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**Abstract**

Recent years have witnessed a growing proportion of female general practitioners (GPs) worldwide. Because female GPs tend to work fewer hours than male GPs, this continuing trend may accelerate the shortage of GPs. This paper investigates the gender difference in the wage elasticity of Australian GPs by maximum likelihood estimation of labour supply and wage equations. Quantitative information regarding the labour supply responses of GPs is vital in designing effective policies. The results show salient gender difference. An increase in hourly wage increases the labour supply of male GPs and reduces the labour supply of female GPs, resulting in an enlarged gender difference in labour supply. The results also suggest that family factors still remain a key driving force of the reduced labour supply of Australian female GPs.

Keywords: General Practitioners; female labour supply; gender gap; wage elasticity; income effect

## 1 Introduction

The rising proportion of female physicians is a worldwide trend (e.g. Constant and Léger, 2008). This trend is particularly noticeable among general practitioners (GPs). In Australia, the percentage of female GPs has increased from 22% in 1984 to 41% in 2011 (DoHA, 2012), and this trend is expected to continue because medical students are predominately female and the majority of GPs retiring in coming decades will be male (AIHW, 2013). Because female physicians are characterised by fewer hours worked than male physicians (Mitchell, 1984; Constant and Léger, 2008; Crossley *et al.*, 2009; Morris *et al.*,

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2011), this trend has implications for the labour supply of physicians. In addition, if female physicians work less and the cost of training new physicians is primarily borne by the tax-payer, this trend implies a lower return to society on its investment (Crossley *et al.*, 2009).

The physician shortage is another widely-reported worldwide trend (Crossley *et al.*, 2009), driven by both supply side factors such as a greater emphasis on the work-and-life balance of younger generations, and demand side factors such as population ageing and income effect (Hall and Jones, 2007). In particular, demand for GPs will continue to grow given the importance of chronic disease management resulting from population ageing. Given the shortage and rapidly growing health care expenditure, there has been much discussion in many countries about appropriate payment mechanisms. For policymakers, quantitative information regarding how male and female physicians change their labour supply in response to changes in their earnings is essential. Whether raising wages and providing pecuniary incentives induce a larger labour supply is theoretically ambiguous because it is determined by the combination of a substitution effect and an income effect. Furthermore, very little is known about whether such policies enlarge or reduce the gender difference in physician labour supply.

This paper examines the wage and income elasticities of GP labour supply, with particular emphasis on gender difference. We use the first wave of the Medicine in Australia: Balancing Employment and Life (MABEL) survey of doctors conducted in 2008. We investigate the annual hours worked of four different subgroups of GPs: self-employed males, employed males, self-employed females, and employed females. To address potential bias due to the endogeneity of the wage rate (defined as medical practice earnings per hour), we also estimate a wage equation which includes years of experience as an instrument, jointly with the labour supply equation. To overcome imprecision due to the small sample size of the subgroups and to aid the identification power of the instrument, we impose one wage equation for four subgroups, assuming a competitive labour market of GPs.

Although myriad studies report the labour supply of physicians by gender, there are only a few studies of gender difference in wage and income elasticities, all of which are two to four decades old and often suffer from the small sample size of female physicians (Kehrer, 1976; Mitchell, 1984; Rizzo and Blumenthal, 1994). We revisit this topic in the context of the rising proportion of female physicians. In addition, although there are many studies on the labour supply of physicians, most of them are confined to the US, Canada, and Europe, and there is no study of physician labour supply in Australia, let alone its gender difference. The fact that there is no direct regulation on the physician's fee or medical practice earnings in spite of the existence of a publicly-funded national health care system is an advantage in studying Australian GPs, because it provides the variation in wage rate in this paper, which is essential for examining wage elasticity.

The estimated wage elasticities for self-employed and employed male GPs are 0.47 and 0.57 respectively, whereas for self-employed and employed female GPs they are −0.24 and −0.34, respectively. Thus, policies that increase the overall wage level *increase* the gender difference in labour supply. We also find that married female GPs have particularly large and negative wage and income elasticities. The standard results in the literature of male and female physician labour supply are also confirmed by the Australian data. These results consistently suggest that family factors still remain a key driving force of the reduced labour supply of Australian female GPs.

## 2 Australian GPs and physician labour supply

### 2.1 GPs in the Australian health system

In Australia, unless salaried or contracted, GPs are remunerated on a fee-for-service basis that allows them to bill patients any amount they choose. The national healthcare system, Medicare, only reimburses patients a fixed amount of the bill as set out in the Medicare Benefits Schedule. The fact that there is no direct regulation on the doctors' fees serves as an advantage in studying Australian GPs, because it provides variation in hourly earnings. Wage elasticity is difficult to analyse in many countries that have a public healthcare system in which the fee-for-service remuneration rate is fixed.

Table I highlights important trends of Australian GPs since 1996. The absolute number of primary care physicians has significantly increased in recent years because of the expansion of medical school places in existing medical programs, the opening of new medical schools, and the recruitment of more overseas-trained physicians (Lennon, 2005). This significant increase, however, does not alleviate the physician shortage. Table I shows that while the population of primary care practitioners increases by approximately 24.0% nationwide from 1996 to 2011, the number of full-time equivalent (FTE) physicians per 100,000 population *decreases* by 10.9% during the same period. Because demand for primary care is expected to grow strongly due to population ageing, this worsening GP shortage is a public concern. Per capita FTE decreases in spite of the increase in the head count of GPs, partly because of the population growth in Australia,[1] but mainly because of the substantial reduction in the hours worked by GPs. From 1996 to 2011, average weekly hours reduce from 44.9 to 39.1 hours. This significant reduction results from two forces. First, all GPs, male and female, work reduced hours. Second, while female GPs are historically characterised by their hours being much fewer than males GPs, the proportion of

[1] The population growth rate in Australia from 1996 to 2011 is 21.9% (ABS, 2013).

female GPs increases from 32.0% in 1996 to 36.2% in 2003 and to 40.5% in 2011. The reduction in average hours worked by both male and female GPs is probably due to the recent emphasis on the work-and-life balance as well as the ageing of the GP population (Scott, 2005), which also explains the greater reduction in the hours worked by male GPs, because the majority of the GPs over age 65 are male GPs.

[Insert Table I: Key characteristics of Australian primary care practitioners in 1996, 2003, and 2011]

## 2.2 Related literature

There are very few empirical studies on gender difference in the wage elasticity of labour supply, and all from US (Kehrer, 1976; Mitchell, 1984; Rizzo and Blumenthal, 1994). They apply two-stage least squares to wage and hours worked separately for male and female physicians. Kehrer (1976) finds that male physicians increase weekly hours in response to a wage increase, while female physicians exhibit a negative but insignificant response. In Mitchell (1984), the results suggest a backward-bending labour supply curve for male physicians, while female physicians are not responsive to wage increases, when labour supply is measured by hours per week. Weeks worked is found to be insensitive to earnings variations for both male and female physicians. Rizzo and Blumenthal (1994) study self-employed physicians and find that female physicians increase hours worked in response to an increase in hourly earnings to a greater extent than male physicians do. Their results do not align with the previous two studies, perhaps because of the very small sample of female physicians. The first two studies find a much smaller wage effects for female physicians than for male physicians, which might appear to be inconsistent with the classical literature of female labour supply in which researchers often find positive wage elasticity (e.g. Killingsworth and Heckman, 1986). Female physicians, however, have very different characteristics from the general female population. The wage rate of female physicians is at the top end of the distribution of female wages and the physician labour supply is more about intensive margin than extensive margin (Baltagi *et al.*, 2005; Crossley *et al.*, 2009). Hence, it is reasonable to find a much smaller wage elasticity compared to the general female population. Lastly, it is worth pointing out that all three studies are old, dating well before the massive feminisation of the profession.

The determinants of labour supply by gender are relatively well-understood. Studies from many countries find that non-practice income, demographics, family circumstance, and practice settings affect hours worked by male and female physicians differently. Female physicians work less than male physicians (Ferrall *et al.*, 1998; Constant and Léger, 2008; Crossley *et al.*, 2009). Married female physicians work significantly less than unmarried female physicians, while marital status has no negative effect on hours worked by male physicians (Kehrer, 1976; Sasser, 2005). Female physicians are found to be more responsive to non-practice income variations (Sloan, 1975; Mitchell, 1984; Ikenwilo and Scott, 2007). The presence of preschool children decreases the hours of female physicians, but has zero or positive effect on the hours of male physicians (Sasser, 2005). Employed female physicians work less than self-employed female physicians, but self-employment status has no significant effect on male physicians (Kehrer,1976).

There are ample studies that explore the wage elasticity of physicians without particular attention to gender difference. The results are mixed. Early studies commonly find a backward-bending physician labour-supply curve (e.g. Feldstein, 1970; Sloan, 1975; Vahovich, 1977; Brown and Lapan, 1979). The later studies provide more reliable evidence by using rich micro data, better control for the endogeneity of earnings, and large sample size, and the findings are more consistent (Showalter and Thurston, 1997; Thornton and Eakin, 1997; Baltagi *et al.*, 2005; Saether, 2005; Ikenwilo and Scott, 2007). With a few exceptions, most recent studies agree on the range of wage elasticity, which lies between 0.1 and 0.3.

## 3 Econometric model

A GP is assumed to choose the desired number of hours of work, which corresponds to the most preferred point on their budget set. The solution of this optimisation depends on factors that influence the marginal rate of substitution between income and non-labour-market hours, such as, wage and preferences over work. A GP faces a 'wage rate' that is determined in the labour market, following the standard approach in the labour supply literature. Because Australian GPs have the legal capacity as a business owner to set the price, it may appear as if they choose their wage. However, it is fairly reasonable to make this assumption when the market of GP services is fairly competitive, GPs rationally choose to price according to the competitive environment, and hence, their hourly wage is determined by their 'productivity'. This term, productivity, should be interpreted here as income-earning capacity, which includes, for example, ability to attract patients and efficient management of their practice.

This underlying relationship allows us to specify the labour supply equation as,

$$h_i = \beta_1^j X_i^h + \beta_2^j \ln w_i + \eta_i, \tag{1}$$

where $\ln w_i$ denotes the natural logarithm of the hourly wage; $h_i$ is annual hours; $X_i^h$ denotes a vector of personal characteristics, including a constant; and $\eta_i$ is the error term. Non-practice income is included in $X_i^h$ to delineate the income effect. In Equation (1), the coefficient parameters vary by subgroup, which is denoted by $j \in${self-employed male, employed male, self-employed female, and employed female}.

Central to our analysis are the substitution and income effects. A higher wage rate means a higher opportunity cost of time devoted to non-market activities, thereby causing the individual to substitute work for leisure (substitution effect). At the same time, a larger income generated by the higher wage increases demand for leisure (income effect). Whether a higher wage rate increases labour supply is theoretically indeterminate because the two effects work in opposite directions. If the income effect outweighs the substitution effect, a negative wage coefficient will be observed.

We pay particular attention not only to gender but also to the self-employment status. The literature finds fewer hours worked by employed physicians (Mitchell, 1994; Morris *et al.*, 2010). We assume that the self-employment status is exogenous, because becoming a self-employed GP is a very long-term decision. The skills required for a satisfactory career may be different, GPs may make future plans at an early stage in their career, and reversing the decision already made is not easy. On the other hand, we do not use other employment type variables available in MABEL, such as practice size, because they are more closely linked to labour supply decisions.

It is standard in the literature to address the endogeneity of the wage rate. The wage rate in our labour supply equation is likely to be correlated with the error term, capturing unobserved talents, motivation, and preferences. The wage and error terms may therefore be correlated and failure to correct for endogeneity of wage may lead to the omitted variable bias.

To address the endogeneity, we estimate the following wage equation jointly with the labour supply equation, (1),

$$\ln w_i = \gamma_1 X_i^w + \gamma_2 F_i + \gamma_3 S_i + \omega_i, \tag{2}$$

where $F_i$ is a dummy variable for female, $S_i$ is a dummy variable for the self-employment status, and $\omega_i$ denotes the error term that may correlate with $\eta_i$. $X_i^w$ is a vector of personal characteristics, including a constant. Following the standard identification strategy in the physician labour supply literature (e.g. Rizzo and Blumenthal, 1994), we include working experience and its quadratic term in $X_i^w$. These terms provide us with an exclusion restriction, instrumenting $w_i$. The underlying assumption is that while working experience increases wage through the accumulation of skills, it does not affect the number of hours directly.

If we estimate this two-equation model for the four subgroups separately, the numbers of observations reduce significantly and precise estimation becomes a challenge. To improve the precision and reduce finite sample bias, we impose a restriction that the wage structure captured by (2) is common to the four subgroups, except for two dummy variables, $\gamma_2$ and $\gamma_3$. Because medicine is a profession based on rigorous and well-established educational training and because we focus on GPs, a narrowly defined subset of the medical profession, it is unlikely that individual GPs will face very heterogeneous wage structures. The literature identifies higher payments to self-employed doctors and male GPs (Cheng *et al.*, 2011; Morris *et al.*, 2011). These gaps are captured by $\gamma_2$ and $\gamma_3$.

We jointly estimate (1) and (2) by maximum likelihood (ML) estimation. The two error terms, $\eta_i$ and $\omega_i$, follow a bivariate normal distribution whose mean vector is zero and covariance matrix is specified separately for males and females as follows,

$$\Omega(k) = \begin{bmatrix} \sigma_\eta(k)^2 & \rho(k)\,\sigma_\eta(k)\,\sigma_\omega(k) \\ \rho(k)\,\sigma_\eta(k)\,\sigma_\omega(k) & \sigma_\omega(k)^2 \end{bmatrix}, \quad k \in \{\text{male, female}\},$$

where $\sigma_\eta(k)$ and $\sigma_\omega(k)$ are gender-specific standard deviations of the two error terms and $\rho(k)$ is the gender-specific correlation coefficient between the two error terms. Denoting the observed labour supply and log wage by $h_i^o$ and $\ln w_i^o$, respectively, the ML problem is

$$\widehat{\theta} = \arg\max_{\theta} \sum_{i}^{N} \ln l_i\left(\theta; h_i^o, w_i^o, X_i, F_i, S_i\right),$$

where $N$ is the number of observations, $X_i = \left(X_i^h, X_i^w\right)$, and $\theta$ is the vector of the parameters, $\left(\beta^j, \gamma, \sigma_\eta(k), \sigma_\omega(k), \rho(k)\right)_{\forall j,k}$. In the Appendix we outline the derivation of the likelihood function used in estimation.

In the result section, we also report the results of the model with no endogeneity. This model can be estimated by imposing $\rho(k) = 0$. The results are expected to be almost identical to the results obtained by applying linear ordinary least squares (OLS) regressions for the four subgroups separately, because without correlation between the two error terms, $\ln w_i$ in (1) is no longer endogenous. The difference between the ML and OLS results is solely due to the normality assumption in the ML procedure. We report the ML results rather than the OLS results, because the results are more directly comparable and we can conduct the statistical test to compare the two specifications.

# 4 Data

## 4.1 Data source and variables

Our data is from the first wave of MABEL. The first wave of MABEL is conducted in 2008 and undertakes a survey of the entire population of doctors providing clinical medical services in Australia (Cheng *et al.*, 2011). The overall response rate of the first wave is 19.36%, and the sample is found to be nationally representative (Joyce *et al.*, 2010). Below, we briefly explain how the variables used are constructed. The names and definitions of variables are summarised in Table II. For further details, see Mu (2013).

[Insert Table II: Definitions of variables]

As the measure of labour supply, we employ annual hours the GP spends in medical work. This variable captures two relevant components of labour supply: hours worked in usual weeks and weeks worked in the year.[2] Annual hours worked are calculated as the product of the number of weeks worked in the previous year and the usual hours of work per week. We construct hours by aggregating the hours spent across a variety of settings: e.g. private consulting rooms, hospitals, and community health centres. The physician labour supply literature uses both hours worked and the natural logarithm of hours worked. We employ the former because its histogram exhibits a symmetric bell-shaped distribution, the Jarque-Bera test rejects the normality assumption of log hours, and the fit of our empirical models is always better with non-log hours. In the literature of female labour supply, researchers generally tend to find the extensive margin more important. As far as we are concerned with physicians, however, it is rare for them as high-income earners to leave their occupation permanently, and thus it is more important to investigate the intensive margin. Baltagi *et al.* (2005) and Crossley *et al.* (2009) have similar discussions.

Hourly wage is measured by hourly practice income, defined as before-tax annual earnings from medical work (including 'in-kind' benefits) divided by annual hours worked. Because our hourly wage data shows a right-skewed distribution, we use the natural logarithm of the wage rate, following the literature. To delineate the income effect, we utilize non-practice income, which consists of spousal earnings, income from other business, dividends, and interests.

The self-employment status is constructed based on GPs' business relationship with their current main practice. GPs are grouped into two categories according to their employment type: (i) principals, associates, independent contractors and solo practitioners and (ii) salaried and contracted employees

[2] We find similar results when we use hours worked in usual weeks instead of annual hours.

and locums. Following Cheng *et al.* (2011), we regard a GP as self-employed if the GP is in the former group.

The number of years of work experience is included in the wage equation to instrument the wage rate in the labour supply equation, following the physician labour supply literature. Work experience is constructed by subtracting the number of years an individual has not practised as a physician from the sum of years between the completion year of their basic medical degree and the year of the survey. We include both linear and quadratic terms of experience assuming decreasing marginal returns to human capital investment.

We use a number of other explanatory variables to better isolate the effects of wage and income as well as to better understand the determinants of labour supply. For GPs' educational attainment, we use the country of basic medical degree and the number of higher medical degrees. GPs are categorised into three groups: (1) Australian graduates, (2) graduates from developed areas, and (3) graduates from less developed areas. The number of higher medical degrees contains Master, PhD, fellowship of colleges, postgraduate certificates/diplomas, and membership. Socio-demographic factors are important determinants of physicians' labour supply (Sloan, 1975; Mitchell, 1984; Ikenwilo and Scott, 2007). Because the information on age in MABEL is available only in five-year intervals, the age effect is captured by the age dummies of five-year brackets. To control for the effect of geographical location, we use the location of the GP's current main practice. We employ a rural and remote dummy that indicates outer regional, remote, and very remote areas, with base group being major city and inner regional areas (according to the Australian Standard Geographic Classification). We regard GPs' location choice as reasonably predetermined and exogenous in the framework of our short-term labour supply analysis. Variables regarding family situation are also included: marital status and the number and age of dependent children. Previous studies find that family responsibilities reduce the labour supply of female physicians, whereas male GPs are non-responsive or even increase labour supply (Kehrer, 1976; Sasser, 2005). One possible explanation for the reduction of female labour supply is that female GPs with lower productivity tend to choose reduced labour supply, be married, and have children. While this explanation may undermine the exogeneity of these family variables, however, Sasser (2005) studies a panel of young physicians in the US and finds no evidence for such self-selection.

MABEL features rich information based on a discrete-choice experiment (DCE) component. We include variables constructed from the DCE component in the labour supply equation to control for individual preferences, which are typically unavailable in past studies, to reduce potential omitted variable bias. The choice experiment in MABEL is tailored for GPs and consists of nine choice questions between two hypothetical alternative jobs. Each alternative job is presented with a list of job attributes, such as working hours, practice location, and on-call ratio. The information extracted from DCE regarding GPs' preferences over various job characteristics is designed to be uncorrelated with GPs' unobservable ability or productivity. We construct the proportion of each job attribute that a GP chooses throughout the nine choice experiments. The range of these variables is thus between zero and one, and a larger value means that the GP prefers or tolerates that particular job attribute to a greater extent.

The first wave of MABEL has 3,906 GP observations. We drop 1,106 observations with missing values, the majority of which lack the information of earnings. By comparing the original sample and the final sample, we confirm that dropping observations with missing values has little impact on the distribution of variables used in our estimation. Cheng *et al.* (2011) also find no strong evidence on the association between non-responses and income. As a result, the final sample size is 2,800.

## 4.2 Descriptive statistics

Table III reports the mean and standard deviation of the variables used in this study across the four subsamples. Female GPs account for 46.3% of the entire sample. The share of female GPs is larger than their share reported in Table I, mainly because females are over-represented by six-percentage points in MABEL (McGrail *et al.*, 2011). 59% of male GPs are self-employed, whereas the percentage of self-employed females is only 30%, partly because female GPs are on average younger than male GPs. Self-employed male GPs work the longest: 2,320 hours per year. The average hours worked by employed males and self-employed females are $1,910$ and $1,820$ hours per year, respectively, while employed female GPs work only 1,380 hours. The same pattern is observed for wage rate: males GPs tend to have a higher wage rate, as do the self-employed. Non-practice income shows a different pattern, where female GPs tend to have a larger non-practice income than male GPs, with self-employed male GPs receiving the smallest amount, reflecting the fact that non-practice income includes spousal income. In terms of other characteristics, compared with male GPs, female GPs tend to be younger and single, have less experience, their medical degree conferred in Australia, have fewer medical degrees, have a small child, and practice in urban areas. Table III also shows that self-employed GPs are older than employed GPs. In terms of the DCE preference variables, there is no systematic pattern across the four groups.

[Insert Table III: Descriptive statistics]

Because the mean age differs significantly across the four subsamples, it is useful to examine how hours worked vary across age groups conditional on gender and the self-employment status. Figure 1 presents the age profile of annual hours by subgroup, highlighting several important patterns. First, even conditional on age, males GPs and self-employed GPs work more hours. Second, average labour supply significantly decreases after age 60, and this reduction is larger for male GPs. Third, hours worked by females increase until they reach a peak in their late fifties, while such an upward trend is not evident for males. In other words, the gender gap in labour supply is largest in the early stage of their career, and it decreases as GPs age.

[Insert Figure 1: Hours-age relationship by gender and self-employment status]

# 5 Results

## 5.1 Parameter estimates

Table IV reports the estimated parameters. The first four columns report the labour supply equation for the four subgroups, followed by the wage equation in the last column.

[Insert Table IV : Estimation results for labour supply and wage equations]

The four numbers in the first row show how hours worked are associated with hourly wage by subgroup. The wage rate has a significant positive effect on hours worked for male GPs, implying that positive substitution effects outweigh negative income effects, while female GPs respond negatively to higher wage. Reported in the second row are the coefficients of non-practice income. A larger non-practice income reduces work hours for both male and female GPs, except for self-employed male GPs. Below, we compute wage and income elasticities based on these coefficients and provide more detailed discussion.

Marital status and children influence labour supply heterogeneously. While the presence of a spouse has no significant effect on employed male GPs and self-employed female GPs, it significantly reduces the labour supply of self-employed male GPs and employed female GPs. The hours worked by female GPs decrease monotonically with the number of children, while the hours worked by male GPs increase with the number of children, probably because males with more children have a larger financial burden and have to support the family. The presence of a child under age five has a significant negative effect on the labour supply of female GPs but not male GPs. Similar gender asymmetry is found in Kehrer (1976). The results suggest that family factors still remain a key driving force of the reduced labour supply of female GPs in Australia.

Regarding other explanatory variables, male and female GPs exhibit similar patterns. GPs in rural and remote areas work more than those in urban areas. The middle-aged group works more than the younger and older generations. The effects of the DCE variables have expected signs. GPs who work longer tend to prefer or tolerate working in rural and remote areas and tolerate frequent on-call jobs. Interestingly, preferences for good social interaction and long consultation lead to fewer working hours, though the estimates are mostly insignificant.

The wage equation serves as the 'first stage' equation. The excluded variables, experience and its squared term, are highly significant, showing the validity of our instruments. Their estimated coefficients imply that hourly wage increases up to 27 years of experience in a concave way. The other coefficient estimates also have expected signs. The wage rate of female GPs is 12.8% lower than that of male GPs. This is close to the finding of Ohsfeldt and Culler (1986); they study the gender difference in hourly earnings of physicians in the US and find that the unexplained gender difference is 13%. Gravelle *et al.* (2011) also report a rather small estimate of unexplained gender difference in the wage of GPs in England. Self-employed GPs enjoy a wage rate 11% higher than that of employed GPs. This finding is also consistent with the literature (Morris *et al.*, 2011). An additional medical degree increases wage by 4%. Not surprisingly, the age dummies do not have significant explanatory power after we control for experience.

At the bottom of Table IV, the estimated variance and covariance parameters are reported. The standard errors of the two equations show that males have larger variances of hours and wage than females. Male GPs have a large negative correlation parameter, while the correlation for female GPs is small and insignificant, suggesting the relevance of unobserved factors that influence the labour supply and wage of male GPs.

We also estimate a variant of the model in which we assume no correlation in the two error terms (not shown due to space limitations - results available on request). We find that this restricted model yields results almost identical to the results of our full model, except for the coefficients of the wage rate as discussed below. We conduct the likelihood ratio test for whether the two models are statistically different, and the test rejects the null hypothesis at a 1% significance level, invalidating the assumption of no correlation in the error terms.

## 5.2 Wage and income elasticities

Table V reports the wage and income elasticities by subgroup. The wage elasticities are calculated at the mean values of hours worked of each subgroup. The point estimate of the wage elasticity of self-employed male GPs, 0.472, implies that a 1% increase in hourly wage increases their annual hours by 0.472%, other things equal. Compared with self-employed male GPs, employed male GPs are slightly more elastic. For self-employed and employed female GPs, the estimated wage elasticities are −0.236 and −0.343, respectively. These estimates suggest that if wage rates increase, female GPs will decrease hours and the gender gap in labour supply will enlarge.

The non-practice income elasticity of labour supply measures the extent to which an individual's labour supply responds to a one percent change in non-practice income. The income elasticities are evaluated at the mean values of hours worked and non-practice income. The table shows that (1) the income effect of self-employed male GPs is effectively zero, (2) female GPs are more income-elastic than male GPs, and (3) employed GPs are more responsive than the self-employed. The fact that female GPs have a larger income elasticity is consistent with the negative wage elasticities of female GPs.

[Insert Table V: Wage and income elasticities of subgroups for full and restricted models]

The comparison of the results between the full and restricted models highlights the importance of taking the endogeneity of wage into account, especially for male GPs. This is consistent with the highly significant estimate of the correlation parameter of male GPs. Even though wage effects are estimated with somewhat large standard errors, it seems robust that male GPs have larger wage elasticities and employed females have the smallest wage elasticity, as shown in both columns.

To further investigate heterogeneity in wage and income elasticities, we calculate the elasticities over the career by marital status, based on the four wage coefficients and the mean values of hours and non-practice income in each age category. The two top panels of Figure 2 show wage elasticity over the career by gender and the two panels at the bottom show income elasticity over the career by gender. The key patterns we have discussed so far are again evident. The signs of the wage elasticity of male and female GPs are positive and negative, employed GPs are more responsive than self-employed GPs in terms of both wage and income, and self-employed male GPs are not responsive to non-practice income. Figure 2 also offers two new perspectives. First, wage elasticity is fairly stable over the career until early sixties,[3] but one notable exception is married employed female GPs, whose wage elasticity is particularly large and negative in their late thirties and gradually increases until their late fifties. Second, it is the

[3]The spike in the age group 65 and over of male GPs reflects their significantly reduced hours.

self-employment status that affects the income elasticity of male GPs, whereas it is the presence of a spouse that makes a critical divide in female GPs' income elasticity. In fact, single female GPs barely respond to non-practice income, whereas married female GPs have a large income elasticity *regardless of the self-employment status*. Married employed female GPs have the largest income elasticity and the income effect is particularly large in their child-bearing years. All these findings support the importance of family factors for female GPs.

[Insert Figure 2: Estimated wage and income elasticities by age]

# 6 Conclusion

This paper examines gender difference in the labour supply of GPs, a medical specialty that is becoming dramatically feminised. With a focus on gender difference in the wage elasticity, we jointly estimate the labour supply and wage equations, addressing endogeneity bias due to unobserved factors. The results show salient gender difference. An increase in hourly wage increases the labour supply of male GPs and reduces the labour supply of female GPs, thus *enlarging* the gender difference in labour supply. Our findings have implications in designing the most appropriate payment mechanisms.

Although our results suggest that family factors are the main driving force of the reduced labour supply and the large negative wage and income elasticities of female GPs, the reason why female GPs prefer reduced labour supply is unclear. One explanation is that married female GPs unwillingly choose such a labour supply path due to extensive social pressure and inadequate social infrastructure. Another explanation is that they enjoy a higher utility from devoting more time to their family. Distinguishing these two arguments is important in designing appropriate policies and predicting future trends. This is an important subject for future research.

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# A Appendix

This Appendix outlines the derivation of the analytical form of the likelihood function used in estimation. Defining a dummy variable, $\pi_i^j$, that indicates whether GP $i$ belongs to subgroup $j$, the individual log likelihood function is written as

$$\ln l_i \left(\theta; h_i^o, w_i^o, X_i, F_i, S_i\right) = \sum_j \pi_i^j \ln l_i^j \left(\theta; h_i^o, w_i^o, X_i\right),$$

where $l_i^j \left(\theta; h_i^o, w_i^o, X_i\right)$ is the subgroup specific likelihood function. Because wage rate, $w_i$, is assumed to be exogenously determined in wage equation,

$$
\begin{aligned}
l_i^j\left(\theta; h_i^o, w_i^o, X_i\right) &= \Pr\left(h_i = h_i^o, w_i = w_i^o | X_i; j, \theta\right) \\
&= \Pr\left(h_i = h_i^o | w_i^o, X_i; j, \theta\right) \times \Pr\left(w_i = w_i^o | X_i; j, \theta\right) \ , \\
&= \Pr\left(h_i = h_i^o | w_i^o, X_i; j, \theta\right) \times \phi\left(\tfrac{\omega_i^o}{\sigma_\omega(k)}\right)
\end{aligned}
$$

where $\omega_i^o \equiv \ln w_i^o - \gamma_1 X_i^w - \gamma_2 F_i - \gamma_3 S_i$ and $\phi\left(\cdot\right)$ denotes the standard normal density. Note that the conditional distribution of $\eta_i$ is expressed as

$$
\left(\eta_i | \omega_i\right)_k \sim N\left(\frac{\rho\left(k\right)\sigma_\eta\left(k\right)}{\sigma_\omega\left(k\right)}\omega_i, \sigma_\eta\left(k\right)^2\left(1 - \rho\left(k\right)^2\right)\right), \text{ for } k \in \left[\text{male, female}\right].
$$

Using this expression, the subgroup specific likelihood function is expressed in the following analytical form,

$$
l_i^j\left(\theta; h_i^o, w_i^o, X_i\right) = \phi\left(\frac{h_i^o - \beta_1^j X_i^h - \beta_2^j \ln w_i^o - \frac{\rho(k)\sigma_\eta(k)}{\sigma_\omega(k)}\omega_i^o}{\sigma_\eta\left(k\right)\sqrt{1 - \rho\left(k\right)^2}}\right) \times \phi\left(\frac{\omega_i^o}{\sigma_\omega\left(k\right)}\right).
$$

Table I: Key characteristics of Australian primary care practitioners in 1996, 2003, and 2011

| | 1996 | 2003 | 2011 | Change 1996-2003 | Change 2003-2011 |
|---|---|---|---|---|---|
| Number of primary care practitioners | 20,185 | 21,919 | 25,056 | +1,734 | +3,137 |
| FTE participation rate[a] | 123.1 | 113.0 | 109.7[b] | −10.1 FTE | −3.3 FTE |
| Average hours worked per week | 44.9 | 40.9 | 39.1 | −4.0 hours | −1.8 hours |
| Average hours: male | 50.3 | 45.9 | 43.4 | −4.4 hours | −2.5 hours |
| Average hours: female | 34.6 | 32.2 | 32.7 | −2.4 hours | +0.5 hours |
| Percentage of female GPs | 32.0 | 36.2 | 40.5 | +4.2% points | +4.3% points |
| Average age | 46.3 | 48.8 | 50.5 | +2.5 years | +1.7 years |

Source: AIHW (1998, 2005, 2013)

Note: [a]Full-time equivalent (FTE) per 100,000 population based on a 40 hour week. [b]In AIHW (2013), the reported FTE participation rate is based on GPs rather than primary care practitioners, unlike the previous years. The number reported in the medical workforce report 2009 is 112.0, showing a similar decreasing trend.

Table II: Definitions of variables

| Variable name | Definition |
|---|---|
| *Dependent variable* | |
| Annual hours worked | = weekly hours worked × weeks worked in the previous year |
| Wage rate | = (annual medical earnings + in-kind benefits) / annual hours worked |
| *Explanatory variables* | |
| Self employment status | = 1 if principal / associate / solo practitioners; = 0 if salaried or contracted employees / locums |
| Non-practice income | = total household income in the previous year − GP's practice income; measured in $100,000 |
| Dummy for missing non-practice income | = 1 if non-practice income is missing; 0 otherwise |
| Eight age dummies | Under age 35 (base group), age 35-39, age 40-44, age 45-49, age 50-54, age 55-59, age 60-64, age 65 and more |
| Female | = 1 if female; = 0 male |
| Married | = 1 if married/ living with partner; 0 otherwise |
| Country of basic medical degree | |
| Australian graduate (base group) | = 1 if basic medical degree in Australia; |
| Basic degree in developed areas | = 1 if basic medical degree in Europe (include UK and North America) |
| Basic degree in less-developed areas | = 1 if basic medical degree in Africa, Asia, Oceania, South America, and others |
| Number of higher medical degrees | $\{0, 1, 2, 3\}$ for no, one, two, and three or more higher medical degrees |
| Work experience | Years of medical practice since the completion of medical education |
| Work experience squared | Square of work experience |
| Child dummies | |
| No child (base group) | = 1 if no dependent child |
| One child | = 1 if one dependent child |
| Two children or more | = 1 if two or more dependent children |
| Child under age 5 | = 1 if at least one child under age 5 |
| Rural and remote areas | = 1 if GP's main practice is located in outer regional, remote, or very remote areas |
| Preference/tolerance constructed from discrete choice experiment (DCE) | |
| DCE: working in rural area | Between 0 and 1; larger value indicates stronger preference/tolerance |
| DCE: increasing work hours | Between 0 and 1; larger value indicates stronger preference/tolerance |
| DCE: on-call with high frequency | Between 0 and 1; larger value indicates stronger preference/tolerance |
| DCE: good social interaction | Between 0 and 1; larger value indicates stronger preference/tolerance |
| DCE: long consultation | Between 0 and 1; larger value indicates stronger preference/tolerance |
| Dummy for missing DCE | = 1 if DCE responses are missing; 0 otherwise |

Table III: Descriptive statistics

| | Male (53.75%) | | | | Female (46.25%) | | | |
|---|---|---|---|---|---|---|---|---|
| | Self-employed | | Employed | | Self-employed | | Employed | |
| Annual hours worked/1000 | 2.32 | 0.65 | 1.91 | 0.69 | 1.82 | 0.67 | 1.38 | 0.62 |
| Wage rate | 121.47 | 116.55 | 101.10 | 52.92 | 104.12 | 86.56 | 88.92 | 60.71 |
| Ln(Wage rate) | 4.63 | 0.58 | 4.49 | 0.52 | 4.49 | 0.55 | 4.37 | 0.45 |
| Non-practice income (in \$100,000)[a] | 0.61 | 1.01 | 0.41 | 0.62 | 1.03 | 1.54 | 1.17 | 1.74 |
| Dummy for missing non-practice income | 0.23 | 0.42 | 0.15 | 0.36 | 0.20 | 0.40 | 0.15 | 0.36 |
| Work experience (years) | 28.20 | 9.01 | 24.66 | 13.23 | 23.40 | 8.21 | 18.61 | 9.73 |
| Country of basic medical degree | | | | | | | | |
| Australian graduate (base group) | 0.83 | 0.38 | 0.78 | 0.41 | 0.87 | 0.34 | 0.83 | 0.37 |
| Basic degree in developed area | 0.07 | 0.26 | 0.08 | 0.26 | 0.06 | 0.25 | 0.07 | 0.26 |
| Basic degree in less-developed area | 0.10 | 0.30 | 0.14 | 0.34 | 0.07 | 0.26 | 0.10 | 0.29 |
| Number of higher medical degrees | 1.24 | 0.99 | 1.12 | 0.99 | 1.34 | 0.92 | 1.22 | 0.94 |
| Married | 0.94 | 0.25 | 0.88 | 0.32 | 0.83 | 0.37 | 0.83 | 0.38 |
| Child dummies | | | | | | | | |
| No child (base group) | 0.32 | 0.47 | 0.42 | 0.49 | 0.27 | 0.45 | 0.29 | 0.46 |
| One child | 0.13 | 0.34 | 0.16 | 0.36 | 0.14 | 0.34 | 0.18 | 0.38 |
| Two children or more | 0.55 | 0.50 | 0.42 | 0.49 | 0.59 | 0.49 | 0.53 | 0.50 |
| Child under age 5 | 0.09 | 0.28 | 0.17 | 0.38 | 0.10 | 0.29 | 0.24 | 0.43 |
| Age dummies | | | | | | | | |
| Under age 35 (base group) | 0.01 | 0.10 | 0.12 | 0.32 | 0.03 | 0.18 | 0.16 | 0.37 |
| Age 35 – 39 | 0.05 | 0.22 | 0.10 | 0.30 | 0.09 | 0.29 | 0.16 | 0.37 |
| Age 40 – 44 | 0.09 | 0.29 | 0.11 | 0.31 | 0.13 | 0.34 | 0.16 | 0.37 |
| Age 45 – 49 | 0.18 | 0.39 | 0.14 | 0.35 | 0.25 | 0.43 | 0.21 | 0.40 |
| Age 50 – 54 | 0.26 | 0.44 | 0.14 | 0.35 | 0.27 | 0.44 | 0.15 | 0.36 |
| Age 55 – 59 | 0.20 | 0.40 | 0.15 | 0.36 | 0.16 | 0.37 | 0.10 | 0.30 |
| Age 60 – 64 | 0.11 | 0.31 | 0.10 | 0.30 | 0.05 | 0.22 | 0.04 | 0.19 |
| Age 65 and over | 0.10 | 0.30 | 0.14 | 0.35 | 0.02 | 0.13 | 0.02 | 0.14 |
| Rural and remote areas | 0.15 | 0.35 | 0.19 | 0.40 | 0.12 | 0.32 | 0.12 | 0.33 |
| Preference/tolerance constructed from DCE[b] | | | | | | | | |
| DCE: working in rural area | 0.73 | 0.14 | 0.72 | 0.14 | 0.73 | 0.14 | 0.72 | 0.13 |
| DCE: increasing work hours | 0.32 | 0.13 | 0.33 | 0.14 | 0.34 | 0.13 | 0.35 | 0.12 |
| DCE: on-call with high frequency | 0.70 | 0.14 | 0.71 | 0.15 | 0.69 | 0.14 | 0.69 | 0.14 |
| DCE: good social interaction | 0.35 | 0.17 | 0.34 | 0.17 | 0.37 | 0.18 | 0.35 | 0.18 |
| DCE: long consultation | 0.48 | 0.14 | 0.50 | 0.15 | 0.51 | 0.15 | 0.51 | 0.14 |
| Dummy for missing DCE | 0.11 | 0.32 | 0.13 | 0.33 | 0.12 | 0.33 | 0.08 | 0.28 |
| Observations | 884 (58.73%) | | 621 (41.26%) | | 389 (30.04%) | | 906 (69.96%) | |

Note: [a]The calculation of means and standard deviations for non-practice income is based on the observations with no missing value in non-practice income. [b]The calculation of means and standard deviations for all DCE variables are based on observations with no missing values in the DCE component.

## Table IV: Estimation results for labour supply and wage equations

| Explanatory variables | Labour supply equation (dependent variable: annual hours worked/1000) | | | | | | | | Wage equation (ln(wage)) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Self-employed male | | Employed male | | Self-employed female | | Employed female | | | |
| Ln(Wage) | 1.095* | (0.52) | 1.090* | (0.52) | −0.428 | (0.42) | −0.474 | (0.42) | | |
| Non-practice income (in $100,000) | 0.006 | (0.02) | −0.125*** | (0.03) | −0.055* | (0.03) | −0.066*** | (0.01) | | |
| Married | −0.123* | (0.07) | 0.063 | (0.09) | −0.029 | (0.08) | −0.115* | (0.05) | | |
| Number and age of dependent children (base is no child) | | | | | | | | | | |
| One child | 0.212*** | (0.07) | 0.153* | (0.08) | −0.202* | (0.10) | −0.221*** | (0.07) | | |
| Two children or more | 0.173*** | (0.06) | 0.016 | (0.07) | −0.243*** | (0.07) | −0.297*** | (0.06) | | |
| Child under age 5 | −0.047 | (0.10) | −0.069 | (0.09) | −0.199* | (0.11) | −0.256*** | (0.06) | | |
| Country of basic medical degree (base is Australia) | | | | | | | | | | |
| Basic degree in developed areas | −0.186* | (0.10) | −0.222* | (0.11) | 0.040 | (0.14) | 0.157* | (0.07) | 0.033 | (0.05) |
| Basic degree in less-developed areas | 0.054 | (0.09) | 0.279*** | (0.09) | 0.190* | (0.10) | 0.435*** | (0.06) | −0.027 | (0.03) |
| No. of higher medical degrees | −0.009 | (0.03) | −0.054 | (0.04) | 0.087*** | (0.03) | 0.060* | (0.03) | 0.041*** | (0.01) |
| Rural and remote areas (base is urban areas) | 0.141* | (0.08) | 0.129* | (0.08) | 0.459*** | (0.08) | 0.272*** | (0.06) | 0.052 | (0.03) |
| Age group (base is age under 35) | | | | | | | | | | |
| Age 35 − 39 | −0.314 | (0.30) | −0.109 | (0.15) | 0.309* | (0.16) | −0.121 | (0.08) | 0.061 | (0.05) |
| Age 40 − 44 | −0.171 | (0.28) | −0.034 | (0.13) | 0.506*** | (0.15) | −0.114 | (0.08) | −0.044 | (0.06) |
| Age 45 − 49 | −0.107 | (0.28) | 0.103 | (0.14) | 0.534*** | (0.15) | 0.016 | (0.08) | −0.058 | (0.06) |
| Age 50 − 54 | −0.069 | (0.27) | −0.016 | (0.15) | 0.658*** | (0.15) | 0.110 | (0.08) | −0.049 | (0.07) |
| Age 55 − 59 | −0.116 | (0.27) | 0.076 | (0.13) | 0.721*** | (0.14) | −0.007 | (0.07) | −0.101 | (0.07) |
| Age 60 − 64 | −0.163 | (0.28) | −0.239 | (0.15) | 0.424* | (0.18) | −0.205* | (0.11) | −0.007 | (0.08) |
| Age 65 and over | −0.564* | (0.28) | −0.783*** | (0.16) | 0.071 | (0.41) | −0.449*** | (0.14) | 0.094 | (0.08) |
| Preference/tolerance constructed from DCE | | | | | | | | | | |
| DCE: working in rural area | 0.077 | (0.16) | 0.468* | (0.19) | 0.164 | (0.24) | 0.406* | (0.17) | | |
| DCE: increasing work hours | −0.194 | (0.17) | 0.079 | (0.21) | −0.289 | (0.21) | −0.173 | (0.16) | | |
| DCE: on-call with high frequency | 0.324* | (0.17) | 0.428* | (0.21) | 0.407* | (0.22) | 0.441*** | (0.14) | | |
| DCE: good social interaction | −0.180 | (0.14) | 0.033 | (0.16) | −0.102 | (0.16) | −0.361*** | (0.13) | | |
| DCE: long consultation | −0.171 | (0.16) | −0.243 | (0.19) | −0.328 | (0.21) | −0.111 | (0.14) | | |
| Experience/10 | | | | | | | | | 0.199*** | (0.05) |
| $(\text{Experience}/10)^2$ | | | | | | | | | −0.037*** | (0.01) |
| Female | | | | | | | | | −0.128*** | (0.02) |
| Self-employed | | | | | | | | | 0.106*** | (0.02) |
| Constant | −2.682 | (2.38) | −3.455 | (2.29) | 3.172* | (1.89) | 3.404* | (1.79) | 4.261*** | (0.05) |
| Estimates of covariance parameters (for male and female) | | | | | | | | | | |
| $\sigma_h$: std. dev. of error term $\eta$ in labour supply equation | | 0.974*** | (0.23) | | | 0.529*** | (0.03) | | | |
| $\sigma_w$: std. dev. of error term $\omega$ in wage equation | | | | | | | | | 0.550*** (0.01) / 0.480*** (0.01) | |
| $\rho$: correlation coefficient between $\eta$ and $\omega$ | | −0.805*** | (0.10) | | | 0.158 | (0.37) | | | |

Note: The sample size is 2800. Log-likelihood value is -4433.06. Numbers in parentheses are standard errors. The labour supply equation includes two dummy variables to control for missing non-wage income and missing DCE variables, whose coefficient estimates turn out to be insignificant. $\sigma_h$ and $\sigma_w$ are the standard deviations of the error terms in the labour supply and wage equations, which vary by gender. $\rho$ is the correlation coefficient between the two error terms in labour supply and wage equations that varies by gender. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Table V: Wage and income elasticities by subgroup

| | Full model | No endogeneity model ($\rho = 0$) |
|---|---|---|
| Wage elasticity | | |
| Self-employed male | 0.472 | −0.141 |
| Employed male | 0.570 | −0.166 |
| Self-employed female | −0.236 | −0.140 |
| Employed female | −0.343 | −0.217 |
| Income elasticity (non-practice income)[a] | | |
| Self-employed male | 0.002 | 0.002 |
| Employed male | −0.027 | −0.028 |
| Self-employed female | −0.031 | −0.031 |
| Employed female | −0.056 | −0.056 |

[a] The calculation of income elasticity is based on observations without missing values in non-practice income.

Figure 1: Hours-age relationships by gender and self-employment status

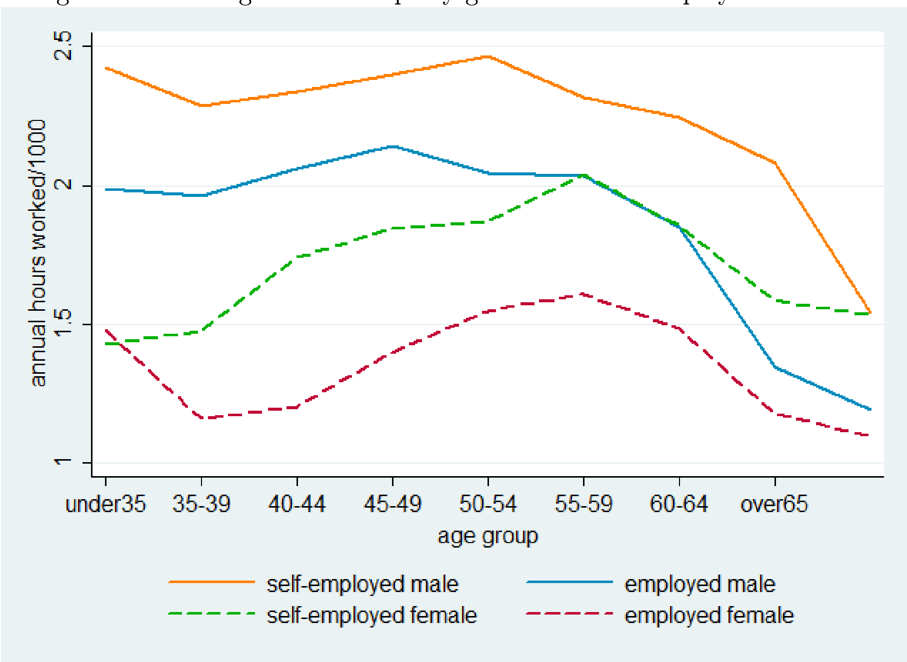

Figure 2: Estimated wage and income elasticities by age