The switch to refillable bottled water in Indonesia: a serious health risk

Ahmad Komarulzaman, Eelke de Jong and Jeroen Smits

ABSTRACT

In recent years, the consumption of refillable bottled water has increased considerably in emerging countries. However, the quality of this water is often questionable, as authorities lack the capacity to properly check refilling depots. Given that refillable bottled water not only replaces unimproved water sources, but also better-quality sources, like piped and branded bottled water, its increasing use poses a major health risk. We investigate the motives behind the decision to switch to refillable bottled water in Indonesia. Findings indicate that this switch is driven by lifestyle motives, as well as by cost and availability considerations. It is mostly the young affluent households who switch from piped and 'other' sources to refillable bottled water. In rural areas, the tendency to make this switch is negatively affected by availability problems and the higher price of refillable bottled water. Availability and cost also influence the switch from branded bottled to refillable bottled water, but here it is the poorer households who have a higher propensity to switch. Further exploration of the lifestyle motive and affordability issues, as well as better monitoring of the refilling depots, are needed to improve the quality of drinking water in Indonesia and other emerging countries.

Key words | drinking water, Indonesia, LMIC, piped water, refillable bottled water

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INTRODUCTION

Access to safe drinking water is an essential need for human beings. In high-income countries, many households use bottled water as their main source of drinking water. Although these households also have access to piped water of good quality, they prefer to use bottled water because they believe it is healthier or they associate its use with good taste and a modern lifestyle (Wilk 2006; Ward *et al.* 2009; York *et al.* 2011).

In low- and middle-income countries (LMICs) a trend towards using bottled water can be observed too (United Nations Children's Fund (UNICEF) & World Health Organization (WHO) 2011; WHO & UNICEF 2008). However, here this trend is more problematic as different kinds of bottled water of varying quality are available. Branded bottled water is usually of similar quality compared to the bottled water sold in industrialized countries. However, its price is relatively high for LMICs' standards. Refillable bottled water is provided by refilling depots. Its price is much lower than that of branded bottled water, but it is often of inferior quality, as the refilling depots are not properly checked by local authorities. The previously mentioned trend towards bottled water is primarily driven by an increased demand for refillable bottled water.

As households in LMICs tend to switch to refillable bottled water from other (improved) sources, and even from branded bottled and piped water, this may lead to serious health problems in these countries. Table 1 shows some relevant figures for Indonesia. The quality of refillable bottled water (as indicated by diarrhoea prevalence) is lower than that of piped water, while its price is much higher. Nevertheless, households increasingly switch from piped to refillable bottled water as their main source of drinking

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Table 1 | The trade-off between price and quality of drinking water sources in Indonesia

Water sources	Price (IDR/ litre)	Diarrhoea prevalence (quality)	Comparison to refillable bottled water
Branded bottled water	842.11	1.53%	Higher price – higher quality
Refillable bottled water	210.53	1.71%	–
Piped water	4.97	1.48%	Lower price – higher quality
Other water sources	0–25	2.05%	Lower price – lower quality

Note: A detailed definition and characteristics of each water source can be found in the Appendix, Table A-1 (available with the online version of this paper).

water (Komarulzaman *et al.* 2015). An extreme example is Surabaya City, where the use of (branded and refillable) bottled water increased from 6.4% in 1998 to 79.3% in 2014, whereas during the same period the use of piped water as the main source of drinking water decreased from 90.7% to 20.5% (Komarulzaman *et al.* 2015).

The increasing use of refillable bottled water, together with the associated health risks, raises the question of why households are switching to this source. This question is particularly intriguing with regard to households that switch from piped water to refillable bottled water. Although they already enjoy the convenience of having access to an improved water source in their home, they switch for their drinking water to the more expensive and often lower-quality refillable bottled water.

So far little is known about the motives of consumers who make this choice. Most of the previous studies focus on the choice of branded bottled water in developed countries (Doria 2006; Saylor *et al.* 2011; York *et al.* 2011; Johnstone & Serret 2012). It is unclear whether these findings can be generalized to the choice of refillable bottled water in LMICs. Earlier studies of LMICs rely mostly on cross-sectional data and are limited to the analysis of factors affecting consumers' preference for refillable bottled water (Francisco 2014) and its microbial and chemical quality (Eflin 2008; Rahayu *et al.* 2013). As far as we know, there is no study for LMICs that has focused on motives affecting households' 'switching behaviour', and more specifically on the switch from piped water to refillable bottled water. A reason for this could be that a proper analysis of switching behaviour requires information about households' main source of drinking water spanning at least two consecutive periods.

The current study aims to investigate the motives for households' decision to switch to refillable bottled water as their main source of drinking water. In particular, the reasons for switching from piped to refillable bottled water are investigated. Additionally, we investigate the switch to refillable bottled water from branded bottled water and other (low quality) water sources. We use the Indonesian household panel socio-economic survey (Susenas panel) 2008–2010, which tracked 66,724 households during three consecutive years. The panel's dataset allows us to observe the characteristics of a large number of households in Indonesia and track the changes in their choices of drinking water sources. This longitudinal aspect of the data is unique and allows us to study households' switching behaviour.

BACKGROUND

Water sources in Indonesia

Two types of bottled water, branded and refillable bottled water, are available in Indonesia. Branded bottled water is produced and marketed in a sealed 19-litre bottle by a limited number of big beverage companies at a price of about IDR 16,000 (1.2 USD, in 2016). The water undergoes comprehensive treatment and strict quality control as part of a strict implementation of regulations and regular monitoring by the government.

Refillable bottled water is sold by refilling 5-gallon (19-litre) bottles at small, privately owned local refilling depots. In these depots, the raw water (i.e. groundwater or spring water) is treated on-site using ultrafiltration or a reverse osmosis membrane together with ultraviolet (UV) disinfection (Keman 2005). Provided the treatment process is properly carried out, any biological and chemical contamination of the raw water is removed (Sima & Elimelech 2013). The price of treated water is about IDR 4,000 (0.3 USD, in 2016) per 19-litre bottle. This price is substantially lower than that of branded bottled water but much higher than the price of piped water (see Table 1).

The operation of refilling depots is regulated by the central government and must be monitored by the local government where the depot is located. However, in practice, this monitoring is hardly implemented due to a lack of local government resources. During recent years, the situation has worsened due to the rapid increase in the number of refilling depots. A recent study shows that refillable bottled water is often not properly treated and that the depots' hygiene and operation are not well maintained, increasing contamination risks (Rahayu *et al.* 2013). Hence, it is no surprise that in an earlier study the water from about 40% of refilling depots was found to be contaminated by faecal coliform (Eflin 2008).

Besides bottled water, other sources of drinking water are used in Indonesia, such as piped water and water from tanker trucks, wells, springs, rivers and lakes. Piped water is commonly produced through a purification and sanitation process by a PDAM (local government-owned drinking water company). The water is distributed to consumers through a water piping network at a price of about IDR 5 per litre (PDAM Bandung 2016). In addition, an upfront connection fee of about IDR 1,300,000 (108 USD) has to be paid (PDAM Bandung 2016). Even though some PDAMs already produce piped water that is drinkable, a point-of-use water treatment, such as boiling, is usually needed. Most of the water from other sources can be obtained freely by households. However, sometimes a fee has to be paid to collectors who distribute the water from those sources and sell it to consumers. A detailed description of each water source can be found in the Appendix, Table A-1 (available with the online version of this paper).

Motives influencing drinking water sources

A considerable amount of literature has been published on the choice of drinking water sources. The relevant studies found three major motives driving the consumption of bottled water: concern about the health risks of other sources of drinking water (risk aversion motive) (Johnstone & Serret 2012; Francisco 2014), belief in the health benefits of bottled water (healthier perception motive) (Anadu & Harding 2000; Gleick 2010; Francisco 2014), and consumption of bottled water as a taste and lifestyle choice (lifestyle motive) (Ward *et al.* 2009; York *et al.* 2011).

The focus of the first motive (risk aversion), is on the disadvantages of other sources of drinking water. In developed countries, the use of bottled water is to a certain extent driven by the perceived health risk posed by tap water (Johnstone & Serret 2012). Jakus *et al.* (2009), for example, found that the perceived risk of arsenic contamination of tap water is positively related to the consumption of bottled water. In developing countries, these health risks are even higher, as the supply of tap water is often intermittent (UNICEF & WHO 2011), which is inconvenient and increases contamination risks (Kumpel & Nelson 2013). These perceived risks could push households to switch from piped water to refillable bottled water as their main source of drinking water (Johnstone & Serret 2012; Francisco 2014).

The second motive for choosing bottled water mentioned in the literature is consumers' perception that bottled water is healthier. While the 'risk aversion' motive is related to the (supposed) risks associated with the initial water source, the 'healthier perception' motive is a positive choice based on households' belief that consuming bottled water is healthier (Doria 2006). Given the popularity of bottled water in the United Kingdom, Ward *et al.* (2009) found that people do not perceive any risks in drinking piped water but generally believe that the good quality and minerals contained in bottled water give a health benefit. In the same vein, Francisco (2014) found that the decision to buy refillable bottled water in Cebu, the Philippines, is mainly explained by households' perception that this type of water is healthier and safer than other sources of drinking water.

However, the 'risk aversion' and 'healthier perception' motives do not fully explain the decision of households to switch to bottled water. The consumption of bottled water keeps increasing, both in regions where the quality of piped water is considered excellent (Doria 2006; York *et al.* 2011) and in regions where the purity and safety of (refillable) bottled water is not fully guaranteed (Rahayu *et al.* 2013). This leads to the third motive for the increase of refillable bottled water consumption that is attributed to a lifestyle choice (Ward *et al.* 2009; York *et al.* 2011). Bottled water is not only believed to be convenient, readily available, easily accessible (Ward *et al.* 2009), and to taste better but also to bestow a higher social status on the consumer (Wilk 2006).

In addition to the three motives mentioned, we expect that the switch to refillable bottled water is a cost-based

decision and affected by the product's availability in the households' neighbourhood.

Hypotheses

Regarding the effects of background characteristics of the household and of the context in which they live, we have developed several hypotheses which are represented by the (+) and (−) in Table 2. First, we predict that the more affluent and smaller households will more easily switch if they are using piped water or 'other water sources', as they can better afford the more expensive refillable bottled water than poor and larger households (York *et al.* 2011; Johnstone & Serret 2012; Francisco 2014). Second, previous research found that younger people have a stronger preference for bottled water, as it is more convenient and reflects their lifestyle, particularly in urban areas (Hu *et al.* 2011). We therefore expect urban households and those with a younger head to switch more easily to refillable bottled water.

Third, regarding the effect of education, formulating an expectation is more complicated. Individuals with more education will be better able to comprehend information about the quality and safety of water sources (Rahut *et al.* 2015) and thus be more aware of the quality of the water they use. If their current source is piped water, they will be aware of the fact that because this source is often intermittent, there is a risk of contamination as the water has to be stored in tanks or bottles. This might lead to a tendency to switch to refillable bottled water. However, from the perspective of the 'healthier perception' motive, we also expect more educated households to be more aware of the fact that refillable bottled water often is of questionable quality and thus not so healthy after all. From this perspective, we would expect more educated households to have a lower tendency to switch than less educated households. Hence, for households with piped water we cannot formulate a clear expectation regarding the direction of the education effect. For households using 'other water sources', which are generally of lower quality, the prediction is easier. More educated households using 'other' sources can be expected to switch more easily, as they are more aware of the low quality of their current water source.

Fourth, for households with a female head, or with young children, we would expect extra awareness of the quality of their drinking water. Females are known to be more concerned with health risks resulting from poor quality of drinking water than males (Hu *et al.* 2011; Saylor *et al.* 2011). Households with children are likely to be more cautious with respect to the quality of drinking water, as children, particularly the young ones, are more susceptible to waterborne diseases (Francisco 2014; Komarulzaman *et al.* 2017). Hence, for households with female heads and with young children predictions are similar to those for

Table 2 | Hypotheses of the switch to refillable bottled water

		Hypotheses		
Motives	**Variables**	**Piped water**	**Branded bottled water**	**Other water sources**
Risk aversion	HH head year(s) of education, HH head is female, HH has infant	(+ −)		(+)
Healthier perception	HH head year(s) of education, HH head is female, HH has infant	(+ −)		(+)
Lifestyle choice	HH head age	(−)		(−)
	Urban	(+)		(+)
Cost	HH expenditure	(+)	(−)	(+)
	HH size	(−)	(+)	(−)
Availability	Coverage of branded bottled water		(−)	
	Coverage of refillable bottled water	(+)	(+)	(+)
	Coverage of piped water	(−)		

Notes: HH is household; A '+' or '−' indicates, respectively, a positive or negative expected effect of the variable on the switch.

educated households: a tendency to switch if they are currently using an 'other' source and no clear prediction if they are using piped water.

Fifth, regarding the availability of water sources, the switch to refillable bottled water can be expected to be positively affected by the availability of refillable bottled water in the market, while it may be negatively affected by the coverage of piped water networks. Sixth, as branded bottled water is of better quality than refillable bottled water, we expect that the switch to the latter is mainly motivated by cost and not by risk aversion or the healthier perception. Thus, consumers using branded bottled water who have less income might see the switch to refillable bottled water as a possibility to maintain their lifestyle at lower costs.

Seventh, for the category of other water sources, we expect that the switch to refillable bottled water differs depending on whether households' previous main source of drinking water was other improved water or unimproved water. Households using unimproved sources will probably more easily switch if they have the possibility to do so. Finally, rural areas differ with respect to the supply of the different water sources from urban areas. Consequently, the effects of the explanatory factors might differ according to level of urbanization of the place of living. We therefore investigate whether there are significant interactions between the urbanization and the other explanatory variables in the model.

DATA AND METHODOLOGY

Data

This study utilizes the Indonesia National Socio-Economic Survey (Susenas) panel dataset for the period 2008–2010. The panel surveys 66,724 households, which is a sample representative of both the national and provincial levels. The Susenas panel survey is composed of a core and a module questionnaire. The core questionnaire contains household characteristics and household members' information. The module questionnaire collects information on consumption and expenditure behaviour of the household.

We examine data related to the main drinking water sources and socio-demographic characteristics of the households, merging the 2008 and the 2010 panel rounds and dropping the households with incomplete information. The result is a balanced panel of 63,276 households.

Method

In developing countries, it is rather common for households to get water from several sources (Nauges & Berg 2009). One of these sources is generally the main source of drinking water. Our analysis focuses on this main source. We categorize the main sources of drinking water into four groups: (1) branded bottled water; (2) refillable bottled water; (3) piped water; and (4) other water sources. The category of other water sources includes other improved sources (tanker truck water, drilled/pumped wells, protected wells, protected springs, and rainwater) and unimproved sources (unprotected wells, unprotected springs, rivers, and others).

Our analyses focus on the switch to refillable bottled water from each of the three other sources of drinking water for each of which a separate logistic regression analysis is conducted. In each analysis, the dependent variable is a dummy variable indicating whether (1) or not (0) the household switched its main source of drinking water from one of the three other sources to refillable bottled water between 2008 and 2010.

The independent variables are characteristic of the household and area in which the household is located. Some of these variables represent the motives to switch to refillable bottled water as explained in the Background section (see Table 2). Education of the household head is measured by years of education completed. Female household head and the presence of children under the age of five are represented by dummy variables. The lifestyle motive is indicated by the household head's age measured in years and a dummy variable represents living in an urban area. To indicate the economic situation of the household, household expenditure is used, because for income there are too many missing values in the data (about 33%).

Besides household level factors, we control for the context at the village level. The village level is chosen because it is the lowest level of public administration in Indonesia. A village covers an area of 25.3 km^2 on average and has a population of about 3,000 (750 households). Characteristics of areas of this size are known to have good explanatory

power for studying the effects of context (Smits *et al.* 2005). Context factors in this study are intended to capture the potential access to the various sources in the surrounding area of the household. When there is no piped network or no market for refillable bottled water in the region, no household within that region is able to use these sources, irrespective of its income and status. We therefore include a set of water coverage variables: coverage of branded bottled water; of refillable bottled water; and of piped water. These three variables are aggregated from the households' data and are calculated as the percentage of households that report making use of that particular source of water within the specified village. In addition, we consider the change over time of these water coverage variables. A description of the variables can be found in the Appendix, Table A-2 (available with the online version of this paper). All variables are centred while the logistic regression results are presented in the form of odds ratios (OR).

Table 3 presents descriptive statistics of the main variables for the three subsamples, namely households that switch to refillable bottled water from (1) piped water, (2) branded bottled water and (3) other water sources. Of the households that had piped water in 2008, 15.6% switched to refillable bottled water in the period 2008–2010. For branded bottled water, the corresponding percentage is about twice as high (34.9%) and for other water sources it is only 5.3%. On average, household heads who use a better source of drinking water (piped and branded bottled water) have more years of education than those who use water of lower quality. Interestingly, the heads of households using branded bottled water are on average 6 years younger than those who use piped water and other water sources. Most of the households using piped and branded bottled water live in urban areas, whereas those using other water sources are mainly located in rural areas. About 92.6% of the users of branded bottled water live in urban areas. The average expenditure of households who initially used piped water (IDR 2.1 million) is less than the expenditure of those who used branded bottled water (IDR 3.9 million). Both types of households are considerably more affluent than the households using other water sources (IDR 1.1 million). Over the period, households using branded bottled water, on average, experienced a larger increase in their expenditure (IDR 0.9 million) than those with piped (IDR 0.6 million) and other water sources (IDR 0.3 million). In the villages in which in 2008 users of piped water lived, the coverage of refillable bottled water grew by 5.43 percentage points, whereas the coverage of piped water decreased by 6.34 percentage points over the period up to 2010.

RESULTS

The results of the logistic regression analysis for the switch to refillable bottled water are presented in Table 4. For those variables that interacted significantly with the urban dummy, separate coefficients for urban and rural areas are presented; otherwise a general coefficient is presented under All (columns 1, 4 and 5).

The switch from piped water to refillable bottled water is significantly affected by the age of the household head. Households with a one-year-older head are 2.4% less likely to switch from piped water to refillable bottled water (see Table 4, columns 1–3). This result provides support for the lifestyle motive. Of the other household variables, neither the household head's education, nor having a female head or having an infant significantly affects the odds of switching from piped water to refillable bottled water. Hence, no evidence is found for either the risk aversion motive or the healthier perception motive. Of course, it could also be that both are relevant, but no single motive dominates so that the effects cancelled each other out.

Regarding the effects of household expenditure and expenditure change on the switch from piped to refillable bottled water, we find a difference between households living in urban and households living in rural areas. The effects of initial expenditure and of expenditure change are significantly positive in rural areas but not significant in urban areas. These results indicate that the switch from piped water to refillable bottled water is more costly for households in rural areas, so that only wealthier households can afford to make this switch.

Regarding the context factors, households in an area with a higher coverage of refillable bottled water and where this coverage increased are more likely to switch from piped water to refillable bottled water. Moreover, households in areas with a higher initial level or an increase

Table 3 | Descriptive statistics for subsamples of households that used to access piped water, branded bottled water and other water sources, balanced panel Susenas 2008 and 2010

	Piped water		Branded bottled water		Other water sources	
	n/mean	%/(SD/range)	n/mean	%/(SD/range)	n/mean	%/(SD/range)
Total	5,434	100.00	1,710	100.00	46,510	100.00
Dependent variable						
HH switch to refillable bottled water	848	15.61	596	34.85	2,457	5.28
HH keeps using the initial water source (Ref.)	4,586	84.39	1,114	65.15	44,053	94.72
Household factors						
Mean HH head years education (SD/range)	9.19	(4.53/0–23)	12.43	(3.59/0–22)	5.86	(4.13/0–22)
HH head is female	773	14.23	271	15.85	6,102	13.12
HH has infant (0–5 years old)	1,742	32.06	505	29.53	15,754	33.87
Mean HH head age (SD/range)	47.63	(13.46/14–95)	41.38	(13.42/15–90)	47.56	(14.12/12–98)
Urban	4,058	74.68	1,583	92.57	12,641	27.18
Mean initial HH expenditure (SD/range)	2.05	(1.59/0.1–27.21)	3.88	(4.27/0.35–65.37)	1.18	(1.09/0.08–92.51)
Mean Δ HH expenditure (SD/range)	0.59	(1.72/− 11.81 –31.75)	0.92	(6.56/− 58.82 –163.55)	0.34	(1.3/− 91.67–124)
Mean HH size (SD/range)	4.09	(1.72/1–16)	3.75	(1.85/1–12)	3.92	(1.66/1–18)
Initial water access						
Branded bottled water	–	–	1,710	100.00	–	–
Refillable bottled water	–	–	–	–	–	–
Piped water	5,434	100.00	–	–	–	–
Other water sources					46,510	100.00
Other improved water	–	–	–	–	34,534	74.25
Unimproved water (Ref.)	–	–	–	–	11,976	25.75
Context factors						
Mean initial coverage of:						
Branded bottled water (SD/range)	–	–	37.20	(21.73/2.08–100)	–	–
Refillable bottled water (SD/range)	8.24	(13.98/0–93.75)	19.57	(17.18/0–86.67)	3.20	(8.54/0–93.75)
Piped water (SD/range)	59.84	(26.56/2.27–100)	–	–	–	–
Mean Δ coverage of:						
Branded bottled water (SD/range)	–	–	–1.69	(17.01/−66.67– 56.25)	–	–
Refillable bottled water (SD/range)	5.43	(17.06/−56.25 –93.33)	7.87	(19.04/–60.83–75)	2.51	(9.75/–74.58–93.33)
Piped water (SD/range)	−6.34	(19.9/−92.86 –81.25)	–	–	–	–

Notes: HH is household; Ref. is reference category; Other water sources includes drilled/pumped wells, protected wells, protected springs, rainwater, unprotected wells, unprotected springs, rivers and others.

in coverage of piped water are less likely to switch from piped water to refillable bottled.

As expected, the switch from branded to refillable bottled water (Table 4, column 4) is mainly driven by cost

Table 4 | Logistic estimation for determinants of switching the water source to refillable bottled water from piped water, branded bottled water and other water sources, Susenas panel 2008 and 2010

	Piped water			Branded bottled water	Other water sources		
	All OR (SE) (1)	Urban OR (SE) (2)	Rural OR (SE) (3)	All OR (SE) (4)	All OR (SE) (5)	Urban OR (SE) (6)	Rural OR (SE) (7)
Household factors							
HH head years of education	1.021 (0.017)			0.971 (0.018)	1.049 (0.007)***		
HH head is female	1.055 (0.193)			0.846 (0.159)	0.944 (0.084)		
HH has infant (0–5 years old)	1.037 (0.129)			1.008 (0.163)	0.900 (0.055)		
HH head age	0.976 (0.005)***			0.991 (0.006)	0.983 (0.002)***		
Urban	1.080 (0.198)			1.085 (0.237)	2.337 (0.166)***		
Initial HH expenditure (2008)		1.035 (0.034)	1.350 (0.126)**	0.867 (0.030)***		1.137 (0.029)***	1.408 (0.037)***
Δ HH expenditure		1.032 (0.045)	1.360 (0.089)***	0.890 (0.025)***		1.054 (0.020)**	1.335 (0.029)***
HH size	0.962 (0.034)			1.073 (0.055)	0.932 (0.017)***		
Initial water access							
Other improved water					1.232 (0.090)**		
Unimproved water (Ref.)					0.000 (–)		
Context factors							
Initial coverage of:							
Branded bottled water				0.966 (0.004)***			
Refillable bottled water	1.048 (0.005)***			1.030 (0.004)***		1.064 (0.002)***	1.082 (0.004)***
Piped water	0.972 (0.003)***						
Δ coverage of:							
Branded bottled water				0.947 (0.005)***			
Refillable bottled water	1.060 (0.004)***			1.031 (0.004)***		1.080 (0.002)***	1.119 (0.003)***
Piped water	0.956 (0.005)***						
Interaction variables							
Urban X Initial HH expenditure (2008)	0.767 (0.072)**				0.807 (0.028)***		
Urban X Δ HH expenditure	0.759 (0.057)***				0.789 (0.023)***		
Initial coverage of:							
Urban X Refillable bottled water					0.983 (0.004)***		
Δ *coverage of:*							
Urban X Refillable bottled water					0.965 (0.003)***		
Observation	5,434			1,710	46,510		
Pseudo R^2	0.435			0.285	0.388		
Log Likelihood	−1,036,826.5			−790.5	−5,885.0		

Notes: The coefficients represent odds ratio of switching to refillable bottled water. All variables are centred. HH is household. Ref is reference category. Significance level at *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

motives, as both expenditure variables are significantly negative. Households with higher expenditure and those with expenditure growth during this period are less likely to switch from branded bottled to refillable bottled water. As expected, the variables representing the risk aversion, healthier perception and lifestyle motives are not significant meaning that these motives are not relevant for this choice.

With respect to the context factors, it is obvious that the odds of switching from branded bottled to refillable bottled water are higher for households in an area with higher coverage of refillable bottled water and with a lower coverage of branded bottled water. There are no significant interaction effects with urbanization. This might be due to the small number of households in rural areas (7%) that use branded bottled water and the even smaller number that have made this change in the study period.

The last three columns of Table 4 present the results for the switch from 'other water sources' to refillable bottled water. It is apparent that all motives play a role in the switching behaviour of this group. Households with a younger head and a head with more years of education, households living in urban areas, households with higher expenditure and with more expenditure growth, and smaller households are more likely to switch from other water sources to refillable bottled water. Hence, for households using these other sources, both risk aversion, healthier perception, costs and lifestyle motives seem to be important.

As explained in the Data and methodology section, the group of households relying on 'other water sources' contains two subgroups, those using other improved sources and those using unimproved sources, and we expected the behaviour of these groups to differ. Table 4 indeed shows that households who initially used 'other improved water' are 23% more likely to switch to refillable bottled water than households using an 'unimproved source'.

Regarding the context factors, we observe that both the initial coverage and the change of coverage of refillable bottled water significantly and positively affect the switch from 'other water sources' to refillable bottled water.

For the 'other water sources' group, our analysis shows that four variables interact significantly with the urban area dummy: initial expenditure, change of expenditure, initial coverage of refillable bottled water and change of coverage of refillable bottled water. In rural areas, the effects of expenditure and expenditure change on the switch to refillable bottled water are significantly stronger than in urban areas, thus indicating that the cost motive is most important for rural households. Likewise, the effects of the coverage and increase in coverage of refillable bottled water are stronger in rural than in urban areas.

CONCLUSION

In LMICs, an increasing number of households use refillable bottled water as their main source of drinking water. The price of this water is much lower than that of branded bottled water, but its quality is often questionable as local authorities lack the capacity to check the refilling depots. In Indonesia, the popularity of refillable bottled water comes even at the expense of piped water as the primary source of drinking water. Given that piped water is cheaper and safer than refillable bottled water, one can question whether the switch to refillable bottled water is an improvement.

This study investigates the households and context factors affecting the switch to refillable bottled water in Indonesia on the basis of a unique panel dataset that tracked 63,276 households in Indonesia for three consecutive years (2008–2010). These data enable us to estimate a logistic model of the switch to refillable bottled water.

Our analyses suggest that the switch from piped to refillable bottled water is caused mainly by lifestyle considerations; households with a younger head choose refillable bottled water more often than other households. This finding is consistent with previous literature (Ward *et al.* 2009; Hu *et al.* 2011; York *et al.* 2011). In our analyses, we use expenditure as a proxy for income. We find that in rural areas more affluent households and those households that experienced an expenditure growth have a higher tendency to switch from piped to refillable bottled water. This finding suggests that in those areas the switch to refillable bottled water is a cost-based decision. This is in accordance with previous studies indicating that more affluent households tend to choose bottled water (York *et al.* 2011; Johnstone & Serret 2012).

However, it is important to note that in urban areas households' affluence does not affect the switch from

piped to refillable bottled water. Apparently, the decision to make this switch is less costly for households in urban areas. The fact that refillable bottled water is widely available in urban areas, might make this type of water more accessible and less costly for urban households in comparison to households in rural areas. Lastly, as hypothesized, we find that the switching behaviour is positively affected by the proliferation of the market for refillable bottled water, while it is negatively affected by the development of the piped water networks.

For households using piped water, the household head's education, female headship and presence of infants do not affect switching behaviour. This is in line with the fact that we could not make clear predictions for these variables. More educated heads, female heads and parents of infants will on the one hand be more aware that piped water has its problems, but they might on the other hand also be more aware of – and sensitive to – the risks associated with refillable bottled. It therefore is not surprising to find no significant effect for these variables for households using piped water.

The switch from branded bottled water to refillable bottled water appears to be an urban phenomenon driven by cost considerations. Within the group of users of branded bottled water, households with a low initial income and those who experienced a decrease in their income during the study period are more likely to switch to refillable bottled water. Users of branded bottled water switch to the much cheaper refillable bottled water but may still take pride in having bottled water.

The sources included in the group 'other water sources' are cheaper and less healthy than refillable bottled water. The switch from one of these sources to refillable bottled can be explained by a mix of all of the motives. In addition to the lifestyle motive, and the cost and availability factors, it is evident that the risk aversion strategy and a search for a healthier source are the motivating factors for households to switch from 'other water sources' to refillable bottled water as their main source of drinking water. This is confirmed by the fact that for this group education – indication knowledge of the health risk of the different sources – has a significantly positive effect on switching to refillable bottled water. However, besides health-related motives, also the fact that this switch benefits the household in terms of convenience and higher social status may play a role of importance.

The interaction effects indicate that the cost and availability factors have a stronger effect for households in rural areas than those in urban areas. This could be caused by the fact that the distribution of refillable bottled water is concentrated in urban areas and hence the effect of market expansion of refillable bottled water in these areas is almost saturated. Given this distribution disparity, the switch to refillable bottled water is more costly for rural households in comparison to households in urban areas.

To sum up, the switch to refillable bottled water is mainly driven by lifestyle and, particularly in rural areas, by cost and availability motives. Our findings call for an exploration of the lifestyle choice in relation to the preference for drinking water sources and the safeguarding of the provision and quality of drinking water supplies in the LMICs. Even though the quality of refillable bottled water is often questionable, the pressure for households to switch to refillable bottled water seems strong. Thus, an urgent policy implication for local governments is to find an effective way to communicate to local residents the contamination and lack of safety of refillable bottled water. Another policy issue is how the depot owners and the government can ensure the hygiene practice of the depots and the quality of the water. This highlights the urgent need for an improved surveillance system and a certification or water quality testing system for the refillable bottled water industry.

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