Estimating the Level of Free Riders in the Refrigerator Buy-Back Program

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An impact evaluation, conducted in 1993 on B.C. Hydro's Refrigerator Buy-Back Program, employed an innovative analysis technique to assess free riders. Rather than the traditional billing analysis, metering combined with a probability analysis was used to estimate net energy savings. The probability analysis incorporated both comparison and participant data to assess free riders. This approach measured the impact of refrigerator removal on the total energy consumption of refrigerators in the province and *not* at the individual household level. Thus the avoided potential energy consumption of refrigerators collected by the program was included in the analysis and credited to the program. This paper focusses on the probability analysis used to assess free riders.

Introduction

Many appliance collection programs in North America limit the collection of refrigerators to secondary units and billing analysis is often used as the primary determinant of energy savings. B.C. Hydro's Refrigerator Buy-Back (RBB) Program does not limit the collection of refrigerators to secondary units. If a primary refrigerator is moved to the basement and the former secondary unit is collected by the program, then billing analysis would measure the difference between the new primary refrigerator and the replaced, former, secondary unit. Similarly, if a primary refrigerator is removed from a home through the RBB program and subsequently replaced by a new refrigerator, a billing analysis would only register the incremental difference between the old and the new refrigerator, assuming that the number of refrigerators in the individual household remains constant. A billing analysis conducted by B.C. Hydro's Load and Market Research department in 1992 supported this point (Jean et al. 1993).

A more appropriate evaluation technique was used to evaluate the RBB program. This evaluation used a metering approach, to estimate gross energy savings, combined with a probability analysis, to estimate net energy savings. The probability analysis incorporated both participant and comparison data to arrive at an estimate of free riders. This approach measured the impact of the removal of a refrigerator on the total energy consumption of all residential customers in the province and not at the individual household level. The free rider analysis will demonstrate how the collection of former primary and secondary units in B.C. Hydro's service territory does generate energy savings which could not be identified through a billing analysis. Using both participant and comparison data lead to a free ridership estimate that is more appropriate than using billing analysis or participant data alone.

This paper focuses on the probability analysis used to assess the level of free riders in B.C. Hydro's Refrigerator Buy-Back Program. The following sections review the program background, the methodology and results of the probability analysis, and finally, provide concluding comments.

Background

Program History

B.C. Hydro's Refrigerator Buy-Back Program began in 1990 as a pilot in two cities and, as of December 1992, was available to all B.C. Hydro residential customers. The program was designed to reduce the level of saturation of second refrigerators in B.C. Hydro's service territory through the collection of former primary and secondary refrigerators. [1]The refrigerators collected by the program were typically under-utilized, unnecessary for excess cold storage and inefficient by current standards. The RBB program was promoted through advertising about the annual costs associated with operating a secondary refrigerator, free pick-up of the refrigerator, and an incentive of $30. Refrigerators had to be operational to qualify for the program. Disposal was conducted in an environmentally-friendly manner.

Through January 1994, 0ver 61,000 refrigerators had been collected through the RBB program. These refrigerators were collected at a cost of $8.9 million, including pick-up costs , disposal costs, incentives and program administration.

Probability Analysis

There are two types of free riders associated with the Refrigerator Buy-Back program. *Pure free riders are* defined as those individuals who would have adopted the program recommended actions in the absence of the program, but who received an incentive from B. C. Hydro for participating in the program. For the Refrigerator Buy-Back program that includes anyone who, without the program, would have permanently removed a refrigerator from service (e.g., deposited it in a landfill). Pure free riders can be indirect in that customers would have, in the absence of the program, submitted their refrigerators to a used appliance dealer who, in turn, would have taken the refrigerator to a landfill. *Incremental or partial free riders are* participants who, in the absence of the program, would have temporarily removed a refrigerator from service. Someone who would have, for energy savings, unplugged a second refrigerator for some period of time but not permanently is an example of a partial free rider.

The probability analysis employs a market approach to analyzing the Refrigerator Buy-Back Program. This approach looks at the effect of the program on the saturation of second refrigerators in the province of B.C. and not at the effect on the individual household. The saturation level is defined as the total volume of second refrigerators in the province of B.C. The distinction between the household and the provincial levels is an important one, as demonstrated by the following example. A second refrigerator removed by the Refrigerator Buy-Back Program is subsequently replaced by another unit, leaving the total number of refrigerators in the individual home unchanged. The provincial saturation of second refrigerators could still potentially be affected. There is some probability that the unit picked up by the program would have otherwise, without the program, been sold/given away and subsequently utilized in another household. The analysis measures the overall impact on total energy consumption including the avoided potential energy consumption which may not be noticed at the household level.

The comparison sample was selected from participants of B. C. Hydro's Energy Efficient Refrigerator Program participants. This group participated in the Energy Efficient Refrigerator Program by purchasing an energy efficient refrigerator and receiving a rebate. The respondents were screened for only those whose new refrigerator replaced an existing unit (e.g., purchases for new homes were not included). These people were familiar with the decision process involved in purchasing a new refrigerator (i.e., replacing a primary unit).

Because of the timing and the limited roll-out of the Refrigerator Buy-Back program, the comparison group did not have the opportunity to participate in the Refrigerator Buy-Back program. The RBB program was only available in certain regions within the province during the time period chosen for the comparison sample. Thus, the potential for self-selection bias was greatly reduced,

Methodology

To determine the level of free riders in the RBB program the following four-step analysis was used. Comparison data were used in combination with participant data to estimate free riders. Figure 1 illustrates the analysis framework graphically.

First, the participant survey was used to determine the former degree of usage of refrigerators picked up by the program. It was important to distinguish between the refrigerators formerly used as primary units (in main kitchens) and those used as secondary units (from other locations in the home). Primary refrigerators, in general, are characteristically different than secondary units. Upon removal, destinations of the refrigerators may differ depending on the characteristics of the unit and circumstances. In general, primary refrigerators are younger than secondary units and are more likely to continue to consume energy in another location upon removal.

Second, survey responses from the comparison group, those who had purchased an energy efficient refrigerator during the previous two year period to replace an existing primary refrigerator, were used to estimate what would have happened to the participant *primary* refrigerators in the absence of the RBB program. These people had been forced to decide on the destiny of the former primary refrigerator that was replaced. These alternative destinations represent what would have happened in the absence of the RBB program to former primary units. The decisions were implemented and real, unlike the participants' predicted refrigerator destinations, which were subjective and speculative.

Third, for participants who submitted secondary refrigerators to the RBB program, the self-reported data on their alternative destinations in the absence of the program were used to estimate what would have happened to the participant *secondary* refrigerators. While somewhat subjective, participant self-reported data on alternative destinations in the absence of the program were used for lack of better information. Table 1 describes the alternative destinations assessed for refrigerators collected by the program.

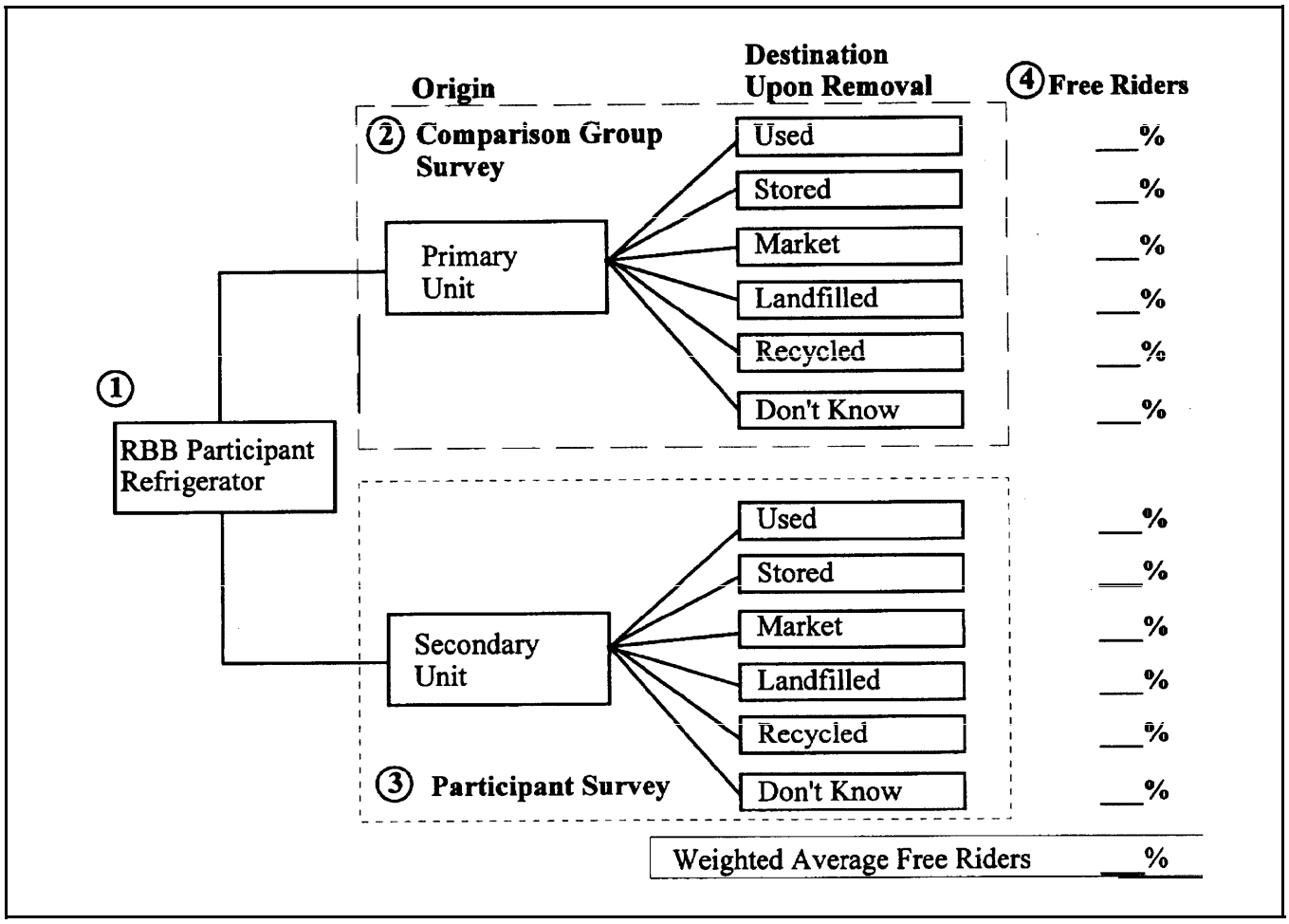

Figure 1. Free Rider - Conceptual Framework

Table 1. Description of Alternative Destinations

Destination	Description
Stored	The refrigerator is functional but not in use at this time. It was stored in the home unplugged.
Used	The refrigerator was moved to another area in the home (most often the basement) and used as a secondary unit. The refrigerator was either used seasonally (< 25% of the year) or used continuously (> 25% of the year).
Market	
Traded In	The refrigerator was traded in when the new refrigerator was purchased.
Sold	The refrigerator was sold privately.
Gave Away	The refrigerator was given away.
Picked Up	The refrigerator was picked up by a community service or a second-hand appliance dealer.
Landfilled	The refrigerator was disposed of at a landfill.
Recycled	The refrigerator was recycled.
Other/Don't Know	The respondent did not know what happened to the refrigerator or stated another alternative destination.

Finally, given the probable alternative destination for these different types of refrigerators, a level of free ridership was determined for each destination. There are various levels of free ridership associated with different destinations. For example, a participant may have, in the absence of the program, continued to use the former primary refrigerator in a different location in the home as a secondary unit. The participant, in this case, is not a free rider. Alternatively, a participant who would have, in the absence of the program, disposed of the refrigerator at a landfill is a pure free rider. Determining the free ridership level for each of the other four destinations required assumptions based on available evidence including more detailed survey responses.

Results

Step 1: Refrigerator Usage. Approximately 50% of the refrigerators collected through the RBB program were former primary units and 50% secondary units.

Step 2: Primary Refrigerators. Comparison group respondents replaced a refrigerator during the two year period prior to the survey. On the survey they indicated the subsequent location of the primary refrigerator that was replaced. Some refrigerators were returned to the market, some were moved to different locations in the home and either used as secondary units or stored, and others were removed from service entirely. The distribution of the comparison group responses is illustrated in Figure 2. This distribution is the best estimate of what would otherwise have happened to the primary refrigerators collected by the program.

The comparison group replacing primary refrigerators was characteristically similar to the participant group submitting their primary refrigerators to the RBB program. The two groups were similar with respect to demographics, freezer ownership, cold storage needs, and participation in other B.C. Hydro conservation programs. It can be assumed that in the absence of the RBB program, the participants submitting a *primary* refrigerator would have submitted their refrigerators to various alternative destinations in a similar proportion to the comparison group.

Step 3: Secondary Refrigerators. The participants' self-reported data were used to determine the alternative destinations for *secondary* refrigerators collected by the RBB program. Participants submitting a secondary refrigerator were asked what they would have done with their refrigerator in the absence of the RBB program. A comparison group of people replacing secondary refrigerators was not surveyed due to difficulty in specifying a sample frame. Figure 3 illustrates the participants self-reported alternative destinations for the secondary refrigerator had the RBB program not been available.

Step 4: Free Riders. Each alternative destination has a varying degree of free ridership associated with its implementation (see Table 2). The degree of free ridership differed depending on whether the refrigerators were used as primary or secondary units prior to collection by the program. The degree of free ridership was determined through extensive analysis of the survey data and assumptions. Where assumptions had to be made, they were based on discussions with experts in the program and the residential evaluation group.

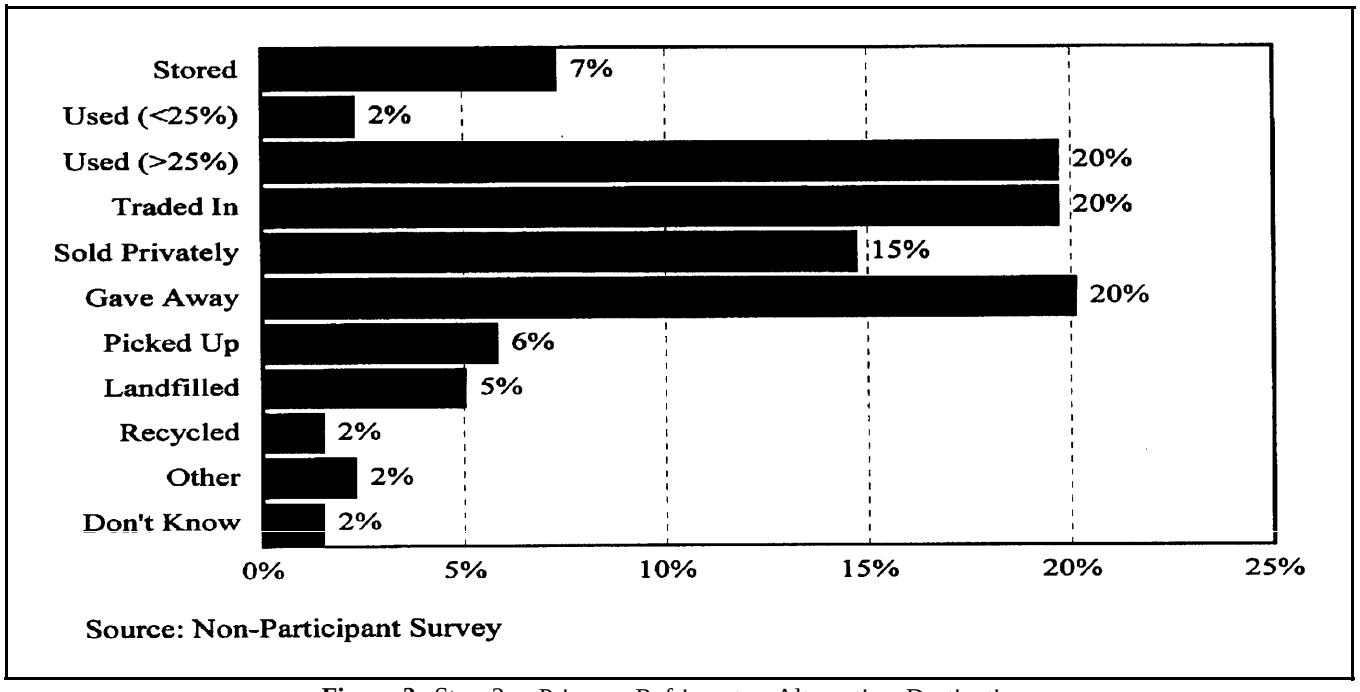

Figure 2. Step 2 - Primary Refrigerator Alternative Destinations

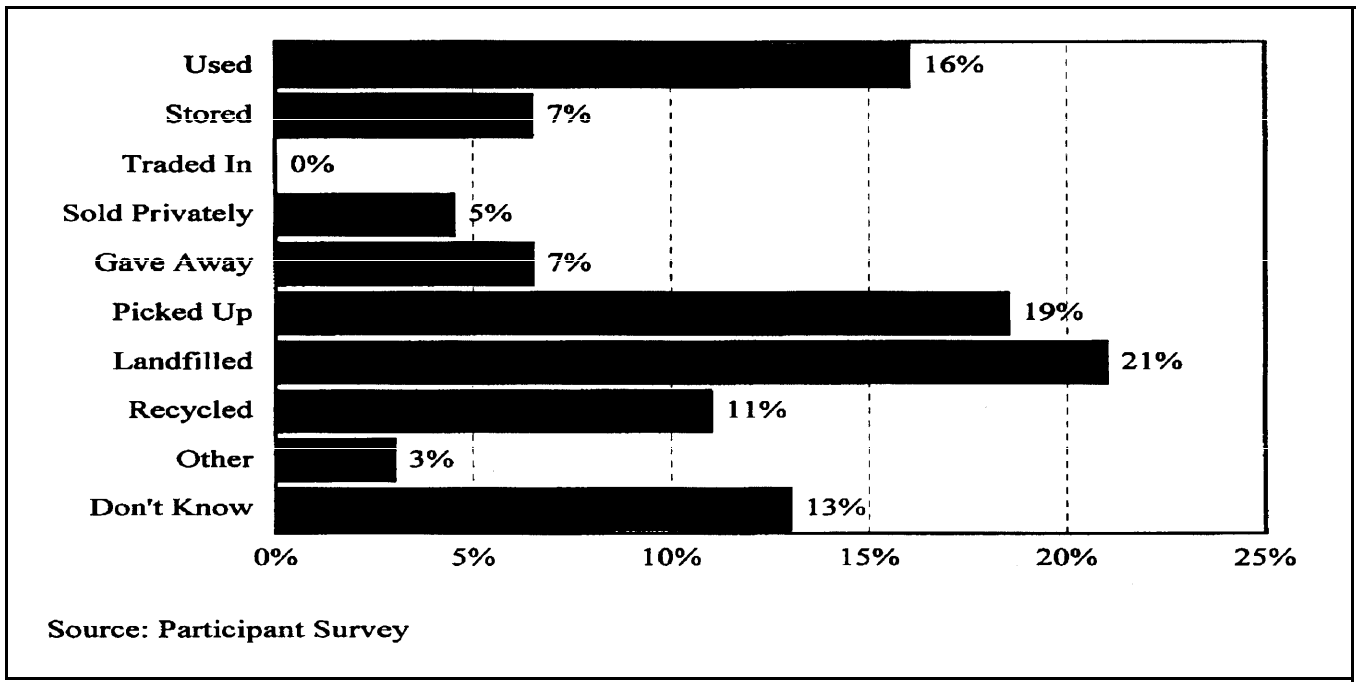

Figure 3. Step 3 - Secondary Refrigerator Alternative Destinations

Table 2. Step 4 - Free Riders for Various Alternative Destinations

Alternative Destinations	Primary Refrigerator Free Riders	Secondary Refrigerator Free Riders
Stored	42%	42%
Used (<25%)	83%	N/A
Used (>25%)	0%	0%
Market		
Traded In	16%	100%
Sold Privately	0%	0%
Gave Away	0%	0%
Picked Up	19%	25%
Landfilled	100%	50%
Recycled	75%	25%
Other	20%	40%
Don't Know	20%	25%
Subtotal	16%	25%
Weighted Average Free Rider Rate		**21%**

Because of the market approach taken to evaluate free riders for the RBB program, the energy savings attributable to primary and secondary refrigerators was the same. The primary units were not credited with the energy savings for the particular household but rather the potential for energy consumption as a secondary unit. Similarly, secondary units were credited with reduced consumption equivalent to operating a second refrigerator, whether it would have been in the home from which it was removed or in another home.

The level of free ridership associated with each alternative destination for the former *primary* units was determined primarily through *comparison group* responses to additional survey questions. Complete details of each alternative are explained fully in Jean et al. (1993). A few of the alternatives will be discussed. The primary refrigerators, that would otherwise have been used elsewhere in the home for more than 25% of the time, were each credited with savings. There were no free riders associated with this alternative because the refrigerator, in the absence of the program, would have consumed the energy required to operate a typical secondary unit. On the other hand, the primary refrigerators that would have otherwise gone to the landfill would be pure free riders, and therefore none of them were credited with savings.

The level of free ridership associated with each alternative destination for the *secondary* units was determined through *participant* self-reported responses. It is widely accepted that there are limitations to using participant self-reported data to estimate free riders (Buller and Miller 1992; Saxonis 1991; Tolkin 1992). Participants, when asked whether they would have made the same decision in the absence of the program, often overstate participation levels. The participants may not have been aware of the

costs and complications involved in bringing a refrigerator to a landfill. They may not have actively sought a disposal avenue prior to responding to the survey. Tolkin (1992) lists four limitations to using self-reported data:

1. Due to a change in the market for the product being offered through the program, participants may not be able to assess their options in absence of the program.

2. Participant responses are subject to bias. Respondents may state a positive response as a justification for participation in the program.

3. Respondents are limited by their recall of the factors and decisions leading to participation in the program.

4. Survey biases often influence participants' responses.

Because of the issues related to calculating free ridership based on *participant?* self-reported data, some adjustments were made to the participant data. Twenty-one percent of the participants indicated that they would have brought their refrigerator to the landfill in the absence of the program (Figure 3). Yet, only 5% of the comparison group purchasing new primary refrigerators *actually* brought their former primary refrigerator to a landfill (Figure 2). The true level of free ridership for this category of participants lies somewhere between these two numbers. It is likely that, due to self-selection, a larger percentage of the participants, than the comparison group, would have, in the absence of the program, actually taken their refrigerators to the landfill. In that case it was assumed that half of the participants indicating that the refrigerator would have been disposed of at a landfill would not have actually taken the refrigerator to the landfill. These refrigerators would have, instead, returned to the market to be used as secondary units. So, among this group of participants that stated their refrigerator would have otherwise gone to the landfill, half of them were assumed to be correct—pure free riders, and the other half were assumed to have overstated their likelihood to have completed the program recommended actions—not free riders.

For both primary and secondary units, there were no free riders associated with the refrigerators that would otherwise have been sold or given away. Such refrigerators have value to the purchaser or receiver. It is likely that these refrigerators would have been used by the purchaser/receiver and would not have gone to a landfill.

Given that 50% of the refrigerators were former primary units and 50% secondary units; and given the proportion of probable alternative destinations, and the level of incremental free riders associated with each destination; the free ridership for the RBB program was calculated to be 21% of all refrigerators collected. This is a weighted average of the incremental free ridership for each alternative destination for both primary and secondary refrigerators.

Conclusion

The pilot evaluation of the RBB program, conducted in 1991, estimated free riders based solely on participant data. Free riders were estimated to be 40% of operating refrigerators collected. Similarly, without the comparison group data, an evaluation of the 1993 participant data alone resulted in an estimate of free riders ranging from 30 to 40%. This represents an upper bound to free riders. Five percent of the comparison group stated that they took their unneeded refrigerators to the landfill. This represents a lower bound to free riders. A more accurate estimate of free riders, as described in this paper, lies between the two estimates at 21%. The analysis described in this paper presents an alternative, more complete approach to assessing free riders through the use of both participant and comparison survey data.

A billing analysis, in this case, would not account for the potential future consumption of the refrigerators being removed from service through the program. It would only count the difference in consumption at the individual household. The probability analysis discussed in this paper accounted for the difference in the total stock of secondary refrigerators in the province. This market approach looked at the avoided potential energy consumption of removing the refrigerators from service which is an appropriate assessment of the greatest unknown: 'what would have happened in the absence of the program?'

Endnote

1. Former primary refrigerators have the potential to affect secondary refrigerator saturation. For example, a primary refrigerator that is being replaced may subsequently go into a basement and thereby increase the stock of secondary refrigerators in the province. If the RBB program intercepts this refrigerator before it goes into a basement, it has reduced the stock of secondary refrigerators by one unit.

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