Australian Government
Department of Health and Ageing

Medicare Financing & Analysis Branch

Full-time Service Equivalent (FSE)

A new experimental measure for general practitioner workload

Medicare Financing and Analysis Branch
Department of Health and Ageing
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1 Introduction

In most industries, full-time equivalence is measured by comparing hours worked against a standard working week of a set number of hours for the industry. This is not the case in general practice. Our ability to enumerate the general practice workforce and to analyse changes is limited by the data available, which does not include hours of work.

The simplest measure of workforce is a headcount of doctors. However, this provides no information on the relative workload of the doctors as it does not account for doctors who worked part-time or excess hours. We therefore have historically supplemented that headcount data with a proxy for effort - total schedule fee billing.

Headcounts and schedule fees are combined to generate the Full-time Workload Equivalent (FWE). In simple terms, FWE is calculated by dividing each doctor's Medicare billing by the average billing of full time doctors for the reference period. However, FWE can produce counter-intuitive results and is influenced by schedule fee changes.

This paper describes the key difficulties with the FWE, and describes the concepts and calculations for an alternative measure of GP workforce, currently in an experimental stage of development, the Full-time Service Equivalent (FSE).

This work has been undertaken as part of the Department of Health and Ageing project, "Tracking the Effects of Corporate Practices on Medicare Outlays". The FSE measure described in this paper has been developed for and used as an input to some elements of the project. Further experimental and exploratory work to refine and confirm the properties of the measure would be required before wider application of FSE could be considered.

2 Motivation

Intuitively, it makes sense for a workload measure to incorporate the available factors that reflect a doctor's workload and not to rely on a single factor.

General practitioner workload is currently measured by the Full-time Workload Equivalent (FWE). In simple terms, FWE is calculated by dividing each doctor's Medicare billing by the average billing of full time doctors for the reference period. This uses Medicare schedule fee billings but does not take into account other relevant information, namely the number of days worked and number of services provided.

Workload measurement with FWE can be counter-intuitive. To illustrate this, consider the hypothetical example in Table 1. Two doctors, "A" and "B" have each earned $250,000 in schedule fees. Doctor A worked 150 days and finished 3,000 services. Doctor B worked 300 days and finished 6,000 services.

Table 1: Hypothetical - workload features of two doctors

	Schedule fee	Work days	Services
Doctor A	$250,000	150	3,000
Doctor B	$250,000	300	6,000

Under current workload measurement, the two doctors would be assigned the same FWE. However, the two doctors have very different work patterns. Doctor B worked on twice as many days and provided twice as many services. It does not seem reasonable that he is only allocated the same FWE as Doctor A.

This paper shows that including days worked and services in the workload calculation enables the creation of a measure that provides a more realistic indication of the relative workload of each doctor.

Further, this paper will demonstrate that using three factors minimises the impact of fee drift in workload calculations. That is, it minimises artificial changes in the workload measurement caused by changes in the Medicare Benefits Schedule, rather than by changes in the working patterns of doctors.

Section 3, describes how these three factors can be used for workload measurement and a new workload measurement, Full-time Service Equivalent (FSE) is introduced in Section 4.

3 Workload Exploratory Factors

In this section, we discuss the idea of using working days, number of services and schedule fee to calculate doctor's workload equivalent. The three factors will be referred to as workload exploratory factors.

First, we analysed the correlations between the three exploratory factors. In other words, we assessed whether they are predictable. Figure 1 is the 2-dimension plot of number of services and schedule fee billing. Obviously, the two variables have a strong linear correlation, as their plot shows an explicit linear trend (straight line).

Figure 1: Linear correlation between schedule fee and number of service.

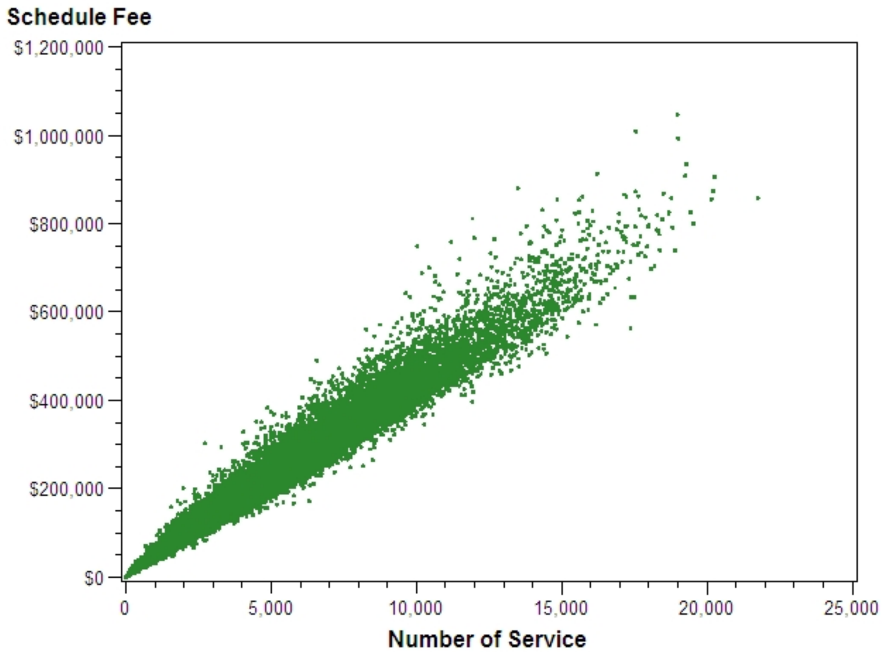


Figure 2 and Figure 3 demonstrate that there is a nonlinear correlation pattern (a curve) between working days and services, and between working days and schedule fee respectively.

Figure 2: Nonlinear correlation between working days and number of services

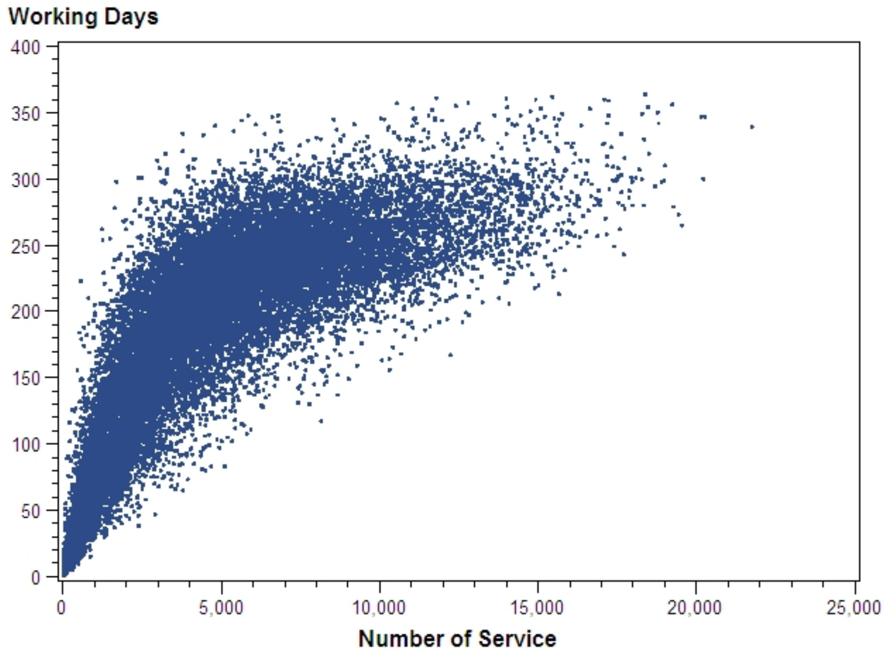
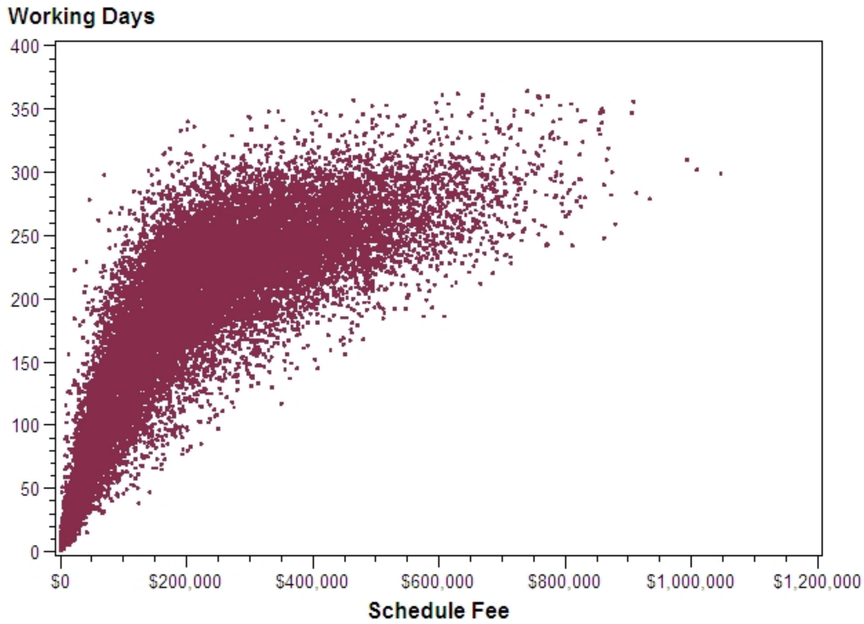
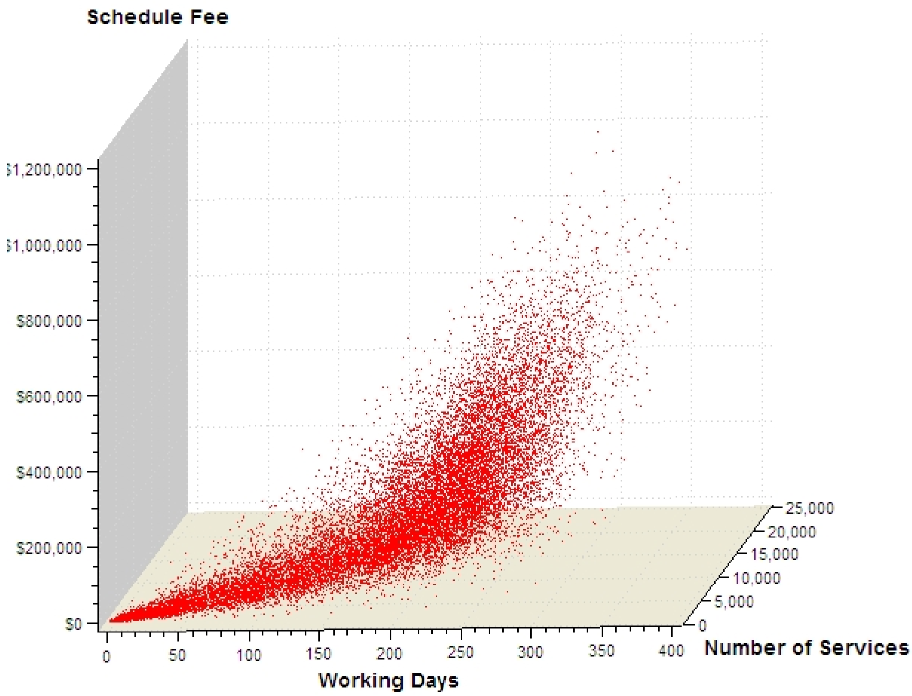


Figure 3: Nonlinear correlation between working days and schedule fee billing



The overall correlation of the three workload exploratory factors forms an explicit nonlinear trend, shown in Figure 4.

Figure 4: Overall distribution of the three exploratory factors



This three-way relationship can be modelled, as will be shown in Section 4. In Section 5 the modelled relationship is used to calculate a new workforce measure.

4 Nonlinear Regression Model

A normal nonlinear regression model can be expressed as:

$$y_i = f(\beta, x_i^{'}) + \varepsilon_i \quad (1)$$

Where:

y_i is the target variable,

$x_i^{'}$ is a vector of predictors (exploratory variables),

$f(\cdot)$ is a nonlinear function relating the response to the predictors,

β is the parameter vector in $f(\cdot)$, and

ε_i is a deviation variable.

The likelihood for the nonlinear regression model is:

$$L(\beta, \sigma^2) = \frac{1}{(2\pi\sigma^2)^{n/2}} \exp\left\{ - \frac{\sum_{i=1}^{n} [y_i - f(\beta, x_i^{'})]^2}{2\sigma^2} \right\} \quad (2)$$

where σ^2 is the distribution variance of the model deviation variable ε_i.

This likelihood is maximised when the sum of squared deviation, $S(\beta) = \sum_{i=1}^{n} [y_i - f(\beta, x_i^{'})]^2$, is minimised. Differentiating $S(\beta)$, we can obtain the partial derivatives:

$$\frac{\partial S(\beta)}{\partial \beta} = -2 \sum [y_i - f(\beta, x_i^{'})] \frac{\partial f(\beta, x_i^{'})}{\partial \beta} \quad (3)$$

Setting the partial derivatives to 0 produces estimating equations for the regression coefficients. Because these equations are in general nonlinear, they require solution by numerical optimisation. As in a linear model, it is usual to estimate the error variance by dividing the deviation sum of squares for the model by the number of observations less the number of parameters (in preference to the maximum likelihood estimator, which divides by n).

Coefficient variances may be estimated from a linearised version of the model.

Let

$$F_{ij} = \frac{\partial f(\hat{\beta}, x_i^{'})}{\partial \hat{\beta}_j} \quad (4)$$

And $F = \{F_{ij}\}$.

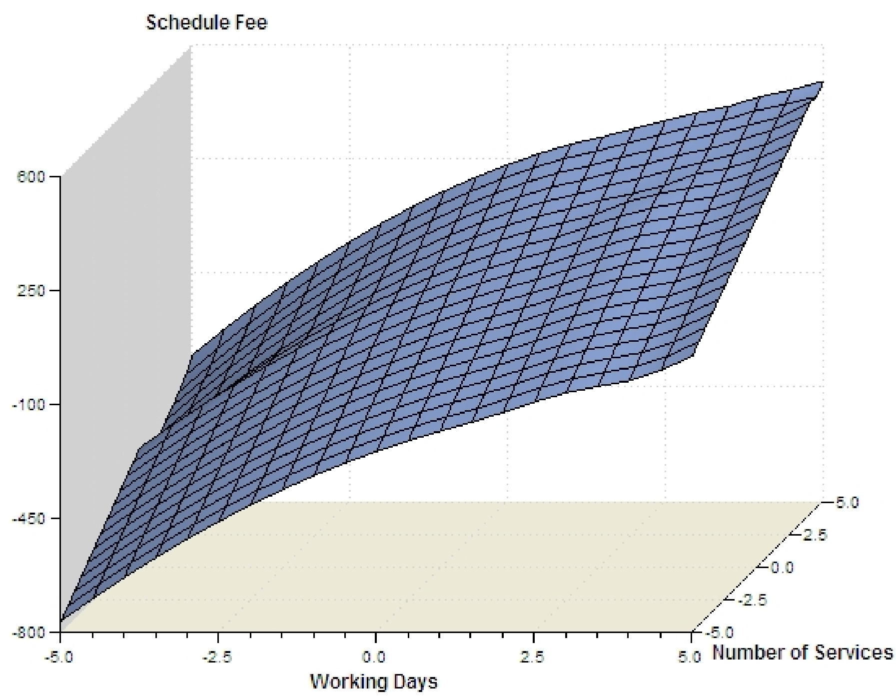
Then the estimated asymptotic covariance matrix of the regression coefficients is

$$\hat{v}(\hat{\beta}) = s^2 (F^{'} F)^{-1} \tag{5}$$

where s^2 is the estimate deviation.

In our model, the predictor vector $x_i = [numserv_i, workday_i]$ and the target $y_i = schedfee_i$. Based on the discussion above, we use an exponential function to fit $f(\cdot)$. Figure 5 demonstrates the nonlinear decision plane generated by the regression model in the 3-dimensional exploratory factor space.

Figure 5: Nonlinear regression plane



In order to measure the workload of doctors, we propose the following definition:

> **DEFINITION 1:** Given a nonlinear model $f(\beta, x)$ and predictors $x = [numserv, workday]$, the expectation of workload equals the output of the model.

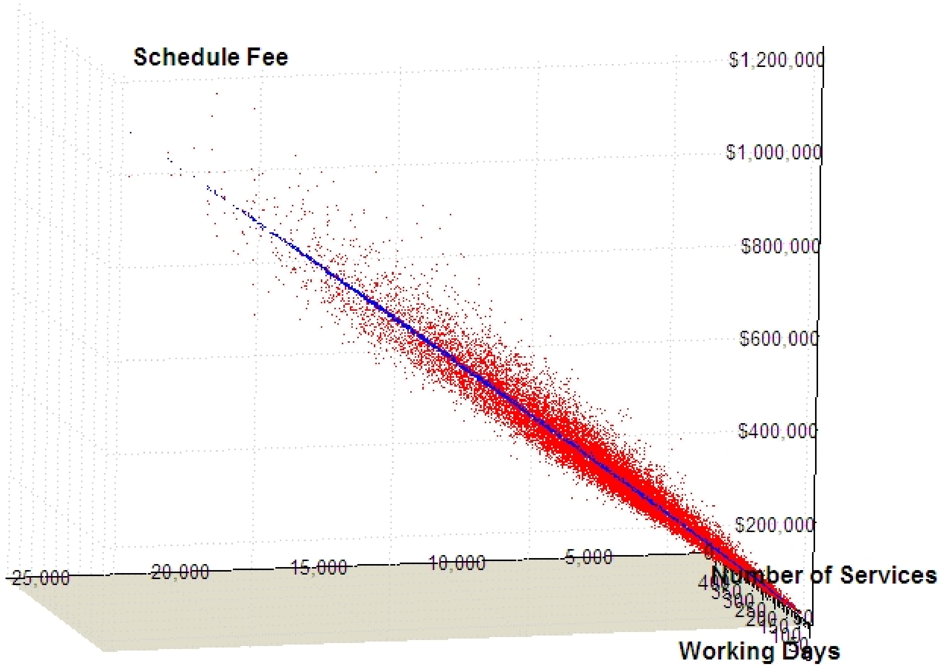
We define $E[workload]$ as the expectation of workload and it forms:

$$E[workload] = f(\beta, [numserv, workday]) \tag{6}$$

Based on equation (6), all three of the exploratory factors are interactively involved in the calculation of expected workload. Furthermore, from a mathematical point of view, the expected workload represents the maximum likelihood of the workload which a doctor would have given these exploratory factors.

In Figure 6, the red dots represent the workload exploratory factors for each doctor in 3-dimenstion space, and the blue line indicates the expectation of workload. Using the expectation of workload as a benchmark, a doctor would have a higher workload than expected if his/her workload exploratory factor point is above the blue line. On the contrary, a doctor would have a lower workload than expected if the doctor's actual workload exploratory factor point is below the blue line.

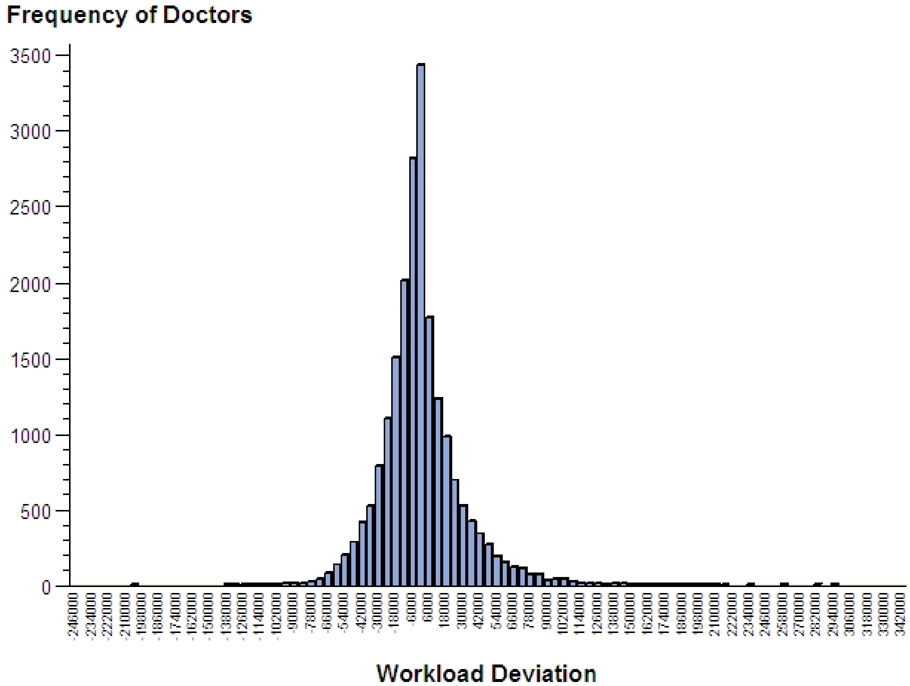
Figure 6: Expected workload trend (blue line)



Therefore, we propose to use the regression deviation variable ε_i to measure the deviation from expected workload for each doctor.

Based on Equation 2, the deviation variable ε_i forms a standard Gaussian distribution, illustrated in Figure 7. It is possible to use this standard Gaussian distributed indicator to measure the relative workload. For example, doctors whose workload exploratory factors are very close to their expected workload will lie in the middle of the distribution in Figure 7. Doctors whose actual workload exploratory factors are higher than expectations will be allocated in the right hand side, while doctors who have lower actual workload exploratory factors will be distributed in the left hand side.

Figure 7: Distribution or workload deviation

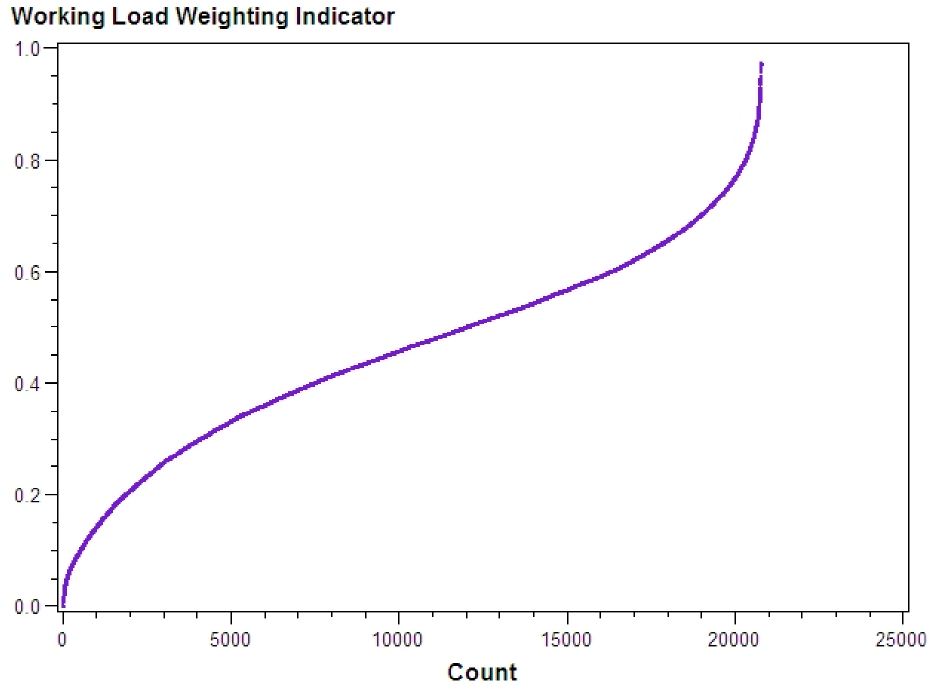


Besides the workload deviation, the expected workload itself is also important to measure the final workload. For example, although a doctor has a very high workload deviation, e.g., top 1% positive deviation, the doctor would not be assigned a high workload value if his/her expected workload level is too low, e.g., in the bottom 1%.

In order to take the level of expected workload into the final workload calculation, we use a standardised weighting curve to measure different levels of expected workload, defined as w_i . As shown in Figure 8, the weighting “S” shape curve will magnify both the lower and higher end of expected workload levels.

For example, a doctor who has 50 working days, 100 services and $3,000 in billed schedule fees will be assigned an extremely small weight ($w_i \approx 0$) in the final calculation of FSE. On the contrary, a doctor who worked 350 days, 20,000 services and $900,000 billed schedule fee will have a very large weight ($w_i \approx 1$).

Figure 8: Workload weighting indicator curve



5 Full-time Service Equivalent calculation

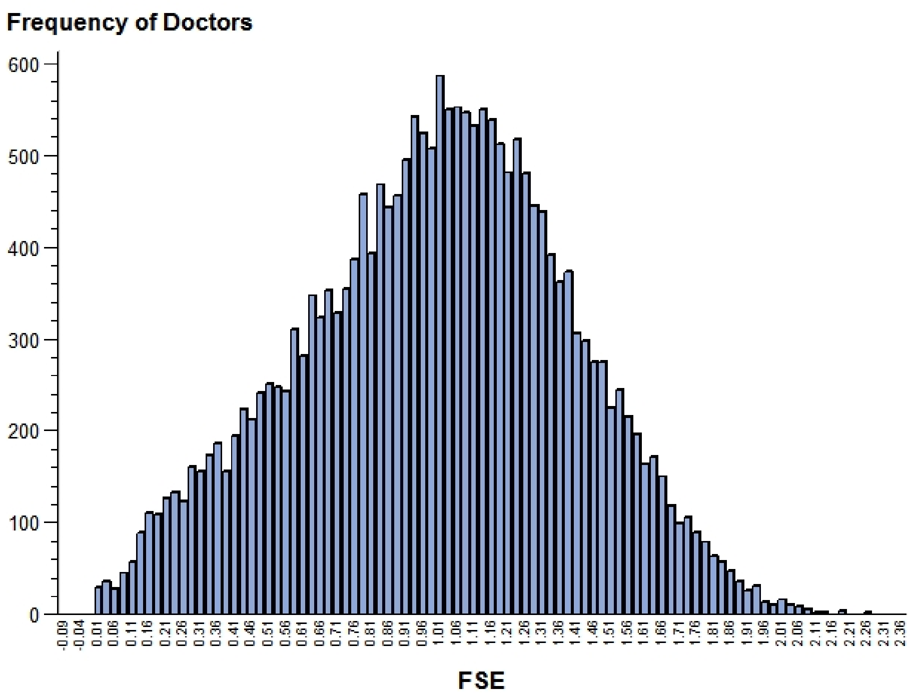
Based on the discussion above, the proposed Full-time Service Equivalent (FSE) is calculated by:

$$FSE_i = g(w_i \varepsilon_i) \tag{7}$$

where $g(\cdot)$ is a standardisation function which is used to constraint the output range $\in [0, \lambda]$, $\lambda = \{1, 2, \cdots, n\}$.

Because the expected workload deviation variable ε_i forms a standard Gaussian distribution, the FSE (which is product of $w_i \varepsilon_i$) also follows a Gaussian distribution. Figure 8 demonstrates the distribution FSE for each doctor based on 2010 date-of-service data.

Figure 9: FSE distribution for 2010 date-of-service data



In the next section, we will take some FSE calculation results to illustrate the reasonability and stability of the new workload measurement.

6 Results

6.1 Reasonability

As the hypothetical example in Section 2 demonstrates, it is more reasonable to measure doctor's workload with consideration of service volume, work days *and* schedule fee than with the schedule fee alone.

Table 2 (below) shows the results for two real doctors, referred to here as Doctor A and Doctor B.

We see that although Doctor B has a slightly greater billed schedule fee, Doctor A has much higher service volume and work days. Under the current FWE measurement, Doctor B would have a slightly higher FWE than Doctor A. However, this does not seem a reasonable assessment of the workload of Doctor A given that he/she provided more services and worked on considerably more days than Doctor B.

Alternatively, under the FSE framework, the expected workload considers the global unbiased means of all the three exploratory variables and so the FSE interactively takes all three factors into account. Therefore, in Table 2, Doctor A has a greater FSE (1.10) than Doctor B (0.99).

Table 2: Exploratory factors and FSE comparison between two doctors

	Schedfee	Service	Work day	FSE
Doctor A	$210,618	4,729	256	1.10
Doctor B	$211,132	4,143	103	0.99

6.2 Stability

Because FSE measures the relative workload of doctors rather than the absolute values of the schedule fee, the new workload measurement also demonstrates greater stability, especially for fee changes.

In the following experiment, the 2010 date-of-service data is used as base data (year 1). In year 2 we assumed a change in the schedule fee for item 23 to $45. In years 3, 4 and 5 data, we changed the item 23 schedule fee to $65, $95 and $135 respectively. We ran both FSE and FWE measurement on these 5 years of scenario data, and listed results in Table 3.

Table 3: Impact of a fee change on FWE and FSE, all else held equal

	Year 1	Year 2	Year 3	Year 4	Year 5
Schedule fee (item 23)	$33	$45	$65	$95	$135
FWE	16,708	17,100	17,745	18,334	18,823
FWE growth		2.4%	3.8%	3.3%	2.7%
FSE	17,915	17,915	17,915	17,915	17,915
FSE growth		0.0%	0.0%	0.0%	0.0%

Based on the FWE/FSE growth rates in Table 3, the FSE measurement shows extremely high stability on fee change scenarios.

7 Conclusion

The usual measure of GP workload, the Full-time Workload Equivalent (FWE) uses schedule fee as a proxy for effort. This can at times produce counter-intuitive results. This paper introduces a new measure, the Full-time Service Equivalent (FSE), developed for limited use in the Department of Health and Ageing project “Tracking the Effects of Corporate Practices on Medicare Outlays”.

The FSE uses work days, number of services, and schedule fee billings together. Because more factors are taken into account, the FSE produces results that are more intuitively reasonable than the FWE. The FSE also offers greater stability in the face of schedule fee changes.

While it was developed to meet the needs of the corporate practices project, FSE appears to provide results that are more intuitive and stable than the current standard measures and thus has potential for wider application, particularly in detailed analysis.

The FSE is a promising measure with potential to be a valuable input to future analytical work. Further experimental and exploratory work to refine and confirm the properties of the measure would be required if wider application of the measure was desired.