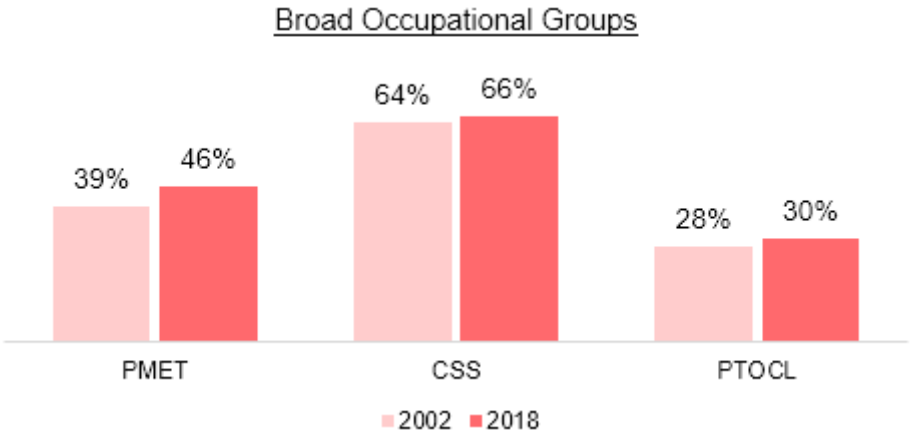
Chart 5: Education Profile of Full-Time Resident Employee Aged 25 to 54



Source: Comprehensive Labour Force Survey

2.4 With improvements in the employment rate and the education profile, the share of women rose across broad occupational groups. The largest increase was observed in PMETs (Chart 6). Yet, even with the significant increase in the proportion of women in professionals and associate professional and technicians ("APT") (Chart 7), many **women remained in traditionally female occupations** (e.g. professionals in nursing, and teaching and training, and administrative APT) **which are generally lower paying compared to occupations with higher male shares** (e.g. medical doctors, professionals in ICT and physical and engineering science APTs). Meanwhile, men continue to be concentrated in higher-paying occupations relative to women, as such, the proportion of women in occupations earning $8,000 and over in 2018 (22%) had fallen further behind that of men (33%) compared to 2002 (Chart 8). We will discuss in greater detail in Section 4 and 5 on occupational segregation and possible factors affecting it.

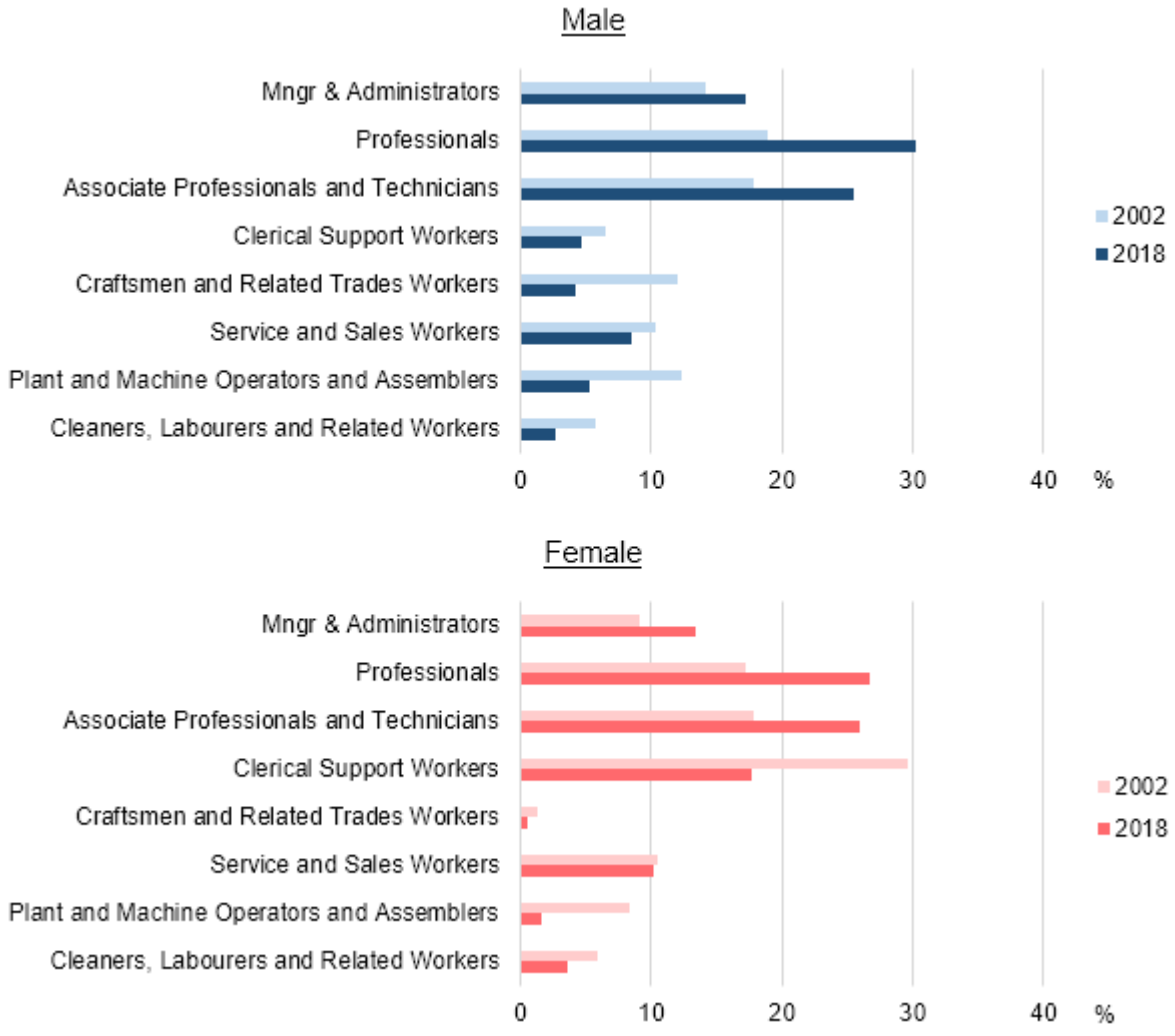
Chart 6: Share of Female Full-Time Resident Employee Aged 25 to 54



Source: Comprehensive Labour Force Survey

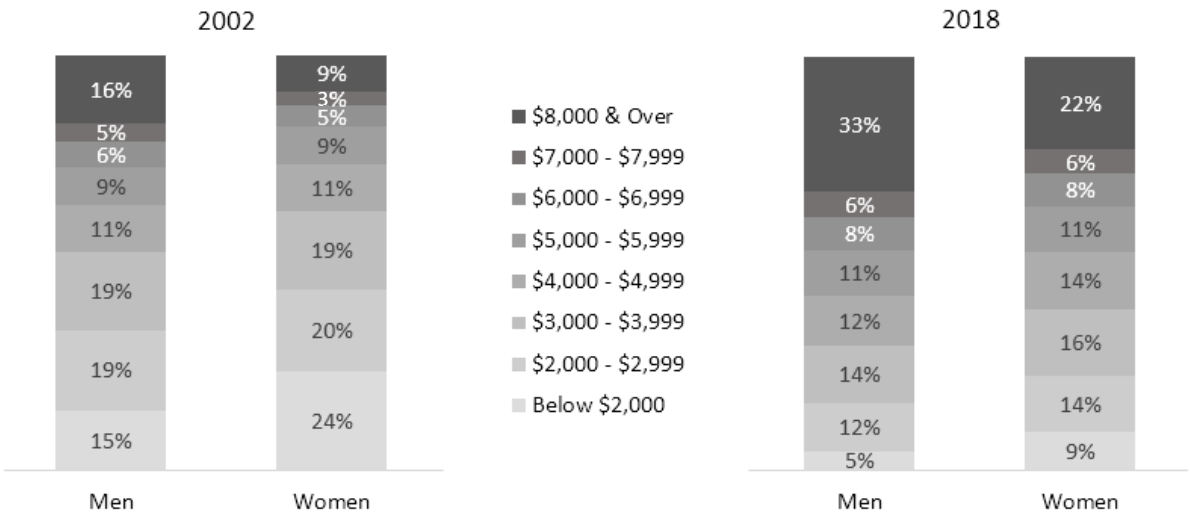
Note: CSS refers to clerical support, service and sales workers. PTOCL refers to craftsmen and related trade workers, plant and machine operators and assemblers, cleaners, labourers and related workers.

Chart 7: Distribution of Full-Time Resident Employee Aged 25 to 54 By Occupation



Source: Comprehensive Labour Force Survey

Chart 8: Distribution of Full-Time Resident Employee Aged 25 to 54 By Real* Gross Monthly Income from Work



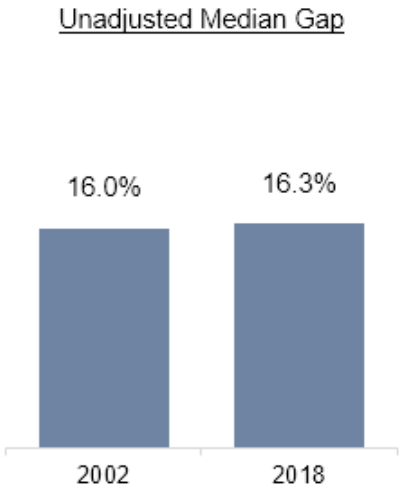
Source: Comprehensive Labour Force Survey

Note: (1) Data exclude full-time National Servicemen
(2) * - Deflated by Consumer Price Index (CPI) for all items at 2014 prices (2014 = 100).

3. DECOMPOSING SINGAPORE'S GENDER PAY GAP

3.1. From 2002 to 2018, **Singapore's unadjusted median gender pay gap** of full-time resident employees aged 25 to 54, was broadly stable. In 2018, women full-time employees earned 16.3% less than men did in terms of median income (Chart 9).

Chart 9: Unadjusted Gender Pay Gap of Full-Time Resident Employee Aged 25 to 54



Source: Comprehensive Labour Force Survey

Note: Data exclude full-time National Servicemen.

3.2. To better understand the factors that drive the gender pay gap, the unadjusted GPG was decomposed into the key drivers using the **Oaxaca-Blinder (OB) decomposition method. The OB decomposition method tells us the extent to which gender differences in measurable characteristics can account for the overall GPG.**

The OB decomposition was used to separate the pay gap between the genders into an "explained" and an "unexplained" portion. The "explained" portion of the gap is the difference in pay caused by the different characteristics of men and women. The remaining "unexplained" portion is the adjusted pay gap.

In the decomposition, the contribution of each characteristic to the gender pay gap is estimated. For this paper's OB decomposition, it was assumed that men and women have the same returns to the various characteristics in the model, i.e. the returns of a median worker (pooled coefficient) was used as the benchmark. For example, it assumes that women and men have the same returns to age and calculates whether men or women should earn more or less depending on whether they are on average older or younger than the median worker. The average gender differences in each characteristic multiplied by the return to each characteristic in terms of income tells us the extent to which gender differences in measurable characteristics can account for the overall GPG.

3.3. The following factors were examined in the decomposition:

a. **Human Capital factors:** Age, education
b. **Labour market factors:** Occupation, industry, usual hours worked per week

3.4. The impact of **human capital factors** on the gender pay gap was relatively modest.

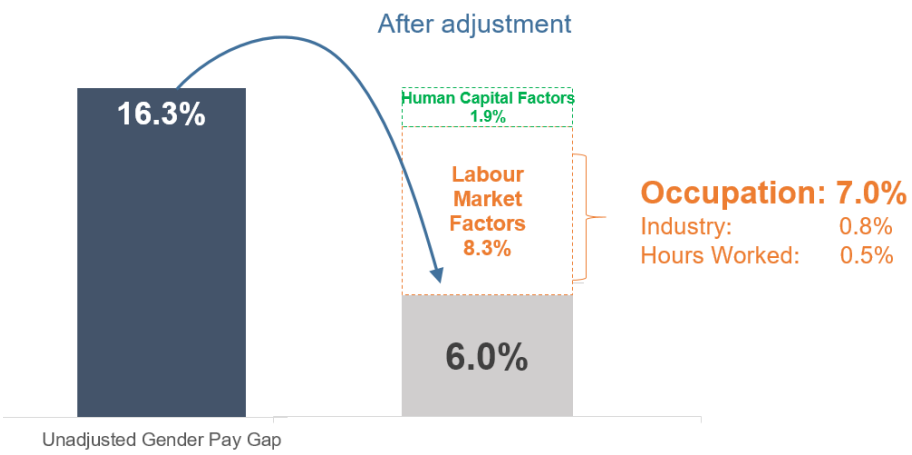
a. Adjusting the overall median GPG of 16.3% by **human capital characteristics reduced the GPG by 1.9%-points to 14.4%.** Given how similar men and women's age and education profiles are today (Chart 4 and 5), it is not surprising that gender differences in human capital characteristics do not contribute much to the gap.

3.5. Labour market factors played a more significant role

a. Controlling for gender **differences in labour market factors (occupation, industry, and usual hours of work) reduced the median GPG by much more (8.3 %-points)**.
b. **The key driver was occupational differences, accounting for 7.0 %-points of the 8.3 %-points.**
c. Other controls such as **industry and usual hours of work** accounted for only an additional 1.3%-points (Chart 10).

3.6. The adjusted gender pay gap in 2018 is 6.0%, after controlling for the human capital and labour market factors. This **is less than half the unadjusted GPG**. The adjusted gender pay gap of 6.0% is also lower when compared with results for similar studies done for USA (8.0%), Canada (7.7% - 8.3%) and China (18.3%) (Fortin.2019, Blau and Kahn. 2017, Wei Chi, Bo Li. 2007).

Chart 10: Decomposition of Unadjusted Median Gender Pay Gap, June 2018



Source: Comprehensive Labour Force Survey

3.7. Comparing 2002 with 2018:

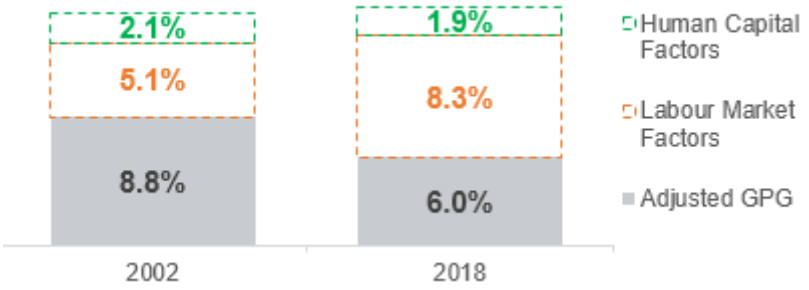
a. Human capital and labour market factors played a similar role in reducing the GPG in both 2002 and 2018. In 2002, the unadjusted median gender pay gap also **narrowed, from 16.0% to 8.8%** after adjusting for both human capital and labour market factors (Chart 11).

b. **However, the effects of labour market factors on the median gender pay gap increased from 2002 to 2018 (from 5.1%-points in 2002 to 8.3%-points in 2018).** This suggests that despite women upgrading their occupations and improving their labour market attachment, gender differences in occupational wages had become larger due to occupation income growth favouring men (Chart 14).

c. **Occupation differences was the key driver for both 2002 and 2018** (Chart 12).

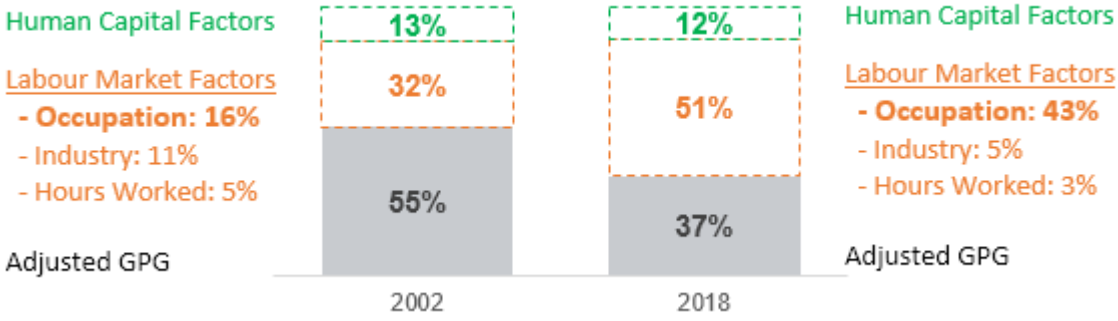
d. A larger portion of the unadjusted median gap in 2018 was explained by the difference in occupations between men and women compared to 2002. Occupational differences accounted for 7 %-points of the GPG in 2018 compared to 2.6 %-points in 2002. There are a few possible explanations for this. One, there could be heightened occupational segregation today than in 2002. Or, the degree of occupational segregation could still be similar but the differences in pay across occupations could have increased. Or, it could also be heightened occupational segregation together with increased differences in pay across occupations.

Chart 11: Decomposition of the Unadjusted Median Gender Pay Gap



Source: Comprehensive Labour Force Survey

Chart 12: Percent of Unadjusted Median Gender Pay Gap By Explanatory Factors



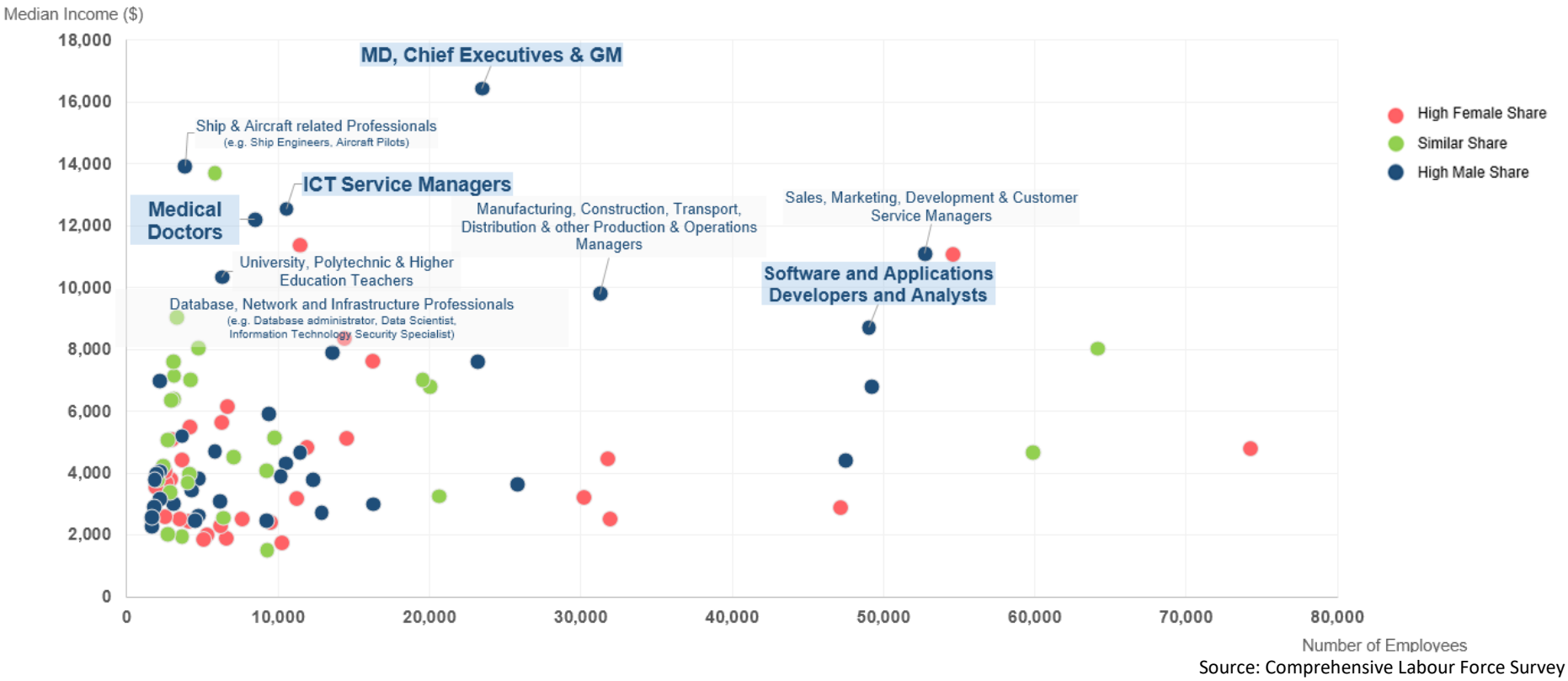
Source: Comprehensive Labour Force Survey

4. OCCUPATIONAL SEGREGATION AND THE GENDER PAY GAP

4.1. **Occupation segregation** by gender refers to the tendency of men and women to work in different occupations. In particular, to describe occupational segregation, we will refer to the distribution of men and women across occupational groups and the representation by gender in occupational groups.

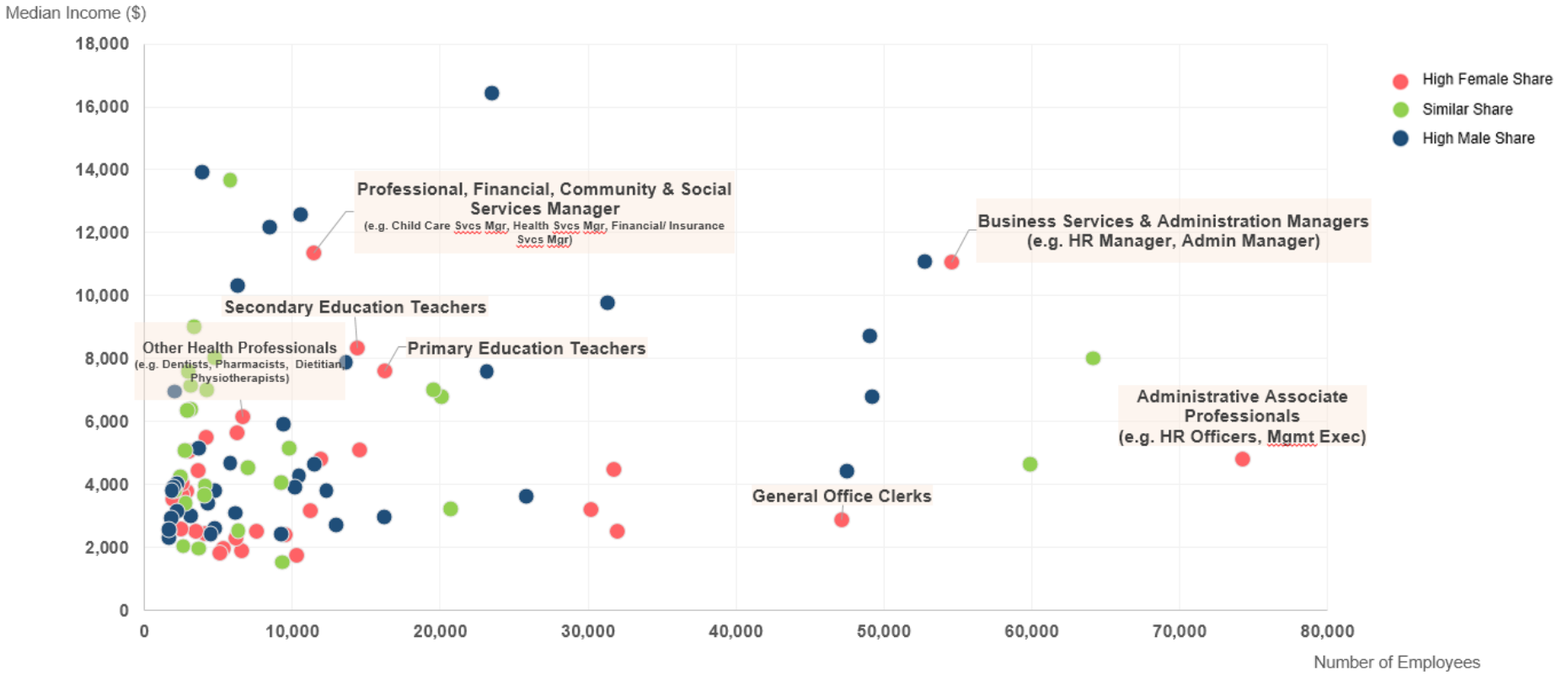
4.2. In Singapore, men continue to be **over-represented in higher-paying occupations** while **women tended to be in lower-paying occupations** (Chart 13), similar to the UK (ONS, 2018). This is also similar to observations discussed in Blau and Kahn (2016) and Levanon, England, and Allison (2009), where occupations with a greater share of females pay less than occupations with higher share of males, even among workers with similar characteristics such as education and skills.

Chart 13: Median Gross Monthly Income of Occupations By Number of Employees, June 2018



Source: Comprehensive Labour Force Survey

Occupations with High Female Share



Source: Comprehensive Labour Force Survey

Note: High male share occupations are those with more than 60% men. The converse holds for high female share

4.3. Though women upgraded their occupations from 2002 to 2018**, the wage consequences of gender differences in occupations became larger** as well.

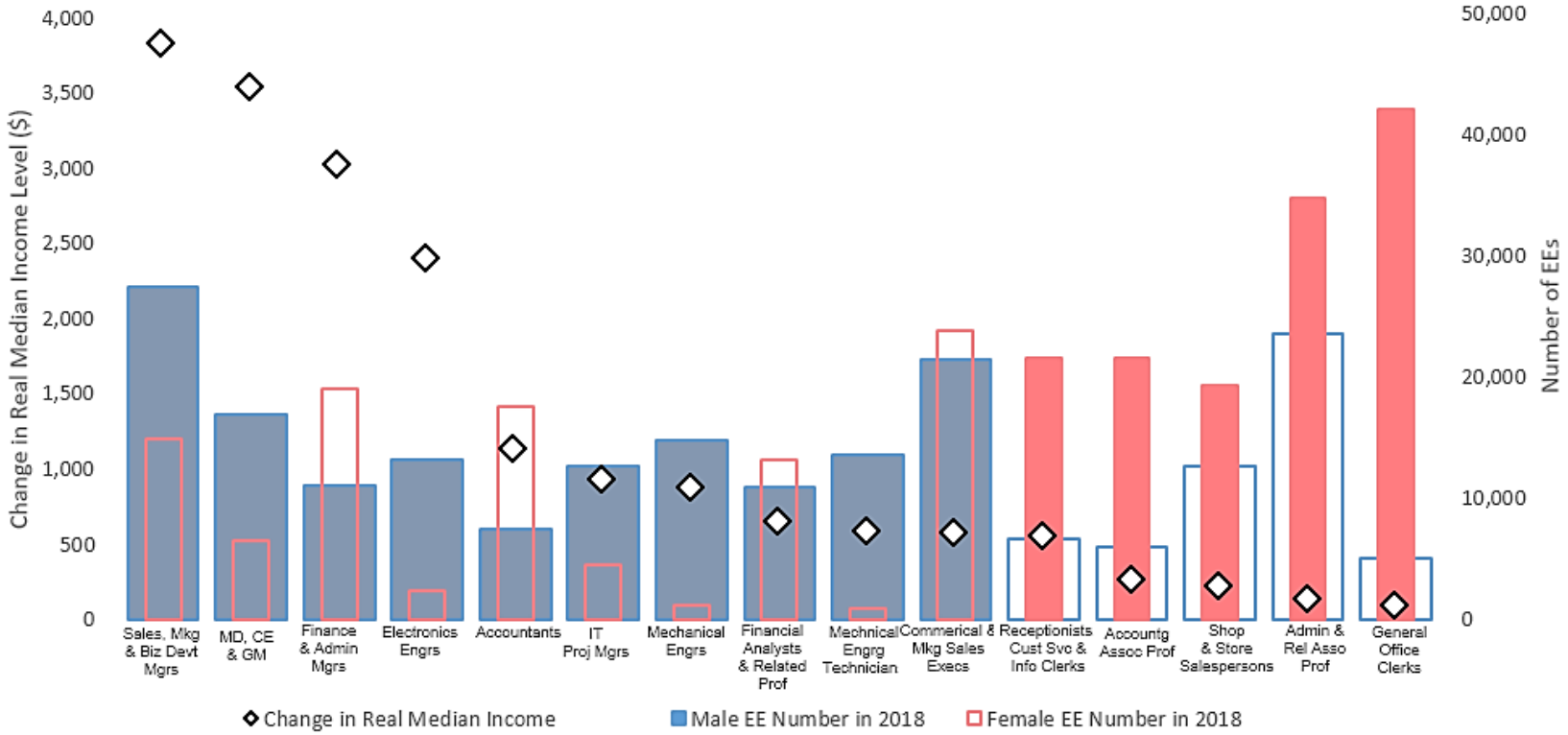
a. Occupational segregation, alongside changes in income in favour of occupations with higher male share, had the biggest impact on the gender pay gap.

b. Comparing the top 10 occupations of men and women, occupations with higher male share tend to see higher increases in income while majority of occupations with higher female share saw very small increases in income (Chart 14).

c. For some specific examples, sales, marketing and business development managers, managing directors, chief executives, and general managers remained among the most common occupations of men in 2018, registering much higher income change over time compared to the other top occupations. On the other hand, the most common occupation of women in 2018 continued to be that of a general office clerk, despite declining in numbers from 2002 to 2018. This occupation also saw little income change over time (Chart 14).

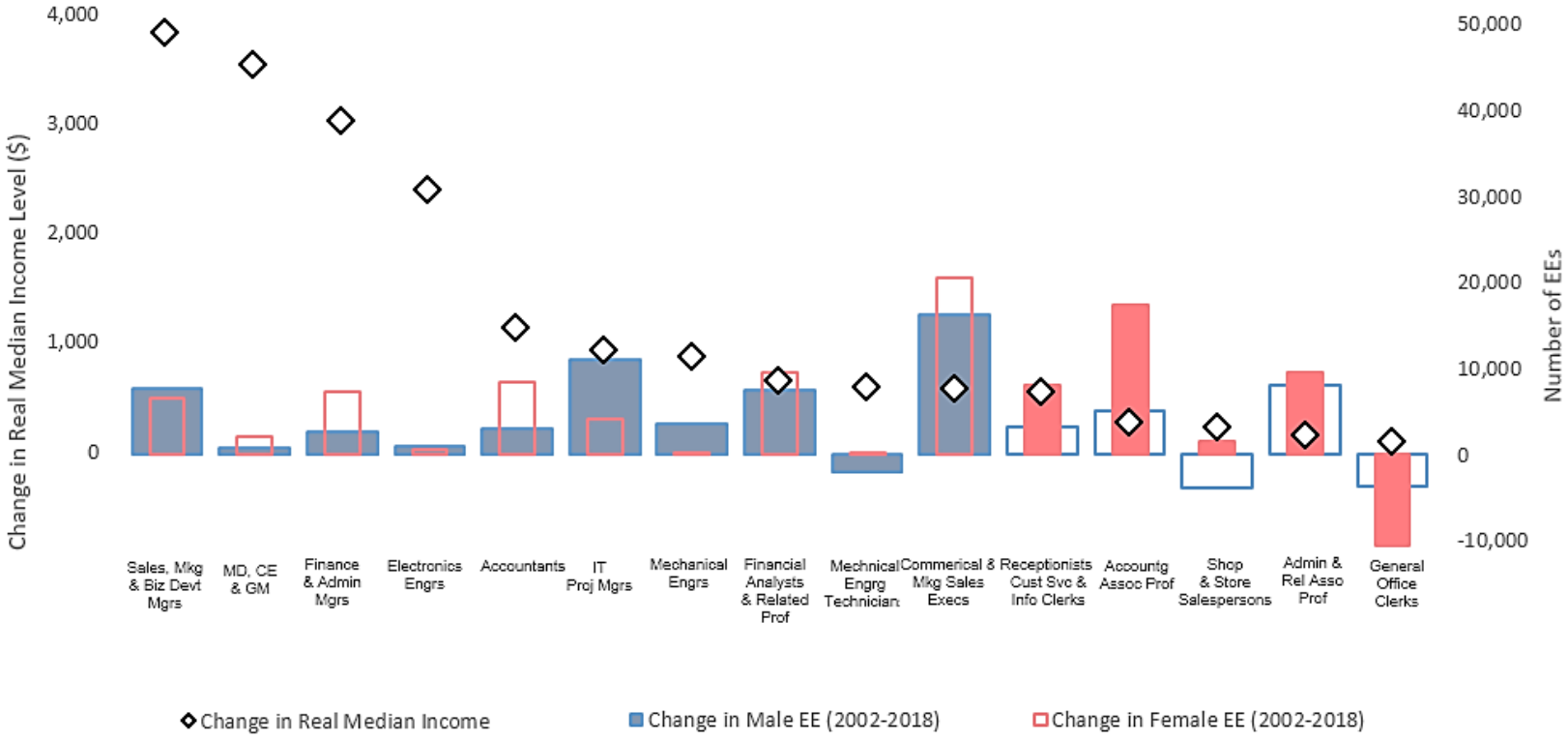
Chart 14: Top 10 Occupations of Men and Women, June 2018

Number Employed and Income Change



Source: Comprehensive Labour Force Survey

Change in Number Employed and Income Change



Source: Comprehensive Labour Force Survey

5. DISCUSSION OF FACTORS AFFECTING OCCUPATIONAL SEGREGATION BY GENDER

In this section, we discuss various factors that might contribute to the observed occupational segregation by gender in the Singaporean labour market. Recent literature suggests that occupational segregation can occur as men and women generally differ in terms of personality traits and skills, psychological attributes, choice of field of study, gender differences in the value placed on workplace flexibility, as well as social norms regarding gender roles within families.

Social Norms in Gender Roles within Families and the Value placed on Workplace Flexibility

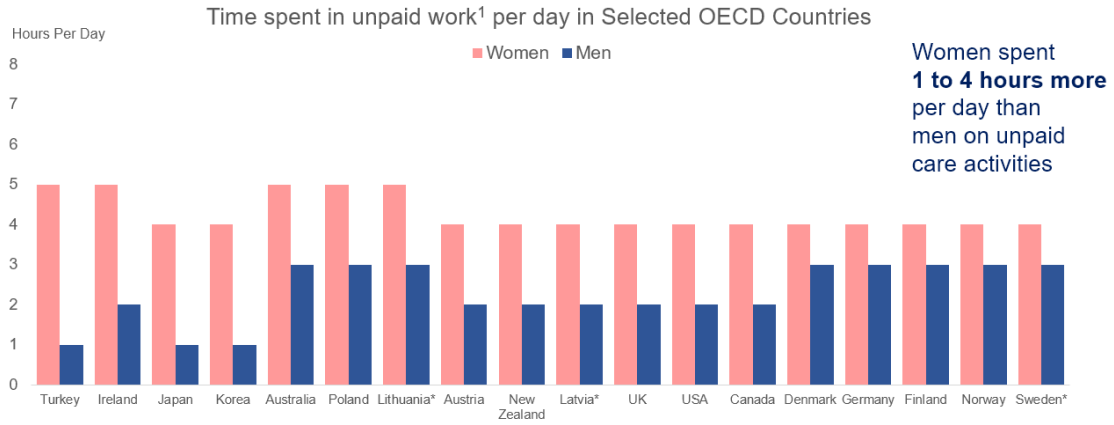
5.1. Women conforming to societal expectations of the appropriate role of women could be a contributing factor for occupational segregation.

a. Research shows that women are more likely to choose or avoid particular occupations/careers, possibly in reaction to social norms and expectations.

b. Results from a laboratory study involving MBA-student participants suggest that **women opt out of competitive professional occupations and careers possibly because of increased awareness of gender/ family identity** over the lifecycle (Cadsby et al., 2013). Specifically, the authors find that female subjects exhibited stronger preferences for competition when their professional identity was made more salient as compared to when gender/family identity was emphasized.

c. Internationally, unpaid care work remains more of a female responsibility with women spending about 1 to 4 hours more per day than men on unpaid care activities (Chart 15). In Singapore, women also play the primary role in care-giving/home-making responsibilities (Chart 16), which may be one of the reasons **women in Singapore worked fewer hours on average than men** (Chart 17). Such adherence to gender roles may be the reason why **women tend to value workplace flexibility more than men would.** Utilizing a survey of hypothetical job choices administered to undergraduate students from an elite university, Wiswall and Zafar (2017) find that women are willing to give up significantly more of their annual salary for a job with the option to work part-time relative to men.

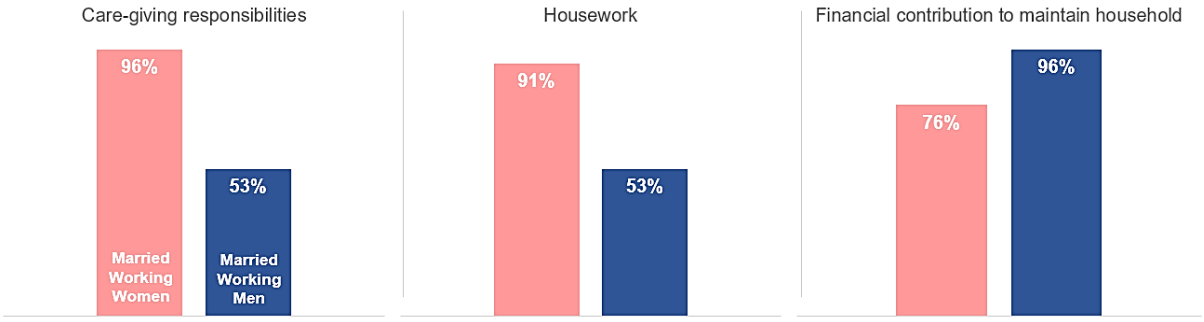
Chart 15: Time Spent in Unpaid Work per day in Selected OECD Countries



[1]Unpaid work includes:
routine housework; shopping; care for household members; child care; adult care; care for non-household members; volunteering; travel related to household activities; other unpaid activities.
* Indicates countries where full-time employment rates among women aged 15 to 64 years were higher than that of Singapore's.

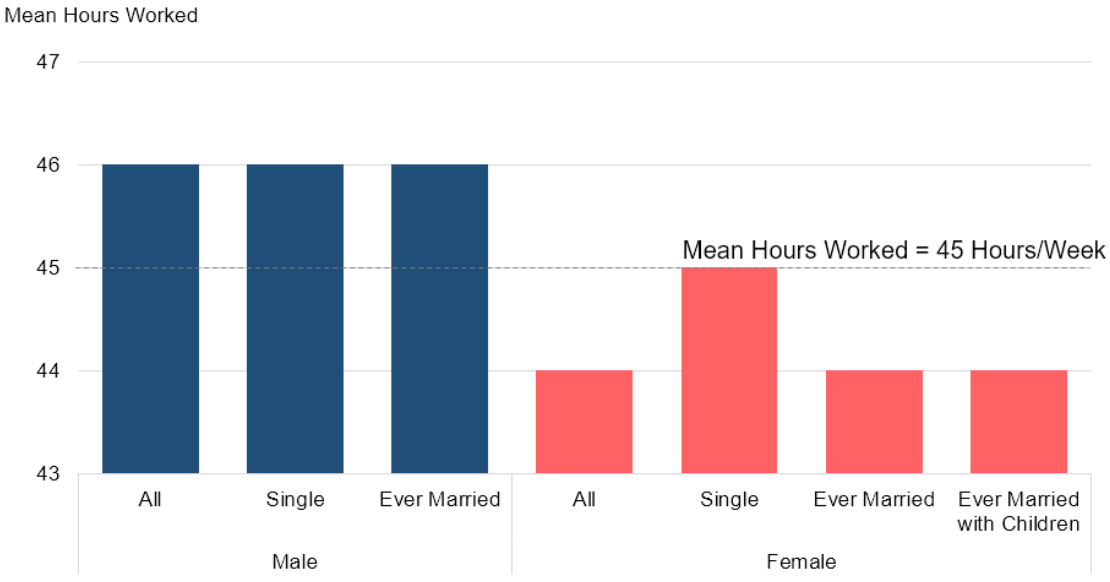
Source: OECD Database

Chart 16: Proportion of Married Working Respondents who indicated that they were equally or primarily responsible for:



Source: Survey on Social Attitudes of Singaporeans, 2013, Ministry of Social and Family Development

Chart 17: Average (Mean) Hours Worked of Full-Time Resident Employees Aged 25 to 54 Years, June 2018



Source: Comprehensive Labour Force Survey

5.2. Personality traits and skills tend to land women in people-oriented occupations

a. **Personality traits and skills** are factors that affect one's choice of occupation and even choice of field of study. Results from a study by Baker and Cornelson (2016) have shown that gender differences in sensory, motor, and spatial aptitudes can strongly predict men's and women's occupational choices.

b. Women tend to have **stronger interpersonal skills**. Opportunities to work with people, to be helpful to others or society are often important considerations for women when choosing a career (Fortin, 2008, Cortes and Pan, 2017). Women tend to prefer jobs that require empathy and interacting with people – they report higher levels of job satisfaction, and are less likely to leave people-oriented occupations (Lordan and Pischke, 2016).

c. This could potentially explain why **we see women over-represented in people-oriented occupations such as HR personnel, teaching and healthcare professionals.** By contrast, men are typically less affected by how people-oriented their occupations are.

d. Such patterns of occupational sorting on the basis of social/interpersonal skills may increasingly favour women due to the growing importance of these skills in the labour market as a result of technological change (Deming, 2017).

5.3. Gender differences in psychological traits contribute to gender occupational segregation and may affect wages directly or indirectly

a. Blau and Kahn (2016) estimate that gender differences in psychological factors accounts for a small to moderate portion of the gender pay gap. Manning and Swafford (2008) found that psychological traits could explain for 16 percent or less of the gender pay gap.

b. Research finds that **women are generally more risk averse and less competitive** (Bertrand, 2011). DeLeire and Levy (2004) found that women are much more risk averse than men, and **tend to take on safer occupations. They argue that** differences in fatality risk across occupations can explain about a quarter of gender segregation by occupation. Large gender differences in the willingness to apply for a job with more competitive compensation scheme have also been documented (Flory, Leibbrandt and List, 2014).

c. **Gender preferences for competition** also affects the choice of field of study, which in turn affects future career choice. Among young people in the Netherlands, a recent study finds that girls are less competitive than boys are and are less likely to choose Science, Technology, Engineering and Mathematics (STEM) fields of study. Even after accounting for grades, perceived mathematical ability and socioeconomic background, gender differences in competitiveness can account for 20% of the gender gap difference in track choice (Buser, Niederle, and Oosterbeek, 2014).

6. ADJUSTED PAY GAP – THE UNEXPLAINED COMPONENT

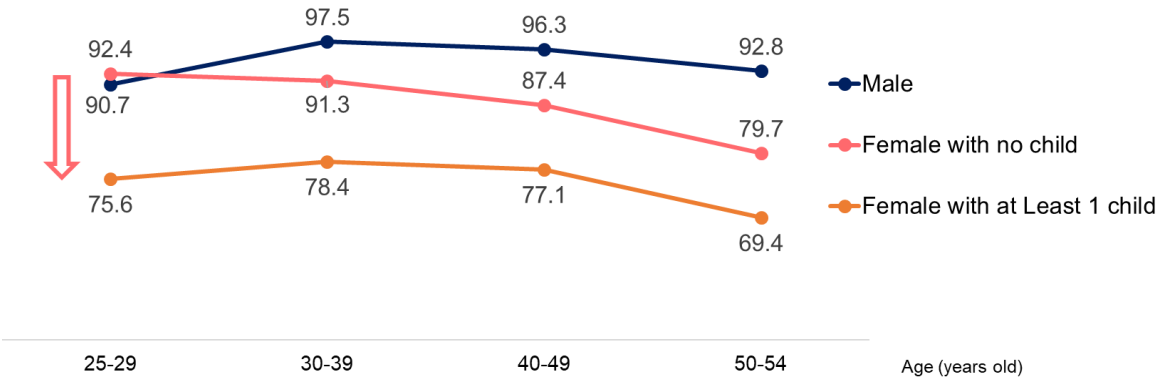
6.1. The adjusted gender pay gap has narrowed from 8.8% in 2002 to 6.0% in 2018. This is the unexplained component from the decomposition, which remains between men and women employees after taking into account gender differences in the available measures for human capital and labour market factors. This unexplained component could reflect the model's inability to capture **other explanatory factors** that cannot be measured using the available data.

Some of these factors include firm type, job scope/position within occupations/industries, work experience, parenthood, caregiving responsibilities, gender differences in psychological attributes, and discrimination.

6.2. Women's propensity to play the primary role in caregiving and take time off work for parenting is one of the key factors that affect the adjusted gender pay gap.

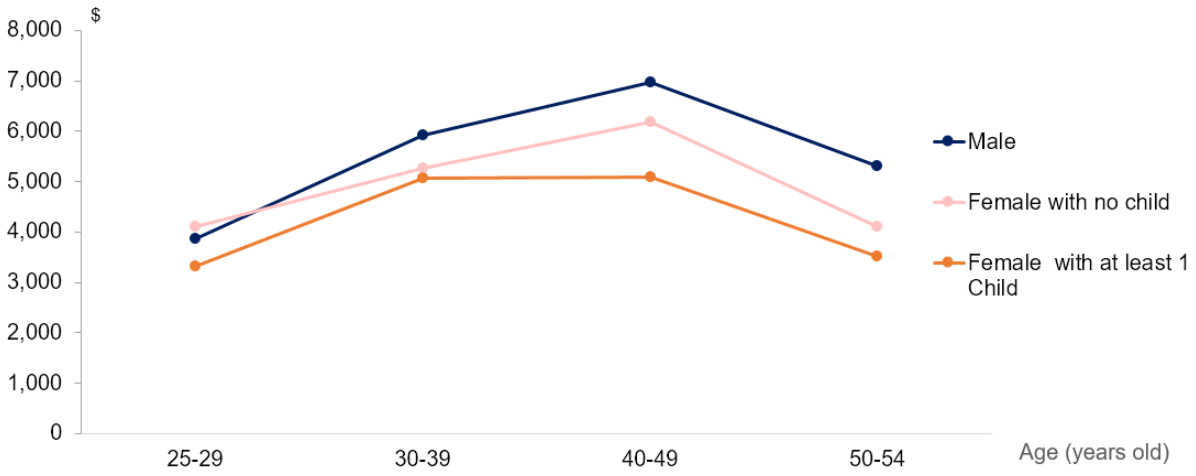
a. Women typically play the primary role in care-giving responsibilities and are more likely to take time off from work (Chart 18) when children are present in the household.
b. As a result, women with children are likely to lag behind in terms of work experience, career progression, and earnings relative to men and women without children (Chart 19).
c. In many countries, parenthood was found to have widened the gender pay gap. Men's and women's earnings diverge after the birth of the first child. In many countries (including UK, US and Scandinavia) the earnings of men and women track closely before parenthood but diverge sharply after parenthood.
d. In Austria where female LFPR and the ER are similar to Singapore's, women with children experienced a 51% earnings penalty in the long-run. This is despite Austria having generous and egalitarian family-friendly policies. Nevertheless, countries that featured larger child penalties (such as Austria & Germany) are also characterised by much more gender conservative views (Kleven, Landais, Posch, Steinhauer and Zweimüller, 2019).
e. Further exploration on parenthood and care-giving responsibilities in the Singapore context would be useful in providing insights to viable initiatives to address the remaining labour market gaps.

Chart 18: Labour Force Participation Rate, June 2018



Source: Comprehensive Labour Force Survey

Chart 19: Median Gross Monthly Income of Full-Time Resident Employees, June 2018



Source: Comprehensive Labour Force Survey

Work experience/seniority of women, type of firm, occupation, and industry, hours worked, are also affected by the choices made by women in consideration of parenting and caregiving responsibilities.

6.3. **The adjusted pay gap narrowed from 8.8% to 6.0% in 2018,** suggesting that some of the above factors could have seen improvements which helped to narrow the gender pay gap. The evolving mindset of women and/or employers today, or the introduction of policies that better enable women to reconcile work inside and outside the household could have contributed to the narrowing observed over this period.

7. CONCLUSION

7.1. We have shown that the **adjusted gender pay gap in Singapore narrowed from 2002 to 2018**. During this period, women's age profile and education profile were fairly similar to men's. As such, human capital factors explained little of the gender pay gap, and with no discernible difference over time. Conversely, gender differences in labour market factors – in particular the occupational distribution continued and grew in importance in explaining the gap in 2018. Women did see improvements in employment and occupational representation and after adjusting for gender differences in human capital and labour market factors, the adjusted pay gap did narrow. Nonetheless, occupation segregation remains a key driver of the gender wage gap, and its role has grown over time. In 2018, it accounted for about two-fifths of the unadjusted gender pay gap.

7.2. We also consider how factors such as gender differences in personality traits and skills, psychological attributes, the value placed on workplace flexibility, and social norms in gender roles within families could affect occupational segregation based on findings from the recent literature. These factors would continue to influence one's choice of occupation, their career progression, and earnings.

7.3. Even though the model can explain more than half of the unadjusted gender pay gap, the unexplained component could reflect the effects of parenthood, caregiving responsibilities, un-measured employment characteristics such as work experience, firm type, and job scope, as well as discrimination. Even though this unexplained component has declined over time, further exploration on the career effects of parenthood and how workplace flexibility and/or social institutions can mediate these effects would be useful in providing insights to viable initiatives to address the remaining gender pay gap.

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Annex A

DATA SOURCE AND METHODOLOGY

Data Source

Data for Singapore's gender pay gap are compiled from MOM's Comprehensive Labour Force Survey (CLFS), an annual survey of private households in Singapore. The survey is conducted every mid-year and offers nationally representative data on income from work. It captures detailed information on resident employed individuals, including their personal or human capital characteristics such as age and education[1], as well as their labour market related characteristics such as their gross monthly income from work (including employer CPF contributions), occupation, industry, whether they are working full-time or part-time and their usual hours of work.

As such, the CLFS data sets are suitable for the decomposition of the unadjusted gender pay gap. They offer an estimate of the pay gap between men and women adjusted for differences in human capital and labour market factors, which is consistent with the top-line gender pay gap.

Methodology

Taking reference from Blau & Kahn (2017), we will use the Oaxaca-Blinder (OB) decomposition method, which involves two stages. The first is a regression analysis, followed by a decomposition analysis. In the regression analysis step, we estimate separate wage equations for men (M) and women (W) full-time resident employees aged 25 to 54 years:

$$ln\ y_i^M = \beta_0^M + \sum_{k=1}^{K} x_{ki}^M \beta_k^M + \varepsilon_i^M$$

$$ln\ y_i^W = \beta_0^W + \sum_{k=1}^{K} x_{ki}^W \beta_k^W + \varepsilon_i^W$$

where

$ln\ y_i$ refers to the natural log of gross monthly income from work for observation *i*;

x_{ki} are the explanatory variables or observed characteristics such as age and occupation, full list in Table 1;

β_0 is a constant, β_k are the corresponding coefficients for explanatory variable *k*;

ε_i is the error term for observation *i*, independent from each other and normally distributed.

1 Or highest qualification attained.

The regression analysis includes the following variables from CFLS to capture human capital and labour market factors that impact men and women's incomes separately.

	Variables	Details
Human Capital Factors	Age	Year and years squared
	Education	Defined based on the corresponding year's Singapore Standard Educational Classification (SSEC) of Educational Qualification Attained Groups defined as below primary (SSEC 2015 Group 0), primary (SSEC 1), lower secondary (SSEC 2), secondary (SSEC 3), post-secondary (non-tertiary) (SSEC 4), diploma & professional qualifications (SSEC 5 & 6), degree (SSEC 7, 8 & 9)
Labour Market Factors	Occupation	Defined based on the Singapore Standard Occupational Classification (SSOC) 2015
	Industry	Defined based on the corresponding year's Singapore Standard Industrial Classification (SSIC)
	Usual hours worked per week	The number of hours that a person usually works in a typical week, regardless of whether he is paid for it. The concept of usual hours of work differs from that of normal hours of work referred to in contractual arrangements.

Note: Type of employment such as permanent employment and term contract employment were tested not significant in this model.

Suppose the fitted regressions for men and women's incomes from work are:

$$\overline{ln\, y}^M = \hat{\beta}_0^M + \sum_{k=1}^{K} \bar{x}_k^M \hat{\beta}_k^M$$

$$\overline{ln\, y}^W = \hat{\beta}_0^W + \sum_{k=1}^{K} \bar{x}_k^W \hat{\beta}_k^W$$

These equations help us better understand the contributors to men's and women's incomes. They provide an estimate for the income returns which result due to an individual's characteristic, such as solely being a science and engineering professional. For example, from the men's equation we can say that the income returns due to the average characteristic $\bar{x}_k^M$ is the estimate $\hat{\beta}_k^M$.

Suppose we are in a world without any gender pay differentiation, i.e. a gender-blind world, we have this fitted regression, where men and women's income structures are similar, and only other characteristics such as occupation, industry, age impact earnings:

$$\overline{ln\, y} = \widehat{\beta_0} + \sum_{k=1}^{K} \bar{x}_k \hat{\beta}_k$$

Consequently, we are able to rewrite the difference in men's and women's log incomes, a representation of the gender pay gap as:

$$\begin{aligned}
\overline{ln\, y}^M - \overline{ln\, y}^W &= \left(\overline{ln\, y}^M - \overline{ln\, y}\right) - \left(\overline{ln\, y}^W - \overline{ln\, y}\right) \\
&= \left(\hat{\beta}_0^M + \sum_{k=1}^{K} \bar{x}_k^M \hat{\beta}_k^M - \widehat{\beta_0} - \sum_{k=1}^{K} \bar{x}_k \hat{\beta}_k\right) - \left(\hat{\beta}_0^W + \sum_{k=1}^{K} \bar{x}_k^W \hat{\beta}_k^W - \widehat{\beta_0} - \sum_{k=1}^{K} \bar{x}_k \hat{\beta}_k\right) \\
&= \underbrace{\sum_{k=1}^{K} \hat{\beta}_k \left(\bar{x}_k^M - \bar{x}_k^W\right)}_{\text{Explained difference (E) in men and women's incomes}} + \underbrace{\left(\hat{\beta}_0^M - \hat{\beta}_0^W\right) + \sum_{k=1}^{K} \bar{x}_k^M \left(\hat{\beta}_k^M - \hat{\beta}_k\right) + \sum_{k=1}^{K} \bar{x}_k^W \left(\hat{\beta}_k - \hat{\beta}_k^W\right)}_{\text{Unexplained difference (U)}}
\end{aligned}$$

Explained difference (E) in men and women's incomes
due to differences in average men and women's characteristics

Unexplained difference (U)

In this paper, we will focus on the explained difference in incomes of men and women across various characteristics and identify key drivers of the overall gender pay gap (GPG). An over-time analysis covering 2002 and 2018 is also presented, to consider how structural changes in profiles of men and women impacted the gender pay gap. For this, we have computed the explained part of the GPG (henceforth, called the adjusted GPG) as:

$$GPG_{adj} = GPG_{unadj} \times \frac{E}{E+U}$$

where $\frac{E}{E+U}$ is the share of the explained part of the unadjusted GPG.

Each characteristic *k*'s contribution to the unadjusted GPG can be compiled using:

$$\frac{\hat{\beta}_k \left(\bar{x}_k^M - \bar{x}_k^W\right)}{E+U}$$

As for the unexplained difference[2], it could be due to a number of factors, including factors for which data were not available in the CLFS (e.g. the specific age when women had children

[2] The second last term $\sum_{k=1}^{K} \bar{x}_k^M (\hat{\beta}_k^M - \hat{\beta}_k)$ corresponds to the difference in income a man receives for each characteristic $\bar{x}_k^M$ relative to that of a general full-time employee in a world without any pay differences due to gender. If this term is positive, it can also be understood as the degree of additional pay men received given each characteristic, e.g. additional income men infocomm professionals actually received

and their incomes at those ages, personal abilities or negotiating skills, preferences for workplace flexibility, type of firms) and therefore not be included in the model. While the unexplained difference is often taken to be an estimate of the extent of discrimination, it is important to note that the unexplained portion also captures unmeasured productivity characteristics (e.g. career breaks, psychological attributes, personality traits, and skills) as well as gender differences in the response to factors such as parenthood and caregiving responsibilities.

The OB decomposition method applies to the *mean* gender pay gap. To apply this decomposition to the *median* gender pay gap, we adopt the method introduced in Firpo, Fortin, and Lemieux (2009), which builds on the OB decomposition. In this method, instead of running the usual men and women regressions in the first step, a Recentered Influence Function (RIF)-regression is used. This is then followed by the steps outlined earlier to arrive at a similar decomposition for the median gender pay gap.

Instead of assuming a gender-blind pay package, similar decompositions can also be performed by assuming that either men's or women's pay package is the gender-blind pay package (i.e. running the regressions on male or female coefficients respectively). We found that the results using alternative assumptions regarding the wage coefficients were generally similar. More information can be found in Annex B.

compared to what they would have received in a gender-blind world. Correspondingly, the last term $\sum_{k=1}^{K} \bar{x}_k^W (\hat{\beta}_k - \hat{\beta}_k^W)$ represents such a pay difference for women.

Annex B

Decomposition of Gender Pay Gap, 2002 and 2018

Variables	Percentage of Mean gender pay gap explained by	
	2002	2018
Human Capital Factors	10.2	9.7
Labour Market Factors	28.0	45.3
Occupation	20.2	34.3
Industry	1.1	5.1
Usual Hours Worked	6.7	5.9
Total explained	38.2	55.0
Total unexplained	61.8	45.0
Total pay gap	100.0	100.0

Variables	Percentage of Median gender pay gap explained by			
	Male coefficients		*Female coefficients*	
	2002	*2018*	*2002*	*2018*
Human Capital Factors	16.1	13.6	10.9	9.9
Labour Market Factors	53.3	56.7	21.6	58.6
Occupation	38.7	49.7	11.7	51.4
Industry	8.9	4.5	8.1	2.2
Usual Hours Worked	5.8	2.5	1.8	5.0
Total explained	69.4	70.3	32.4	68.4
Total unexplained	30.6	29.7	67.5	31.6
Total pay gap	100.0	100.0	100.0	100.0

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