Public Education or Vouchers? The Importance of Heterogeneous Preferences*

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This paper looks at the impact heterogeneous preferences for education have on education funding under private, public and voucher systems. An overlapping generations model incorporating human capital is used, where parents are the decision-makers. They determine their labour supply and their child’s education – either directly with personal contributions or collectively by voting on taxes.

The education systems are compared by their impact on the growth and distribution of human capital. The use of heterogeneous preferences proves to be critical, as these comparisons differ markedly from the homogenous case.

1 Introduction

In most countries the majority of school funding comes from public sources. Justifications for state intervention draw on arguments of reducing inequality, internalising education externalities and promoting social cohesion. In recent times, however, there has been pressure for provision of public goods to be exposed to market forces and education is no exception.

Friedman (1962) is regarded as the first modern economist to attempt to popularise the use of education vouchers. He argued that vouchers would raise the quality of the sector through increased competition, at the same time providing a minimum education level for the poor. He proposed a system where all parents are given a voucher which subsidises each child’s tuition fees for privately run schools. Advocates of voucher systems such as West (1997, p. 84) suggest that, ‘vouchers enable families to break through these obstacles to give equal opportunity a genuine chance’. On the other hand, opponents of voucher schemes have argued that only children of wealthy families will be able to benefit from vouchers. Levin (in West 1997, p. 243) argues that vouchers will ‘tend to create greater transmission of inequalities from generation to generation than the present public schools . . . and . . . reinforce existing class dimensions based on parental education attainment’.

This paper compares voucher and public education systems, and analyses the effect the two funding mechanisms have on the growth and distribution of human capital. The allocation of public funds is determined by voting in both systems. Of specific interest in the paper, is how these voting decisions are affected by values parents place on education. In many models of education systems, these values are assumed to be uniform, so preferences over education are homogenous. In this paper, however, as in Cardak (1999), parents are allowed to have heterogeneous preferences for education.

The non-theoretical academic literature looking at education is well established.1 An early theoretical

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paper by Glomm and Ravikumar (1992) focused on education funding and income inequality. They employed an overlapping generations framework to analyse human capital development and used majority voting to determine tax decisions. The authors show that a public education system always reduces income inequality, where a private system may not.

Cardak (1999) extended this paper by making the parental education preference heterogeneous, which, along with income, differentiated agents. He showed that the agent median preference was the decisive voter in the public system, and that the heterogeneity of preferences made the case for public education stronger on distributional grounds. In both these models human capital is a function of children’s efforts in school, the quality of their education and the human capital of their parents.

Benabou (1996a and 1996b) included the average education of a community in human capital formation to represent education externalities. He looked at economic segregation into different communities that education may induce, suggesting public funding may reduce inefficiency arising from that process. A large portion of the literature originating in America focuses on such migration effects. Public schools are a local government responsibility in the U.S.A., and the funds are raised in large part, by property taxation. As Australian funding is not so localised, this paper uses a single community model.

The papers mentioned so far employ models of public education systems that are exclusive, with no private schooling allowed. This is for solvability as mixed schools were first analysed by Stiglitz (1974), who showed that voting equilibrium for taxes may not exist. Glomm and Ravikumar (1998) and Epple and Romano (1996) have since shown cases where existence occurs. Bearse et al. (2001) however, have shown that cycles are pervasive in voting in a mixed system when taxes finance both public education and a redistributive transfer.

Due to general solution problems when public and private options coexist, computational experiments have been used frequently to analyse voucher systems. Epple and Romano (1996 and 1998) looked at the effect of exogenously determined vouchers on public school enrolment and segregation. Bearse et al. (2000) had an endogenous choice of tax rates and compare a mixed regime to uniform or means-tested vouchers. They found means-tested vouchers outperform uniform vouchers for reducing income inequality. Hoyt and Lee (1998) analysed the impact of the introduction of a voucher system from an exogenous public education base.

This paper analyses the funding effects that private, public and voucher systems have on education and human capital evolution. Human capital is determined by schooling and in-home learning. An overlapping generations model is used where parents are the decision makers. A parent’s income is a product of their human capital and the amount of labour they choose to supply. Parents gain utility from consumption, leisure and their child’s human capital. Parents collectively choose a proportional tax in the public and voucher systems, and can make personal contributions to education in the voucher and private systems. The use of log-utility preferences simplifies analysis, allowing the use of heterogeneous preferences for education.

In section II we analyse the three education systems with heterogeneous preferences. As a benchmark to indicate the importance of preferences, we analyse the models with homogeneous preferences in section III. Section IV concludes.

II Heterogenous Preferences

The structure behind all models is that of an overlapping generations economy. Agents live for two periods and have a child in the second period of their life. Parents, the decision-makers in the economy, gain utility from their consumption and leisure, and from their children’s human capital. This latter source of utility motivates intergenerational spending and is allowed to vary between parents. This heterogeneity of preference allows parents of similar means to make different education choices for their children, as happens in the community.

A child’s human capital is determined by the quality of their education and their parent’s human capital. In this model, education quality is determined solely by its funding. It is assumed that all educators spend their resources hiring the most

4 Motivations for intergenerational spending have been modelled in a number of different ways. For example, in Loury (1981) parents gain utility from their children's utility. In other models, parents gain utility from the money they spend on their children’s education.
effective teaching inputs.\textsuperscript{5} The source of the funding is not a factor that determines efficiency – no quality distinction is made between public and private schooling.\textsuperscript{6} The inclusion of parental human capital recognises that considerable child development occurs inside the home.\textsuperscript{7} Finally, it is important to note that the initial distribution of human capital is assumed to be lognormal, with initial distribution parameters of \((\mu, \sigma^2)\). The human capital of a child, \(h_{i,t+1}\), evolves according to the following:

\[
h_{i,t+1} = E_i^\gamma h_{i,t}^\delta, \tag{1}
\]

where \(E_i\) is the education received by the child, \(h_i\) is parental human capital, and \(\delta\) and \(\gamma\) are constants in \((0, 1)\).

The income of agents in this economy is a product of their human capital and labour.\textsuperscript{9} It is assumed each agent can determine her own work hours and find a job paying a rate equal to her human capital level.\textsuperscript{10} Depending on the education system, income is taxed, with the remainder spent on either consumption or education expenses. The population in this model is normalised to one.

Parents are the decision makers and their utility is represented by Cobb-Douglas preferences:

\[
U_i = \ln C_i + a_i \ln (h_{i,t+1}) + \eta \ln L_{i,t+1}, \tag{2}
\]

where \(C_i\) is parental consumption and leisure and \(L_{i,t+1}\) is parental leisure – their fraction of time spent not working.\textsuperscript{11} The parameters \(\eta\) and \(a_i\) are the weights parents place on their leisure and their child’s human capital; both are in \((0, 1)\). The latter weight represents the education preference and is similar to that of Cardak (1999). For simplicity, the distribution of \(a_i\) is assumed to be uniform. We also assume that the full spectrum of education preferences exist for each level of parental human capital. To allow for inter-generational comparison, the preference parameter is passed from parent to child. This recognises that ideals and social preferences are often the result of conditioning and transferred between generations. This assumption also allows the long-run effects of the heterogeneity to be assessed.

\(i\) Private Education

In this system, education is funded solely by parental contributions. It is assumed a continuum of school qualities are available, so a parent can find a school regardless of their preferred education expenditure. In this system the budget constraint is:

\[
h_{i,t+1} (1 - L_i) = C_i + E_i. \tag{3}
\]

In the private system agent \(i\)’s utility function is:

\[
U_i = \ln(h_{i,t} (1 - L_i) - E_i) + a_i \ln(E_i^\gamma h_{i,t}^\delta) + \eta \ln L_i. \tag{4}
\]

Maximising with respect to \(L_i\) and \(E_i\) results in labour and education choices that are a function of the preference. The leisure choice is:

\[
L_i = \frac{\eta}{1 + \eta + a_i \gamma}, \tag{5}
\]

and the education choice:

\[
E_i = a_i \gamma \frac{h_i}{1 + \eta + a_i \gamma}. \tag{6}
\]

Not surprisingly, parents with a higher preference choose to supply their children with a better education. The use of Cobb-Douglas preferences mean that income effects net out – parents who share the same preference parameter devote an identical share of income to education. Education preference is also linked with work ethic. Like-minded parents all work the same hours – parents with a higher

\textsuperscript{5} Card and Krueger (1992) show a positive correlation between school quality and subsequent earnings. For a survey of empirical studies on the impact of teaching inputs on education quality see Hanushek (1986).

\textsuperscript{6} Gradstein and Justman (1996) for a model where public education is treated as less efficient than private schooling.

\textsuperscript{7} Aughinbaugh (2000), Solon (1992) and Zimmerman (1992) for evidence on in-home learning and inherited ability.

\textsuperscript{8} The important element of this assumption is that the distribution is right-skewed. Since income distributions are generally right-skewed, and are positively correlated with human capital, we feel this assumption is realistic. Dagum and Slotje (2000) for a discussion of human capital distribution. The fact that the assumed distribution is lognormal in particular is to make the growth calculus easier and does not affect the results.

\textsuperscript{9} Cardak (1999) the child is the agent with a leisure choice, where time devoted to schooling is chosen. Given most countries have set school hours we focus on the parent’s work decision. An interesting use of the time allocation of children is in Glomm (1997). That paper focuses on education in developing economies, with a choice of spending time in child labour instead of at school.

\textsuperscript{10} This implies that the labour market operates perfectly and that there are constant returns to human capital. A potential extension may be to consider the wage as an increasing function of the distance from the average human capital level.

\textsuperscript{11} We do not use C.E.S. preferences as they would make the model with heterogeneous preferences excessively complex.
preference supply more labour. This occurs because a higher preference increases the opportunity cost of leisure thus increasing the desire to work.

(ii) Public Education

In this education system, the government levies a flat tax \( \tau \) on income. The revenue raised provides a uniform education for all children. Parents are prohibited from spending further on their child’s education; all disposable income is then consumed. The tax rate in the economy is determined by voting. A tax will be voted in if there is no non-single peaked preferences that can occur in mixed education systems.

The utility maximisation problem in the public system is:

\[
\tau_p = \frac{a_m\gamma}{1 + a_m\gamma} \quad (12)
\]

The education received by all children is:

\[
h_i(1 - \tau)(1 - L_i) = C_i \quad (7)
\]

The size of each voucher is:

\[
V = \tau \int h_i(1 - L_{iv,i}) = \tau \tilde{y}_v \quad (15)
\]

where \( \tilde{y}_v \) is the average income in the voucher system.

We determine the supplement and labour choices first before considering voting. Substituting (1) (13) and (15) into (2) we have utility given by:

\[
U = \ln(h_i(1 - L_i)(1 - \tau) - S_i) + a_i \ln(\tau \tilde{y}_v + S_i)\gamma + \eta \ln L_i \quad (16)
\]

Maximising with respect to \( L_i \) and \( S_i \), and substituting gives leisure and supplement choices of:

\[
L'_i = \eta \frac{h_i(1 - \tau) - S_i}{h_i(1 - \tau)(1 + \eta)} = \frac{\eta(h_i(1 - \tau) + \tau \tilde{y}_v)}{h_i(1 - \tau)(1 + a_i\gamma + \eta)} \quad (17)
\]

and,

\[
S_i = \frac{a_i\gamma h_i(1 - \tau) - \tau \tilde{y}_v(1 + \eta)}{1 + a_i\gamma + \eta} \quad (18)
\]

Equation 17 shows that the leisure choice in the voucher system is bound by the public (upper) and private systems (lower). Similar to the private system, parents who supplement more, work more. Parents who do not supplement have the same amount of leisure time as they did in the public system. The level of supplement is an increasing, concave function of \( a_i \) and increases linearly in \( h_i \). From now on we will consider supplementers and non-supplementers separately.

12 Many papers analysing contributions to public schooling make this assumption for simplicity to avoid non-single peaked preferences that can occur in mixed education systems.
Setting (18) to zero agents we can characterise agents who do not supplement by the following:

$$a, h_i < \tau Y_i \frac{1 + \eta}{\gamma(1 - \tau)}.$$  

(19)

With heterogeneous preferences wealthy agents who have a low valuation of education may not supplement – because they deem the proportion of their income already devoted to education through taxes as excessive. Similarly, poorer agents with sufficiently high preference may supplement.

**Political equilibrium**

As education is treated as a purely private good in these models, parents with above average income lose from any level of government intervention in education.\(^{13}\) The voucher they receive is always smaller than their tax bill, and for this reason, they prefer a tax of zero.

Parents with below average income prefer the same tax as they would in the public system. This is because these agents will find it optimal to not supplement in order to maximise the benefit they can gain from transfer of the voucher. Importantly, the tax preferences of agents with lower than average income are single peaked. That is, they prefer a tax that is below their optimal to a rate of zero in order to obtain some transfer benefit.

So while average income plays an important role in determining this tax choice cut-off, it is difficult to determine analytically. This is because the leisure choice is a stepwise function, determined by the decision to supplement or not.

However, we do know that the work choice is positively correlated with human capital. This correlation will accentuate the initial right-skew of the human capital distribution, meaning that there will be more parents with below average income than there are with below average human capital. Therefore, parents with below average income are in the majority.

The tax preferences of the parents are presented in Figure 1. Agents with lower than average income are left of the axis break, those with higher income to the right. The poorer agents are then sorted by their education preference. By way of example in Figure 1, we use an income distribution where 60 per cent of agents have a lower than average income.

**Proposition 1** The tax rate chosen in the voucher system is always less than the rate chosen in the public system, i.e. \(\tau_v < \tau_{pu}\).

Under the voucher system, the median preference is not decisive, as it was in the public system. Those preferring \(\tau_{pu}\) to a lower tax are limited to half the number in the below average income section (30 per cent). A lower tax will be favoured by all parents with income above the average and half those below it. For this reason, \(\tau_{pu}\) will not be a majority winner, the tax in the voucher system is always lower. This result holds irrespective of the skew of the human capital distribution. The tax will fall from \(\tau_{pu}\) until the number of agents with below-average income who prefer the winning rate or higher is equal to 50 per cent of the population as a whole.\(^{14}\) The right skew of income is important because it means a positive tax will be voted in. Communities with a larger skew of income have higher tax rates in the voucher system. As the preference has a uniform distribution, the decisive voter has preference parameter

$$a_v = 1 - \frac{1}{2F_y(y_i \leq \bar{y})} < a_m,$$  

(20)

where \(F_y(y_i \leq \bar{y})\) is the proportion of the population with below average income. The tax chosen by majority vote is then:

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\(^{13}\) An earlier version of the paper included an education externality which, among other things, provided an incentive for richer agents to vote for positive taxes. The inclusion of this parameter did not substantially affect the comparison of the education systems, though it made this voting equilibrium considerably more complex, so it has been omitted.

\(^{14}\) This has a similar property to a result in Epple and Romano (1996). For a particular case in that paper, voting in a mixed education regime resulted in low and high income agents forming a coalition against the middle-class.
level of the agents and multiply by mine average income by finding the average effort Labour and initial average income
ty and growth.

(iv) Comparison of the Systems
We now look at the effects the education systems have on average income and human capital inequality and growth.

Labour and initial average income
In the private education system we can determine average income by finding the average effort level of the agents and multiply by \( \hat{h} \). The average work time is:

\[
\tilde{L} = \int_0^\infty \frac{1 + a_i \gamma}{\eta + a_i \gamma} da_i = 1 - \frac{\eta}{\gamma} \ln \left(1 + \frac{\gamma}{1 + \eta}\right).
\] (22)

Formulation of \( \tilde{L} \) was straightforward because of the assumed uniform distribution of \( a_i \). Now we can show the ratio of private to public average income is:

\[
\frac{\bar{y}_{pv}}{\bar{y}_{pu}} = (1 + \eta) \left(1 - \frac{1 + \eta}{\gamma} \ln \left(1 + \frac{\gamma}{1 + \eta}\right)\right). (23)
\]

This is greater than 1 for all \( \gamma, \eta \in (0, 1) \). We do not calculate the average income for the voucher system but note that it is bound by the public and private levels. The lower the tax rate, the closer \( \bar{y}_v \) is to the private level.

Human capital distribution
**Private system** The evolution of human capital can be determined from (1) and (6) to give:

\[
h_{i,t+1} = \left(\frac{a_i \gamma}{1 + \eta + a_i \gamma}\right)^\gamma h_i^{\delta + \gamma} = g(a_i) h_i^{\delta + \gamma}. (24)
\]

This is similar to equation 16 in Cardak (1999). \( g(a_i) \) is increasing in \( a_i \), indicating that human capital growth is also increasing in \( a_i \). Taking logs and using recursive substitution (24) becomes:

\[
\ln h_{i,t+1} = \left(\ln g(a_i) + \ln g(x_i)\right) \frac{1 - (\gamma + \delta)^\gamma}{1 - (\gamma + \delta)} + (\delta + \gamma)^\gamma \ln h_{i,t}. (25)
\]

From this, the variance of human capital at time \( t \) is:

\[
\sigma_{h,t}^2 = \frac{1 - (\gamma + \delta)^\gamma}{1 - (\gamma + \delta)} \sigma_{g(a_i)}^2 + (\gamma + \delta)^\gamma \sigma_{h,t}^2. (26)
\]

\[\text{This is dependent on the variance of the preference parameter and the initial variance of human capital. When } (\gamma + \delta) \leq 1, \text{ the influence of the initial distribution of } h_{i,t} \text{ on future variance decays over time. However, the distribution of human capital does not converge under private provision. When } (\gamma + \delta) > 1, \text{ the income inequality is further magnified by the recurrent impact of the initial human capital distribution.}
\]

**Public system** In the public system the evolution of human capital is characterised by:

\[
h_{i,t+1} = \left(\frac{a_i \gamma}{1 + a_i \gamma} \right) \gamma \left(\frac{1}{1 + a_i \gamma}\right) \left(\frac{1}{1 + a_i \gamma}\right) h_{i,t}. (27)
\]

In this system, the median preference determines the growth path of human capital for all agents. From (27) the variance of the log of human capital can be derived:

\[
\sigma_{p_{h,t+1}}^2 = (\gamma + \delta)^\gamma \sigma_{h,t}^2. (28)
\]

Since \( \delta < 1 \) we can see that variance in human capital converges unconditionally in the public system. **Voucher system** For the voucher system, the evolution of average human capital cannot be formulated due to the complexity of determining \( \bar{y}_v \). However, comparing human capital accumulation between supplementers and non-supplementers is instructive for analysing human capital inequality and growth.

First note that because children of non-supplementers share the same education, the human capital variance within this group will decay to zero. This is similar to the equalising affect public education had on human capital. Over time, the result of this is that the human capital of non-supplementers will converge on a single level, \( h_{w} \). Recall from (19) that agents who do not supplement are categorised initially by a locus of points in \( (a, h) \) space. We

\[\text{This result does not imply that it is impossible to move between groups (i.e. a child supplementing when their parent did not). It does suggest though, that the variance of human capital declines amongst those who continue not to supplement.}\]
define parent \((a_*, h_*)\) as having the highest preference of the non-supplementers once their human capital has converged. This parent meets the condition of (19) with equality and is just indifferent between supplementing and not.

The following equation is the ratio of human capital accumulation under vouchers for supplementers and non-supplementers:

\[
\frac{h_{s,t+1}}{h_{n,t+1}} = \left( \frac{E_s}{E_n} \right)^{1-\delta} \left( \frac{h_s}{h_n} \right)^{\gamma} \left( \frac{a_s}{a_n} \gamma \right)^{\tau} \left( \frac{h_n}{h_s} \right)^{\delta}
\]

where \(E_s\), \(h_s\), and \(a_s\) are the education, human capital and education preference of supplementers and \(E_n\) is the education of non-supplementers. The current stratification of human capital is represented by \(h_s/h_n\) with the supplementers having higher human capital. For this stratification to be maintained, both \(h_s\) and \(h_n\) will have to grow at the same relative rate, so that \(h_{s,t+1}/h_{n,t+1} = h_s/h_n\).

This equality transforms (29) to:

\[
\frac{E_s}{E_n} = \left( \frac{h_{s,t}}{h_{n,t}} \right)^{1-\delta} \left( \frac{h_s}{h_n} \right)^{\gamma} \left( \frac{a_s}{a_n} \gamma \right)^{\tau} \left( \frac{h_n}{h_s} \right)^{\delta}
\]

Equation 30 can be interpreted as the ratio of supplementers’ education to non-supplementers’ education that is required to maintain the existing variance in human capital. Depending on the value of \((\gamma + \delta) > 1\), there are three cases of this ratio of education which are displayed in Figure 2.

Figure 2 also displays lines (the group that range from \(a_s\) to \(a_s = 1\)) that represent how \(E_s/E_n\) actually does change in response to changes in \(h_s/h_n\). This change is driven by the supplement with increasing human capital. The slope of these lines changes with education preferences, for a given \(a_s\) it is:

\[
\frac{\partial E_s}{\partial h_s} \frac{h_n}{E_n} = \frac{a_s(1+\eta)}{\eta a_s(1+\alpha_s\gamma + \eta)}.
\]

For agents with preference of \(a_s\), (31) becomes \((1+\eta)/(1+\alpha_s\gamma + \eta)\), which is less than one. The other lines represent the expansion of education for parents with different education preferences. These lines, intersecting \(E_s/E_n = 1\) at lower levels of \(h_s/h_n\), represent poorer parents with a higher preference who choose to supplement.

**Proposition 2** With heterogeneous preferences, stratification of human capital occurs in the voucher system for all values of \((\gamma + \delta) > 1\).

For proposition 2 to hold for all levels, it must hold for \((\gamma + \delta) < 1\). In this case, \(1 - \frac{\delta}{\gamma}\) is greater than one.

In equation 30 this would require \(E_s/E_n\) to exceed \(H_s/H_n\). An obvious group of parents for whom this holds are those whose human capital equals \(h_s\), but whose preference exceeds \(a_s\). As these agents supplement, their children’s education exceeds that of non-supplementers, even though both parents have the same human capital.

Proposition 2 holds because \(E_s/E_n\) is an increasing function of education preference, as well as human capital. Because preferences for education are heterogeneous, different human capital growth rates can result from the same human capital base. Stratification in human capital will occur according to education preferences – agents with the highest preference achieving the highest human capital.

The slope of the lines represented by (31) is relevant because it determines the extent of stratification. For agents with high education preferences, these slopes may exceed one. When \(\delta + \gamma = 1\) these

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17 As \(h_s\) represents the human capital of supplementers, it comprises an array of human capital levels. Maintaining stratification will mean different absolute changes in human capital depending on the level of \(h_s\). This can be represented by a single ratio though, as it equates to a uniform relative growth rate.

18 The slope is determined by substituting the partial differential of (18) as well as (19) when met with equality into the left hand side.

19 Note that these lines cannot start below \(E_s/E_n\) as this would mean the supplement is negative.
agents (those with $a \geq a_v$ in Figure 2) will experience relative human capital growth that always exceeds that of non-supplementers. This will create an increasing human capital gap between these two groups. Other agents that supplement (those with $a_v > a > a_*$ in Figure 2) are bounded in the extent to which their human capital will exceed supplementers. This is because of the redistributive nature of the voucher and the diminishing returns to additional human capital. For such agents at higher levels of human capital, increases in education are insufficient to sustain the relative gap over non-supplementers. For example, this happens for agents with preference $a_*$ whose human capital exceeds $h_v$. The growth in human capital for this group of agents will be exceeded by that of the non-supplementers, until their human capital falls back (in relative terms) to $h_v/h_{v*}$.

For the case of $\gamma + \delta < 1$ it is not possible for any agents to experience unbounded growth in human capital relative to non-supplementers. This is because the slope of the $\gamma + \delta < 1$ line exceeds one and is increasing in $h_v/h_{v*}$. For his case, there are diminishing return in totality for the inputs into human capital accumulation. So while stratification exists, it is bounded for all preference levels. On the other hand when $\gamma + \delta > 1$, returns to the combination of human capital inputs are increasing, so only supplementers with low preferences do not experience unbounded relative human capital growth.

**Education levels and growth**

Despite having a lower tax level, the voucher system may not necessarily result in a lower minimum level of education than the public system. This is because some agents work more in the voucher system, so while stratification favours vouchers because it limits the average income toward education, which is $\gamma a/a^*$, the public system provides a higher minimum education than the voucher system.

To consider the likelihood that Proposition 3 results in the voucher system providing a higher minimum level of education, parameter values are substituted in. This outcome is most likely to be the case for high values of $\gamma$ and $\eta$. When $\eta = \gamma = 1$, Proposition 3 becomes $\tau_v/\tau_{pu} \leq 84$ per cent. Given these parameters, the tax in the public system would be one-third, and from (20) and (21) the voucher system tax is:

$$\tau_v = \frac{2F_y(y \leq \bar{y}) - 1}{4F_y(y \leq \bar{y}) - 1}. \quad (32)$$

Comparing this rate with the public rate, for the voucher system to provide a better minimum education than the public system, the income distribution would have to be skewed such that:

$$F_y(y \leq \bar{y}) \geq 81.2\%. \quad (33)$$

That is 81.2 per cent of people would have to have an income less than the average level.\(^{20}\) This is a highly right skewed income distribution in Australia, 62.5 per cent of all income earners have an income less than the average.\(^{21}\) A highly right skewed distribution favours vouchers because it limits the difference between $\tau_{pu}$ and $\tau_v$ and also increases $\bar{y}$.

As the voucher system may provide a lower minimum level of education than the public system we cannot be sure whether average human capital growth in the voucher system exceeds that of the public system. As $\gamma < 1$, returns to human capital from education are diminishing. This means that agents with lower human capital will outgrow agents with higher human capital if both receive the same level of education. In the voucher system, the minimum level of education may be lower than in the public voucher system, so agents with low human capital may experience slower growth than they would achieve in the public system. Of course, vouchers allow agents with high preferences faster human capital growth than the public system. Which of these effects proves dominant will depend in large part on the size of $\gamma$ with high values favouring the voucher system.

**III Homogeneous Preferences**

In this section we allow education preferences to be homogenous and briefly analyse how this affects comparison of the education systems. All parents now share the same preference $a$, while human capital still varies as before. An obvious general change of homogenous preferences, is that all parents prefer to devote the same proportion of income toward education, which is $a\gamma/1 + a\gamma$.

\(^{20}\) The critical distribution is also sensitive to the values of $\eta$ and $\gamma$. When $\eta = \gamma = \frac{1}{10}$, the critical level becomes 91 per cent.

(i) Education and labour results

In the private system parents devote the same proportion of their income to education and all work the same hours. Of course, children of wealthier parents still receive higher levels of education.

In the public system the agents still work the same hours, but now also choose the same tax rate \( \tau = a \gamma (1 + a \gamma) \).

With vouchers, preferences over taxes are not uniform. Parents with below average income prefer the same tax as they would in the public system, while wealthier parents prefer a tax of zero. This is because of the transfer from wealthy parents to poor parents that vouchers provide. Wealthy parents will devote the same proportion of their income to education, but they would prefer to fund their children’s education privately, with a tax rate of zero. However, because of the right skew of human capital (which results in a right skew in income) the wealthier parents will be outvoted. With homogenous preferences, parents of below average income share the same tax preference. This means the tax in the voucher system is identical to that of the public system. This is in contrast to the heterogenous result, where the voucher tax rate was always less.

The labour choices in the voucher system are linked with the decision to supplement or not. Since parents who supplement can directly influence their child’s education, this raises the opportunity cost of leisure. As a consequence these parents work more than non-supplementers, with the wealthiest parents (highest supplementers) working the most. This impact of vouchers on labour choices raises the average income. As a consequence, while the tax rate is identical in the voucher and private systems, the minimum level of education is higher under the voucher system, because of the higher average income in that system.

**Proposition 4** When preferences for education are homogenous, vouchers result in a higher initial average income and provide higher levels of education for all agents than does the public system.

(ii) Human Capital Growth and Inequality

A clear implication of Proposition 4 is that average human capital growth under vouchers will always exceed that of the public system. This is because, on average, parents both work more and contribute a higher proportion of their income to educating their children (as some parents choose to supplement).

Unfortunatly, the growth rates under vouchers cannot be formulated, due to the stepwise nature of the supplementing decision. This means that we cannot determine whether growth is higher under the voucher or private system. However, this comparison is analogous to the comparison of voucher growth with public growth under heterogenous preferences. That is, when \( \gamma \) is low, the system that provides a higher minimum level of education is more likely to outgrow the other than it is when \( \gamma \) is high. When \( \gamma \) is low the voucher system may experience faster growth in average human capital than the private system.\(^{22}\)

Turning to human capital inequality, we first consider the private system.

The homogenous version of (26) is:

\[
\sigma_{\gamma}^2 = (\gamma + \delta) \sigma_{\delta}^2. \tag{34}
\]

Unlike the heterogenous case (34) shows that human capital inequality can decay under homogenous preferences. This will occur only when \( \gamma + \delta < 1 \). When \( \gamma + \delta = 1 \) human capital inequality remains constant in the private system, it grows when \( \gamma + \delta > 1 \).

In the public system, inequality always decays as it did under heterogenous preferences.

To consider inequality in the voucher system, we again consider the ratio of supplementers’ human

\(^{22}\) For a comparison of growth rates under private and public systems when preferences are homogeneous see Glomm and Ravikumar (1992).
capital to that of non-supplementers, as was done Section III. The homogeneous version of \((29)\) is:

\[
\frac{h_{s,\gamma+1}}{h_{n,\gamma+1}} = \left( \frac{h_s + a\gamma y_s}{1 + a\gamma + \eta y_s} \right)^\gamma \left( \frac{h_n}{h_{s,\gamma}} \right)^{\gamma-1} \Rightarrow E_s = E_n = \left( \frac{h_{s,\gamma}}{h_{n,\gamma}} \right)^{\frac{\gamma}{1-\gamma}}.
\]

(35)

The right hand side of (35) is the condition that needs to hold to maintain a constant relative stratification of human capital. Again, for this to occur, there are three separate cases to consider for each of \((\gamma + \delta) \geq 1\). These are displayed in Figure 3 which is the homogeneous version of Figure 2.

Also in Figure 3 is line \(K\), which depicts how \(E_s/E_n\) expands with \(h_s/h_n\). Since preferences are homogenous, there is only one of these lines, rather than the multiple lines for different preferences in Figure 2. Note that the slope of line \(K\) must be less than 1. If it were otherwise, it would imply the income elasticity of education was one or greater. Since there is a positive tax rate, this is not possible. In fact, we can see from (31) that with constant preferences, the slope of \(K\) is \((1 + \eta)/(1 + a\gamma + \eta)\).

**Proposition 5** When preferences for education are homogenous, human capital inequality persists under vouchers only when \((\gamma + \delta) > 1\).

For the cases of \((\gamma + \delta) \leq 1, \frac{1-\delta}{\gamma}\) is one or higher.

For stratification to occur under these circumstances, the slope of \(K\) would have to exceed one, which has shown not to be the case.

This result contrasts with Proposition 2, which showed that when preferences are heterogeneous human capital inequality always persists. The cause of this difference is that with heterogeneous preferences it is possible for parents to contribute different shares of income to education. This cannot happen when preferences are homogeneous. As a result, the redistributive nature of the voucher can reduce inequality when \((\gamma + \delta) \leq 1\).

With homogeneous preferences, stratification of human capital may occur when \((\gamma + \delta) > 1\). In Figure 3, agents with \(h > h_s\) experience faster relative growth than supplementers. Agents with \(h_s < h < h_n\), however, experience slower growth and their human capital will converge to that of non-supplementers.

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23 Again, for this discussion we use the fact that the human capital of non-supplementers converges to a uniform level of \(h_o\).
opportunity for children in the latter. Friedman (1962) suggested the role of government in education is ‘ensuring schools meet a minimum standard’. These results suggest that determining the minimum level is itself a subjective decision. A decision that is heavily influenced by the education system that is in use.

This work could be extended to consider means-tested vouchers. A higher base level of education for the poorest families could potentially be achieved by targeting vouchers to the poorer families. The means testing of vouchers has the potential to reduce the cost of the scheme, and hence, its tax bill. As such, means-testing vouchers may provide a higher minimum level of education than do uniform vouchers.

REFERENCES


