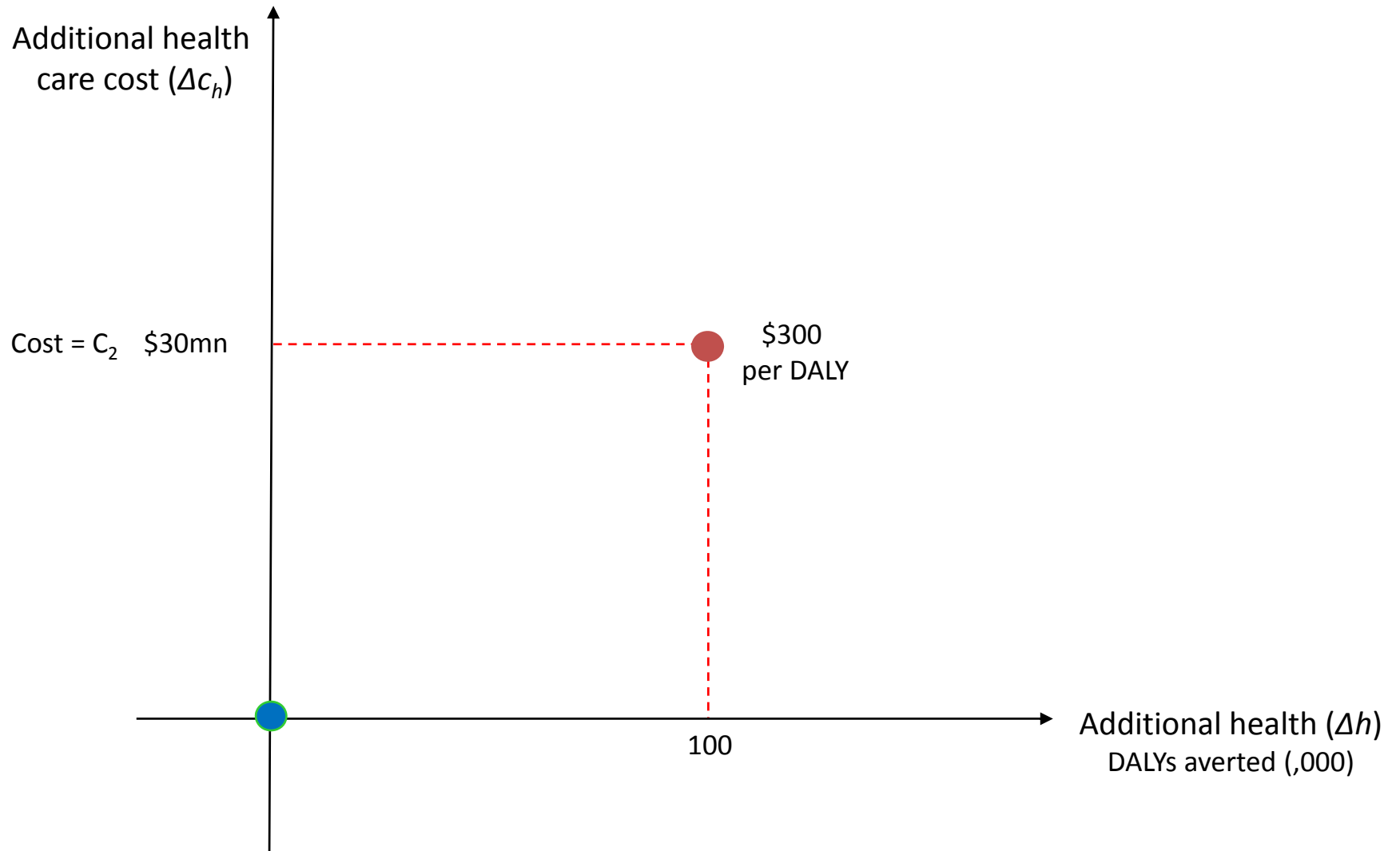


Accounting for the timing of costs and benefits in the evaluation of health projects relevant to LMICs

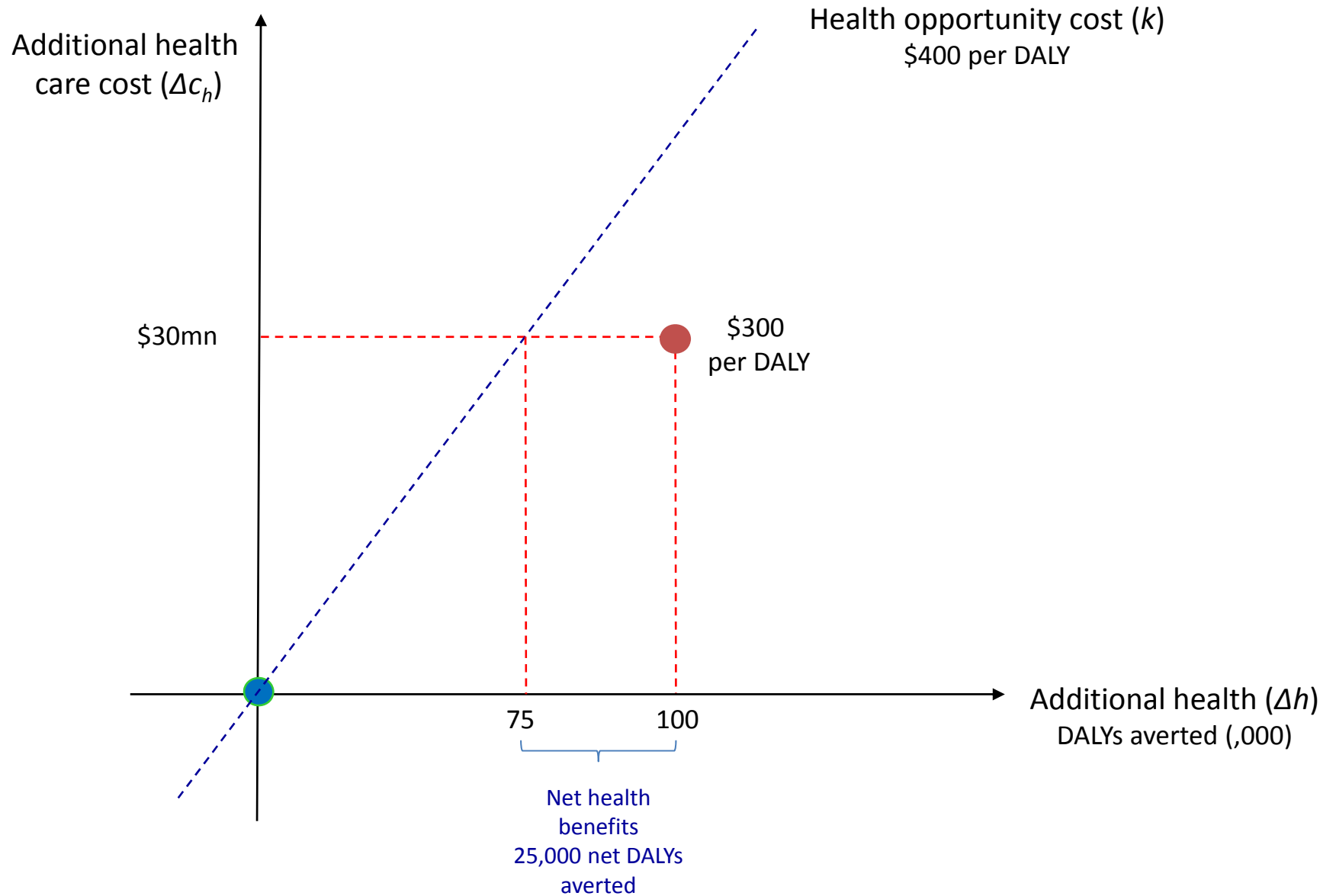
Karl Claxton

2/11/2017

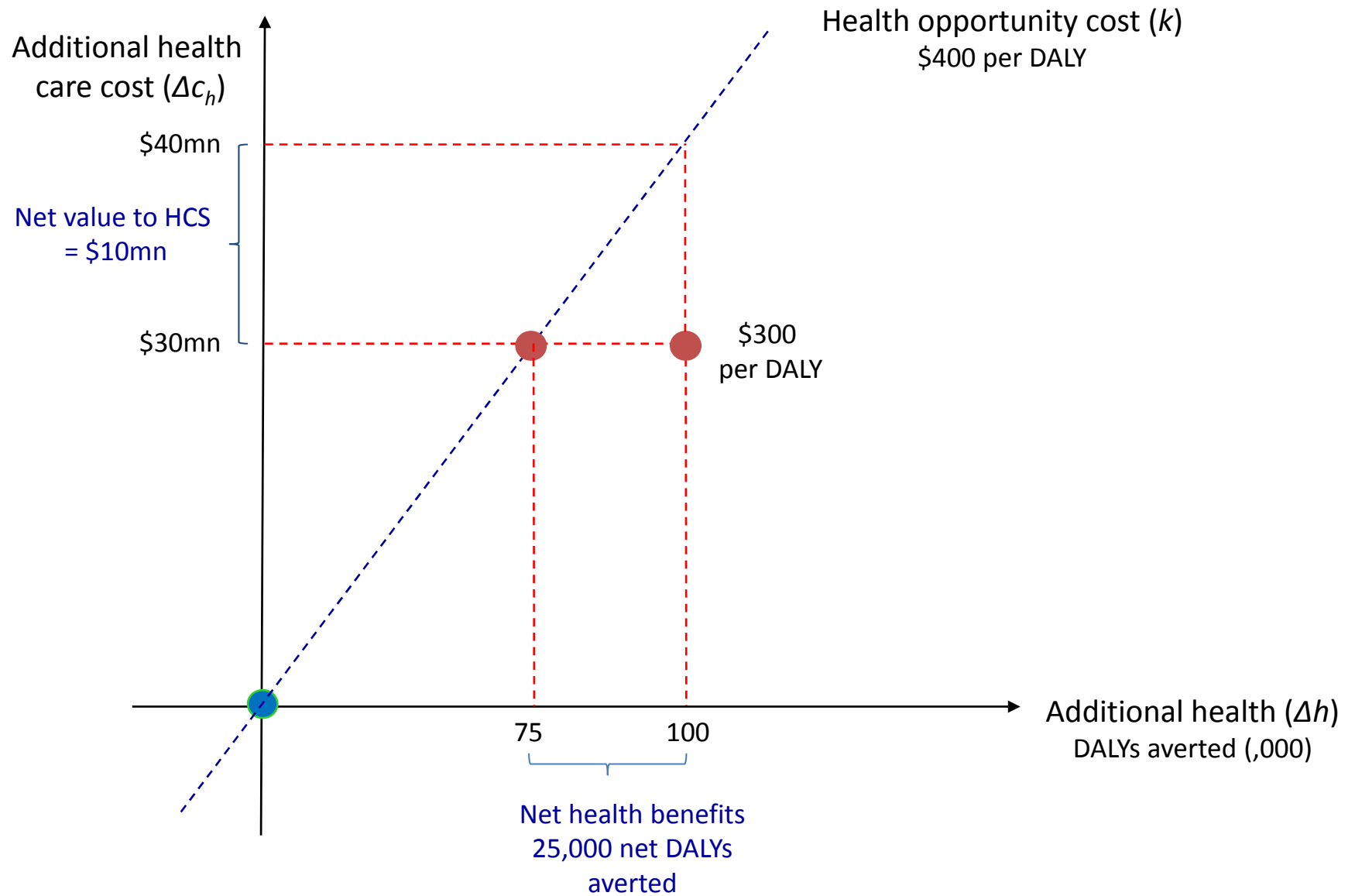
Project with health benefits and health care costs



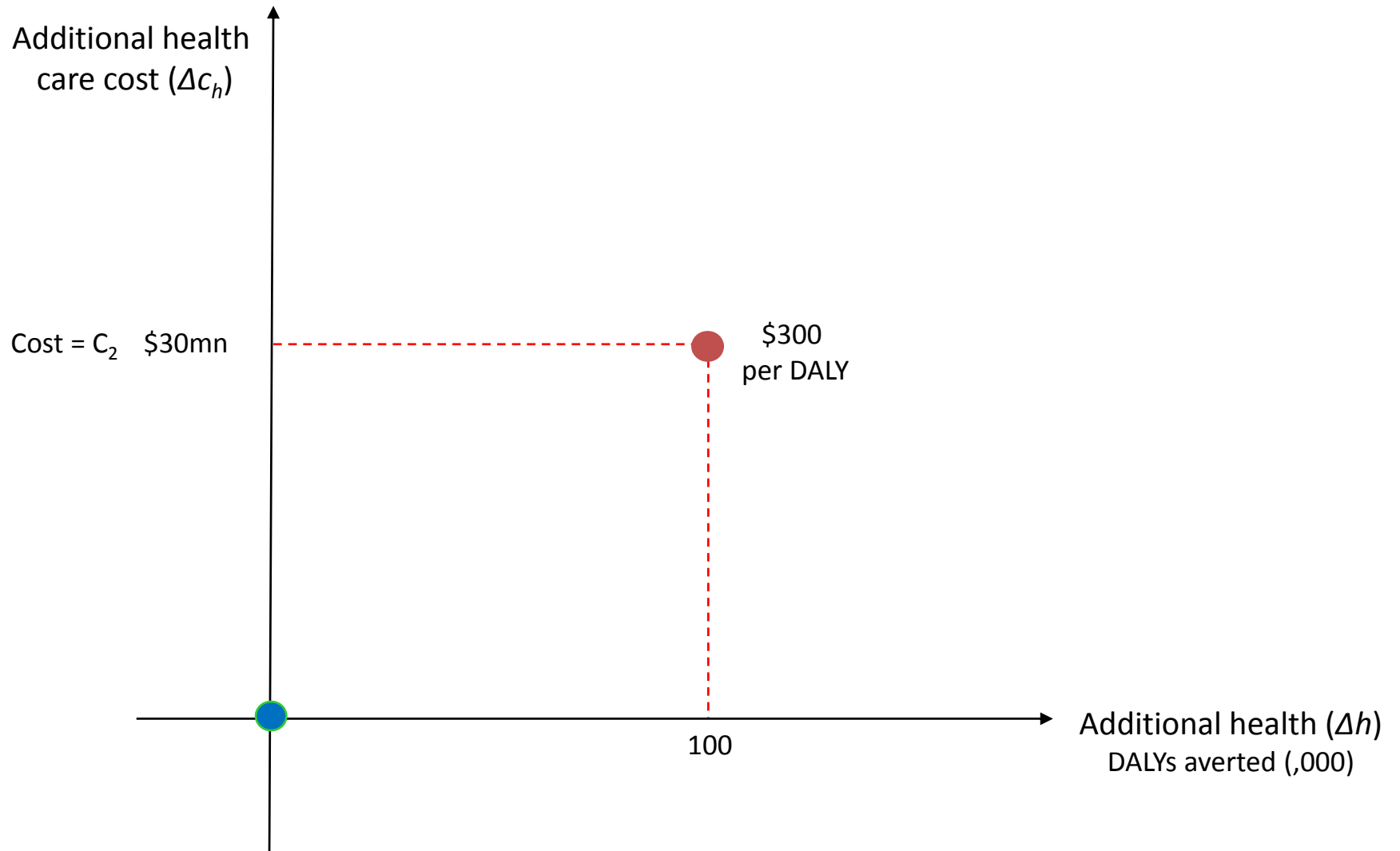
Project with health benefits and health care costs



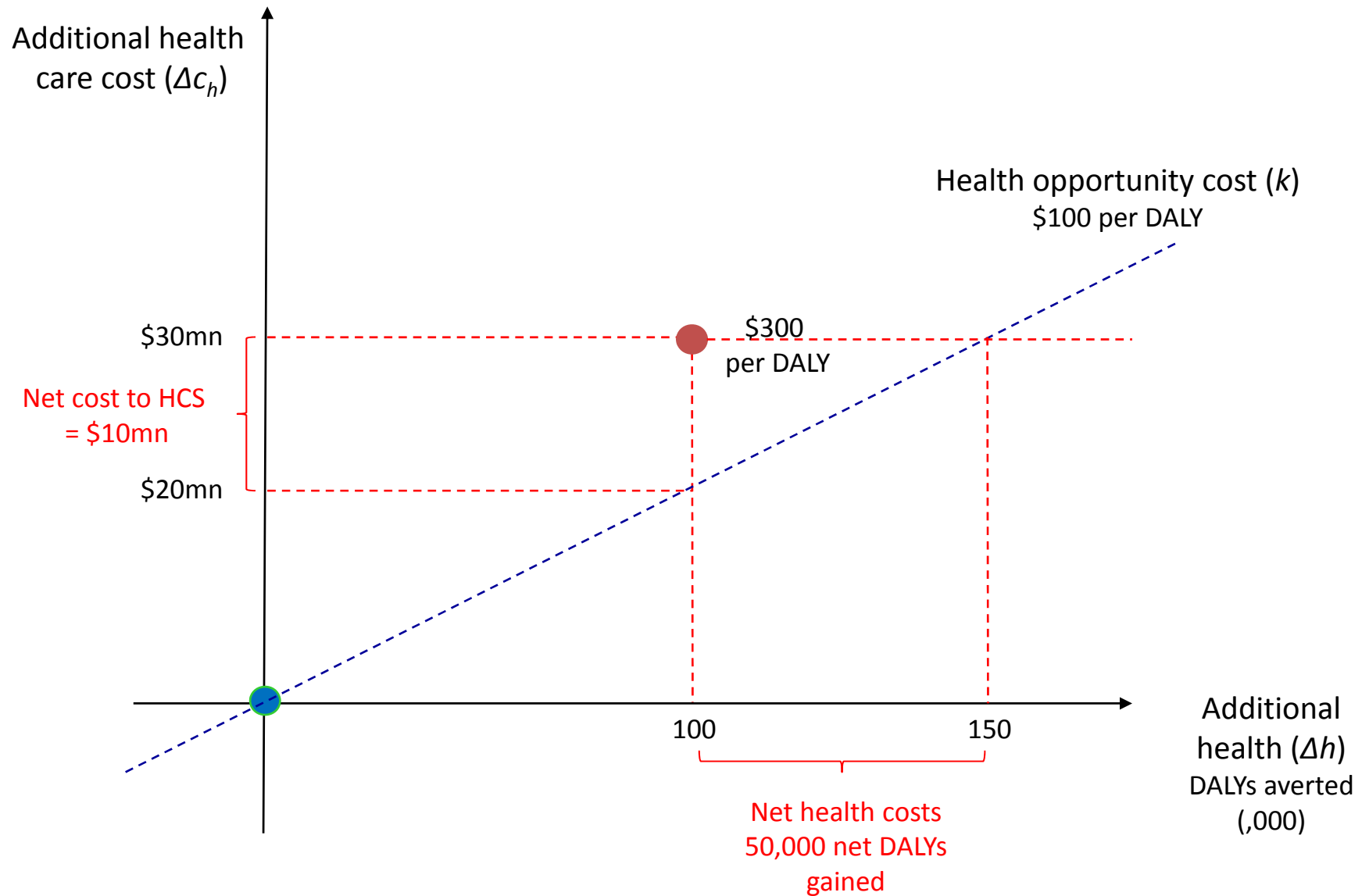
Project with health benefits and health care costs



Project with health benefits and health care costs



Project with health benefits and health care costs



Project with health benefits and health care costs

	Effects of the project							
(1)	(2)	(3)						
Time	Additional health benefits	Additional health care costs						
1	Δh_1	Δc_{h1}						
..						
t	Δh_t	Δc_{ht}						
..						
T	Δh_T	Δc_{hT}						

Project with health benefits and health care costs

Effects of the project		Health Effects					
(1)	(2)	(3)	(4)	(5)			
Time	Additional health benefits	Additional health care costs	Benefits	Costs			
1	Δh_1	Δc_{h1}	Δh_1	$\Delta c_{h1}/k_{h1}$			
..			
t	Δh_t	Δc_{ht}	Δh_t	$\Delta c_{ht}/k_{ht}$			
..			
T	Δh_T	Δc_{hT}	Δh_T	$\Delta c_{hT}/k_{hT}$			

Project with health benefits and health care costs

Effects of the project		Health Effects		Equivalent health care resources				
(1)	(2)	(3)	(4)	(5)	(6)	(7)		
Time	Additional health benefits	Additional health care costs	Benefits	Costs	Benefits	Costs		
1	Δh_1	Δc_{h1}	Δh_1	$\Delta c_{h1}/k_{h1}$	$k_{h1} \cdot \Delta h_1$	Δc_{h1}		
..		
t	Δh_t	Δc_{ht}	Δh_t	$\Delta c_{ht}/k_{ht}$	$k_{ht} \cdot \Delta h_t$	Δc_{t1}		
..		
T	Δh_T	Δc_{hT}	Δh_T	$\Delta c_{hT}/k_{hT}$	$k_{hT} \cdot \Delta h_T$	Δc_{hT}		

Project with health benefits and health care costs

Effects of the project		Health Effects		Equivalent health care resources		Equivalent consumption effects		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Time	Additional health benefits	Additional health care costs	Benefits	Costs	Benefits	Costs	Benefits	Costs
1	Δh_1	Δc_{h1}	Δh_1	$\Delta c_{h1}/k_{h1}$	$k_{h1} \cdot \Delta h_1$	Δc_{h1}	$V_{h1} \cdot \Delta h_1$	$V_{h1}(\Delta c_{h1}/k_{h1})$
..
t	Δh_t	Δc_{ht}	Δh_t	$\Delta c_{ht}/k_{ht}$	$k_{ht} \cdot \Delta h_t$	Δc_{t1}	$V_{ht} \cdot \Delta h_t$	$V_{ht}(\Delta c_{ht}/k_{ht})$
..
T	Δh_T	Δc_{hT}	Δh_T	$\Delta c_{hT}/k_{hT}$	$k_{hT} \cdot \Delta h_T$	Δc_{hT}	$V_{hT} \cdot \Delta h_T$	$V_{hT}(\Delta c_{hT}/k_{hT})$

Project with health benefits and health care costs

Effects of the project		Health Effects		Equivalent health care resources		Equivalent consumption effects		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Time	Additional health benefits	Additional health care costs	Benefits	Costs	Benefits	Costs	Benefits	Costs
1	Δh_1	Δc_{h1}	Δh_1	$\Delta c_{h1}/k_{h1}$	$k_{h1} \cdot \Delta h_1$	Δc_{h1}	$V_{h1} \cdot \Delta h_1$	$V_{h1}(\Delta c_{h1}/k_{h1})$
..
t	Δh_t	Δc_{ht}	Δh_t	$\Delta c_{ht}/k_{ht}$	$k_{ht} \cdot \Delta h_t$	Δc_{t1}	$V_{ht} \cdot \Delta h_t$	$V_{ht}(\Delta c_{ht}/k_{ht})$
..
T	Δh_T	Δc_{hT}	Δh_T	$\Delta c_{hT}/k_{hT}$	$k_{hT} \cdot \Delta h_T$	Δc_{hT}	$V_{hT} \cdot \Delta h_T$	$V_{hT}(\Delta c_{hT}/k_{hT})$

How should these streams be discounted?	$D_h = r_s + gk_h$	$D_h = r_s$	$r_c = \delta + \eta g_c$
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Effects on health, health care costs and consumption

Attributes	Investment ($\Delta c_h = \$30mn$)	Opportunity costs		Net effects
Health (,000 DALYs)	100			
Consumption costs (Δc_h)	-\$40mn			

Effects on health, health care costs and consumption

Attributes	Investment ($\Delta c_h = \$30\text{mn}$)	Opportunity costs		Net effects
Health (,000 DALYs)	100	k_h \$200 per DALY	150	-50
Consumption costs (Δc_h)	-\$40mn			

Effects on health, health care costs and consumption

Attributes	Investment ($\Delta c_h = \$30\text{mn}$)	Opportunity costs		Net effects
Health (,000 DALYs)	100	k_h \$200 per DALY	150	-50
Consumption costs (Δc_h)	-\$40mn	$k_c = 1$ HC\$ per consumption\$	-\$30mn	-\$10mn

- Is failing to avert 50,000 DALYs worth \$10mn of additional consumption benefits?
 - How much additional consumption are people willing to give up (accepts) to gain (lose) a unit of health (v_h)
 - This project is only worth while if v_h is less than \$200 per DALY

Effects on health, health care costs and consumption

	Effects of the project				
(1)	(2)	(3)	(4)		
Time	Additional health benefits	Additional health care costs	Consumption costs		
<i>1</i>	Δh_1	Δc_{h1}	Δc_{c1}		
..		
<i>t</i>	Δh_t	Δc_{ht}	Δc_{ht}		
..		
<i>T</i>	Δh_T	Δc_{hT}	Δc_{hT}		

Effects on health, health care costs and consumption

	Effects of the project			Effects on health	
(1)	(2)	(3)	(4)	(5)	
Time	Additional health benefits	Additional health care costs	Consumption costs	Net health benefits	
1	Δh_1	Δc_{h1}	Δc_{c1}	$\Delta h_1 - \Delta c_{h1} / k_{h1}$	
..	
t	Δh_t	Δc_{ht}	Δc_{ht}	$\Delta h_t - \Delta c_{ht} / k_{ht}$	
..	
T	Δh_T	Δc_{hT}	Δc_{hT}	$\Delta h_T - \Delta c_{hT} / k_{hT}$	

Effects on health, health care costs and consumption

	Effects of the project			Effects on health	Effects on consumption
(1)	(2)	(3)	(4)	(5)	(6)
Time	Additional health benefits	Additional health care costs	Consumption costs	Net health benefits	Net consumption costs
1	Δh_1	Δc_{h1}	Δc_{c1}	$\Delta h_1 - \Delta c_{h1} / k_{h1}$	$\Delta c_{c1} + k_{c1} \cdot \Delta c_{h1}$
..
t	Δh_t	Δc_{ht}	Δc_{ht}	$\Delta h_t - \Delta c_{ht} / k_{ht}$	$\Delta c_{ct} + k_{ct} \cdot \Delta c_{ht}$
..
T	Δh_T	Δc_{hT}	Δc_{hT}	$\Delta h_T - \Delta c_{hT} / k_{hT}$	$\Delta c_{cT} + k_{cT} \cdot \Delta c_{hT}$

Effects on health, health care costs and consumption

	Net effects		
(1)	(2)		
Time	Equivalent consumption effects		
1	$v_{h1}(\Delta h_1 - \Delta c_{h1}/k_{h1}) - (\Delta c_{c1} + k_{c1} \cdot \Delta c_{h1})$		
..	..		
t	$v_{ht}(\Delta h_t - \Delta c_{ht}/k_{ht}) - (\Delta c_{ct} - k_{ct} \cdot \Delta c_{ht})$		
..	..		
T	$v_{hT}(\Delta h_T - \Delta c_{hT}/k_{hT}) - (\Delta c_{cT} - k_{cT} \cdot \Delta c_{hT})$		

Effects on health, health care costs and consumption

	Net effects		
(1)	(2)	(3)	(4)
Time	Equivalent consumption effects	Equivalent health effects	Equivalent health care resources
1	$v_{h1}(\Delta h_1 - \Delta c_{h1}/k_{h1}) - (\Delta c_{c1} + k_{c1} \cdot \Delta c_{h1})$	$(\Delta h_1 - \Delta c_{h1}/k_{h1}) - (\Delta c_{c1} + k_{c1} \cdot \Delta c_{h1})/v_{h1}$	$k_{h1}((\Delta h_1 - \Delta c_{h1}/k_{h1}) - (\Delta c_{c1} + k_{c1} \cdot \Delta c_{h1})/v_{h1})$
..
t	$v_{ht}(\Delta h_t - \Delta c_{ht}/k_{ht}) - (\Delta c_{ct} + k_{ct} \cdot \Delta c_{ht})$	$(\Delta h_t - \Delta c_{ht}/k_{ht}) - (\Delta c_{ct} + k_{ct} \cdot \Delta c_{ht})/v_{ht}$	$k_{ht}((\Delta h_t - \Delta c_{ht}/k_{ht}) - (\Delta c_{ct} + k_{ct} \cdot \Delta c_{ht})/v_{ht})$
..
T	$v_{hT}(\Delta h_T - \Delta c_{hT}/k_{hT}) - (\Delta c_{cT} + k_{cT} \cdot \Delta c_{hT})$	$(\Delta h_T - \Delta c_{hT}/k_{hT}) - (\Delta c_{cT} + k_{cT} \cdot \Delta c_{hT})/v_{hT}$	$k_{hT}((\Delta h_T - \Delta c_{hT}/k_{hT}) - (\Delta c_{cT} + k_{cT} \cdot \Delta c_{hT})/v_{hT})$

Aggregating effects across countries or jurisdictions

Equivalent consumption effects across countries or jurisdictions			
	Country A	Country B	Country C
Effects in period t	$v_{h,t}^A \left[\Delta h_t^A - \frac{\Delta c_{h,t}^A}{k_{h,t}^A} \right] - \left[\Delta c_{c,t}^A + k_{c,t}^A \cdot \Delta c_{h,t}^A \right]$	$v_{h,t}^B \left[\Delta h_t^B - \frac{\Delta c_{h,t}^B}{k_{h,t}^B} \right] - \left[\Delta c_{c,t}^B + k_{c,t}^B \cdot \Delta c_{h,t}^B \right]$	$v_{h,t}^C \left[\Delta h_t^C - \frac{\Delta c_{h,t}^C}{k_{h,t}^C} \right] - \left[\Delta c_{c,t}^C + k_{c,t}^C \cdot \Delta c_{h,t}^C \right]$
Net present value	$\sum_{t=1}^T \frac{v_{h,t}^A \left[\Delta h_t^A - \frac{\Delta c_{h,t}^A}{k_{h,t}^A} \right] - \left[\Delta c_{c,t}^A + k_{c,t}^A \cdot \Delta c_{h,t}^A \right]}{(1+r_c^A)^t}$	$\sum_{t=1}^T \frac{v_{h,t}^B \left[\Delta h_t^B - \frac{\Delta c_{h,t}^B}{k_{h,t}^B} \right] - \left[\Delta c_{c,t}^B + k_{c,t}^B \cdot \Delta c_{h,t}^B \right]}{(1+r_c^B)^t}$	$\sum_{t=1}^T \frac{v_{h,t}^C \left[\Delta h_t^C - \frac{\Delta c_{h,t}^C}{k_{h,t}^C} \right] - \left[\Delta c_{c,t}^C + k_{c,t}^C \cdot \Delta c_{h,t}^C \right]}{(1+r_c^C)^t}$
Global net present value	$\sum_{t=1}^T \frac{v_{h,t}^A \left[\Delta h_t^A - \frac{\Delta c_{h,t}^A}{k_{h,t}^A} \right] - \left[\Delta c_{c,t}^A + k_{c,t}^A \cdot \Delta c_{h,t}^A \right]}{(1+r_c^A)^t} + \sum_{t=1}^T \frac{v_{h,t}^B \left[\Delta h_t^B - \frac{\Delta c_{h,t}^B}{k_{h,t}^B} \right] - \left[\Delta c_{c,t}^B + k_{c,t}^B \cdot \Delta c_{h,t}^B \right]}{(1+r_c^B)^t} + \sum_{t=1}^T \frac{v_{h,t}^C \left[\Delta h_t^C - \frac{\Delta c_{h,t}^C}{k_{h,t}^C} \right] - \left[\Delta c_{c,t}^C + k_{c,t}^C \cdot \Delta c_{h,t}^C \right]}{(1+r_c^C)^t}$		

Key quantity		Possible default estimates
Health opportunity costs of health care expenditure	k_{ht}	<ul style="list-style-type: none"> • Estimates for most LMICs for 2015 expenditure provide useful initial defaults • Initial projections of these estimates based on other published projections of health expenditure and consumption are also available • These initial country specific estimates can be refined and updated as other country specific estimates emerge, ideally using within country data where this is possible.
Consumption opportunity costs of health care expenditure	k_{ct}	<ul style="list-style-type: none"> • Default assumption of 1 (1\$ spent on health care delivers 1\$ in net production or consumption opportunities) • Default assumption that the real value of the net production effects of the health effects of changes in health expenditure will grow at g_c
Consumption value of health and its evolution over time	v_{ht}	<ul style="list-style-type: none"> • Estimating v_h (see other methods papers) • Evolution of v_{ht} based on growth in consumption (which is already required for r_c) and a default assumption about the income elasticity of demand for health. • A default assumption of an income elasticity of demand for health of 1 (v_{ht} would grow at g_c) • Alternative scenarios based on evidence that income elasticity is likely to differ.
Other sectors	v_{xt}/k_{xt}	<ul style="list-style-type: none"> • Default assumption that $v_{ht}/k_{ht} = v_{xt}/k_{xt}$ when considering impacts on public sectors
Time preference for consumption	r_c	<ul style="list-style-type: none"> • Default normative assumption $\delta = 0$ for social choices • Default assumption that $\eta = 1$, so $r_c = g_c$ (reported as expected growth in measures of national income per capita for that country). • Alternative scenarios based on evidence or reasoning of why η is likely to differ in specific contexts or different judgements about g_c • As evidence for values of η specific to LMICs evolves and estimates of economics growth are revised these defaults can be updated.

Key quantity	Possible default estimates
Catastrophic risk	<ul style="list-style-type: none"> • Exclude catastrophic risk from a common discount rate for consumption effects ($\delta=0$) • Elicited probabilities of truly catastrophic events ($\delta < 0.1\%$)
Project specific risks	<ul style="list-style-type: none"> • Project specific risks should be included in the analysis and how 'consumption equivalent' time streams of effects are estimated rather than in a project specific discount rate.
Macroeconomic risk and prudential saving	<ul style="list-style-type: none"> • No adjustment for macroeconomic risk for projects with time horizons less than 40 years • Longer time horizons or where macroeconomic risk is greater and increases more rapidly with term declining rates should be based only on the nonlinear effects of uncertainty • Since growth and uncertainty about that growth will be country specific any decline in r_c will necessarily be country specific. • Any declining rates for r_c should be based on an initial assumption of $\beta=1$ for all projects
Interaction of project specific and macroeconomic risk	<ul style="list-style-type: none"> • A qualitative indication of whether or not projects are likely to be strongly pro or counter cyclical should be provided • Further research is required on how the effects of these interactions might be best quantified for these types of project relevant to LMICs.

Key quantity		Further research
Health opportunity costs of health care expenditure	k_{ht}	<ul style="list-style-type: none"> • Continue to update and refine estimates based on cross country data • Refine projections based on the same estimates of g_c used for r_c • Encourage bespoke estimates based on within country data
Consumption opportunity costs of health care expenditure	k_{ct}	<ul style="list-style-type: none"> • Marshall existing micro and macro evidence to provide default estimates of the net consumption effects of changes in health by type of health effect (e.g., survival and disability but age and gender) and context (e.g., income, expected growth, region or country specific) • Seek estimates of the multiplier associated with health care expenditure compared to other sectors by context (e.g., income, expected growth, region or country specific)
Consumption value of health and its evolution over time	v_{ht}	<ul style="list-style-type: none"> • Continue to link how v_{ht} is likely to evolve to country specific estimates of future growth (i.e., g_c embedded in r_c) • Seek relevant evidence and refine estimates of income elasticity of demand for health and how it is likely to differ by context (e.g., income, expected growth, region or country specific)
Other constrained sectors	v_{xt}/k_{xt}	<ul style="list-style-type: none"> • Improved estimates of v_{ht}/k_{ht} (see above) will provide more secure shadow price for other sectors (x). • Directly estimating v_{xt} and k_{xt} might be a long term goal
Time preference for consumption	r_c	<ul style="list-style-type: none"> • Review theory and evidence (including revealed values from other social choices) of why η might differ in specific contexts (e.g., income, expected growth, region or other country specific characteristics) • Review existing estimates of median income and set out how its expected growth might be linked to current projections of economic growth • Advocate the routine reporting of expected growth in median income as well as per capita national income.

Key quantity	Further research
Catastrophic risk	<ul style="list-style-type: none"> Given availability of estimates and its modest contribution to a common discount rate for consumption effects further research is not a priority
Project specific risks	<ul style="list-style-type: none"> Encourage/demonstrate project analysis that attempts to characterisation of all sources of uncertainty relevant to the time stream of consumption effects Encourage/demonstrate how the consequences of this uncertainty can be embedded in estimates of the equivalent time stream of consumption effects
Macroeconomic risk and prudential saving	<ul style="list-style-type: none"> Review estimates of g_c relevant to LMICs and consider whether macroeconomic risk is greater and increases more rapidly with term so that declining rates maybe required for shorter terms in some circumstances Since growth and uncertainty about that growth will be country specific any decline in r_c will necessarily be country specific. Develop tools which will provide appropriate declining rates for r_c based on g_c, measures of uncertainty in g_c by term, η and an initial assumption of $\beta=1$ for all projects
Interaction of project specific and macroeconomic risk	<ul style="list-style-type: none"> Explain and demonstrate how a qualitative indication of whether or not projects are likely to be strongly pro or counter cyclical might be made Identify the circumstances where quantifying the interaction of project and macro risk is likely to be important in project choice (e.g., as well as pro/counter cyclical characteristics the impact of high and rapidly increasing macro and project risk and where costs and benefits of the project are not marginal wrt macro considerations) Demonstrate how this interaction might be best quantified (Betas estimated) for these types of project relevant to LMICs.