Contribution of seed orchards to timber harvest in the short-run and in the long-run

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Summary: Seed orchards contribute to increasing forest growth through the production of genetically superior seeds. It is obvious that, other things the same, the increase in forest growth will lead to greater timber harvests in the long-run. When future forests grow faster than existing ones, it may be profitable to harvest and regenerate an existing forest a few years earlier than in the case when there is no difference in growth between the future and the existing forests. Therefore, access to genetically improved regeneration materials could also motivate a forest owner to harvest more in the short-run. By how much timber harvest would increase in each time period depends on, among other things, the current and future timber prices. It should be noted that normally seed orchards are established at such scales that sufficient amount of seeds are produced to meet the regeneration needs within large regions. When a large number of forest owners increase their harvests simultaneously, the price of timber would inevitably be affected. In order to assess the contribution of seed orchards to timber harvest, one has to take into account the impact of changing harvest level on the price of timber.

This study investigated the potential contribution of seed orchards to timber harvest in Sweden by comparing the optimal harvest volumes over time with and without access to genetically improved seeds from seed orchards. A timber market model was developed to determine the market equilibrium price and supply of timber over time. The model builds on an exogenous timber demand function, which is assumed to be constant over time. The supply curve in each period was determined using a managerial decision model which optimizes the harvest volume of individual forest owners conditional on a given time series of timber price. Market equilibrium timber price and supply in each year during a 200-year time horizon were determined by maximizing the present value of social surplus (the sum of forest owners' profits and consumer surplus).

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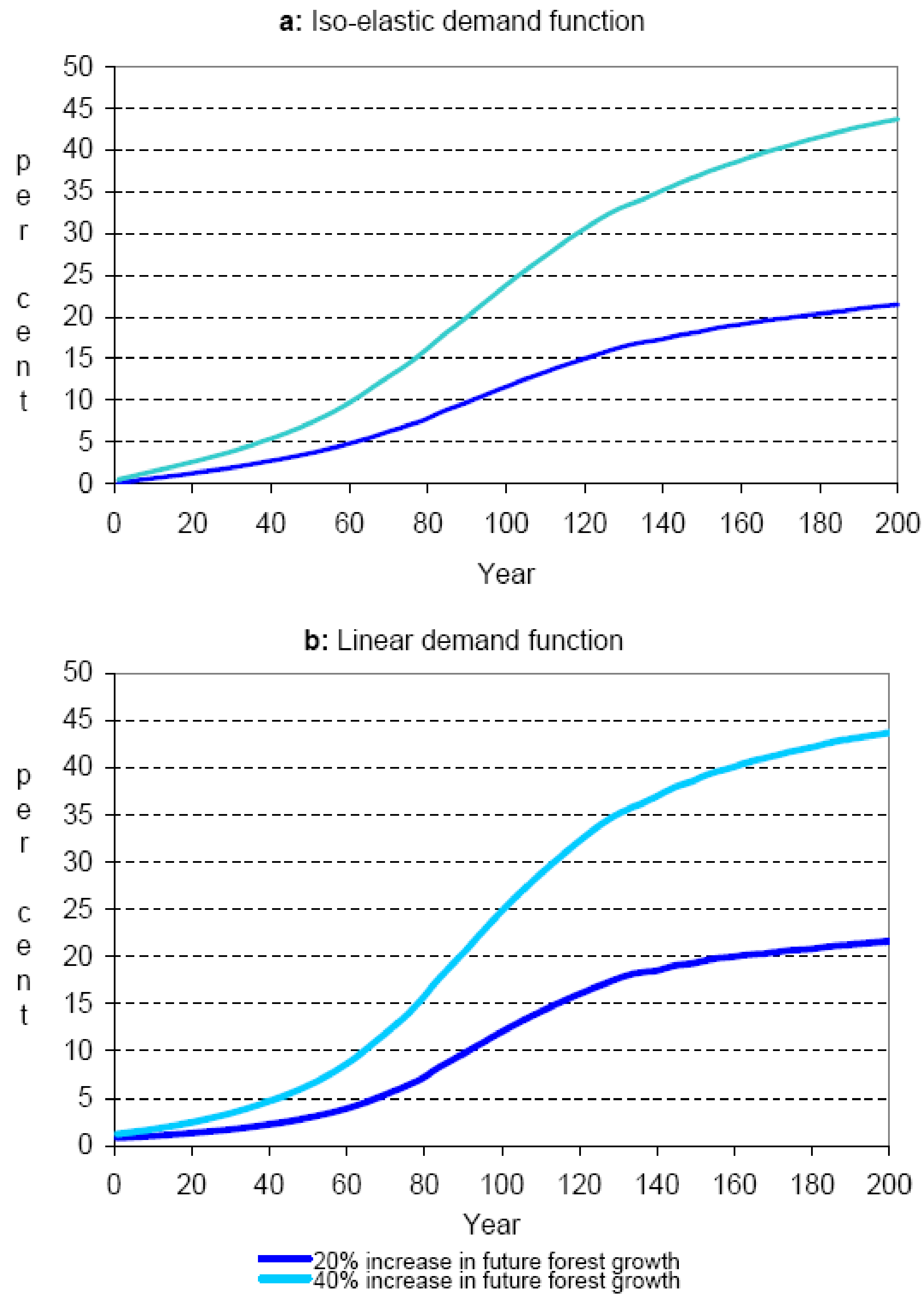

Figure 1. The percentage increase in timber harvest resulted from the increase in Future forest growth.

The analysis was conducted with an iso-elastic and a linear demand function, respectively. The two demand functions are comparable in the sense that they give the same price (314 SEK/m^3) and have the same price elasticity (-0.6) at a harvest level of 80 million m^3 (which is roughly the current harvest level in Sweden). The total forest area covered in the analysis was 20 million ha (which includes all forests under the age of 120 years), divided into two soil productivity classes of approximately equal size. The age-class distributions of the forests were determined based on data from national forest inventory. Two levels of future forest growth improvement, resulted from the use of seeds produced in seed orchards, were evaluated. Specifically, it was assumed that future forests grow 20% or 40% faster (measured in terms of the maximum mean annual increment) than the existing ones. A real interest rate of 3% was used throughout the analysis. Other important assumptions underlying the analysis include: a) the growth effect of genetically improved seeds is known with certainty, b) seeds from seed orchards are available from now on and will be used in all future forest regenerations, and c) forest owners' objective is to maximize the profit of timber production.

The results show that the access to genetically improved seeds has relatively small effects on timber harvest in the short-run. During the first 60 years (that is, before forest owners can start to harvest the new forests), the increase in timber harvest is about 10% of the potential increment in future forest growth. The impact on timber harvest increases over time (see Figure 1). In the long-run (i.e. when the harvest effect stabilizes), the increase in harvest is determined by the increase in future forest growth. For example, if the new forests grow 20% faster than the existing ones, timber harvest would in the long-run rise by approximately 20%.

The price of timber becomes lower when genetically improved seeds are used in regeneration than in the case when such seeds are not used. Since the demand function is by assumption constant over time, the decrease in timber price induced by large scale applications of genetically improved seeds becomes larger as time goes (see Figure 2). With the iso-elastic demand function, the average timber price during the 200-year time horizon decreased by 18% if future forests grow 20% faster. A 40% improvement in future forest growth would lead to a 30% decrease of the average timber price. With a linear demand function the effect of improvement in future forest growth on timber price is smaller, but still significant.

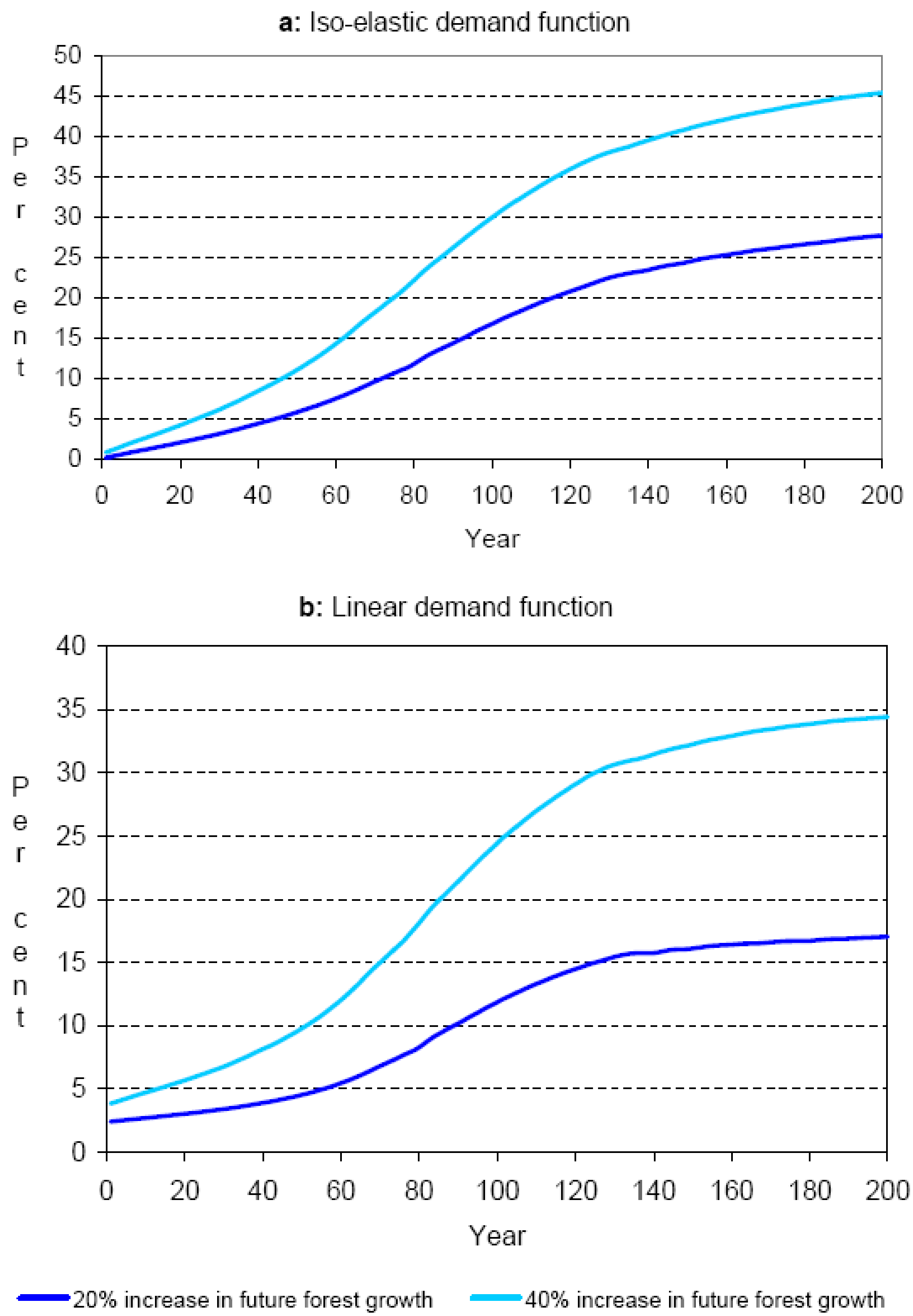

Figure 2. The percentage decrease in timber price induced by the increase in future forest growth.

In short, an important consequence of widespread application of genetically improved seeds in forest regenerations is that more timber will be produced and traded at lower prices. Results from the current analysis show that forest owners' profits will drop by 5% if genetically improved seeds lead to a 20% increase in future forest growth. With a 40% increase in of future forest growth the profits of timber production would decrease by about 10%. Timber based industry, on the other hand, would benefit considerably from the use of genetically improved seeds in forest regenerations, which makes it possible for the industry to buy more timber at lower prices. The social surplus would increase by 15 billion SEK if future forests grow 20% faster, and by about 30 billion SEK if the increase in future forest growth is 40%. This result indicates that advances in tree improvements can generate significant benefits to society.

It should be emphasized that this study ignored several issues which are of importance when assessing the consequences of tree improvements. First, the analysis did not pay any attention to the non-timber benefits associated with the forests, except that about 3 million ha of the existing old forests were saved from harvesting. The effect of the non-timber benefits on the harvest decision may be different when genetically improved seeds are used in future regenerations than when such seeds are not used. Thus, explicit inclusion of the non-timber benefits in the analysis may lead to different results about the impacts of applying genetically improved seeds on timber harvest and price. A second issue is uncertainties in the growth effect of and the potential ecological risks associated with the use of genetically improved seeds. With consideration of such uncertainties and risks, genetically improved seeds may not be used in all future forest regenerations. To what extent genetically improved seeds will be used depends on the expected growth improvement and the degree of uncertainties and risks involved, as well as on forest owners' attitudes towards such uncertainties and risks. A third issue is the continuous progress in tree improvement. A fourth issue is the possible increase in future timber demand which may occur as a consequence of increasing forest growth. Progress in tree improvements not only lead to faster growing forests, but may also stimulate increasingly higher demand for timber. Increase in future timber demand would in turn affect the price and supply of timber. Further analyses need to be conducted in order to quantify the impacts of these factors on the effects of using genetically improved seeds on future timber harvest and price.