Does an empirical Heckman curve exist?

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Abstract

The Heckman Curve suggests that the rate of return to public investments in human capital declines across the life course. This paper assesses the empirical evidence for the Heckman Curve, using estimates of program benefit cost ratios from the Washington State Institute for Public Policy. We find no support for the claim of an inverse relationship between rates of return and the age of the person who receives the intervention. The paper concludes by discussing the various features of human capital and interventions that might explain why the predictions of the Heckman Curve are not consistent with the empirical evidence.

Introduction

A key focus of developmental social science in recent decades has been the importance of the early childhood period. Many studies suggest prenatal and early childhood environments have important and long-term impacts on a range of outcomes including health and life expectancy [1-5], educational achievement [6], employment and earnings [7,8] and youth and adult offending [9].

A large body of research has documented how differences in maternal health, the quality of parenting, and family income play a critical role in child development [7]. In addition, there is evidence that early childhood education programs can have a profound impact on later life outcomes [10,11].

These findings have had a major influence on public policy. They suggest that early intervention in childhood can be an effective strategy to reduce the prevalence of later adult problems such as poverty, unemployment, criminal offending and intergenerational disadvantage [12].

Central to the case to shift more public investment towards the prenatal period 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 child and young adult ages. The widely-cited Heckman Curve describes how the rate of return of social policy interventions declines rapidly with age, with interventions targeted at older disadvantaged young people and adults providing net benefits that are less than the costs of the programs.

This paper is the first to empirically consider the Heckman Curve. We use a large dataset of program benefit cost ratios constructed by the Washington State Institute for Public Policy. Our research concludes the Heckman Curve is not an accurate empirical characterisation of how the cost-effectiveness of programs differs by the age of recipients. The last section of the paper describes some caveats, and also provides some explanations and broader policy implications of the findings.

Background on the Heckman Curve

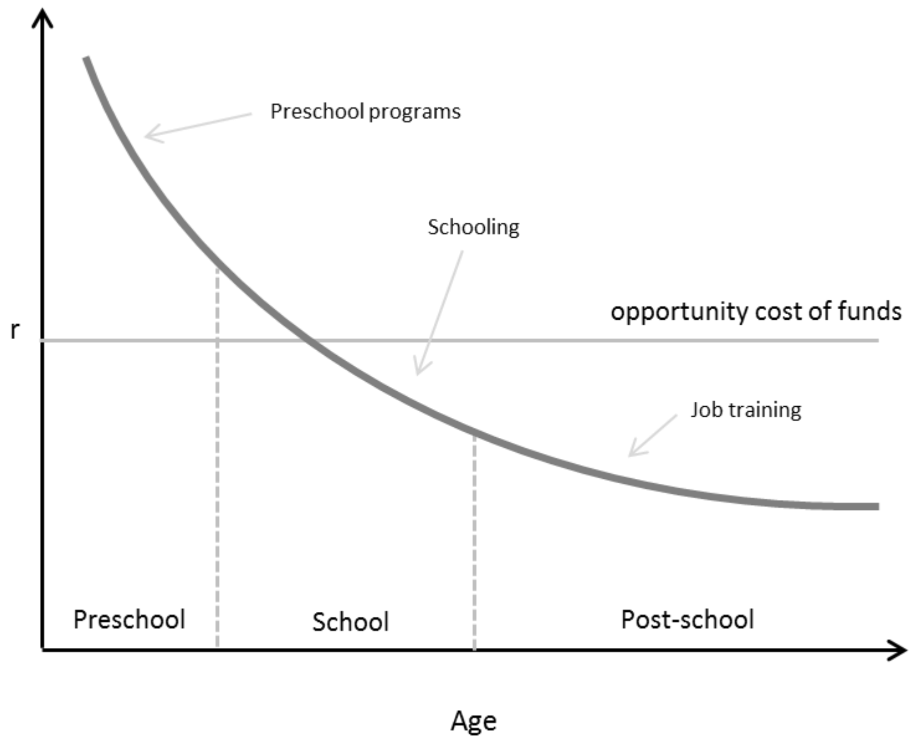
The Heckman Curve describes how the rate of return for investments in the human capital of disadvantaged individuals differs by age. An early version was set out in a discussion paper on investing in human capital in the context of the changing US labour market of the 1990s. Based on a narrative summary of research Heckman concluded:

> *'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 [13, p48]*

Figure 1 reproduces the Heckman Curve from a paper published in Science [14]. It shows the rate 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 interventions the returns 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 to taxpayers and other members of the community. Third, the return on investment metric does not incorporate any distributional or equity valuations. However, Heckman makes the point that investment in early intervention programs provides 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 THE DISADVANTAGED BY AGE)



Source: Figure 2 Heckman 2006

The Heckman Curve is typically described in terms of the ‘internal rate of return’ of the investment. However it can also be stated in terms of the more commonly estimated 'benefit cost ratio' metric which is used in this paper (Appendix 1 shows how these two measures are related).

Described in terms of benefit cost ratios, the 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 [15,16]. 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 attributes and health [15];
- 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 [16-18].

Early intervention obviously generates large benefits because of the longer period over which returns can potentially accumulate. However in addition, 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 a range of positive long-term impacts on future outcomes. This theory is interpreted as consistent with the findings from the long-term follow-up of the randomised trials of the Perry and Abecedarian pre-school programs [10].

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 [13].

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* [19]. 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.

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.

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.

Consistent with the Heckman Curve, programs targeted to children under five have an average benefit cost ratio of around $7 per dollar invested, 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 recent intervention studies where the returns are more modest or where fade-out occurs [20, 21]. Additionally, 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 [11].

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.

In addition, the programs cited in the OECD report represent only a small sample of human capital interventions with well measured program returns. As is evident in the following section, many rigorously studied interventions were excluded from the analysis.

Methods and data for this study

The aim of this paper is to assess the empirical evidence for the Heckman Curve using an independent dataset of program benefit cost ratios calculated by the Washington State Institute for Public Policy.

Since the 1980s the Washington State Institute for Public Policy has focused on analysing 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 involving disadvantaged populations and a wide range of age groups.

The Washington State Institute for Public Policy has developed a sophisticated set of methods to estimate benefit cost ratios in a consistent manner [23]. Their methods have been extensively peer reviewed, most recently in collaboration with the Pew-MacArthur Results First Initiative [24].

The Washington State Institute for Public Policy approach involves three broad components:

- 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 of the estimates by repeated estimation using different assumptions [22].

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 creation and implementation of the program.

The time profiles 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.

An estimate of investment risk is also calculated for each intervention. This is the chance that the benefit cost ratio for an intervention is greater than unity, and is calculated by a Monte Carlo simulation involving the benefit cost model being run 10,000 times. Key input parameters including program effect sizes, linked effect sizes, and discount rates are randomly varied for each run of the model.

The Washington State Institute for Public Policy estimates are regularly updated as more credible impact information becomes available. The dataset used for this paper is from the August 2017 update and contains information on 314 different interventions. The full dataset is provided in the online appendix accompanying this article.

Results

Table 2 describes the broad characteristics of the programs in our dataset. The table reports three different samples to ensure that our findings are robust to different criteria for selecting the population of programs to be assessed. 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 in the dataset 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.

Table 2: Overview of the Washington State Institute for Public Policy dataset (as at August 2017)

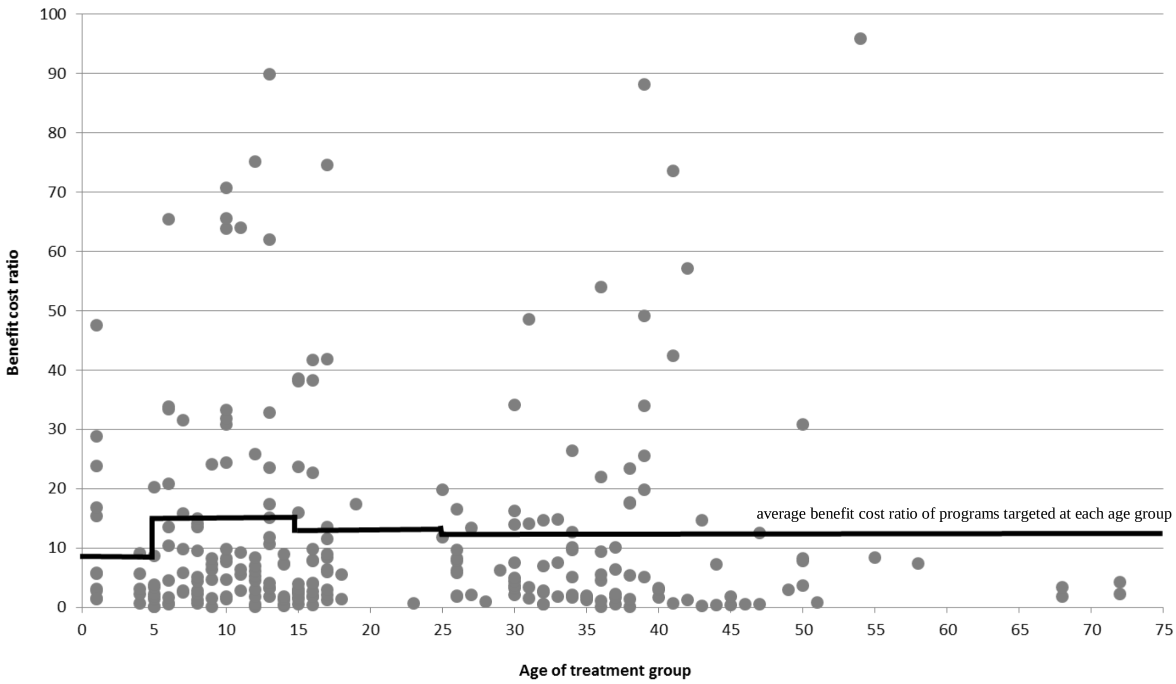
	All programs (sample a)	Programs with benefit cost ratios greater than zero (sample b)	Programs with benefit cost ratios greater than zero and less than 100 (sample c)
Program type			
Child Welfare	6	4	4
Child mental health	16	13	13
Public health and prevention	64	52	48
Healthcare	35	29	29
Substance 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. Note: 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.

Our analysis focuses on the estimated benefit cost ratios of interventions by age of the primary recipient. If the data is consistent with the Heckman Curve then investments targeted at very young children should have average benefit cost ratios that are larger than those targeted at older age groups. Moreover investments targeted at older age groups should also have cost benefit ratios that are less than unity.

Figure 2 plots the actual and average benefit cost ratios of programs by age for sample ‘c’.

FIGURE 2: 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).

As can be seen, the data does not show 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.

Table 3: 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 3 reports average benefit cost ratios of interventions by age groups for each of the three samples. 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.

Table 3 also reports average benefit cost ratios that are weighted by the Washington State Institute for Public Policy's estimate of investment risk. These show a similar pattern to the unweighted results.

Table 3 also shows that programs targeted at youth and adults are able to achieve average benefit cost ratios 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 more recent early childhood education interventions which appear to be broadly in line with the consensus of many of the leading scholars in the field [11]. Even if the benefit cost ratios of the earlier model interventions were calculated using the Washington State Institute for Public Policy methodology, it is unlikely that the addition of these studies would change the overall results given the magnitudes reported for these estimates from other studies [19].

Discussion

The Washington State Institute for Public Policy dataset of benefit cost ratios provides information on a large range of well researched social policy interventions.

Estimates are based on a sophisticated and consistently applied methodology, and the dataset is regularly updated as more high quality impact information becomes available.

The August 2017 update of the dataset does not show a Heckman Curve relationship between the age of the recipient and the benefit cost ratio of the intervention.

While many interventions targeted at young children generate very high returns, the 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. 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.

While the data suggests that a Heckman Curve does not exist, there are some reasons to be cautious. The dataset is still small compared to the range of interventions that could potentially be considered (particularly in the health area), and as occurs with any benefit cost analysis, the magnitude of the estimates reflect a large number of meta-analysis and modelling assumptions [22].

Given the findings of our analysis of the Washington State Institute for Public Policy dataset, it is natural to ask if there are any problems with the conceptual underpinnings of the Heckman curve.

We are of the view that much of the general theory of human capital and skills advanced by Heckman and colleagues is correct. Across many areas of science it is recognised that 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.

However the nature of human capital across the life cycle is not the only factor that influences the rate of return of interventions. Overall the extent to which a social policy investment gives a high rate of return depends on the discount rate, the cost of the intervention, the interventions ability to impact on outcomes, the time profile of impacts, and the value of the impacts.

Factors other than the nature of human capital often play a key role. For example, some interventions may be so low cost that even with modest and limited impacts the intervention is highly cost effective.

The effectiveness of the targeting of the intervention can also be important. Some interventions may generate a high rate of return because they are well targeted to those who benefit. Other interventions may be less well targeted, and hence lead to spending on those who do not require help. 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 involve considerable deadweight - investment in those who are not at risk of offending in the first place.

While it is often argued that an intervention in childhood has a longer period of time over which benefits can accumulate, 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 at younger ages will always have more effective active ingredients. Interventions informed by good behavioural design are increasingly showing promise. In addition, some adult interventions may be effective because they occur at a time or in a situation where people are highly motivated and responsive to change.

In general there are many circumstances where interventions to deliver 'cures' and ‘mitigations’ 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.

Conclusion

The Washington State Institute for Public Policy dataset of benefit cost ratios of a large number of well researched social policy programs does not illustrate an empirical Heckman curve. The data suggests that there may in fact be no systematic relationship between program cost effectiveness and the age of the program 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 suggests that prevention can be cost effective, but in addition, later treatment and amelioration using evidenced based programs can also succeed.

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ANNEX 1: THE INTERNAL RATE OF RETURN AND THE BENEFIT COST RATIO

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 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:

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