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PRACTICAL APPLICATION

Productivity Costs in Economic Evaluations: Past, Present, Future

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Abstract Productivity costs occur when the productivity of individuals is affected by illness, treatment, disability or premature death. The objective of this paper was to review past and current developments related to the inclusion, identification, measurement and valuation of productivity costs in economic evaluations. The main debates in the theory and practice of economic evaluations of health technologies described in this review have centred on the questions of *whether* and *how* to include productivity costs, especially productivity costs related to paid work. The past few decades have seen important progress in this area. There are important sources of productivity costs other than absenteeism (e.g. presenteeism and multiplier effects in co-workers), but their exact influence on costs remains unclear. Different measurement instruments have been developed over the years, but which instrument provides the most accurate estimates has not been established. Several valuation approaches have been proposed. While empirical research suggests that productivity costs are best included in the cost side of the cost-effectiveness ratio, the jury is still out regarding whether the human capital approach or the friction cost approach is the most appropriate valuation method to do so. Despite the progress and the substantial amount of scientific research, a consensus has not been reached on either the inclusion of productivity costs in economic evaluations or the methods used to produce productivity cost estimates. Such a lack of consensus has likely contributed to ignoring productivity costs in actual economic evaluations and is reflected in variations in national health economic guidelines. Further research is needed to lessen the controversy regarding the estimation of health-related productivity costs. More standardization would increase the comparability and credibility of economic evaluations taking a societal perspective.

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Key Points for Decision Makers

- Despite their strong impact on cost-effectiveness outcomes, productivity costs are ignored in the majority of economic evaluations
- Productivity costs related to unpaid labour have received relatively little attention in the scientific literature
- Common standards regarding the inclusion, identification, measurement and valuation of productivity costs are lacking

1 Introduction

Economic evaluations are increasingly used to aid decision makers in allocating scarce healthcare resources. Given the direct influence the results of economic evaluations may have on healthcare decisions, ensuring a sound methodology is critical. Many fierce debates regarding the methodology of economic evaluations are ongoing. Importantly, these debates normally do not relate to the methodological choices that marginally affect the final outcomes of economic evaluations. In many cases, their influence can be

Table 1 Important issues relating to the estimation of productivity costs within economic evaluations

Issues	Main questions	A selection of literature discussing these issues
Inclusion of productivity costs	Should productivity costs be included in economic evaluations?	
Ethics	Is it ethical to include productivity costs?	[10, 11]
Perspective	Which perspective should be taken in economic evaluations?	[2–4, 12–15]
Relevance	Is including productivity costs relevant?	[16–20]
Identification	How can health-related productivity changes be identified?	
Input and output	How do health changes affect productive input and output?	[21, 22]
Paid and unpaid labour	How can and should productivity changes in paid and unpaid labour be identified?	[17, 21, 23–25]
Ill workers and co-workers	How can the effects of productivity changes on co-workers be identified?	[26–28]
Measurement	How can productivity changes best be measured?	
Data collection	How and when should data on productivity be collected?	[9]
Content of instruments	Which productivity-related information should be collected?	[9, 29, 30]
Availability of instruments	Which instruments are available and how good is their performance?	[31–33]
Indirect measurement	Is it possible to adequately measure productivity changes indirectly?	[34–36]
Valuation	How can productivity changes best be valued?	
Approach: theory	Which valuation approach should be applied?	[8, 22, 37–44]
Approach: empirical	Are income effects already captured in the QALY?	[45–52]
Values	Which values should be placed on productivity changes?	[21, 53]
Reporting outcomes	How should productivity cost estimates be reported in economic evaluations?	[15, 19]

profound. Examples of such debates [1–7] relate to the normative foundations of economic evaluations, the perspective of economic evaluations (i.e. what costs and benefits to include), how to discount future costs and benefits, and the nature and height of the threshold used in judging cost-effectiveness results. One area of debate closely related to the appropriate perspective of economic evaluations is the inclusion of productivity costs and the methodologies used to measure and value them. Productivity costs can be defined as the costs associated with paid and unpaid production loss and replacement due to illness, disability or the deaths of productive persons [8]. The main debates in the theory and practice of economic evaluations of health technologies have centred on *whether* and *how* to include these costs, especially those related to paid work.

Several important topics regarding the questions above have been recently reviewed and discussed by Zhang et al. [9], who pointed out "more attention should be paid to the methodologies of measuring and valuing productivity loss", since many concerns regarding productivity costs are yet to be resolved. Table 1 presents a summary of the important questions addressed in the literature and a selection of literature references pertaining to them, highlighting the attention the topic has received.

In this review, we focus on the past and current developments related to the inclusion of productivity costs and address their inclusion in economic evaluations. This highlights how the debates in this area have evolved and where we currently stand in the theory and practice of including productivity costs in economic evaluations. The objectives of this paper are to (1) discuss the main debates and developments regarding the inclusion, identification, measurement and valuation of productivity costs; (2) summarize the most topical unresolved issues regarding productivity costs in economic evaluations;[1] and (3) encourage future research in this area.

2 Should Productivity Costs Be Included in Economic Evaluations?

2.1 Ethical Concerns

Some authors (e.g. Williams [10] and Olsen and Richardson [11]) have raised concerns regarding the equity implications of including productivity costs in economic evaluations. One issue is that healthcare programmes aimed at productive people (especially in exchange for pay) can produce substantial societal gains due to improved productivity. Inclusion of these costs would therefore result in more

[1] This review generally focuses on issues regarding productivity cost estimation in economic evaluations conducted to inform (national) decision makers regarding the relative cost effectiveness of new health interventions. Some of the topics discussed may therefore not fully relate to, for instance, the US healthcare system, where employers are significant purchasers of healthcare.

favourable cost-effectiveness results for interventions aimed at employed persons than those aimed at the unemployed or retirees.[2] This could, in turn, lead to fewer resources allocated to interventions aimed at unemployed individuals, which could be considered inequitable.

However, the complete exclusion of costs based on equity considerations seems problematic, since many types of costs (including medical) may be perceived to 'discriminate' between different groups (e.g. young and old). Therefore, health decision makers have to balance the desirable effects of freeing additional resources due to productivity gains with the equity implications of including productivity costs. As recommended (e.g. by Brouwer et al. [15] and Pritchard and Sculpher [17]), final cost-effectiveness ratios may be best presented with both scenarios, i.e. with and without productivity costs. Moreover, as recently argued [54], equity considerations should have a prominent place in deliberations on final policy decisions based on the results of economic evaluations.

2.2 Perspective

The debate on including or excluding productivity costs in an economic evaluation is closely related to the issue of the appropriate perspective to take in economic evaluations and (therefore) the relevant decision context and decision rule [2]. Two prominent perspectives are the healthcare perspective and the societal perspective.

The important normative choice between these perspectives relates to the context of economic evaluations (e.g. healthcare) and the objective(s) of the decision maker. (See Claxton et al. [2] and Brouwer et al. [15] for more elaborate discussion.) If we assume that economic evaluations are to inform a decision maker with the aim of maximizing health from a given healthcare budget, costs falling outside of that budget (and non-health benefits) can be left out of the evaluation. Such economic evaluations performed from a healthcare perspective, therefore, do not include productivity costs. Influential textbooks [13, 14], however, suggest that taking a broader, societal perspective in economic evaluations is appropriate. Such thinking furthermore seems to align with the welfare economic roots of economic evaluations [55]. Adopting a societal perspective, all costs and effects directly or indirectly induced by the intervention are incorporated (when significantly present) in the evaluation, *regardless of where the burden (or benefit) falls* [14]. This relates to the decision maker's broader underlying objective of maximizing social welfare [3]. When adopting such a perspective, productivity costs are clearly relevant and should be included in the evaluation.

While the discussions regarding the appropriate perspectives are ongoing at the theoretical level, different viewpoints have been employed in practice. For instance, when investigating the various national guidelines for (pharmaco-)economic evaluations, we notice that many countries (e.g. the UK [57], Belgium [56], New Zealand [86]) require analysts to take a narrower, healthcare perspective, encouraging analysts to ignore costs outside the healthcare sector, such as productivity costs (or at least not to report them). Other countries (e.g. Sweden [58] and The Netherlands [59]) do prescribe a societal perspective and thus require analysts to consider productivity costs whenever relevant.

Brouwer et al. [15] proposed a two-perspective approach as a new standard in economic evaluations, whereby the cost-effectiveness ratios from *both* the healthcare and the full societal perspective are presented. Such an approach would highlight discrepancies (i.e. when an intervention is deemed cost effective from a societal perspective but not from a healthcare perspective and vice versa) that inspire further attention. The approach also allows decision makers to attach more weight to some costs than to others. In some ways, the suggestion aligns with recent work on appropriate perspectives [2] in the sense that costs outside the healthcare sector could be accounted for but weighted differently.

The two-perspective approach is already recommended in several national health economic guidelines (e.g. Italy [60] and Norway [61]). Moreover, numerous country guidelines prescribing a healthcare perspective for the base-case analysis allow presenting results from additional perspectives. Whether and how this affects (or improves) decision making, however, remains unclear. In general, balancing outcomes from evaluations using different perspectives may be a demanding task for decision makers, since it requires determining which costs and savings outside the healthcare system are important, and whether and how these costs can be directly or indirectly transferred into healthcare funds.

2.3 Relevance

While systematically ignoring productivity costs seems hard to defend, their inclusion is not necessarily influential. In general, the inclusion of productivity costs related to paid work is especially relevant when the intervention is targeted at patients of working age or younger patients whose future productivity is at stake.[3] Moreover, productivity cost inclusion is only relevant if an intervention

[2] Note that the inclusion of productivity costs does not necessarily lower cost-effectiveness estimates or favour interventions for productive individuals [17–20].

[3] Whether it is relevant to include potential effects on future productivity depends on the valuation approach. If the friction cost approach is adopted, these costs normally need not be included, since they will commonly fall beyond the friction period. Their inclusion is important, however, when using the human capital approach.

indeed affects patients' work ability and, in turn, productivity. Interventions may not affect productivity in cases involving very mild conditions (patients continue to work) or very severe conditions (patients are not able to work before and after treatment). Finally, for productivity costs to affect incremental cost effectiveness, the intervention and comparator should affect productivity differently. If we can reasonably expect cost-effectiveness outcomes to be unaffected by productivity costs, they can be ignored even when adopting a societal perspective [20].

Hence, in some cases, productivity cost inclusion seems irrelevant. However, a decision to exclude productivity costs in an economic evaluation should be taken with caution. Several studies have shown that, if the ability of productive, working-age individuals to work is indeed affected, the choice of including or excluding productivity costs in economic evaluations can strongly influence both incremental costs and incremental cost effectiveness [16–18, 20]. Nyman [37] has recently suggested that excluding productivity costs in the friction cost approach[4] may not substantially bias incremental cost-effectiveness estimates since "under the frictional approach, the omitted costs are likely to be relatively small". We urge caution here, since it seems that in practice such biases can still be considerable. Krol and colleagues have shown that, even with the more conservative friction cost estimates, productivity costs on average reflected 23 % of total costs in studies considering expensive drugs administered in a hospital setting [20] and 56 % among interventions targeted at depressive disorders [19]. The precise impact of productivity cost inclusion varied strongly in individual economic evaluations, both as a fraction of total costs and in incremental cost-effectiveness outcomes. Nevertheless, the strong potential impact of productivity costs on cost-effectiveness outcomes confirms that structurally ignoring them may lead to suboptimal decision making (in terms of welfare) and inefficient use of societal resources.

In summary, while there may be reasons for decision makers to assign different weights to productivity costs depending on where they fall, a case for their full and systematic exclusion is hard to defend. The question of *how* these costs need to be included is then the relevant one.

3 Identification of Factors Influencing Productivity Costs

3.1 Paid Labour

In the context of the identification of paid labour, several aspects need to be addressed. Further information on these (and some other) aspects is provided in Table 2.

3.1.1 Absenteeism

Traditionally, patients having paid work *and* experiencing absenteeism due to illness, disability or premature death would be a reason to consider productivity costs in economic evaluations. Absenteeism from paid work clearly represents a major source of productivity costs as emphasized in the literature [19].

3.1.2 Presenteeism

Reduced productivity at work, also called presenteeism, can be important. Presenteeism may occur without absenteeism, but can also precede absenteeism (e.g. a progressive illness whose onset is mild) or follow absenteeism (e.g. a partial recovery that allows a return to less productive work) [34]. For some illnesses (e.g. depression or migraine) presenteeism may be particularly important and may, in fact, be more important (cost-wise) than absenteeism. Moreover, we should note that presenteeism (and its related costs) may be more prominent in situations where sickness benefits are limited, since employees may be reluctant to call in sick in order not to lose income.

3.1.3 Compensation Mechanisms

Not all reduced productivity results in reduced production. Compensating for lost work is quite common [29, 62, 63]. For instance, an ill worker may compensate for lower productivity in normal or extra hours (potentially after returning to work); colleagues may take over some or all tasks (in normal or additional hours); and new personnel may be hired to compensate for losses. Compensation mechanisms (even those involving compensation during normal work hours) are not costless, but little is known about their actual costs.

3.1.4 Multiplier Effects

Productivity losses in one individual may negatively affect co-workers' productivity in case of team-dependent production. The productive output of a full team can be jeopardized by one member's illness. This is especially relevant when substitutes are less equipped or unavailable. The effect of ill health on co-workers' productivity ('the multiplier effect' [26–28]) can be non-negligible.

3.2 Unpaid Labour

That productivity costs involve costs related to paid *and* unpaid labour is often ignored. Productivity costs related to unpaid work are rarely included in economic evaluations and, as a consequence, have little influence in decision-

[4] Valuation approaches are further discussed in Sect. 5 of this review.

Table 2 Glossary of some key productivity cost terms

Identification of productivity losses	
Absenteeism	Not attending work
Presenteeism	Diminished functioning (in terms of quantity and/or quality) while attending work
Unpaid productivity/labour	"All productive activities outside the official labour market" [64], e.g. volunteer work, household activities and taking care of children
Compensation mechanisms	The ways in which lost productivity is compensated for, e.g. substitutes are hired to replace ill workers or work is postponed
Multiplier effects	Productivity losses related to the effects of an ill employee's diminished productivity on co-workers' productivity, e.g. if a surgeon is not able to perform surgery, the whole operating team cannot function
Valuation of paid labour	
Human capital approach	With this approach, all potential production not performed by a person because of morbidity or early mortality is counted as production loss
Friction cost approach	With this approach, calculated production losses are limited to the friction period: the time needed to replace an ill employee and train a new employee
US Panel approach	With this approach, the effect of ill health on productivity is valued within the QALY as the effect of reduced income on quality of life
Valuation of unpaid labour	
Replacement cost method/proxy good method	With this method, unpaid labour is valued based on the time it would take others to perform the tasks normally performed by the ill individual. The value of this time is determined by the costs of hiring a paid worker to perform these tasks
Opportunity cost method	With this method, the value of time spent on unpaid work is set equal to the value of spending this time on competing use of time, e.g. paid labour

making processes. From a societal viewpoint, productivity losses related to unpaid labour are important. Swiebel [64] defines unpaid work as "all productive activities outside the official labour market done by individuals for their own households or for others"; *inter alia*, this includes household work, caring for significant others and volunteer work. Productivity costs related to unpaid work may result from a loss of unpaid production or replacement costs. Little is known about lost unpaid work involving absenteeism and presenteeism. Along with the growing relevance of interventions targeted at the elderly, unpaid productivity should have a more prominent role in economic evaluations.

4 Measurement

4.1 Paid Productivity

A sound estimation of productivity costs requires sound measurement of the relevant identified components. Unfortunately, there is an apparent lack of standardization of measurement methods for productivity costs and no consensus on the best instruments to reliably capture changes in productivity. Ideally, information is also gathered on the effects of productivity changes on co-workers and the relevance and costs of compensation mechanisms. When using the friction cost method (see Sect. 5), total absenteeism, its frequency and the duration of each separate period of absenteeism must be captured.

Actual, objective measurement of productivity changes (absenteeism and presenteeism) at the work sites of the relevant individuals is normally impossible in the context of health economic evaluations. Commonly, individuals are required to self-assess diminished productivity in terms of absenteeism and, occasionally, presenteeism. The reliability of such measures has not been adequately tested [65].

Many instruments for self-completion have been developed to measure health-related productivity changes. Selecting an appropriate instrument among those available is challenging [31]. Empirical research has shown that the use of different instruments can lead to large differences in outcomes [66]. Such differences are worrying, since they seriously hamper the comparability of productivity cost outcomes and can lead to justifiable doubt regarding the validity of productivity cost estimates. Differences in outcomes secondary to instrument choice are likely to be influenced by how questions are framed and the applied recall period. Zhang et al. [9] pointed out in a recent review that the outcomes of scientific research on the appropriate recall period for absenteeism and presenteeism are inconclusive. Still, given the available evidence, these authors recommended applying a 3-month recall period for questions regarding absenteeism and a 1-week time period for questions relating to presenteeism. [9] The feasibility of different time frames within one questionnaire for self-completion, however, deserves attention.

It is not clear which of the currently available instruments provides the best estimates of absenteeism and presenteeism [9]. Most instruments focus on a particular aspect of productivity losses, such absenteeism. Other, typically more recently developed instruments capture diminished productivity related to both presenteeism and absenteeism (Reviews of productivity instruments can be found elsewhere [31–33]). Few instruments (e.g. The Health and Labor Questionnaire [67]) seem to include the measurement of unpaid productivity losses by, for instance, questioning the ability to perform household tasks. Furthermore, the validity of the answers to such questions has rarely been investigated.

Zhang et al. [68] recently developed a new productivity cost questionnaire, which seems to be the first to combine absenteeism, presenteeism, paid and unpaid labour, job characteristics, compensation mechanisms, and team dynamics. While being the most comprehensive instrument to date, to our knowledge, its validity needs to be explored further.

Some elements relevant to productivity costs, especially compensation mechanisms and multiplier effects, are inherently difficult to measure by self-completed questionnaires. Ill employees may not have sufficient knowledge of how their health problems affect team output and how their diminished productivity is compensated for. Previous research [62] has indicated that ill employees and their supervisors appear to provide different answers to questions on how health-related absenteeism is compensated. Regarding the effects of illness on co-workers and team output, some attempts have been made to construct 'job-dependent multipliers' that take account of the (average) effect of co-worker absenteeism and presenteeism in specific job types. The idea behind them—which is worthy of future research—is that, if the multipliers are robust and transferable, it would be possible to include the effects on co-workers in economic evaluations solely based on information about the ill worker's job type. Investigating how the compensation of health-related productivity losses interacts with the effects of the losses on co-workers' productivity is also important.

Another measurement difficulty is deciding on how often to repeat measurement. The appropriate frequency obviously depends on the type of intervention and when and how often changes in productivity are expected. A trade-off must be made between the costs of measurement, study compliance, and accuracy of outcomes. Accuracy is likely to increase with the number of measurements but this is at the expense of the evaluation costs and patient burden, the latter of which is likely to negatively affect compliance rates. In this light, it is important to note that it is unclear how to estimate productivity when measurement gaps exceed the recall period.

4.2 Unpaid Productivity

Two approaches seem the most commonly used in measuring health-related productivity changes in the context of unpaid labour [13, 14]. The first measures the changes in time spent on unpaid labour and the second measures the additional time others spend on unpaid labour tasks not performed by the patient due to illness. Both approaches have difficulties. In the first, distinguishing between the time spent on unpaid labour and leisure time is challenging. Time spent with one's children, for example, may be considered leisure time but it is also childcare; should the parent become ill someone else would have to look after them, a task that, at least in part, could be considered unpaid work. In 1934, Reid [69] introduced the 'third-person criterion', whereby all output replaceable by a third person can be considered unpaid labour. Elements people cannot take over (e.g. the enjoyment of playing tennis) are then considered leisure. The distinction is useful, but can be difficult to apply in practice. Tasks such as caring for children especially may involve elements of both leisure and unpaid labour, which may be difficult to disentangle.

This difficulty is avoided to some extent by applying the second approach, measuring the time spent by others who take over the patient's unpaid work. In that case, however, all tasks that are simply forgone or later compensated for remain unvalued, potentially leading to an underestimation of productivity loss related to unpaid labour. A solution may be to ask patients how much time others would have to spend to perform all lost activities, rather than how much time others actually did spend taking over tasks. To date, clear guidance and sufficient knowledge on how unpaid labour changes can be best measured is lacking, introducing another potential for undesirable variation in measurement.

4.3 Indirect Estimation

A practical concern associated with productivity cost measurement is that collecting all the required information relating to productivity changes might not be feasible. Researchers are sometimes fully dependent on retrospective data or data collection within clinical trials that do not include questions concerning patients' productivity. In these situations, published estimates of previous studies are occasionally used (if available), but productivity costs largely seem to be ignored under such circumstances [17, 19, 20, 70, 71]. One partial remedy is to indirectly estimate productivity losses based on other available patient information, especially quality-of-life measures, which have been shown to be significantly associated with productivity [35]. In a recent exploration of this possibility, the results of a study by Krol et al. [36] were promising, but require additional confirmation. Applying prediction models to estimate productivity losses in cases where no actual data are available may be preferable to ignoring the effect of illness on productivity. Whether it is possible to predict productivity related to unpaid work based on quality-of-life data has not yet been explored.

5 Valuation

5.1 Valuation Approaches of Lost Paid Work

Valuation methods for productivity have been fiercely debated in the health economic literature. Early work on the valuation of reduced productivity was based on the theory of human capital [72] whereby, in the case of total non-productivity due to illness, the relevant value of the production loss was assumed to equal the present value of all lost future earnings of the individual. That is, income acts as a proxy for the production value of the individual and all production not produced by this person is counted as production loss. This obviously produces relatively large estimates of productivity costs in the case of long-term absenteeism, disability and premature death. Consider, for instance, a person who would have retired at age 65 years but dies at age 35 years from acute heart failure. Applying a lifetime time horizon, the human capital approach then counts all the lost production time (i.e. from age 35 to 65 years) to calculate productivity costs and commonly multiplies it with the expected average annual wage rate. For an annual wage of €40,000, for example, the total value of lost productivity would be 30 × €40,000, or €1,200,000 (without discounting).

The very high valuations resulting from the human capital approach induced important criticism [38, 73–75]. The approach was importantly challenged by Koopmanschap and van Ineveld [73], who argued that it does not take into account the existence of involuntary unemployment. In reality, ill workers are often replaced by healthy (unemployed) persons. In that case, Koopmanschap and van Ineveld [73] argued, productivity losses due to long-term absence would be limited to the 'friction period', or the period it takes to replace the ill worker with a formerly unemployed person and, hence, to restore production to its initial level. Production losses and transaction costs (related to advertising, hiring, training, etc.) occur during the friction period only. Moreover, since a reduction in labour time is often assumed to cause a less than proportional decrease in production, Koopmanschap et al. [22] originally proposed the application of an elasticity factor of 0.8, which is often used in empirical studies employing the friction cost approach. Productivity costs using this method are commonly lower than those using the human capital approach, especially in the case of long-term absence [19, 20].

The friction cost approach was subsequently criticized by proponents of the human capital approach [43, 76]. Important criticisms were that it lacked a sound theoretical underpinning and would render leisure time valueless. Although an unemployed person replacing the ill worker sacrifices leisure time to perform paid work, the friction cost approach gives it no value. Friction cost proponents indicated that leisure was not treated as 'costless', but rather that gains and losses of leisure at a societal level even out between the sick worker and the replacing worker. Moreover, differences in the ability to enjoy leisure time are commonly valued in terms of quality of life [42, 44]. Although the debate between proponents of the two approaches is likely to continue, Nyman [37] recently concluded on theoretical grounds that "to be consistent with the societal perspective … frictional accounting of productivity costs should be adopted rather than the human capital accounting".

This recommendation, made especially for the US context, was important, since during the debate between proponents of the two approaches in the 1990s, the US Panel on Cost-Effectiveness in Health [14] implicitly criticized both by advocating the inclusion of productivity costs[5] in economic evaluations as *effects* rather than costs. The Panel suggested that the effect of disease on productivity is (and should be) valued through a preference-based measure of health like the QALY as health effects [14]. They moreover indicated that respondents in health state valuations underlying QALY calculations would consider the effects on productivity and income when valuing health states, unless explicitly instructed otherwise. This implies that any additional monetary valuation of the impacts on productivity would be double-counting.

The US Panel method was criticized soon after it was proposed. It was suggested that its estimates would be unreliable, since people may be unable to translate a hypothetical health state, described in a health state valuation exercise, into an estimate of productivity. Moreover, the link between productivity and income on an individual level is weak because of private and social security systems [40, 77]. In spite of the theoretical criticisms of the US Panel approach, the suggestion of double-counting when also applying the human capital or friction cost approach could not be easily rejected. Further empirical research followed and is discussed in the next section.

[5] Obviously, the term productivity *costs* is less appropriate if lost productivity is valued in terms of effects instead of costs.

5.1.1 Empirical Evidence and the Theoretical Debate

An important issue in the US Panel method was the assertion that individual respondents would include income consequences of reduced productivity as a result of poor health in their valuations of health states, for instance, when answering common time trade-off questions. This issue initiated empirical studies focusing on whether respondents in health state valuations indeed consider income changes and, if so, how it affects valuations.

Recently, Tilling et al. [78] reviewed the seven studies thus far published on the topic, which varied substantially in design and approach. Their review indicated that, while a non-negligible minority of respondents may indeed include income changes in health state valuations when not explicitly instructed not to do so, inclusion did not appear to significantly affect health state valuations. Tilling et al. [78] concluded that this evidence suggests that the US Panel method is not a reliable valuation method for productivity costs. This underlines the theoretical criticism it received. Moreover, in terms of the risk of double-counting, Tilling et al. [78] indicated that: "the evidence seems to suggest that population value sets derived using generic instruments such as the EQ-5D are not noticeably influenced or 'polluted' by income effects and therefore can be used alongside monetary valuation methods of productivity costs, as well as in contexts where income effects are to be excluded from the analysis completely". Although they indicated that more research is warranted to fully exclude the risk of double-counting, it seems that a monetary valuation method (human capital or friction cost) is necessary to adequately value productivity costs and can be used in combination with conventional health state valuations. Nyman [37], after considering these issues, recently proposed to change US guidelines and move away from the US Panel approach. He moreover suggested explicitly instructing respondents in health state valuation exercises to assume income would *not* be affected by illness. Since empirical evidence suggests that spontaneous inclusion of income effects does not seem to affect health state valuations, [78] it is uncertain whether such explicit instruction (which may unintentionally overemphasize income in health state valuations) [53] results in 'better' health state valuations. Future research is thus required.

The debate between the proponents of the human capital and friction cost approaches has generated less empirical research, partly related to the debate's more fundamental differences that render empirical research difficult at best. For example, the existence of involuntary unemployment may be undisputable, but it need not be viewed as complete evidence that the friction cost approach is appropriate. More empirical research, such as on exactly how firms replace ill workers, where they are recruited from, and what it implies for the friction period (one period or a chain of periods), would be an important area for future research. It is, moreover, important to have estimates of the transaction costs for the replacement of employees, since they can be substantial [79]. In addition, for most countries, the appropriate friction period to apply is unknown. Without establishing (and regularly updating) these data, an accurate calculation of productivity costs is hampered.

5.2 Other Valuation Issues

Common standards regarding the appropriate operationalization of valuation methods are lacking, resulting in practice variation even between studies claiming to use the same method. An important source of variation is the exact value attached to lost time from work. In published economic evaluations, values have been based on, for example, the employees' added value to the firm, the employees' gross income, average national gross income or, less frequently, GDP per capita, insurance payments or doctors' opinions. Patients' gross wages, however, or the (age- and gender-dependent) average national gross wage seem the most commonly used valuation sources [19]. Which of the two is more appropriate depends on the study sample. Posnett and Jan [24] claim that: "Unless the study is designed in such a way that the study population can be taken to be fully representative of the population of all potential patients, the results of the evaluation will be more readily generalized if market values for potential patients (of wage rates for example) are used".

An unresolved valuation issue is whether and how to adjust conventional productivity cost estimates for compensation mechanisms. Currently, such adjustment is uncommon in economic evaluations, although estimates using the friction cost approach may already include a correction for compensation of lost work during normal working hours by factoring in the 0.8 elasticity. What this elasticity exactly represents is unclear, however, and to our knowledge its appropriateness has not been extensively investigated. If the elasticity indeed already represents compensation in normal hours, additionally correcting for compensation mechanisms could be a 'double correction' that artificially lowers productivity cost estimates. Adjusting estimates for multiplier effects is also uncommon. Important research questions linger in this area too, like whether the influence of one person's productivity on a team is not yet reflected in his wage.

To date, few attempts have been made to directly correct productivity cost estimates for either team effects or compensation mechanisms [27–29, 62]. One recent study corrected for these effects simultaneously [63], but how compensation mechanisms and team effects interact in practice has not been explored. Examining this interaction

Table 3 Productivity cost inclusion in the identified reviews

Study (year)	Source(s)	Type of studies	Number of studies	Studies including PC [N (%)]	% PC of TC	Methodology		
						Identification	Measurement	Valuation
Gerard [71]	BIDS and Excerpta Medical	CUAs published in 1980–1991	51	5 (9.8)	NA	NA	NA	NA
Stone et al. [70]	PubMed, HealthSTAR, CancerLit, Current Contents and EconLit	CUAs published in 1975–1997	228	19 (8.3)	NA	NA	13 studies applied literature estimates, 5 expert opinion, 1 NS	18 HCA, 1 HCA and FCA, 1 FCA
Pritchard and Sculpher [17]	HEED	Economic evaluations published up to and including 2000	1,086	120 (11) 40 CUAs and CEAs were further analysed	Wide variation	Absenteeism paid work and 5 out of 40 studies included unpaid work	NA	26 HCA, 7 USPA, 7 FCA
Krol et al. [19]	PubMed and Cochrane Library	CEAs, CUAs and CMAs published in 1997–2008 of therapies for depressive disorders, working-age adults	81	25 (31)	3–92 % mean HCA: 61 % mean FCA: 56 %	Absenteeism paid work. One study included presenteeism, one study included presenteeism and unpaid labour	10 studies used questionnaires, 10 used literature estimates, 3 doctor estimates, 5 NS, 2 other	24 HCA, 6 FCA, 13 average wages, 5 GDP-based values, 4 insurance payments, 5 NS, 3 other
Krol et al. [20]	PubMed	CEAs, CUAs and CMAs of expensive intramural drugs published in 1998–2009	249	22 (9)	0.3–83 % mean HCA: 49 % Mean FCA: 23 %	Absenteeism paid work. None of the studies reported presenteeism and unpaid labour	None of the studies specified the measurement instrument	22 HCA, 3 HCA and FCA, 10 studies used average wage rates, 10 did not specify values, 2 used other values

BIDS Bath Institute for Scientific Information Data Service, *CEA* cost-effectiveness analysis, *CMA* cost-minimization analysis, *CUA* cost-utility analysis, *FCA* friction cost approach, *HCA* human capital approach, *HEED* Health Economic Evaluations Database, *NA* not applicable, *NS* not stated, *PC* productivity costs, *TC* total costs, *USPA* US Panel approach is relevant, since complementary team work could increase the opportunity to compensate for a missing member in some cases, but may lead to larger losses in others.

5.2.1 Valuation of Unpaid Labour

Although some attention has been paid to the valuation of unpaid work related to informal care [80–85], little attention has been paid to valuing patients' unpaid work. Time spent on unpaid labour such as household work can be considered a non-marketed use of time, which is commonly valued by assigning a shadow price based on the opportunity cost method or the replacement cost method [13, 82]. With the replacement cost method (also called the proxy good method [82]), the value of unpaid labour is determined by valuing the time it would take others to perform the tasks normally performed by the patient, determined by the cost of hiring a paid worker to perform the tasks. The value of an hour of household work, for example, would be determined by the (average) hourly gross wage of a paid household help.

Alternatively, the opportunity cost method could be applied, where the value of unpaid work is commonly set equal to the value of a competing use of time spent on paid labour. For the employed, the value of their net wage could be used as a basis for computation; for the unemployed, potential wage could be used.

In practice, most economic evaluations ignore unpaid labour and little attention is paid to further develop and implement its valuation methods. A lack of theoretical attention and practical inclusion, however, are likely to interact. An increase in scientific interest in unpaid labour may eventually lead to an increase of the inclusion of unpaid labour in economic evaluations.

6 Productivity Costs in Practice

So far, debates regarding whether and how to include productivity costs in economic evaluation have not led to an increase of their inclusion in economic evaluations during the past several decades. As seen in Table 3, productivity costs related to paid work are neglected in the vast majority of cases and their exclusion rate seems to be rather stable over time. Productivity costs related to unpaid labour are rarely included. Moreover, there is a clear lack of standardization regarding the methodology when including productivity costs. Exclusion may be partly explained first by the fact that half the national health economic guidelines prescribe a healthcare perspective. Second, it may not always be relevant to include productivity costs, such as those related to paid labour in studies including elderly patients. These explanations nonetheless leave a considerable number of cases unaccounted for [20]. Productivity costs seem somewhat randomly included or excluded. Krol et al. [20] suggest this may indicate the existence of some kind of perspective selection bias, i.e. decisions regarding productivity cost inclusion and exclusion could be based on the expected effects on incremental cost-effectiveness outcomes. To avoid such bias, decision-making bodies should be more aware of their inclusion or exclusion whenever a societal perspective is (or ought to be) taken.

7 Future Research

Further scientific research is needed to lessen the controversy regarding the estimation of health-related productivity costs. In Table 4, we provide an overview of the most

Table 4 Identified research needs

Unpaid labour	Further develop and test methods to identify, measure and value relevant unpaid productivity changes
Paid labour	
Inclusion	Reduce the lack of standardization and guidance regarding the inclusion of productivity costs
Identification	Explore how health-related productivity changes affect co-workers' productivity and team output
	Develop methods to identify and include these effects in economic evaluations
Measurement	Develop and validate measures of compensation
	Develop and validate measures of multiplier effects
	Investigate the relationship between wages and multiplier effects
	Investigate the robustness and transferability of multiplier effect estimates
	Further investigate whether estimated productivity changes based on quality-of-life data can be useful for productivity cost calculations in cases where direct productivity measurement is not feasible
Valuation	Investigate the costs of compensation mechanisms
	Investigate the friction cost period for different countries
	Investigate replacement costs of employees
Other	Explore the actual and potential redistribution (mechanisms) of productivity costs and savings within and outside the healthcare sector

topical issues inspired by the questions and concerns discussed in the previous sections. The table partly reiterates earlier pleas for further research [30].

The activities in Table 4 may serve a number of general objectives: (1) to increase the inclusion of productivity costs in economic evaluations whenever (deemed) relevant; (2) to increase scientific research regarding (the inclusion of) health-related changes in unpaid labour; (3) to promote the comprehensive inclusion of the costs of health-related productivity changes in paid labour (i.e. absenteeism, presenteeism, and the effects on co-workers' productivity); (4) to increase knowledge on how health-related productivity changes lead to societal costs or savings; (5) to investigate how employee replacement costs can be measured and included in economic evaluations when relevant; and (6) to explore the theoretical and practical potential to transfer societal savings due to productivity increases induced by medical treatment into the healthcare sector.

8 Conclusion

A variety of aspects regarding the inclusion of productivity costs in economic evaluations have received attention in the scientific literature. This review shows that the past few decades have seen important progress; however, a consensus has not been reached on either the inclusion of productivity costs in economic evaluations or the methods used to produce productivity cost estimates. Such a lack of consensus has likely contributed to ignoring productivity costs in economic evaluations and is reflected in variations in national health economic guidelines [17, 19, 20, 70, 71]. A useful aim would be to develop common standards regarding the identification, measurement and valuation of productivity costs. Such standardization would increase the comparability and credibility of economic evaluations taking a societal perspective. Given the current variety in applied productivity cost methodology, accurately reporting the methods used to estimate productivity costs in economic evaluations is critical to understand the nature of potential differences in outcomes; however, the reported level of detail is often poor [20]. Reporting productivity costs separately from direct costs to enable comparison of outcomes between studies, as is sometimes done, is recommended.

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Author contributions WB and FR had the idea for the review. MK was primarily responsible for reviewing the literature and writing the manuscript, in cooperation with WB and FR. All authors read, edited and approved the final manuscript. WB is the overall guarantor for the content of this article.

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