# Labour Economics
# Supervision 3

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## Question 1

### (a)

A payroll tax on employers usually requires employers to pay a percentage of their staff's salaries to the government. For some tax rate $t$, this will raise the unit labour costs of the employer by a factor of $(1+t)$. For example, for a perfectly competitive firm with no fixed costs and two inputs $K$ and $L$, its cost is given by $rK + wL$ without a payroll tax. With the payroll tax of $t$ assessed on total wages paid $wL$, its cost is given by $rK + wL + twL = rK + (1+t)wL$. With imperfect competition in the labour market $\left(\frac{\partial w}{\partial L} < 0\right)$ the effect is similar. Given that reducing the payroll tax amounts to reducing the unit labour cost, this should increase the demand for labour and total employment should increase. Also, if the reduction in payroll tax also leads to less generous unemployment insurance payments, this will further encourage employment to the extent that non-participation in the labour market is voluntary.

### i.

Assuming the relationship found is causal, then a unit increase in years of schooling leads to an approximately 10% increase in wages, since

$$\begin{aligned}
\ln W &= 1.12 + 0.10E + 0.00X + e \\
\frac{\partial \ln W}{\partial E} &= 0.10 \\
\frac{1}{W} \cdot \frac{\partial W}{\partial E} &= 0.10 \\
\frac{\partial W}{\partial E} &= 0.10W
\end{aligned}$$

If the relationship is exact and causal, then the net present value of lifetime earnings is

$$\begin{aligned}
\int_E^\infty W e^{-rt} \mathrm{d}t &= \int_E^\infty e^{1.12+0.1E} e^{-rt} \mathrm{d}t \\
&= \int_E^\infty e^{1.12+0.1E-rt} \mathrm{d}t
\end{aligned}$$

The net effect of an additional year of education is

$$\begin{aligned}
\frac{\partial}{\partial E}\int_E^{\infty} e^{1.12+0.1E-rt}\mathrm{d}t &= -e^{1.12+0.1E-rE} + \int_E^{\infty} 0.1e^{1.12+0.1E-rt}\mathrm{d}t \\
&= -e^{1.12+0.1E-rE} - \left[\frac{0.1}{r}e^{1.12+0.1E-rt}\right]_E^{\infty} \\
&= -e^{1.12+0.1E-rE} + \frac{0.1}{r}e^{1.12+0.1E-rE} \\
&= \frac{1}{10r}We^{-rE} - We^{-rE}
\end{aligned}$$

where the term on the left is the approximate benefit of an additional year at school, which is the wage premium $0.1W$ discounted over the remaining lifespan $\left(\int_E^{\infty} 0.1We^{-rt}\mathrm{d}t\right)$, and the term on the right is the forgone earnings discounted to the present day. For this to be an equilibrium, the net effect must be 0, meaning $r = 0.1$.

### ii.

ii. With a tuition fee equal to 30% of W, the cost of an additional year of education is now $1.3We^{-rE}$. This means that in equilibrium,

$$\begin{aligned}
&\frac{1}{10r}We^{-rE} - \frac{13}{10}We^{-rE} = 0 \\
&r = \frac{1}{13} \approx 0.0769
\end{aligned}$$

which means the equilibrium interest rate is now slightly lower. This makes sense since the returns to education are now lower, and a lower interest rate is needed to equalize returns to education and interest payments.

### iii.

If the interest rate is lower than the equilibrium interest rate, the net returns to education will be positive over an infinite horizon, and the optimal choice of years of education would tend toward infinity. In short, the wage premium from education will always outweigh the discount rate from delaying the stream of income, so it is always profitable to put off employment into the future. This unrealistic outcome could be avoided if the model implied diminishing returns to education, for example if a negative quadratic term for $E$ was added or if the model was specified in terms of $\ln E$. In this first case $\ln W$ admits a maximum at some level of education. In the second case the marginal benefit of one year of education is decreasing as education increases, since the coefficient on $\ln E$ roughly denotes the percentage change in wages from a percentage change in years of schooling. When an individual has many years of schooling, an extra year becomes very small relative to the total years of schooling.

## Question 2

The paper investigates the effects of children's diets on educational outcomes by exploiting a natural experiment where changes to school menus were introduced in all 80 schools in Greenwich. The research question is relevant to policymakers as disparities in diet across socio-economic strata are one possible channel through which inequality can persist. With "45% of school kids in primary and secondary schools" eating school lunches every day and "18% of the entire pupil population" eligible for free school meals, intervening in the diets of schoolchildren is a promising way to alleviate trends in inequality.

The authors use panel data which covers the period 2002-2007 and contains observations down to the school and pupil level. The treatment group here was Greenwich and the selected control group comprised five neighbouring Local Education Authorities with roughly comparable values in key health and socio-economic indicators.

To answer the research question, the authors perform a difference-in-differences analysis on the outcomes before and after the intervention in 2005. They estimate the following model on individual outcomes:

$$Y_{islt} = \alpha + \beta \text{Greenwich}_1 + \gamma \text{Greenwich}_1 \times \text{Post-2005}_t + X_{ist}^{\intercal}\delta + \lambda Z_{st} + \theta_1 \text{LEA}_1 + \pi_t T_t + \rho_1 t + \varepsilon_{ist}$$

where $Y_{islt}$ is the outcome variable for pupil $i$ in school $s$ and LEA $l$. The important coefficient is $\gamma$, which shows how different the outcome trend is in the treatment group relative to the control group after the intervention. Mathematically, the significance of $\gamma$ can be seen by taking the partial derivative of $Y_{islt}$ with respect to Post-$2005_t$. The term which remains is $\gamma\text{Greenwich}_1$, where $\text{Greenwich}_1$ is a dummy variable equal to 1 for the treatment group and 0 for the control group. This suggests that drawing an observation from after 2005 is associated with a difference in the outcome variable of $\gamma$ for Greenwich and 0 for the other LEAs. If the magnitude of $\gamma$ is large, then there is plausibly an effect of the dietary intervention on educational outcomes. The trends in the control group are 'partialled out' in the model, which leaves $\gamma$ as the "difference-in-differences".

For $\gamma$ to capture a causal effect, it is important that the regressor $\text{Greenwich}_1 \times \text{Post-2005}_t$ is not strongly correlated with $\varepsilon_{ist}$, which is the error term and could contain any other factor not in the model that would affect the outcome variable. For example, if there was some development in infrastructure after 2005 and only in Greenwich which greatly decreases the time spent in traffic, $\text{Greenwich}_t \times \text{Post-2005}$ could be positively correlated with the schoolchildren's waking time and hours of sleep which could itself have some causal effect on the outcome variables. As it stands, there seems no obvious reason to think that the five LEAs are problematic as controls, since they are geographically close and the neighbourhood statistics are more or less in the same range. There is no systematic difference above or below the other LEAs within the indicators, and Greenwich "appears to be in the middle" of the control group. Only the proportion of white people is obviously higher in Greenwich.

When the authors analyse just the sample of Greenwich schools, there is evidence in some subjects of an improvement in test scores after 2005 (the Post-$2005_t$ coefficient is large and positive). When including the other LEAs, but not controlling for the LEA fixed effects and trends ($\text{LEA}_1$ and $\rho_1 t$), the coefficient on the post-2005 dummy variable becomes slightly negative or close to zero (the post-2005 effects in Greenwich are obscured by similar trends in the other 5 LEAs). Once the LEA-specific trends and dummies are controlled for, the intervention dummy becomes large and positive, though the result is somewhat obscured by statistical noise for Math. There are other effects also tested for, such as the difference between girls and boys, but the important result is that the intervention seems to have produced better test scores and lower absenteeism.

The results seem convincing especially given that this is likely a lower bound on the treatment effects: not all schoolchildren eat school lunches and are affected by the policy. There is a risk of bias in the results since the change in policy could itself affect the number of children eating school lunches. However, the authors find no evidence of a relative change in take-up rates for free school meals (which is the best proxy they have available). If anything, the qualitative evidence suggests that any bias would be downward, with reports that "the implementation of the campaign showed initial difficulties with resistance from the children to eat the new meals". If we assume that children who are put off by the new menus do not move on to healthier diets (which seems a reasonable assumption), the estimate of $\gamma$ will be attenuated toward zero.

The fact that only part of the pupils analysed have truly been treated by the campaign is worth noting but ultimately inconsequential. For one, as mentioned above, this is likely to bias the result toward zero, so the evidence supporting this intervention is not weakened. The other, more important point is that intention-to-treat effects are really the important metric for policymakers. It is true that the analysis groups together the effects on compliers and non-compliers. But this is the outcome policymakers should expect and be concerned with anyway. They are looking for evidence for or against implementing healthier school menus; they are not concerned with the effects of a policy where the menu is changed and where all schoolchildren are forced to eat school lunches. 100% compliance is not what they are aiming for, and the attrition bias is precisely what the policymaker should try to include in his or her assessment. The same goes for many other policies like tax reform, minimum wages, and immigration policy. Capital and labour and foreigners are free to move about, and policymakers should account for these movements in their assessment of any intervention.