New evidence on the Heckman Curve[t]

By David Rea and Tony Burton[a]

The Heckman Curve describes the rate of return to public investments in human capital for the disadvantaged as rapidly diminishing with age. Investments early in the life course are characterised as providing significantly higher rates of return compared to investments targeted at young people and adults. This paper uses the Washington State Institute for Public Policy dataset of program benefit cost ratios to assess if there is a Heckman Curve relationship between program rates of return and recipient age. The data does not support the claim that social policy programs targeted early in the life course have the largest returns, or that the benefits of adult programs are less than the cost of intervention. The paper concludes by discussing the various features of both human capital and interventions that might explain why the predictions of the Heckman Curve are not consistent with the evidence. (JEL I21, I24, I28, J13, J24)

[t] Go to [webaddress] to visit the article page for additional materials and the authors' disclosure statement.

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I. Introduction

A key finding of social science in recent decades has been that experiences in a child's earliest years can have long-lasting impacts. Many studies have documented prenatal and early childhood environments as having important and long-term impacts on a range of outcomes including health and life expectancy (Center on the Developing Child, 2010; Felitti et al., 1998; Poulton et al., 2002; Aizer et al., 2016; Hoynes et al., 2016), educational achievement (Duncan and Magnuson, 2011), employment and earnings (Almond and Currie, 2010; Caspi et al., 2016) and youth and adult offending (Fergusson et al., 2005).

A large body of research has documented how differences in family environments such as maternal health, the quality of parenting, and family income play a critical role in child development (Almond and Currie, 2010). In addition, there is also evidence that environments outside the family, and in particular early childhood education programs, can also have a profound impact on later outcomes (Heckman et al, 2013; Phillips et al., 2017).

These findings have had a major influence on public policy as they suggest that early intervention in childhood can be an effective strategy to reduce the prevalence of later adult problems of poverty, unemployment, offending and intergenerational disadvantage (OECD, 2009).

Central to the case to shift more public investment towards prenatal and early childhood has been James Heckman's research showing that early intervention programs provide higher rates of return compared to remediation programs targeted at older age groups. The widely cited Heckman Curve describes how the rate of return of social policy interventions declines rapidly with age, with intervention targeted at older disadvantaged young people and adults providing net benefits that are less than the costs of the program.

This paper provides new evidence on the Heckman Curve. We use a large dataset of program benefit cost ratios estimated by the Washington State Institute for Public Policy. The results suggest that the Heckman Curve is not an accurate characterisation of how the cost effectiveness of programs differ by the age of recipients. In the last section of the paper we offer some explanations for our findings, and also explore the broader policy implications of the results.

II. The Heckman curve

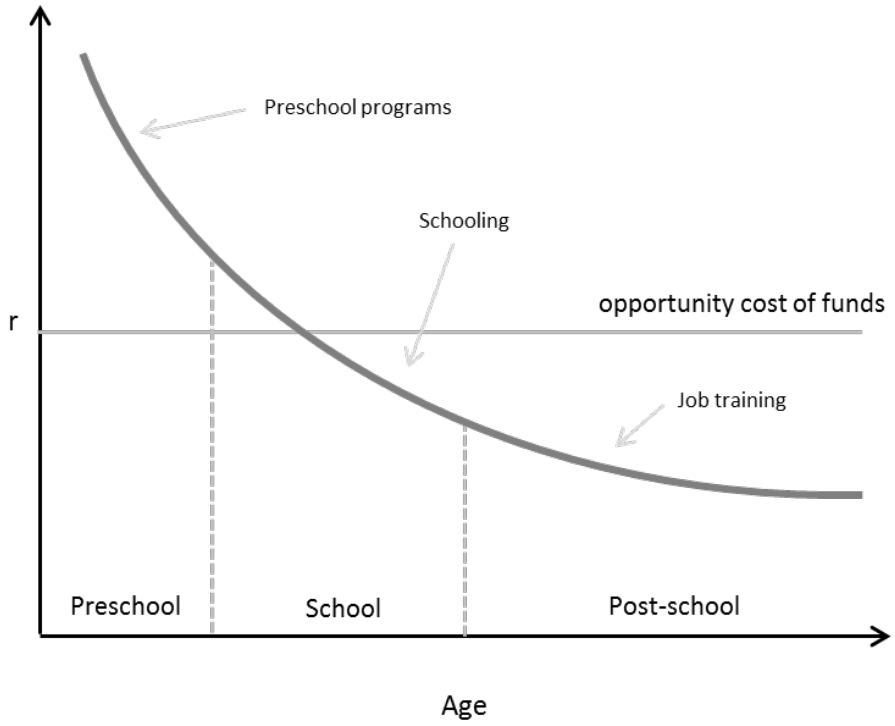
The Heckman Curve describes how the rate of return for investment in the human capital of disadvantaged individuals differs by age. An early version is set out in a discussion paper about the rate of return of spending on human capital in the context of a changing US labour market during the 1990s. Based on a narrative summary of research Heckman found that:

> *'Skill remediation programs for adults with severe educational disadvantages are much less efficient compared to early intervention programs. So are training programs for more mature displaced workers. The available evidence clearly suggests that adults past a certain age and below a certain skill level obtain poor returns to skill investment (Heckman, 1999 p48)*

Figure 1 reproduces the Heckman Curve from a paper published in Science (Heckman, 2006). It shows the rates of return to human capital investment in disadvantaged people as highest for programs targeted at preschool children. Returns for interventions at older ages are considerably lower, and for some school and post-school age interventions are less than the opportunity cost of funds.

There are a number of important features of the relationship described in figure 1. First, rates of return are for the marginal participant given the existing levels of investment. This means that the empirical relationship depends on the existing portfolio of investments, and might not apply in some contexts or countries. Second, it is the social rate of return on investment that is depicted. Measured impacts are not just those related to the individuals who receive an intervention, but also taxpayers and other members of the community (eg as a result of offending and victimisation). Third, the return on investment metric does not incorporate any distributional or equity concerns. Heckman makes the point that investment in early intervention programs provide an example where there is no conflict between efficiency and equity, whereas such a trade-off exists for many later remediation programs targeted at young people and adults.

FIGURE 1: HECKMAN CURVE (RATES OF RETURN TO HUMAN CAPITAL INVESTMENT IN DISADVANTAGED PEOPLE BY AGE)



Source: Figure 2 Heckman 2006

The Heckman Curve is typically described in terms of the 'internal rate of return' of the investment, but it can also be stated in terms of the more commonly estimated 'benefit cost ratio' metric which is used in this paper.[1] If described in terms of benefit cost ratios, the

[1]The internal rate of return of a program is the maximum interest rate at which the present value of benefits equals the present value of costs of the intervention. It is the maximum interest rate (v) which solves:

$$\sum_{t=1}^{t=T} \frac{(\text{Benefits}_t)}{(1+v)^t} = \sum_{t=1}^{t=T} \frac{(\text{Costs}_t)}{(1+v)^t}$$

The benefit cost ratio is calculated for a given discount rate (r) and is the net present value of the benefits of the intervention as a proportion of the net present value of the costs of the specific costs of the investment. It can be expressed as:

$$\text{BCR} = \frac{\sum_{t=1}^{t=T} \frac{(\text{Benefits}_t)}{(1+r)^t}}{\sum_{t=1}^{t=T} \frac{(\text{Costs}_t)}{(1+r)^t}}$$

If the rate of return of a program is equal to the discount rate then the benefit cost ratio is equal to 1. Where the rate of return is less than the discount rate then the benefit cost ratio is less than 1. If the rate of return is above the discount rate then the benefit cost ratio is greater than 1. For any specific investment the benefit cost ratio can be expressed as a function of the internal rate of return and the discount rate. However there is no simple general formula because the internal rate of return

Heckman Curve suggests that early childhood investments have significantly higher benefit cost ratios than those targeted at older age groups, and in addition, investment targeted at older age groups have cost benefit ratios that are less than unity.

Underpinning the Heckman Curve is a comprehensive theory of skills that encompass all forms of human capability including physical and mental health (Heckman and Corbin, 2016; Heckman and Mosso, 2014). The essential elements of the theory are that:

- skills represent human capabilities that are able to generate outcomes for the individual and society;

- skills are multiple in nature and cover not only intelligence, but also non cognitive skills, and health (Heckman and Corbin, 2016);

- non cognitive skills or behavioural attributes such as conscientiousness, openness to experience, extraversion, agreeableness and emotional stability are particularly influential on a range of outcomes, and many of these are acquired in early childhood;

- early skill formation provides a platform for further subsequent skill accumulation because childhood is a highly influential time for human development, and also the skills acquired during this time provide the basis for further accumulation (there are dynamic complementarities);

- families and individuals invest in the costly process of building skills; and

- disadvantaged families do not invest sufficiently in their children because of information problems rather than limited economic resources or capital constraints (Heckman, 2007; Cunha et al., 2010; Heckman and Mosso, 2015).

Early intervention creates higher returns because of a longer payoff over which to generate returns. However in addition, a key proposition is that early childhood education is able to

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depends on both the magnitude and timing of the costs and benefits. For an investment where investment costs are incurred at period 0 and benefits are incurred in only period 1 the relationship is:

$$BCR = \frac{(1+v)}{(1+r)}$$

address deficiencies in the level of investment in non-cognitive skills for disadvantaged children, and given that 'skill begets skills', such investment will have a range of positive long term impacts on future outcomes. This theory is interpreted as consistent with the findings of the impacts found in the long-term follow-up of the randomised trials of the Perry and Abecedarian pre-school programs (Heckman et al., 2013).

III. The existing evidence for the Heckman Curve

The original papers that introduced the Heckman Curve cited evidence on the relative return of human capital interventions across early childhood education, schooling, programs for at-risk youth, university and active employment and training programs (Heckman, 1999).

A more recent review by Heckman and colleagues is contained in an OECD report *Fostering and Measuring Skills: Improving Cognitive and Non-Cognitive Skills to Promote Lifetime Success* (Kautz et al., 2014). The report contains a chapter on the empirical evidence on the efficacy of interventions and provides a useful catalogue of the latest evidence for the Heckman curve. Overall 27 different interventions were reviewed based on inclusion criteria relating to, among other things, the quality of the identification strategy for the research, and the length of time over which impacts were measured. Of the interventions reviewed, twelve had benefit cost ratios reported and these are set out in Table 1.

Table 1: Benefit cost ratios by age for programs reported in Kautz et al., 2014		
Program	Age of recipients	Benefit cost ratio
Nurse Family Partnership	<0	2.9
Abecedarian Project	0	3.8
Perry Preschool	3	7.1-12.2
Chicago Child-Parent Center	3-4	10.8
LA's Best	5-6	0.9
Seattle Social Development Project	6-7	3.1
Big Brothers Big Sisters	10-16	1.0
Empresários Pela Inclusão Social	13-15	0.9-3.0
Quantum Opportunities Program	14-15	0.42
National Guard ChalleNGe Program	16-18	2.66
Jobs Corps	16-24	0.22
Canadian Self-Sufficiency Project	19+	2.67

Source: Source: Kautz et al., 2014 p36.

As can be seen, the programs range across the social policy spectrum from the well-known Nurse Family Partnership home visiting program for first-time at-risk mothers, to the Canadian Self Sufficiency project that provided a temporary earnings supplement for long-term recipients of income support if they worked full-time.

Consistent with the Heckman Curve, programs targeted to children under five have an average benefit cost ratio of around $7, while those targeted at older ages have an average benefit cost ratio of just under $2.

This result is however heavily influenced by the inclusion of the Perry Preschool programme and the Abecedarian Project. These studies are somewhat controversial in the wider literature on the impact of early childhood education because there are other high quality modern ECE intervention studies where the returns are more modest (Duncan and Magnusson, 2013). Many researchers argue that the Perry Preschool programme and the Abecedarian Project do not provide a reliable guide to the likely impacts of early childhood education in a modern context (Phillips et al., 2017).

It is also important to note that the data on programs targeted at older ages do not appear to be entirely consistent with the Heckman Curve. In particular the National Guard ChalleNGe program and the Canadian Self-Sufficiency Project provide examples of interventions targeted at older age groups which have returns that are larger than the cost of funds.

Overall the programs in the OECD report represent only a small sample of the human capital interventions with well measured program returns. As is evident in the following section, many rigorously studied and well known interventions are not included.

IV. Assessing the Heckman Curve using the Washington State Institute for Public Policy dataset

In order to assess the Heckman Curve we analyse a large dataset of program benefit cost ratios developed by the Washington State Institute for Public Policy.

Since the 1980s the Washington State Institute for Public Policy has focused on evidence-based policies and programs with the aim of providing state policymakers with advice about how to make best use of taxpayer funds. The Institute's database covers programs in a wide range of areas including child welfare, mental health, juvenile and adult justice, substance abuse, healthcare, higher education and the labour market. Importantly for assessing the Heckman Curve, the programs have a traditional social policy focus and target disadvantaged populations across a range of difference age groups.

Description of the Washington State Institute for Public Policy benefit-cost methodology

The Washington State Institute for Public Policy has developed a sophisticated and consistent set of methods to estimate benefit cost ratios for social policy programs. Key aspects of their extensively documented methodology involve:

- conducting a meta-analysis of high quality studies in order to estimate the impacts of an intervention;

- estimating the expected value of the investment based on both how much it would cost to deliver the program, and also the stream of future discounted benefits associated with the impacts resulting from the intervention; and

- modelling the uncertainty in the estimates by repeated estimation using differences in assumptions (Washington State Institute for Public Policy, 2017).

The estimated effect sizes of the impacts of an intervention are drawn from randomised and quasi experimental intervention studies for direct impacts, or causal studies where there are impacts that are 'linked' to the direct impacts.

Intervention impact effect sizes are adjusted for the quality of research design, as well as other dimensions including researcher involvement in the design and implementation of the program.

The time-profile of program impacts are modelled over the life course after the intervention. The extent of fade-out is based on estimates of impact at different points in time where these are available from rigorous studies. In other instances fade-out is estimated.

The cost benefit model attaches a price per unit to the impacts of each intervention. These prices include earnings, the value of life, the costs of criminal victimisation, and the deadweight costs of taxation. The model uses a discount rate of 3.5% to adjust all costs and benefits.

The Washington State Institute for Public Policy benefit cost model has been extensively peer reviewed, most recently in collaboration with the Pew-MacArthur Results First Initiative (Dube and White, 2017).

The Washington State Institute for Public Policy dataset as at August 2017

The Washington State Institute for Public Policy dataset is regularly updated as more high quality impact information becomes available. The August 2017 update provides estimates of the benefit cost ratios for 314 interventions. Table 2 describes the broad characteristics of these programs, and the average age of recipients.[2] The table reports three different samples of the dataset. Sample [a] contains all programs. Sample [b] is only those programs where the benefit cost ratio is positive, and sample [c] contains those where the benefit cost ratio is positive but less than $100.

As can be seen, the programs cover a wide range of different portfolios. The programs also span the life course with 10% of the interventions being aimed at children 5 years and under.

[2]In some cases the dataset contains an estimate of the average age of both a primary and a secondary recipient (who is usually a child). For our analysis we allocate the program to the recipient for whom the benefits are the largest.

Table 2: Overview of Washington State Institute for Public Policy dataset of program			
	All programs (sample a)	Programs with benefit cost ratios greater than zero (sample b)	Programs with benefit cost ratios greater than zero and less than 100 (sample c)
Program type			
Child Welfare	6	4	4
Child mental health	16	13	13
Public health and prevention	64	52	48
Healthcare	35	29	29
Substance use disorder	37	29	29
Adult mental health	24	20	19
Pre-K to 12 Education	50	44	41
Higher education	7	6	4
Juvenile Justice	28	23	23
Adult Justice	37	31	31
Workforce development	10	7	7
Total	*314*	*258*	*248*
Age of treatment group			
5 years and under	31	25	25
6 to 15 years	118	99	95
16 to 24 years	42	30	27
25 years and above	123	104	101
Total	*314*	*258*	*248*

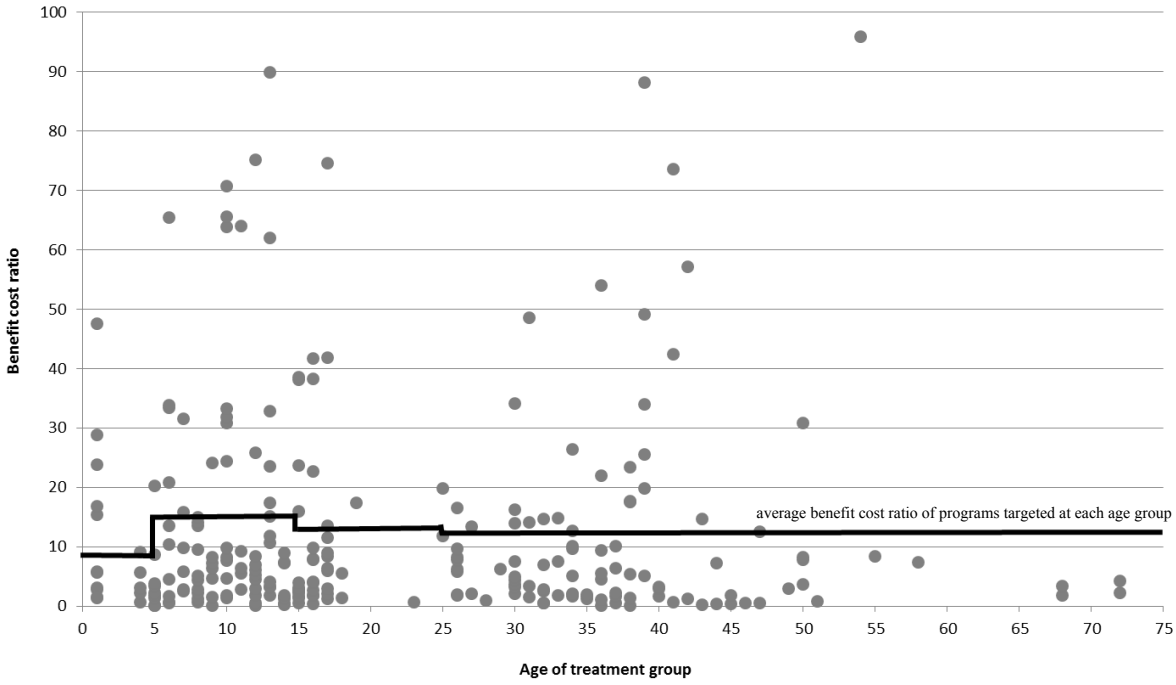
Source: Washington State Institute for Public Policy, August 2017 update

Analysis of benefit cost ratios by age

Figure 3 plots the actual and average benefit cost ratios of programs by age for sample 'c'. As can be seen, the data does not appear to suggest any relationship between the age of the treatment group and program cost effectiveness. It is hard to see any support for the Heckman Curve proposition that interventions targeted at children have the highest rates of return, or that those targeted at older people are a poor investment. Average returns for interventions targeted at those 5 years of age and under are lower than other age groups. In

addition, many interventions targeted at adults have benefit cost ratios that are significantly greater than unity.

FIGURE 3: BENEFIT COST RATIO'S BY AGE FOR PROGRAMS FROM THE WASHINGTON STATE INSTITUTE FOR PUBLIC POLICY



Source: Washington State Institute for Public Policy, August 2017 update. Note: Programs with benefit cost ratios greater than zero and less than $100 (N=248).

Table 2 shows average benefit cost ratios of interventions by age group for each of the three samples. As well as the average benefit cost ratios we also report results that are weighted by a measure of the investment risk for each intervention.[3]

As can be seen, across the different samples, the average benefit cost ratios for interventions targeted at those aged 5 years and under are *lower* than for other age groups. However it is important to note there are large standard errors for many of the estimates, and the difference is not always statistically significant. At a minimum the data suggests that interventions targeted at young children do not have higher rates of return than those targeted at older age groups.

[3]The Washington State measure of investment risk is the chance that the benefit-cost ratio is greater than one. The measure is estimated by a Monte Carlo simulation involving the benefit cost model being run 10,000 times for each intervention. Key input parameters (including program effect sizes, linked effect sizes, and discount rates) are randomly varied each time.

Table 2: Average benefit cost ratios for programs targeted at different age groups

Age group	Number of interventions	Mean benefit cost ratio	Standard error	Mean benefit cost ratio (weighted)	Standard error
Sample (a)					
5 years and under	31	7	2.0	9	2.2
6 to 15 years	118	14	3.4	**21**	3.4
16 to 24 years	42	20	8.4	26	8.6
25 years and above	123	23	8.6	34	10.4
Total	314	18	3.8	26	4.5
Sample (b)					
5 years and under	25	9	2.3	10	2.4
6 to 15 years	99	**20**	3.2	**24**	3.6
16 to 24 years	30	**31**	11.1	**32**	10.6
25 years and above	104	28	10.1	36	11.5
Total	258	24	4.4	28	5.0
Sample (c)					
5 years and under	25	9	2.3	10	2.4
6 to 15 years	95	**15**	2.0	17	2.1
16 to 24 years	27	13	3.3	15	3.6
25 years and above	101	12	1.8	14	1.9
Total	248	13	1.1	15	1.2

Source: Washington State Institute for Public Policy, August 2017 update. Weighted results use the Washington State estimate of investment risk (the benefit cost ratio for the intervention is greater than one). Where the estimate is in bold the difference with '5 years and under' is statistically significant (alpha=0.05 HCC errors)

Table 2 also shows that programs targeted at youth and adults are able to achieve average benefit cost ratios that are well above what would be required to cover the cost of funds. In contrast to a Heckman curve, in all cases the 95% confidence interval for the benefit cost ratios for youth and adult interventions are above unity.

One possible issue is that the Washington State Institute for Public Policy data does not provide benefit cost ratios for the Perry and Abecedarian studies. They do however provide estimates of modern early childhood education which appear to be broadly in line with the

recent consensus statement on the impact of early childhood programs (Phillips et al., 2017). Even if the benefit cost ratios of the earlier model interventions were calculated using the Washington State Institute for Public Policy methodology, it appears unlikely that the addition of these studies would change the overall results given the magnitudes reported for these estimates from other studies (Kautz et al., 2014).

V. Discussion

The Washington State Institute for Public Policy has created a dataset of benefit cost ratios for a large range of well researched social policy interventions. The dataset is based on a sophisticated and consistently applied methodology, and estimates are regularly updated as more high quality impact information becomes available.

The August 2017 dataset does not appear to show a Heckman Curve relationship between the age of the recipient and the benefit-cost ratios of the interventions. Average benefit cost ratios for interventions targeted at young children are not higher than those targeting older age groups. In addition, average benefit-cost ratios of interventions targeted at older age groups show that many are cost effective.

The dataset provides many examples of interventions targeted at young people and adults that are predicted to generate a good return on the investment. A few examples include cognitive behavioural therapy for youth offenders, post-secondary and vocational education in prison, drug treatment during incarceration, cognitive behavioural therapy for depression, case management for unemployment insurance claimants, and summer outreach programs and text messaging to encourage low income students to enrol in college.

It is instructive to ask if these results call into question the more general theory of human capital and skills advanced by Heckman and colleagues.

We are of the view that this is not the case, and Heckman's insights about the nature of human capital are essentially correct. Early child development is a critical stage of human development, partly because it provides a foundation for the future acquisition of health, cognitive and non-cognitive skills. Moreover the impact of an effective intervention in childhood has a longer period of time over which any benefits can accumulate

However crucially, the importance of early child development and the nature of human capital are not the only factors that influence the rate of return for any particular intervention.

Overall the extent to which a social policy investment gives a good rate of return depends on the assumed discount rate, the cost of the intervention, the interventions ability to impact on outcomes, the time profile of impacts over the life course, and the value of the impacts.

Some interventions may be low cost which will make even modest impacts cost effective.

The extent of targeting and the deadweight loss of the intervention are also important. Some interventions may be well targeted to those who need the intervention and hence offer a good rate of return. Other interventions may be less well targeted and require investment in those who do not require the intervention. A potential example of this might be interventions aimed at reducing youth offending. While early prevention programs may be effective at reducing offending, they are not necessarily more cost effective than later interventions if they require considerable investment in those who are not at risk.

Another consideration is the proximity of an intervention to the time where there are the largest potential benefits. For example, the transition to adulthood is associated with an increase in mortality, injury, offending and unintended pregnancies. Youth interventions that aim to address these issues may potentially be more cost effective than early intervention because the cost of the intervention is incurred later than an early childhood intervention.

Another factor is that the technology or active ingredients of interventions differ, and it is not clear that those targeted to younger ages will always be more effective. Some interventions aimed at individuals who are older age may be particularly effective because they work at a time or in a circumstance where individuals are motivated to change their behaviour.

In general there are many circumstances where interventions to deliver 'cures' can be as cost effective as 'prevention'. Many aspects of life have a degree of unpredictability and interventions targeted as those who experience an adverse event (such as healthcare in response to a car accident) can plausibly be as cost effective as prevention efforts.

VI. Conclusion

The Washington State Institute for Public Policy dataset of the benefit cost ratios of a large number of well researched social policy programs does not show a Heckman Curve relationship. The data suggests that there may in fact be no relationship between program cost effectiveness and the age of the recipient.

This finding does not imply that there should be less investment in early childhood programs. There are many early interventions that have large positive rates of return, and there are powerful equity reasons for investment in children.

The data shows that prevention can be cost effective, but in addition, later treatment and amelioration using evidenced based programs can also succeed.

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