IS THE HECKMAN CURVE CONSISTENT WITH THE EMPIRICAL EVIDENCE ON PROGRAM RETURNS BY AGE?*

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Abstract

The Heckman Curve depicts the empirical evidence on rates of return to public investment in human capital as rapidly diminishing with age. Investment early in the life course is characterised as providing significantly higher rates of return compared to investments targeted at people who are older. In this paper we use the Washington State Institute for Public Policy estimates of program benefit cost ratios to assess whether the Heckman Curve is consistent with the latest evidence. The data does not support the claim that programs targeted earlier in the life course provide the largest returns, or that adult programs will have benefit cost ratios that are less than one. 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.

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1. Introduction

A key focus of social science research over recent decades has been the finding that experiences in the early years, particularly those in the prenatal and early childhood periods, have important impacts on later life course outcomes.

Although there is unexplained variation, childhood environments appear to have large 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), educational achievement (Duncan and Magnuson, 2011) , employment and earnings (Caspi et al., 2016) and youth and adult offending (Fergusson et al., 2005).

Longitudinal life course research has documented that one of the most important childhood environments is the family, with maternal health, the quality of parenting, and family income playing a critical role in child development (Almond and Currie, 2010).

In addition, research has identified that a central feature of child development is the formation of various skills and capacities, with non-cognitive skills such as self control (Moffitt et al., 2011) and the ability to regulate personal behaviour (Fergusson et al., 2008) being highly important for successful adult behaviour.

These research findings have been highly influential in public policy as they suggest that earlier intervention in childhood could potentially be an effective strategy to tackle later adult problems of poverty, unemployment, offending and intergenerational disadvantage.

The case for increased public investment in early childhood has also been bolstered by the work of James Heckman who has summarised the empirical evidence on the relative rate of return of interventions across different ages. The widely quoted 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 program costs.

The aim of this paper is to assess the consistency of the Heckman Curve with the empirical evidence. To do this we use a large dataset of estimates of program benefit cost ratios calculated by the Washington State Institute for Public Policy. Our results suggest that the Heckman Curve is not an accurate characterisation of how the cost effectiveness of programs differs by age. In the last section of the paper we offer some explanations for our findings, and also explore the broader policy implications of the results.

2. The Heckman curve

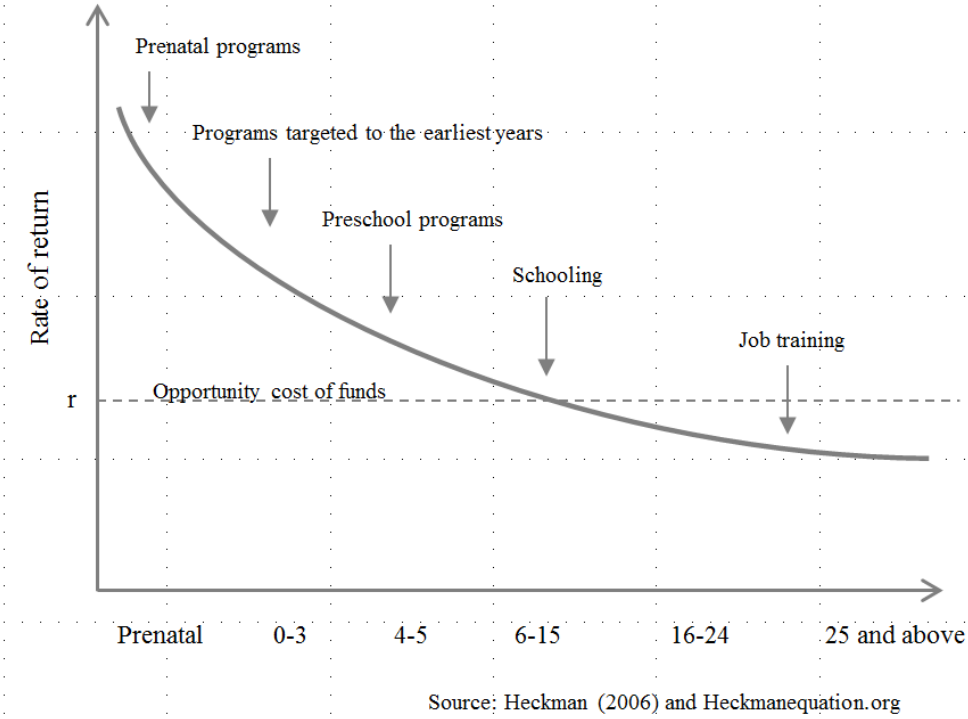
The Heckman Curve describes how the rate of return for investment in the human capital of disadvantaged individuals differs by age. It appears to have been originally formulated in the late 1990s and an early version is set out in a discussion paper about the rate of return of spending on human capital in the context of the changing US labour market. In this paper Heckman argued 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)*

In subsequent papers Heckman argued that the empirical evidence suggested that at current levels of funding in the USA there was an overinvestment in most schooling and post-schooling programs and under-investment in preschool programs for disadvantaged children (Heckman, 2006).

While the original focus of the work was the rate of return of investments in education, training and labour market programs, in later work Heckman and colleagues have outlined a comprehensive theory of skills that encompass all forms of human capacity including physical and mental health (Heckman and. Corbin, 2016; Heckman and. Mosso, 2014). In line with this, we interpret the Heckman Curve as referring to any public investment in human capital. As set out below, the curve depicts that: (i) there are high returns to early investment, particularly for ECE programs for children; and (ii) there are low returns to investments for older age groups, and the present value of these returns are frequently less than the cost of the intervention.

Figure 1: Rates of return to human capital investment in disadvantaged children



Source: Heckman (2006) and Heckmanequation.org

Importantly it is the social rate of return on investment that is depicted. There are a number of important features of this metric. First, these should be based on the empirical impacts observed from high quality studies that construct a valid counterfactual and have long term follow-up. Second, measured impacts are not just those related to the individual who receives the intervention, but also include taxpayers or other members of the community where there are spill over costs and benefits (eg as a result of offending and victimisation). Third, the underlying efficiency value of each impact is estimated in order to create a social rate of return.

It is important to note that the return on investment metric does not incorporate any distributional or equity concerns. Heckman makes the point that investment in early years 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.

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 tractable 'benefit cost ratio' metric which is used in this paper. When transformed in this way the curve suggests that early childhood investments have significantly higher benefit cost ratios than those targeted at older age groups, and in addition, that investment targeted at older age groups have cost benefit ratios that are less than unity.[1]

Underlying the Heckman Curve is a sophisticated theory of human capital that James Heckman and co authors have described over the last decades. 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);

- the so called 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 in that early 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 considerable dynamic complementarities);

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

[1]The internal rate of return (v) 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 can be expressed as the maximum interest rate r which solves:

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

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. However there is no simple general formula because the internal rate of return 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:

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

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

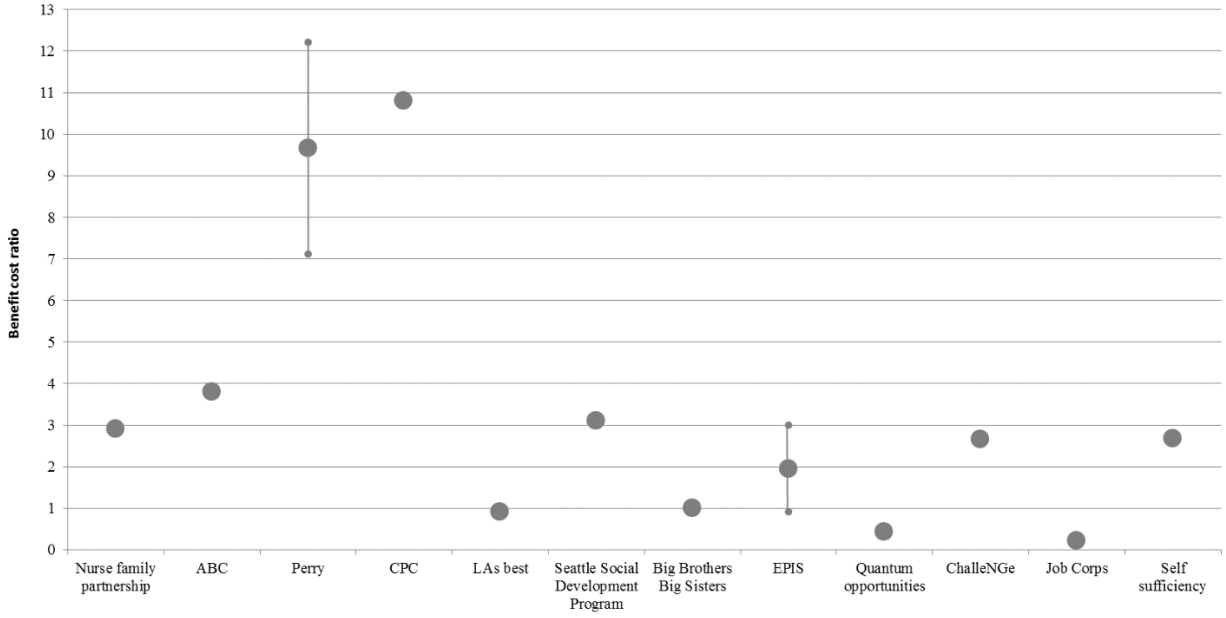
A key proposition is that early childhood education is able to address deficiencies in the level of investment in non cognitive skills for disadvantaged children, and given that 'skill begets skills', such investment will have long term impacts on future outcomes. This theory is interpreted as consistent 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.

3. The Heckman evidence

The original paper that introduced the Heckman Curve provides a narrative summary of 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 is contained in an OECD report *Fostering and Measuring Skills: Improving Cognitive and Non-Cognitive Skills to Promote Lifetime Success* authored by Heckman and colleagues (Kautz et al., 2014). The report contains a chapter on the empirical evidence on the efficacy of interventions which provides a useful catalogue of the latest empirical evidence for the Heckman curve.

Overall 27 different interventions were included in the analysis based on a range of criteria including the quality of the identification strategy for the research and the length of time over which impacts were measured. Figure 2 sets out the benefit cost ratios for the subset of programs where these were reported (only three of the programs had an internal rate of return calculated). 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 earning supplement for long term recipients of income support if they worked full-time.

Figure 2: Benefit cost ratios by age for programs reported in Kautz et al., 2014



Source: Kautz et al., 2014. Note: NFP (Nurse Family Partnership), ABC (Abecedarian), Perry (Perry Pre-School), CPC (Chicago Child-Parent Centre), LAB (LA's Best), SSDP (Seattle Social Development Project), BBBS (Big Brothers Big Sisters), EPIS (Empresários Pela Inclusão Social), QOP (Quantum Opportunity Program), ChalleNGe (National Guard ChalleNGe Program), Jobs Corps, SSP (Canadian Self-Sufficiency Project)

So is this evidence consistent with the Heckman Curve? Note that the sample size is very small (n=12), and as such there is a need for some caution in making an inference about any underlying relationship. In addition, the programs in the review do not appear to be a representative sample of the human capital interventions with well measured program returns. As is evident in the following section, many rigorously studied and well known child protection, education, health, welfare, training and justice interventions are not included.

These caveats notwithstanding, it is also not clear that the data supports the two propositions described by the Heckman Curve.

First, while it might appear that early intervention programs have higher returns than those aimed at older people, this is partly driven by the inclusion of the Perry Preschool and Abecedarian programs. This inclusion is somewhat controversial in the wider literature on the impact of early childhood education as there are a large number of high quality modern ECE intervention studies where the returns are more modest (Duncan and Magnusson, 2013). It is argued that the early model pre-school programs do not provide a reliable guide to the likely impacts of investing in this area in a modern context (Phillips et al., 2017).

Second, the inclusion of the National Guard ChalleNGe program and the Canadian Self-Sufficiency Project show that there are interventions targeted at older age groups that can have returns that are larger than the cost of funds.

4. The Washington State Institute for Public Policy data on program benefits and costs

Given the uncertainty of the published evidence for the Heckman Curve we turn to a larger dataset of programs developed by the Washington State Institute for Public Policy.

Description of the Washington State Institute for Public Policy dataset

The Washington State Institute of Public Policy provides an expert and independent assessment of the net benefits of a wide range of social policy programs. Since the 1990s the institute has studied evidence-based policies and programs with the aim of providing Washington State policymakers with advice about how to make best use of taxpayer funds. The institute's database of benefit-cost results 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, given the traditional social policy focus of the programs they can be classified as being Heckman Curve appropriate in that they target disadvantaged populations.

Underpinning the database is a sophisticated methodology to calculate a comparable benefit cost ratio for each program. Key aspects of this methodology are to:

- conduct a meta-analysis of high quality studies in order to determine the average impacts of an intervention;

- estimate how much it would cost to implement, and also the benefits in terms of the value of both direct and linked impacts; and

- last, assess the risks in the estimates that a particular policy option will break even (Washington State Institute for Public Policy, 2017)

The important feature of the calculations is that the estimates are the return on investment for the program in Washington State. For example, the program costs and benefits (ie the value of the impacts such as the return to education) are specific to Washington State, and will not necessarily be the same in another jurisdiction.

We have used the December 2016 update of the WSIPP cost benefit ratios, with the addition of a number of new reviews from the May 2017 update.

Table 1 sets out 325 interventions in the dataset classified according to the age group that is targeted by the intervention. The table shows the numbers of programmes in different samples. Sample 'a' contains programs irrespective of whether the benefit cost ratio is positive. Sample 'b' is only those programs where the benefit cost ratio is positive, and sample 'c' also removes programs with very large benefit cost ratios. As can be seen, the programs span the life course with 10% of the interventions being aimed at children 5 years and under.

Table 1: Overview of Washington State Institute for Public Policy data on program returns by age

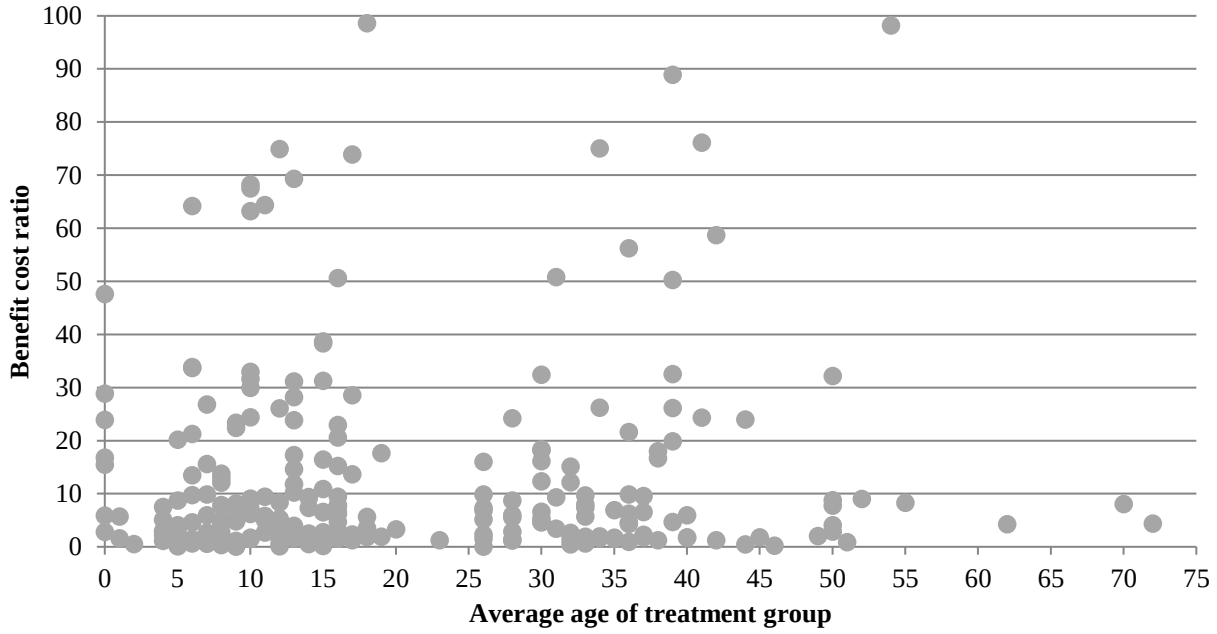
Area	All programs (a)	Programs with BCR's greater than zero (b)	Programs with BCR's greater than zero and less than 100 (c)
Prenatal	10	7	7
0-3	5	3	3
4to5	16	14	14
6to15	130	99	94
16to24	45	34	32
25+	119	93	90
Total	325	250	240

Source: Washington State Institute for Public Policy, www.wsipp.wa.gov/BenefitCost

Analysis of benefit cost ratios by age

Figure 3 provides a scatter plot of the benefit cost ratios of programs by age for sample 'c'.

Figure 3: Benefit cost ratios by age for programs from Washington State Institute for Public Policy dataset



Source: Washington State Institute for Public Policy www.wsipp.wa.gov/BenefitCost. Note: Programs with benefit cost ratios greater than zero and less than 100 (N=240)

Visually the data does not appear to suggest any relationship between age and program cost effectiveness. It is hard to see any support for the proposition that interventions targeted at childhood have the highest rates of return, or that those targeted at older people have a lower return on investment. There are a substantial number of interventions at older ages that are higher than those at younger ages, and many interventions targeted at adults have benefit cost ratios that are significantly greater than unity

Table 2 provides the mean benefit cost ratios of interventions by age group for all programs with different samples, as well as the associated confidence intervals.

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

Sample	Age group	Number	Mean	95% confidence interval	
				lower	upper
All programs (a)	Prenatal	10	13.2	1.3	25.2
	0 to 3 years	5	1.3	-2.0	4.6
	4 to 5 years	16	3.7	1.0	6.5
	6 to 15 years	130	13.6	7.5	19.8
	16 to 24 years	45	16.3	0.6	32.1
	25 +	119	24.7	6.6	42.9
	Total	325	17.4	10.0	24.7
Programs with benefit cost ratio greater than zero (b)	Prenatal	7	20.2	6.1	34.2
	0 to 3 years	3	2.6	-4.2	9.3
	4 to 5 years	14	4.3	1.3	7.3
	6 to 15 years	99	20.7	14.1	27.2
	16 to 24 years	34	25.7	6.3	45.0
	25 +	93	32.7	9.7	55.6
	Total	250	24.7	15.4	33.9
Programs with benefit cost ratio greater than zero and excluding outliers greater than 100 (c)	Prenatal	7	20.2	6.1	34.2
	0 to 3 years	3	2.6	-4.2	9.3
	4 to 5 years	14	4.3	1.3	7.3
	6 to 15 years	94	14.5	10.7	18.2
	16 to 24 years	32	13.2	5.2	21.1
	25 +	90	13.7	9.5	17.8
	Total	240	13.4	11.0	15.8

Source: Washington State Institute for Public Policy, www.wsipp.wa.gov/BenefitCost

Table 2 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 addition, the average benefit cost ratios are not lower than those targeted at those aged under 6 years. A potential exception to this is the higher average benefit cost ratios of prenatal programs in the most constrained sample. It is important to note however that the 95% confidence intervals with these estimates are wide and the difference is not statistically significant.

We also conducted a more formal assessment of the Heckman Curve by assessing the following two predictions:

- the benefit cost ratio of interventions aimed at children under 6 years of age should be larger than those targeted at adults aged 25 years and above

- interventions targeted at adults we should have benefit cost ratio's less than one.[2]

[2]The Washington State Institute for Public Policy use a discount rate of 3.5%. Heckman et. al., (2009) use a discount rate of 3% as their central estimate for the analysis of Perry Preschool.

Table 3 sets out the results across the three different samples where we have estimated a model of the form:

$$\text{Benefit cost ratio}_i = \beta_0 + \beta_1(\text{INT\_under 6}) + \beta_2(\text{INT\_6to15}) + \beta_3(\text{INT\_16to24}) + u$$

The estimate of the difference in the benefit cost ratio of child versus adult programs is not statistically significant but consistently negative (rather than positive as predicted). In addition, interventions targeted at adults have average benefit cost ratios that are statistically significant and well above 1.

Table 3: Formal assessment of the Heckman Curve

Hypothesis	Sample	Estimate	Standard error	p-value
Difference in benefit cost ratios for	a	-18.3	13.6	0.2
interventions for children under 6 compared to	b	-23.9	17.0	0.2
those for 25 and over (β_1)	c	-4.9	4.3	0.3
Benefit cost ratios for interventions targeted at	a	24.7	6.2	<.0001
adults 25 years and above (β_0)	b	32.7	7.7	<.0001
	c	13.7	2.0	<.0001

Source: Washington State Institute of Public Policy, www.wsipp.wa.gov/BenefitCost

One possible issue is that the Washington State Institute for Public Policy data does not provide benefit cost ratios for the early 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). However, even if the benefit cost ratios of earlier model interventions were calculated using the Washington State Institute for Public Policy methodology, it appears unlikely that they would change the overall results given the magnitudes reported for these estimates from other studies (Kautz et al., 2014).

5. Discussion

The Washington State Institute for Public Policy has created a world leading dataset of benefit cost ratios for a large range of well researched social policy interventions. An analysis of the data does not support a Heckman Curve view of the rates of return being significantly higher for interventions targeted at young children compared to older age groups, or that interventions for older age groups are generally not cost effective.

The dataset provides many examples of interventions with youth and adults that are able 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, other well designed alcohol and drug addiction programs such as ‘Seeking Safety’, 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 why the results appear different to the theory of human capital and skills advanced by Heckman and colleagues. We are of the view that the essential insights from the work are 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 the benefits accumulate

However crucially, these factors are not the only influence over the cost effectiveness of interventions.

Overall the cost effectiveness of an intervention depends on both the cost of the intervention, and the ability to impact on outcomes over the life course.

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

Others may have a well identified target group which means that cost effectiveness is higher because the population who receive the intervention contain a higher proportion of those who can benefit. A useful example of this appears to be interventions targeted at non cognitive skills. While near universal early prevention may be cost effective, it is not necessarily more cost effective than more limited interventions targeted at individuals later in life where the absence of these skills are fully apparent.

A further issue 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 due to target effectiveness point above, but also 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 at younger ages will always be more effective. Some interventions aimed at older age groups 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 'cures' can be as cost effective as 'prevention'. Many aspects of life have a degree of unpredictability and interventions targeted as those who have experienced an adverse event (such as healthcare in response to a car accident) can plausibly be as cost effective as prevention (in the form of seat belt regulations).

6. Conclusion

Analysis of the Washington State Institute for Public benefit cost data shows that the Heckman Curve is not an accurate description about what is currently known about the cost effectiveness of a significant number of well researched programs.

This finding should not be understood as suggesting that we should disinvest from early childhood prevention programs. There are many early interventions that have positive rates of return, including in the New Zealand context Early Start (Fergusson, 2012) and Family Start (Vaithianathan et al., 2016). In addition, there are very powerful equity reasons for early intervention.

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

Building on this finding, a useful overall approach is described by Aos et al (2005) who describe a portfolio approach to public investments. The essential elements of this approach are to look at the cost effectiveness of programs on a case-by-case empirical basis. In the New Zealand context this would require:

- the creation and maintenance of a carefully constructed database of country specific program benefit cost ratios;

- investing in well researched programs that will generate high returns;

- reducing investments in programs where there is little evidence of effectiveness;
- having a portfolio of programs across the life course as early intervention is not always effective for all people and all circumstances;
- investing in a substantial amount of design and trialling of interventions that have robust evidence from other jurisdictions; and
- understanding that successful investment requires more than just selecting an evidenced based program, as implementation with care and fidelity is the key to achieving results.

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