Key economic issues

Barry M. Popkin

Abstract

Economic issues of fortification that are addressed by economists include the role industry and government should play, the question of compulsory or voluntary fortification, the nature of the economic costs and benefits of food fortification, and the level of public investment justified for implementation and quality assurance. Emphasis is placed on knowledge about the costs and benefits of fortification. Essentially, the literature shows that micronutrient fortification is one of the most cost-effective health interventions and represents a very efficient use of public resources.

Introduction

The perspective taken for this paper is that of an economist called in to work with a country on the design and execution of a micronutrient-fortification programme. In handling this, there are a range of important topics to address that relate to the role government should play, the question of compulsory or voluntary fortification, and the nature of the economic costs and benefits of food fortification. Emphasis will be placed on knowledge about the costs and benefits of fortification. As background, it is surprising how little economic analysis has been conducted. Despite the importance of micronutrient deficiencies in terms of prevalence and impact, there has been surprisingly little systematic research undertaken by economists.

Beginning in the 1970s, there have been several small case studies that have looked at the costs and/or benefits of fortification efforts. In the 1980s there was one large effort by the World Bank and another smaller case study, but now there is an emerging effort to begin to collect cost data in a systematic manner.

Barry Popkin is affiliated with the Department of Nutrition in the University of North Carolina at Chapel Hill, North Carolina, USA.

What role should industry and government play?

Generally, governments are expected to initiate fortification efforts that are focused on reaching low-income, high-risk populations in a systematic manner. However, in considering the costs and benefits of such efforts, governments typically focus on the benefits to the nation rather than to the individual or the industry; only when it comes to effects on programme efficiency and impact do they consider the costs to industry and the consumer. In contrast, industry obviously focuses on the impact on its short- and long-term market and profitability. Whereas some companies wish to retain a comparative advantage by having an unequal field where regulations are not carefully laid out, major food companies benefit from clear and precise guidelines. Related to this is a desire not to be forced into adopting fortification that will affect the organoleptic properties (taste, odour, colour) of the product or that will be associated with adverse publicity. The concerns for public education come from the fears of adverse publicity or the need, in a few cases discussed below, to change consumer behaviour to successfully implement a fortification effort.

Compulsory or voluntary fortification?

An excellent short monograph from the World Bank lays out some of the compulsory and voluntary issues in more detail than we will go into here [1]. Voluntary fortification sounds attractive. It does not limit consumer choice and does not force unwilling companies to bear financial costs. In countries where fortification is high on the list of consumer food preferences, e.g., salt and flour in the United States and bread in the Netherlands, voluntary fortification has worked. But in most other countries, consumer demand is lacking, and those companies that act first to fortify take more risks than those that act later or never act. These initial cost components include product development,

market research, and advertising. Competitors adding fortification later often obtain a free ride, or producers may reach only a slim market when they use fortification as a way to increase the market share for their product.

In many cases, those first to fortify get a market advantage, but this is normally true only for products that serve higher-income and educated consumers who are more likely to shift food choice. Lower-income consumers and those in more isolated rural areas are less likely to make such shifts in food choice. Most people experienced in working with fortification feel that compulsory fortification is the only way to proceed to reach the poor. Experience in Latin America has shown us that voluntary fortification or inadequate enforcement of compulsory legislation is associated with poor implementation and reduced benefits of the fortification programme. Even if this situation changes or limits consumer choice, compulsory fortification may be justifiable for a number of public health reasons: widespread prevalence of the deficiency, serious and costly health effects of the deficiency, and cost-effectiveness of prevention versus case management.

Many issues were noted above regarding the assurance of industry cooperation with compulsory fortification efforts. Clearly, food carriers that reach the target population must be identified, and it is desirable that these be centrally processed. Then questions relate to the costs and the price elasticity of this product for the poor. A low cost, which is typical for most fortification efforts, means that the price elasticity for the poor is not a major concern. If the poor reduce their demand when there are small price changes, then it is imperative that costs be kept low.

This is a most complex issue when the fortification process requires an intrusion in the production or marketing process. The most notable examples of this occur when fortification is mandated for products processed in highly decentralized locations or under primitive manufacturing conditions. This has been the case for fortification of salt with iodine in many countries and for fortification of rice in rice-producing Asian countries. Significant costs are added to the process when premixes must be prepared, distributed, and introduced to primitively processed food.

The result is usually a black market selling unfortified salt or rice, incomplete coverage, or both. In a historic attempt to get around these issues, Dr. Chen Junshi lays out most precisely the problems that China faces in attempting to fortify salt with iodine [2].

What are the economic benefits and costs of food fortification?

To begin to gain some sense of the merits of investing scarce public resources in fortification or other micronutrient prevention efforts, one needs to understand the economic benefits and costs of these efforts and then be able to compare these costs and benefits with those of other micronutrient and human resource investments.

Economic benefits

Most public health researchers are aware of the vast literature that reviews most carefully the effects of iron-deficiency anaemia, vitamin A deficiency, and iodine-deficiency disorders on health and behaviour. I briefly summarize this literature, as well as the way an economist might evaluate each of these effects.

The largest and most systematic research has focused on the effects of vitamin A deficiency on morbidity and mortality. A large number of studies have examined most systematically, under varying disease and ecological conditions, the effects of vitamin A deficiency or elimination of vitamin A deficiency on morbidity and mortality patterns [3]. Table 1 summarizes the results in terms of their effects on mortality rates for preschool children.

The effects of iron-deficiency anaemia on adult physical performance have been understood for decades, but more recent studies in a number of countries under varying conditions lead us to understand that improvement of haemoglobin status in adult workers, particularly adults in piece work or highly structured production conditions, will enhance economic performance in terms of actual productivity. These studies, conducted mainly among road-construction workers, tea-plantation pickers, rubber-plantation workers, and workers in similar types of occupations, provide a consistent picture indicating that an improved adult haemoglobin status of 1% is associated with a 1% to 2% increase in labour productivity. Levin et al.[4] have reviewed

TABLE 1. Economic costs and benefits of food fortification: Linkage of micronutrient deficiency of vitamin A to improved health and productivity

Relationship	Evidence
Vitamin A deficiency in children ⇒ mortality	85% coverage with supplements or adequately fortified foods leads to reduction of mortality in children 1 to 6 years of age: » 34% in areas of clinical deficiency » 23% in areas of moderate to high prevalence of subclinical deficiency » 10% in areas of marginal to low prevalence of subclinical deficiency

these studies. An earlier World Bank report by Levin [5] examines these studies in more detail.

Levin et al. [4] also reviewed briefly the vast literature on the relationship between iron-deficiency anaemia and iron supplementation as it affects cognitive function and learning or aspects of learning of infants, preschool, and school-age children. Although there are certainly questions regarding some of the conclusions, this literature, which is dominated by the work of Pollitt [6] and his colleagues, Lozoff [7], and Walter [8], provides ample evidence of an important effect of iron-deficiency anaemia and of iron supplementation on recall, concentration, and a few other dimensions of learning and cognitive function.

There is an equally extensive literature that links iodine-deficiency disorders, particularly endemic goitre, to cretinism and reproductive failure. Under severe conditions, stillbirths, spontaneous abortions, and congenital abnormalities occur significantly often. The largest single cause of preventable brain damage and mental retardation is often assumed to be iodine-deficiency disorders.

However, it is probably the more subtle effects of iodine-deficiency disorders on cognitive function that represent the major cost of this deficiency disease. There are a number of reviews and one meta-analysis on this relationship that come to roughly the same conclusion [9, 10]. There has been less research undertaken on this topic because of the cost and complexity of doing so. However, the historical studies and the more scientifically controlled ones arrive at a similar profile of the effects of iodine deficiency both on the foetus and directly on the infant in compromising cognitive function [11].

Once these health and behavioural impacts are understood, it is necessary to ascertain their economic impact. A summary of the broad set of relationships is presented in table 2. There is a vast literature on methods of evaluating each of these benefits; Levin [5] and an earlier case study in the Philippines present the only attempts to quantify the economic benefits of reducing micronutrient deficiencies [12-14].

Economic costs

In ascertaining the economic costs, it is important to realize that the major rationale for a fortification effort is its long-term sustainability, which can be self-

TABLE 2. Valuation of economic benefits of fortification programmes

Outcome	Benefits	Value
Reduced morbidity	Reduction in health care (depending on patterns of care)	Expenditure on health care, associated travel, and drugs
	Reduction in days of work lost by sufferer or carer (depending on employment status)	Improved marginal productivity of labour
	Improvement in school attendance, concentration, and performance (depending on school enrolment)	Reduction in wasted education expenditure
	Production and consumption benefits	Discounted present value of per capita income over the years of life lost from premature death
Increased physical work capacity	Increased work output (depending on availability of work and complementary factors of production, job type, and skill and intelligence of worker)	Improved marginal productivity of labour
Improved cognitive effects	Greater efficiency of school system; increased future productivity	Reduction in wasted education expenditure Relationship with earnings and marginal productivity of labour

financing. As such, all planning and related efforts are usually focused on ways to front-load the costs that government incurs. These might include foreign exchange for the fortificant or some reduction of taxes and foreign-exchange controls for purchase of the fortificant, preliminary research and planning undertaken by the government, preliminary technical and other research on consumer acceptability financed by the public sector, and social marketing and all quality assurance costs at the retail and consumer level funded by the government. It is typically assumed that costs to the consumer and industry are negligible, and thus they are ignored. Moreover, within-company quality assurance costs are rarely covered by the government.

In a typical situation concerning centrally processed foods, particularly foods handled in ways that are amenable to fortification, such as is found in the baking and milling sectors and the preparation of most condiments, this assumption of minimal costs to industry is typically true. Recent studies on the costs of fortification provide some guide [15]. The most complete review is the exceptional review volume by Lotfi et al. [16]. What these studies and the other cases noted above show is that generally the costs of fortification are very small in terms of annual costs for centrally processed foods. The estimated annual costs per person in 1994 were typically about US$0.02 to US$0.20 for iodine, US$0.06 to US$0.30 for retinol palmitate, and US$0.07 to US$1.07 for iron. These costs vary with the vehicle, the fortificant, the conditions the product will face, and the process used (e.g., premixes). This is a cost per total population reached and gives some sense of the small total cost and the very small likelihood that fortification with a centrally processed nutrient will affect the price of a processed food.

Comparable costs

Alternative measures for eliminating micronutrient deficiencies are typically found to be less cost-effective, particularly in terms of the costs the government faces. Provision of vitamin A and E capsules, iron tablets, or iodized oil injections is typically fully covered by public funds. These costs are typically greater per person than fortification costs. For instance, the studies noted earlier all found that the annual per person costs were US$1 to US$3 for injections of iodized oil, US$0.25 to US$1.50 for provision of mass dosage capsules of vitamin A plus E, and US$1.89 to US$5.30 for provision of iron tablets [1, 4, 12, 15]. Typically, these costs ignore the enormous expenditures in terms of health worker time, transportation, and so forth. They are the marginal costs of the programme.

There are two major ways that these cost relationships can be adversely affected. One relates to the fortification of a food, such as salt, that is processed in a wide-ranging variety of ways, many of which are primitive. This is particularly the problem for salt, as it is processed in many Asian and Latin American countries with large iodine-deficiency disorder problems. When this is the case, provision of fortified salt to be added to crudely processed salt or insistence that salt be centrally processed interferes significantly with the typical salt food chain and leads to unusual costs for the producer and often the consumer. Black marketing and other attempts to bypass the fortification requirements of government regulations are typically the result. Another result essentially places all small primitive processors at risk of losing their means of production.

A second issue is the cost of reaching people at high risk. When this cost is considered, there are many circumstances under which a general approach, such as fortification, turns out to be inefficient. When pregnant women, infants, or pre-schoolers are the target, there are circumstances in which supplementation is more cost-effective when total societal costs are considered. However, when one focuses on costs to the government and ignores the costs industry will bear, there are almost no situations in which fortification is less cost-effective. Moreover, there is absolutely no evidence that supplementation programmes are sustainable over a long period, whereas there is clear evidence of the sustainability of fortification programmes.

There are important gaps in all the cost research to date. None of these efforts have included the costs of quality assurance and social marketing. Quality assurance is particularly important. The steps that specifically require quality assurance are:

» Purchase quality equipment and supplies;
» Routinely inspect processing equipment;
» Validate the mixing process to ensure consistent mixing;
» Monitor food ready for distribution;
» Monitor food in the marketplace to ensure that adequate levels of the fortificant are available;
» Monitor food at the household level to assure that adequate levels of the fortificant are reaching the target population,

The amount of experience and the number of models of quality assurance are insufficient to develop these costs yet.

In addition, it is clear that costs are often underestimated to improve the appearance of programmes. The results are adverse; they can lead to reduced allocation of resources and inefficient programme management. Materials are being developed that provide guidelines for the collection of the costs of fortification programmes [15].

Current experience with cost-effectiveness and cost-benefit analysis

Major efforts in this area have already been noted above [4, 12, 13, 15]. For such an important set of nutritional

problems, this represents a small effort in the analysis of the costs and benefits of eliminating micronutrient deficiencies through fortification. But there is also a vast set of experiences by the food industry, particularly flour and other cereal processors and manufacturers using cereal-based products. There is also extensive experience in other manufacturing sectors.

At this point, the major gap appears to be application of economic analysis to actual large-scale fortification efforts. However, there is only the experience of attempting to estimate costs for the Guatemalan sugar fortification effort by Phillips et al. [15].

References

1. World Bank. Enriching lives: overcoming vitamin and mineral malnutrition in developing countries. Washington, DC: World Bank, 1994.
2. Chen J. Fortification of salt with iodine. Food Nutr Bull 1998;19:172–175.
3. Beaton GH, Martorell R, Aronson KA, Edmonston B, McCabe G, Ross C, Harvey B. Vitamin A supplementation and child morbidity and mortality in developing countries. Food Nutr Bull 1994;15(4):282–9.
4. Levin HM, Pollitt E, Galloway R, McGuire J. Micronutrient deficiency disorders. In: Jamison DT, Mosley WH, Measham AR, Bobadilla JL, eds. Disease control priorities in developing countries. New York: Oxford University Press, 1993:421–51.
5. Levin HM. A benefit-cost analysis of nutritional interventions for anemia reduction. Washington, DC: World Bank, Population, Health, and Nutrition Department Technical Note 85-12, 1985.
6. Pollitt E. Iron deficiency and cognitive function. Annu Rev Nutr 1993;13:521–37.
7. Lozoff B. Has iron deficiency been shown to cause altered behaviour in infants? In: Dobbing J, ed. Brain, behaviour, and iron in the infant diet. London: Springer-Verlag, 1990:107–31.
8. Walter T. Infancy: mental and motor development. Am J Clin Nutr 1989;50(suppl):655–64.
9. Maberly GF. Iodine deficiency disorders: contemporary scientific issues. J Nutr 1994;124:1473s-8s.
10. Bleichrodt N, Born MA. A meta-analysis of research on iodine and its relationship to cognitive function. In: Stanbury J, ed. The damaged brain of iodine deficiency: cognitive, behavioral, neuromotor, educative aspects. New York: Cognizant Communication, 1994:195–200.
11. Fierro-Benitez R. Impact of iodine deficiency on development of the Andean world: a philosophical perspective In: Stanbury J, ed. The damaged brain of iodine deficiency: cognitive, behavioral, neuromotor, educative aspects. New York: Cognizant Communication, 1994:157–72.
12. Popkin BM, Solon FS, Fernandez TL, Latham MC. Benefit-cost analysis in the nutrition area: a pilot project in the Philippines. Soc Sci Med 1980;14c:207–16.
13. Solon FS, Fernandez TL, Latham MC, Popkin BM. Planning, implementation, and evaluation of a fortification program. J Am Diet Assoc 1979;74:112–8.
14. Solon FS, Popkin BM, Fernandez TL, Latham MC. Vitamin A deficiency in the Philippines: a pilot project Part I: Baseline analysis and program design. Part II: Evaluation and benefit-cost analysis. Food Nutr 1980; 6:27–36, 43.
15. Phillips M, Sanghvi T, Suarez R, McKigney J, Fiedler J. The costs and effectiveness of three vitamin A interventions in Guatemala. Soc Sci Med 1996;42:1661–8.
16. Lotfi M, Mannar MGV, Merx RHJHM, den Heuvel PN. Micronutrient fortification of foods. Ottawa: Micronutrient Initiative, and Wageningen, Netherlands: International Agriculture Centre, 1996.