Lifecourse Economic Evaluation: A Microsimulation Approach

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Abstract
We present LifeSim – a new microsimulation framework for lifecourse economic evaluation, which provides detailed information about long-term costs, benefits and inequality impacts over the lifecourse. LifeSim uses life-stage-specific equations to synthesise a large body of scientific theory and evidence about the complex causal pathway linking early life circumstances to later life outcomes. We use longitudinal survey data from the Millennium Cohort Study (MCS) up to age 14, and our subsequent equations are parameterised using causal effect estimates from quasi-experimental studies combined with target data from surveys and administrative records, with outcomes to age 46 validated using the 1970 British Cohort Study. We illustrate the framework by evaluating a training programme for parents of young children at risk of conduct disorder. We trace how multiple disadvantages cluster and compound over time to generate heterogeneity in long-run benefits and costs, allowing us both to pinpoint which subgroups benefit most and to simulate distributions of inequality of opportunity for lifetime health, consumption and wellbeing within the general population.

Keywords
Simulation Modelling — Cost Benefit — Health — Human Capital — Skill — Inequality — QALY — Wellbeing

Full technical working paper available at: `https://sites.google.com/site/ievaskarda/research`

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Background

Many public policies have potentially important but poorly understood long-run consequences for health, income, public cost and inequality. We aim to improve understanding by:

- developing LifeSim – a novel discrete time lifecourse microsimulation model of an English birth cohort;
- using LifeSim to illustrate lifecourse economic evaluation of a training programme for parents of young children exhibiting antisocial behaviour.

Methods

LifeSim Model

We simulate a **cohort of 100,000 English children** born in 2000-2001, using data from the Millennium Cohort Study (MCS) to describe their characteristics and family circumstances.

Difference equations vary across the **four key life stages** to represent the specific **causal pathways** linking family circumstances, skills, conduct disorder and educational attainment in childhood to diverse later **life outcomes**. The model is parametrised using quasi-experimental evidence and calibrated against longitudinal survey data.

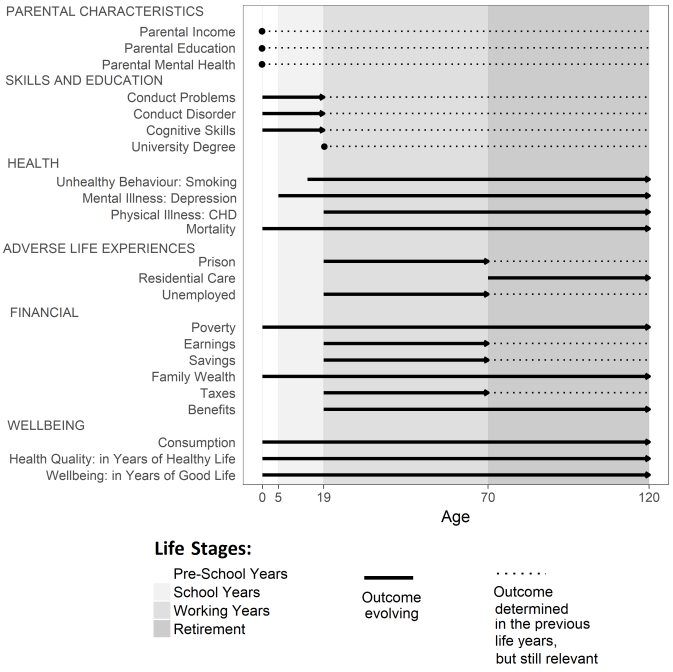

Figure 1. LifeSim models a wide range of life outcomes as they evolve throughout four life stages: preschool years (up to age 4), school years (ages 5-18), working years (ages 19-69), and retirement (age 70+).

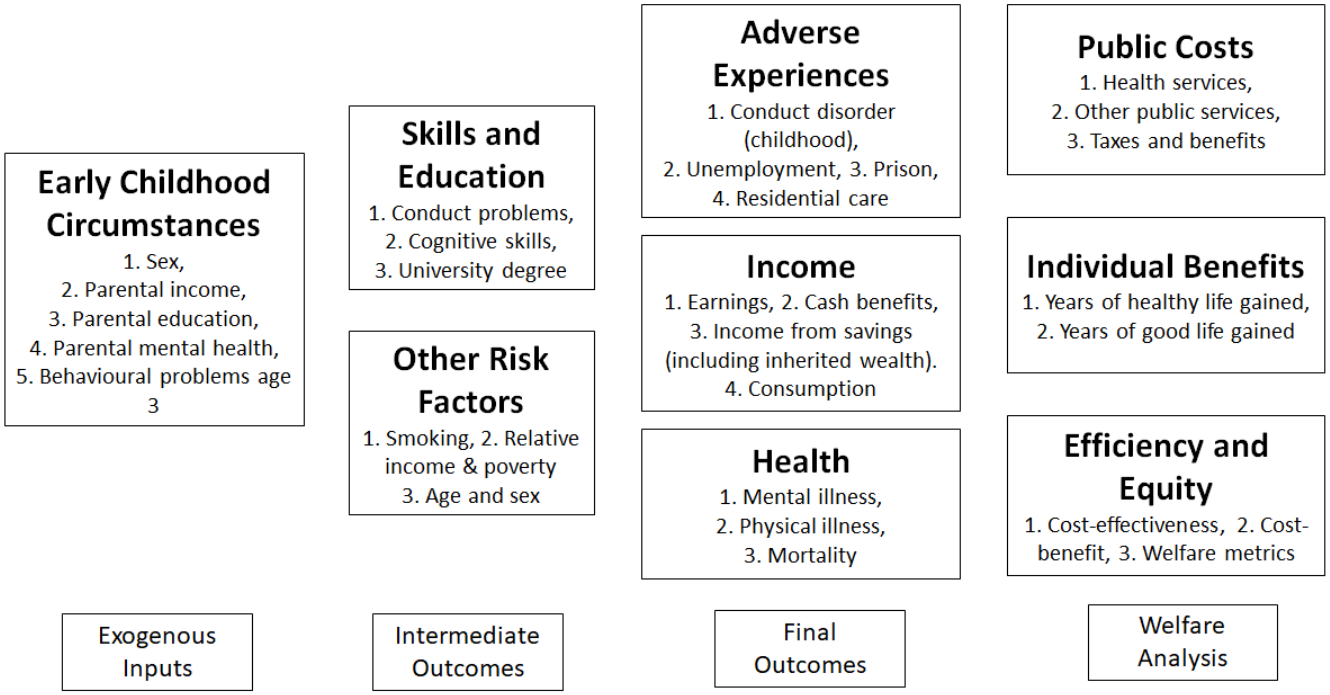

Figure 2. Key outcomes and metrics produced by LifeSim.

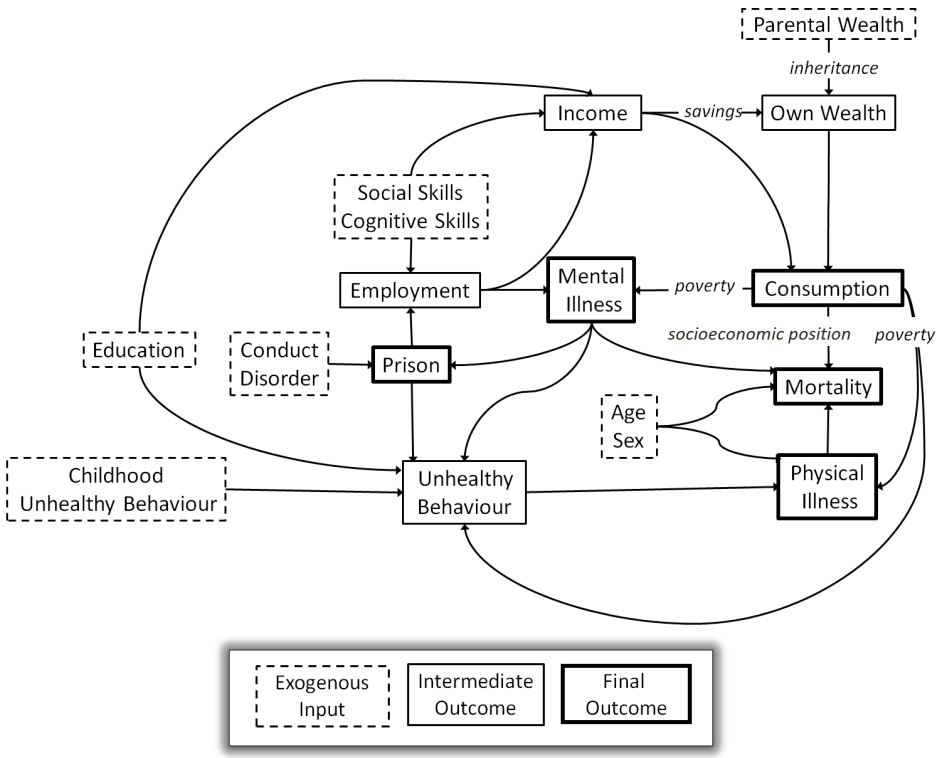

Figure 3. Causal pathways for the 'working years' life stage, synthesized using theory and evidence from across the social sciences. See causal pathways for the other life stages and more details in the technical working paper.

Primary Outcome Measure

We summarise lifetime benefits using **good life-years** which go beyond conventional quality-adjusted life-years to adjust for consumption as well as health [2].

Figure 4. Distribution of 'years of good life' in the simulated cohort.

Illustrative Policy Intervention

We illustrate how LifeSim can be applied to evaluating a hypothetical national parent training programme. We assume that the hypothetical policy intervention:

(i) is delivered to parents of all 5-year old children screened as being at risk of developing a conduct disorder, based on a parent-reported SDQ conduct problems score at age 5 within the abnormal range (4 or above);

(ii) causes an average 0.46 standard deviation decrease in the SDQ conduct problems and impact scores of a child recipient, with heterogeneous effects conditional on child and parental characteristics (larger effects for the children of parents with mental health problems and for children with a higher baseline conduct problems score, and correspondingly smaller effects for other children [5]).

In the technical working paper we present results of sensitivity analysis to alternative assumptions about effectiveness, including a homogeneous effect for everyone, a random error reflecting individual heterogeneity and a conservative assumption of additional effect fade-out over time [4, 8].

Results

Conduct Disorder

	Pre-Policy	Post-Policy	Absolute Effect	Relative Effect, %
Conduct Disorder, Age 5, %	35.64	17.68	**-17.96**	-50.39
Conduct Disorder at Age 18, %	16.05	11.95	**-4.11**	-25.59
SDQ Conduct Problems Score at Age 5	4.64	3.99	-0.65	-12.21
SDQ Conduct Problems Score at Age 18	2.87	2.28	-0.59	-8.26

Table 1. The effects of the hypothetical policy intervention on conduct disorder, among the 7,166 recipient children.

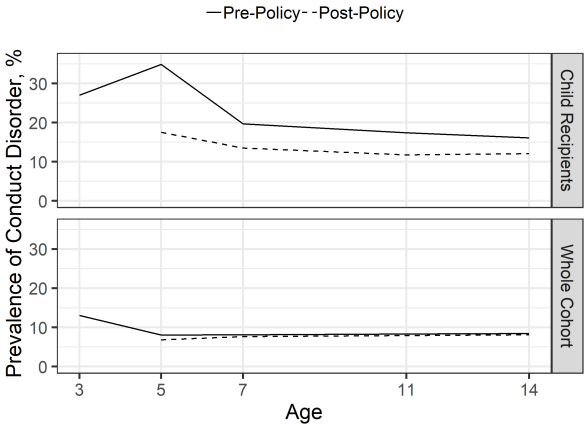

Figure 5. Prevalence of conduct disorder for children at different ages with and without the intervention. The top panel focuses on 7,166 child recipients, the bottom panel – on the general population cohort of 100,000 individuals.

- Immediate positive effect: almost 18% of the recipient children prevented from developing a conduct disorder at age 5.

- The positive effect on conduct disorder diminishes by age 18, but remains substantial, with 4% of conduct disorders prevented.

Other Lifecourse Outcomes

Outcome	Pre-Policy	Post-Policy	Absolute Effect	Relative Effect, %
University Graduates, %	42.06	42.76	0.70	1.66
Working Years in Unemployment, %	8.85	7.61	-1.24	-14.00
Life Years in Poverty, %	36.37	35.77	-0.61	-1.67
Working Years in Prison, %	2.82	2.10	-0.71	-25.30
Retirement Years in Residential Care, %	3.59	2.93	-0.66	-18.32
Adult Years as a Smoker, %	33.46	31.82	-1.64	-4.91
Adult Years with CHD, %	5.96	5.98	0.02	0.25
Life Years with Mental Illness, %	9.97	8.36	-1.61	-16.11
Years of Life	79.17	79.27	0.09	0.12
Premature Mortality Rate (before age 75), %	28.45	28.20	-0.25	-0.88
Final Wellbeing Outcomes				
Annual Consumption (lifetime average), £	16,981	17,004	22.40	0.13
Years of Healthy Life	75.74	76.14	0.40	0.53
Years of Healthy Life (discounted)	44.52	44.68	0.16	0.37
Years of Good Life	71.30	71.72	0.41	0.58
Years of Good Life (discounted)	41.32	41.49	0.17	0.42

Table 2. The effects of the hypothetical policy intervention on other outcomes, among the 7,166 child recipients. Years of healthy and good life are discounted at 1.5% annually [7].

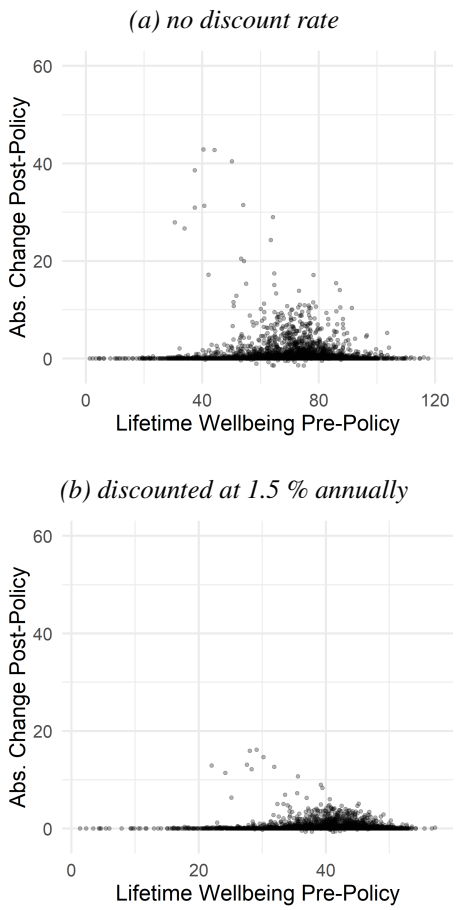

Figure 6. Individual lifetime wellbeing gains among the 7,166 child recipients, as a result of the policy intervention, given the good years of life without an intervention.

Public Cost Savings and Revenues

Public Cost Savings and Revenues (per recipient), £	5 years	10 Years	15 Years	20 Years	Lifetime
Conduct Disorder	1,051	1,412	1,511	1,511	1,511
Healthcare: CHD	0	0	0	0	-3
Healthcare: Mental Illness	125	192	242	290	2,444
Prison	0	0	197	1,110	6,624
Residential Care	0	0	0	0	681
Benefit Payments	0	0	71	434	3,721
Tax Revenues	0	0	0	9	1,374
Total Savings	1,177	1,604	2,020	3,355	16,353

Table 3. Estimated savings as a result of the policy intervention per child recipient, discounted at 1.5 % annual rate [7]. The sources for the costs are [1], [6]. Estimated cost per recipient of a similar programme: £1,612-2,418 [3].

Distributional Effects

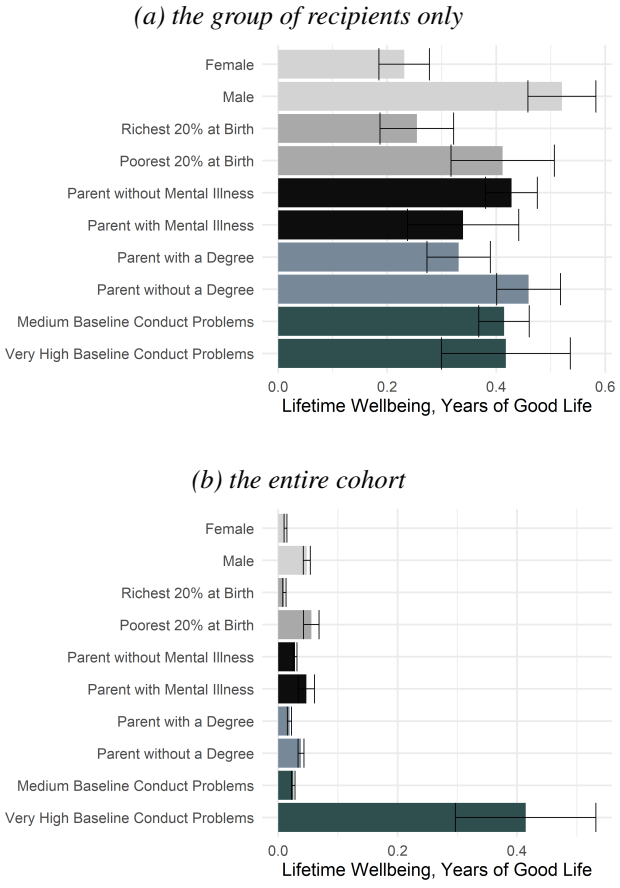

Figure 7. Average lifetime wellbeing gains as a result of the policy intervention for cohort subgroups with 95% confidence intervals.

Discussion

Findings of the Illustrative Evaluation

We find that an illustrative parent-training programme can substantially reduce cases of conduct disorder from age 5 to 7, though the effect partially fades out since many conduct problems would have resolved by age 11 in any case. Despite this fade out, we estimate that public cost savings are sufficient to cover the cost of the programme within the first 5-10 years and that further public savings accrue into adulthood.

While later life benefits are small for most intervention recipients, a subset of recipients gain substantial long-term benefits in terms of both length and quality of life – including better material living standards as well as reduced risks of mental and physical illness, poverty, unemployment and imprisonment. Our subgroup analysis suggests that these substantial beneficiaries are disproportionately children from socially disadvantaged backgrounds, and that the programme contributes to reducing inequality of opportunity for lifetime wellbeing.

Strengths and Limitations

The key strength of LifeSim is that it captures the clustering and compounding of disadvantage over the lifecourse and how this generates substantial individual-level heterogeneity in policy outcomes. Poor conduct in early years results in poor educational and employment outcomes, sometimes resulting in spells in prison and often leading to poor health, which then manifests itself in costs to public services and the social protection system.

Other advantages of our approach are that it can integrate the various outcomes that occur over the lifecourse into a summary measure of lifetime wellbeing and it can be generalised to incorporate a wide range of additional social and health outcomes.

The main limitation is that, although we have devoted considerable time and effort to parameterising each of our lifecourse equations by reviewing literature and consulting experts, larger teams of researchers would be able to improve each of our many equations by adopting more systematic approaches to reviewing evidence and eliciting expert beliefs about cohort effects and other biases in using existing data to predicting future trends.

Other limitations are that we only model a single birth cohort and we do not model the dynamics of family formation and relationships, behavioural responses to changed incentives, or sector specific budget constraints and opportunity costs.

Implications

Despite the many limitations of our prototype microsimulation model, the general framework within which it is embedded is extremely flexible and opens up an exciting research agenda for lifecourse economic evaluation. Policy-makers are often accused of "short-termism", and the lifecourse perspective often receives short shrift in public debates. Lifecourse economic evaluation can potentially help keep the lifecourse perspective in view, by routinely providing policy makers with detailed and credible information about lifecourse policy consequences. We hope that this prototype study will encourage others to develop better methods of lifecourse economic evaluation, which address the many limitations of our prototype model and provide policy makers with useful insights about the lifecourse consequences of alternative policy options across all sectors of public policy.

Acknowledgements

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References

[1] E.-M. Bonin, M. Stevens, J. Beecham, S. Byford, and M. Parsonage. Costs and longer-term savings of parenting programmes for the prevention of persistent conduct disorder: a modelling study. *BMC public health*, 11(1):803, 2011.

[2] R. Cookson, O. Cotton-Barrett, M. D. Adler, M. Asaria, and T. Ord. Years of good life based on income and health: Re-engineering cost-benefit analysis to examine policy impact on wellbeing and distributive justice. 2016.

[3] R. T. Edwards, C. Jones, V. Berry, J. Charles, P. Linck, T. Bywater, and J. Hutchings. Incredible years parenting programme: cost-effectiveness and implementation. *Journal of Children's Services*, 11(1):54–72, 2016.

[4] L. Feinstein, H. Chowdry, and K. Asmussen. On estimating the fiscal benefits of early intervention. *National Institute Economic Review*, 240(1):R15–R29, 2017.

[5] F. Gardner, P. Leijten, J. Mann, S. Landau, V. Harris, J. Beecham, E.-M. Bonin, J. Hutchings, and S. Scott. Could scale-up of parenting programmes improve child disruptive behaviour and reduce social inequalities? using individual participant data meta-analysis to establish for whom programmes are effective and cost-effective. 2017.

[6] P. R. McCrone, S. Dhanasiri, A. Patel, M. Knapp, and S. Lawton-Smith. *Paying the price: the cost of mental health care in England to 2026*. King's Fund, 2008.

[7] M. Paulden and K. Claxton. Budget allocation and the revealed social rate of time preference for health. *Health Economics*, 5(21):612–618, 2012.

[8] J. van Aar, P. Leijten, B. O. de Castro, and G. Overbeek. Sustained, fade-out or sleeper effects? a systematic review and meta-analysis of parenting interventions for disruptive child behavior. *Clinical psychology review*, 51:153–163, 2017.