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1. INTRODUCTION

This paper discusses pricing and mass customization in the last mile of the postal value chain. It does so by analyzing a delivery model based on the receiver pays principle. It is calibrated by means of market research data. We look at a case study, and discuss our conclusions.

Indeed, given the high cost-relevance of the last mile, and against the background of decreasing economies of density² from declining volumes, universal service providers are increasingly focusing on ways to reduce costs at the distribution end of the value chain. These include delivering more efficiently or reducing service levels. In contrast to these approaches, Felisberto et al. (2006) present a delivery model which gives *more* value to the last mile by introducing a delivery fee payable by recipients in order to receive services above a minimum standard level. While this minimum standard level is likely to be below current USO-levels, fee-driven services or service bundles will open the door for tailor-made delivery according to the needs of individual recipients. This Receiver Pays Principle (RPP) aims to reduce the proportion of overserved receivers in order to align supply (delivered value) and demand (expected value), allowing both potential savings as well as a level playing field for new price-service bundles created according to the segmented receiver base.

¹ The views expressed in this paper are those of the authors and do not necessarily reflect the opinion of the institutions they are affiliated with.

² For a detailed discussion on economies of scale, density and scope in Switzerland see Farsi et al. (2006)

Pricing the last mile equals a two-part tariff scheme where both sender and recipients bear the cost of sending a piece of mail: the former paying the postage and the latter a delivery fee. As shown in Felisberto et al. (2006), a two-part tariff, for example including a variable postage and a fixed delivery fee, would allow postal rates to come closer to marginal costs and thus to economically more efficient pricing. It can also be shown that this model provides an option for financing the universal service obligation – or, more precisely, the universal delivery obligation of postal operators – and that it increases overall welfare.³

There are a number of political and market developments that point to the same direction. Given the ongoing policy shift towards liberalization, the current levels of the universal service obligation are increasingly questioned. At the same time, the trend towards “convenience”, and technological advances supporting this trend, lead to increased demand for customized delivery services. This opens the way for innovations at the delivery end of the postal value chain.⁴

The paper is structured as follows. Section 2 discusses the willingness of households to pay for home delivery of mail. It also shows how a discrete choice analysis yields different results on the consumers’ willingness to pay for last mile delivery than a linear regression based on direct questioning. Section 3 reassesses the welfare implications of last mile pricing. We find that demand effects have to be well understood before introducing a delivery flat rate in the postal market. Section 4 presents field results from Denmark. These highlight the cost sensitivity of recipients. We conclude in Section 5.

2. WILLINGNESS TO PAY FOR LAST MILE DELIVERY

In 2005, a representative survey was conducted among private households in order to elicit the willingness to pay for mail home delivery in

³ Kim and Lim (2000), Jeon, Laffont and Tirole (2004) and Hermalin and Katz (2004), among others, discuss under which exact assumptions, RPP increases both welfare and profits.

⁴ The introduction of the RPP is not actually a real innovation: In the pre-Rowland Hill era, the RPP was a common means of payment for mail services. Cf. e.g. Crew and Kleindorfer (1991).

Switzerland.⁵ Two different survey methods were applied: A factorial survey and a direct questioning.

Factorial Survey – Discrete Choice Analysis

In a factorial survey a representative sample of decision makers is presented a (discrete) choice in a hypothetical situation whether or not to accept a certain offer, which is characterized in several dimensions, e.g. price and quality. Thereby, the individuals are presented different choice situations (“vignettes”) to get a comprehensive picture on the preferences over the analyzed product dimensions. Such a factorial survey is therefore an experimental design. It can be developed in three steps: (1) identifying the variables, (2) writing a coherent vignette, and (3) randomly generating the vignettes. To get more insights on the receiver’s willingness to pay for mail delivery to the doorstep, we chose the product dimensions as shown in Table 1.

Table 1: Hypothetical product characteristics

Dimensions	Values
Price for home delivery	CHF 10, 20, 30 per month
Product ⁶	Food, Beverages, Mail
Time of P.O. box delivery	6am, 10am
Time needed for pickup by the customer	5, 15, 30 Minutes per pickup
Household characteristic	Single household, Family with two kids

A total of 460 interviews with 4640 vignettes were conducted by the Kalaidos Fachhochschule in Switzerland. Due to inconsistent responses, 210 vignettes were cancelled from the data, such that 4430 vignettes were finally included in the analysis. Thereof, 1411 concerned vignettes on mail delivery.

The economic model behind the factorial survey can be summarized as follows.⁷ Indirect utilities from choosing home delivery or post office box delivery is assumed to be

$$U_{ij} = \alpha_j + z'_{ij} \beta + w'_i \gamma_j + \varepsilon_j$$

with subscript i denoting individuals and subscript $j \in \{h, p\}$ being the chosen mode of mail delivery (h standing for home delivery and p standing for post office box delivery). α_j is a mode-dependent constant, z_{ij} are mode

⁵ An early reference on the households’ willingness to pay for doorstep delivery is Elsenbast (1996).

⁶ In order to camouflage the purpose of the survey, other products than mail delivery were also included in the vignettes.

⁷ This is the random utility interpretation to the households’ discrete choice model (cf. e.g. Greene, 2000, Chapter 19).

characteristics, such as price of a P.O. box, the time to reach it, and the delivery time. w_i is the household characteristic, and ε_j is an error term. Hence, indirect utility in either delivery mode depends on the household characteristic and the characteristics of the mode itself. The probability P that doorstep delivery is chosen is equal to the probability that the corresponding indirect utility is higher than under post office box delivery:

$$\begin{aligned} P(j=h) &= P(U_{ip} \leq U_{ih}) = P(\alpha_p + z'_{ip} \beta + w'_i \gamma_p + \varepsilon_p \leq \alpha_h + z'_{ih} \beta + w'_i \gamma_h + \varepsilon_h) \\ &= P((\varepsilon_p - \varepsilon_h) \leq (\alpha_h - \alpha_p) + (z'_{ih} - z'_{ip})\beta + w'_i (\gamma_h - \gamma_p)) \\ &= F_{\varepsilon_p - \varepsilon_h}((\alpha_h - \alpha_p) + (z'_{ih} - z'_{ip})\beta + w'_i (\gamma_h - \gamma_p)) \end{aligned}$$

where F is chosen to be the logistic distribution,

$$F(\eta) = \frac{\exp(\eta)}{1 + \exp(\eta)}.$$

Due to the logistic functional form of F , the parameters β and γ can be estimated directly via logistic regression. The results are shown in Table 2.⁸

Table 2: Logistic regression results

	Coefficient	Std. Dev.	Wald ⁹	Significance
Price	-0.088	0.009	107.299	0.000
Pickup time	0.016	0.006	6.656	0.010
Delivery time	0.179	0.129	1.938	0.164
Household ¹⁰	0.094	0.127	0.547	0.460
Constant	0.201	0.216	0.872	0.350

These results can be explained as follows: The price and the pickup time influence the decision for home mail delivery on a 1% level of significance (p-value equal or below 1%). Delivery time and household characteristic do not significantly influence the decision.

The sign of the coefficient gives the direction of the effect of a change in the explanatory variable on the probability of choosing home delivery. The negative estimated coefficient on price suggests that an increase in price gives a lower probability of choosing home delivery. Suppose the original

⁸ Cox & Snell R²=0.089, Nagelkerkes R²=0.129 which measure the goodness of fit for binary choice models (Cf. Backhaus et al., 2003).

⁹ Cf. Greene (2000), p. 825.

¹⁰ Household is a dummy variable controlling for household size: 0 if family household, 1 for single household.

probability of choosing home delivery was 15%. Then, an increase of CHF 1 per month decreases the probability by 0.04 percentage points, controlling for other variables in the model.¹¹

As indicated, for the logit model, the estimated coefficients do not have a direct economic interpretation, since the estimated logit coefficients by themselves without assuming an original probability of choosing home delivery do not yield changes in the probabilities associated with a unit change in each explanatory variable. Marginal changes in the probabilities could be calculated by rescaling the estimated logit coefficients, but this value changes at each probability level and hence has to be evaluated at different probability levels. Therefore, it is useful to consider the same question by directly eliciting the individual willingness to pay. This can be analyzed meaningfully by an OLS regression where the coefficients lend themselves to an interpretation of marginal effects on the dependent variable.

The results of the logistic regression are displayed graphically in the next section in comparison with the revealed willingness to pay as obtained from direct questioning.

Direct Questioning – Linear Regression

In the direct questioning part of the survey, individuals were asked directly how much they would be willing to pay for mail home delivery, a free post office box service being the alternative. Thus, they are no longer asked to make a discrete choice over a range of hypothetical products but rather they can express their valuation for the product 'home delivery of mail' in currency. This enables us to apply ordinary OLS regression techniques.

The model used here treats the willingness to pay ϖ as a function of age, gross monthly income, gender, number of children in the household, number of adults in the household, nationality, household location (urban, rural), all contained in x :

$$\varpi = x' \delta + \varepsilon,$$

¹¹ The computation is as follows: An initial probability of 15% corresponds to odds of $15/85 = 0.176$. The logistic coefficient is -0.088 . This corresponds to an odds ratio of $\exp(-0.088) = 0.92$. Thus the odds of 0.176 multiplied by the odds ratio of $0.92 =$ new odds of the dependent of 0.176 . Let x be the new probability. We know $x/(1-x) = 0.176$ since the odds are defined as the probability divided by the not-probability (which is thus $1-x$). Solving for x , we get $x = 0.1496$. Thus, for an original probability of 15%, a logistic coefficient of -0.088 means that a unit increase in the price decreases the probability to 14.96%.

where δ are the coefficients to be estimated. Table 3 presents the results.¹²

Table 3: Results of linear regression

	Coefficient	Std. Dev.	t	Significance
Age	0.079	0.087	0.910	0.365
Gross income	0.000	0.000	2.081	0.040
Gender	3.303	2.170	1.523	0.131
Children	-2.077	1.153	-1.801	0.074
Adults	-0.277	1.641	-0.169	0.866
Nationality	-4.754	3.150	-1.509	0.134
Urban Citizen	1.072	2.600	0.412	0.681
Rural Citizen	1.318	2.730	0.483	0.630
Constant	10.628	5.566	1.910	0.059

Only household income (at the 5% level) and the number of children living in a household (at the 10% level) have a significant influence on the willingness to pay for home mail delivery. The amount people are willing to disburse increases in the gross household income and decreases with the number of children. Interestingly, the willingness to pay seems to be independent of whether a person is living in rural or city regions.

When asked directly, only 36% of all households seem to have a positive willingness to pay for doorstep delivery ($\varpi > 0$). Out of these households, 58% prefer daily delivery, 21% are content with weekly delivery, while the others wish a delivery every other day (12%) or twice per week (9%).

64% of all households say they have zero willingness to pay for doorstep delivery, thus preferring P.O. box delivery anyways ($\varpi \leq 0$). Those choosing post office box delivery of mail seem to be motivated partly by the lack of need for frequent mail reception: Only 46% of households would pick up mail daily, as compared to 58% who prefer daily home delivery. More importantly, 35% percent of P.O. box holders state that they would not empty their P.O. box anymore – their value of mail seems to be lower than the opportunity cost of emptying the P.O. box.¹³

Finally, based on the direct questioning we know how many percent of the population would choose home delivery over post office box delivery at a certain price: at a price of CHF 1 per month, 36% would choose home delivery (this corresponds to the number of households mentioned above with a positive willingness to pay). 28% would do so at a price of CHF 10

¹² R²=0.110, adjusted R²=0.043.

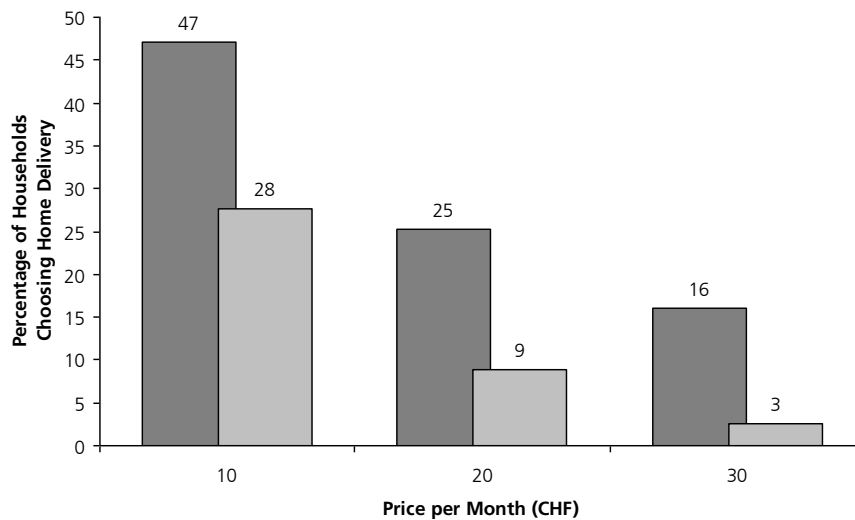
¹³ We think that this figure needs to be taken with caution. Evidence from an existing P.O. Box delivery scheme suggests that only a very small fraction of people would, in fact, not empty their P.O. Boxes at all.

per month. Then the willingness to pay drops: at a price of CHF 20 only 9% would choose home delivery, and 3% at a price of CHF 30.

Comparison: discrete choice analysis – linear regression

Based on the two surveys (factorial survey, direct questioning), a comparison between the results of the two designs is possible (see Figure 1). It is interesting to note that the revealed willingness to pay is significantly higher when elicited by a factorial survey (dark shaded bars) than when obtained by direct questioning (light shaded bars): For instance, when directly asked, only 9% of households would pay CHF 20 or more for mail home delivery, compared to 25% when asked indirectly in the factorial survey.

Figure 1: Consumers' willingness to pay: Revealed vs. stated



Hence, one has to be careful when basing actual pricing decisions on survey data since households are extremely reluctant to reveal their true willingness to pay for goods and services. The willingness to pay revealed by the factorial survey is superior, as strategic answers can be excluded. We base our further analysis on this first approach and conclude that the receiver's willingness to pay depends primarily on the three factors price of home delivery, time to reach the pick-up point, and household income.

3. RECALIBRATED WELFARE ANALYSIS

Based on these results we are now able to recalibrate the model as set out in Felisberto et al. (2006). For a complete description of the model including data sources, we refer to this paper. For the moment, the main difference concerns the calibration of the demand function for home delivery. We will briefly recalibrate the model according to the willingness to pay as set out in Section 2, calculate the optimal delivery charge and restate the estimated effects on total welfare.

In the original model, demand for doorstep delivery was determined by the receivers' opportunity cost OC of collecting the mail at the P.O. box location:

$$OC(w, t) = \alpha(w \cdot t)^\beta - s.$$

I.e. the opportunity cost was assumed to be a function of the two observed variables household income w and pick-up time t (the time needed to empty the P.O. box) which we let unchanged. Using the revealed preferences as presented in Section 2, we can now calibrate the three remaining parameters α , β and s . The variables α and β express the way customers value the opportunity money and time, and s can be interpreted as the search costs needed to realize the opportunity income. Table 4 presents the new calibration.

Table 4: Recalibrated parameters

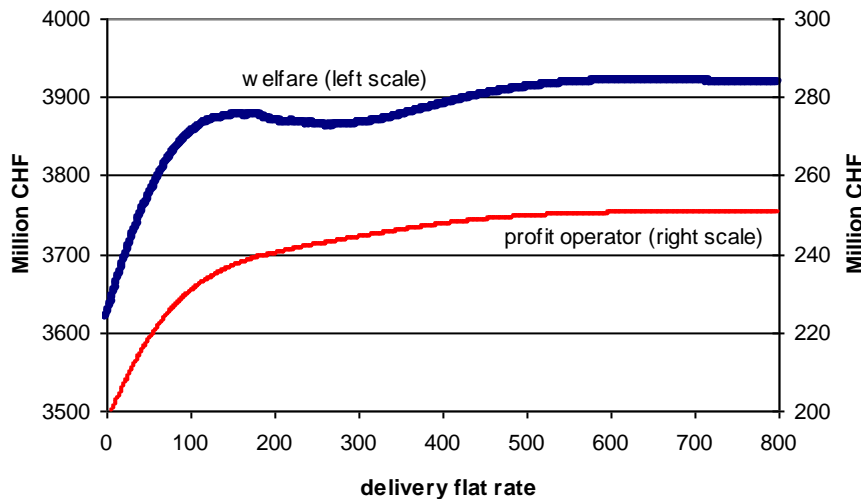
Parameter	Value
s [CHF]	300
α	1.15
β	0.75

These new values yield a demand curve that corresponds to the revealed preferences as shown in Figure 1. We note that the new curve is surprisingly close to the original one. The main difference is the larger fraction of the population willing to pay relatively high delivery flat rates.

Figure 2 presents the new results of Scenario 1, *where we assume that every P.O. box holder collects its mail*. This assumption enables us to ensure that the change from doorstep delivery to P.O. box delivery does not effect mail demand. I.e. the sender's utility of mail is not affected, because it still knows that the mail is finally received and accepted by the recipient. We further assume that the average yearly fixed costs of providing a P.O. Box is CHF 60.

The graph shows that the welfare optimizing delivery rate would be about CHF 636 where only 2% of the individuals would pay the fee for doorstep delivery. In other words, it would be optimal to abolish home delivery to a large extent. The local maximum is located at a flat rate of CHF 156 where over 40% of the households would keep household delivery.

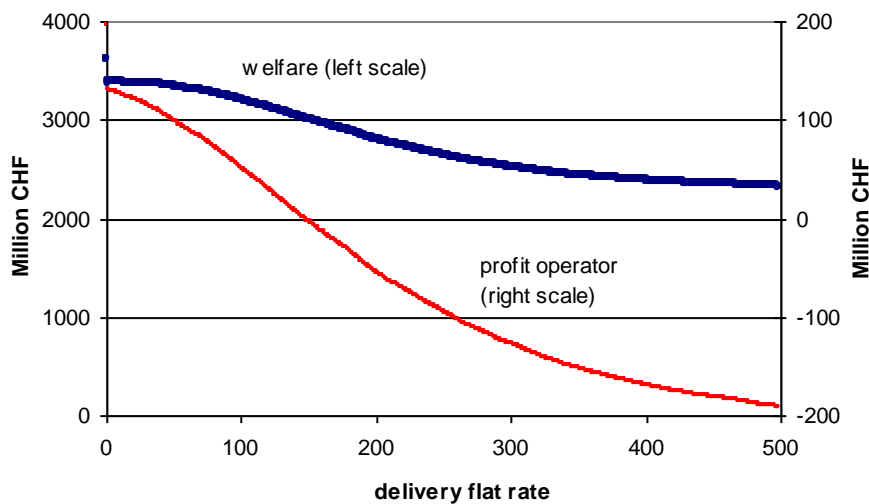
Figure 2: Recalibrated welfare effect of delivery flat rate (Scenario 1)



We now relax the assumption, that all the new P.O. box holders will empty their mail and assume according to the data presented in Section 2, that 35% of the P.O. box holders will not anymore collect their mail. This has now an effect on the senders' utilities, as all the mail destined to 35% of P.O. box recipients is returned to the sender. Hence, the sender only incurs a cost, but no utility for these letters; the sender will think twice to send again letters to these 35% P.O. box addresses.

We consider this effect in our second scenario by assuming that the senders stop mailing to P.O. box that are not emptied. By assuming, that the recipients' volumes are identically distributed among the willingness to pay for doorstep delivery, demand drops exactly by 0.35 times the fraction of P.O. box users.

The effects on welfare and profit are dramatic as shown in Figure 3. The reduction in mail demand is not offset by the cost reduction that occurs from the change from doorstep to P.O. box delivery. This yields a decline in both welfare and profit. We conclude that demand effects need to be well understood before introducing a receiver pays principle in the postal market.

Figure 3: Strong dependency on receivers' behavior (Scenario 2)

The two presented scenarios represent the boundaries of the effects of a delivery flat rate. No better welfare results as shown in Scenario 1 can be expected as long as the willingness to pay for doorstep delivery is not lower than revealed from our representative sample in Section 2. On the other hand, Scenario 2 will be the lower bound of the effects of RPP, as the ones who do not collect their mail anymore are most probably the ones that receive fewer letters per year (our assumption of uniform distribution among willingness to pay is too pessimistic). Further to that, we question whether the respondents indicating a zero willingness to pay carefully considered the consequences of not being connected to the postal network.

We so far conclude from our analysis, that it is a crucial point for the whole mailing industry whether recipients are willing to empty their mailbox or not. If the perceived value of the mail is low, it can not be ruled out that these individuals will not collect their mail anymore if in the same time the cost associated to empty the mail or P.O. box is too high (unless they are forced by law to do so).

If we think the story further on, one could even argue that some receivers should *not pay, but receive* money to collect their mail. Why should senders not start to compensate those receivers with (1) either low net utility of receiving mail or (2) with high bargaining power towards the sender? We will not develop this point further and leave the computation within our model for future research.

4. FIRST EXPERIENCES WITH LAST MILE PRICING IN DENMARK

We now present a case study on the Receiver Pays Principle from Denmark. One of the strategic goals for Post Danmark on its way towards 2006 has been to enlarge the customer perspective, so the receiver's needs also is considered as a possible business case. This new market approach is considered to fit well with the overall trends in the society, where the consumers increasingly demands long opening hours and tailor made solutions to a more and more individual way of living. Until now, the focus has been primarily on the senders. This new approach with focus on the receiver's needs has challenged the Danish Post to develop services targeted to the receiver.

The first target has been to enable the receiver to decide when he or she wants to receive the mail, as this kind of services seems to meet the trend in the private households, where more and more people are working at home, and the needs within the business to react quickly.

This means that standard delivery terms are defined by the sender, and if the receiver wants another service level, he has the possibility to choose among two alternatives. The first step in Denmark was to check if the receiver was willing to pay for either for an early home delivery before 10am or a P.O. box where the mail can be picked up before 9am.

Based on some of the theoretical considerations as mentioned earlier, and against the background of a market study, Post Danmark decided to test the concept of a delivery flat rate in the market. The market study indicated that a significant number of households value early delivery; however, it remained not clear, how far the fact that delivery had been considered a free service in the past would influence the willingness to pay for a value-adding, fee-based early delivery.

The concept chosen for the market test represents a simple but typical example of the receiver pays principle. The product profile guarantees delivery before 10am. Post Danmark has – inspired by publishers of newspapers and magazines – decided to offer customers a subscription to these services. This decision was made with a view to offering customers simple product solutions and minimizing the company's administrative costs.

The individual customer is bound by half-yearly subscriptions. Today, it is possible to buy a subscription for letters, and the option will later be extended to include parcels as well as a combination of letters and parcels. Post Danmark guarantees delivery of the items before 10am six days a week. If delivery is not made as guaranteed, the customer can claim reimbursement of the amount paid for guarantee of delivery on the day in question. As a basic rule, Post Danmark will trust the customer and pay back the amount. If

the same customer repeatedly complains about non-performance of the guarantee of delivery, it is possible for Post Danmark to check the quality of delivery to the customer, as the mail carrier will each day scan a barcode at the site of delivery as documentation.

Delivery before 10am is a product, which all urban zone customers, i.e. business as well as private recipients, can buy. 85% of all households in Denmark are urban zone households. Therefore, the service has a great potential in relation to all households.

The product was marketed as of the beginning of February, 2006. This means that a time span of four months can be evaluated. For a product which potentially alters a long-established paradigm in the postal industry (free delivery) and which may need some time to penetrate the market this is not a long time. However, we may draw some first conclusions.

So far, the results have been modest. Approximately 2,000 customers have bought a subscription for delivery before 10am. There are a number of different reasons for the modest results.

Firstly, a number of business customers having earlier received their mail before 10am are resistant to having to pay for the service in future. These customers perceive early delivery of mail to be a service included in the postage charged for delivery. The resistance has proved to be exactly as pronounced as reflected in the market analyses. The reactions from a significant number of receiving customers indicate that these customers place greater demands on the service, which they also believe is a service for which payment is to take place by means of the postage charged from the sender.

Some of these customers understand that Post Danmark cannot offer everyone a supplementary service at no charge. However, they believe that Post Danmark might have started by offering new customers to buy a subscription for the service.

Secondly, Post Danmark has opted for a soft introduction. Accordingly, routes have not been reorganized in connection with the implementation of recipient-paid services, which means that approximately 80,000 business customers will continue to receive their mail before 10am. A number of these customers have chosen to wait and see and consider the situation on the implementation of the reorganized routes. In connection with the launch of recipient-paid services, Post Danmark also recommended the customers to wait and consider the situation on the implementation of the reorganized routes, thereby explicitly allowing free-riding and accepting the associated negative demand effects for the 10am guarantee.

Thirdly, the frequent practice of co-distribution of letters and parcels means that customers receiving many parcels take simultaneous delivery of letters. This has reduced the potential for selling delivery before 10am in

respect of letters, as this cannot be made available until Post Danmark's implementation of delivery before 10am in respect of parcels from 1 January 2007.

There are a number of preliminary conclusions, which can be drawn at this stage. Firstly, the market test has shown that customers react heavily against having to pay for a service that was previously provided at no charge. This is consistent with one of the results of the 2005 market study in Switzerland: the willingness to pay for established home delivery services, such as for food or beverages, is significantly higher than the willingness to pay for home delivery for letters or parcels. We think that this difference will get smaller over time, when customers get used to a new delivery business model. Moreover, in the Danish case, a number of customers understand that it is necessary to pay for a higher service level. In return, they also expect that more value is added to the service they now have to pay for.

A second conclusion is that the subscription scheme essentially benefits recipients taking daily delivery of mail. Small business customers receiving mail perhaps only three to four days a week are reluctant to buying a subscription for delivery before 10am six days a week. However, a number of these customers are the opportunity to buy an alternative in the form of a post office box, which is a more affordable solution in terms of price. This emphasizes the importance of the discussion in Section 3 where it was stated that it is a crucial point for the mailing industry whether recipients have a low or high net utility of receiving (daily) mail.

Thirdly, we observe a typical free-rider problem, if non-subscribing households do not in turn receive their mail significantly later than the subscribers. Thus, the marginal utility of subscribing is clearly reduced. The resolution this problem would require corresponding measures on the operations side.

Finally, it seems that delivery services, too, need to be segmented based on needs and willingness to pay. The market test also shows that the product of delivery before 10am is in excess of the needs of and too expensive for private recipients. It might therefore be a challenge to consider the relevance of launching a product to cater for the needs of certain categories of private recipients, such as housing associations with delivery boxes in the staircase.

5. CONCLUSIONS

RPP has the potential to increase both economic welfare and operators' profits. RPP opens the door for a variety of last mile services. Such new services aim at satisfying the specific needs of the receivers and will be priced closer to operating costs. Thus, by creating effective incentives, supply and demand are better aligned along the last mile.

To develop the RPP as set out in Felisberto et al. (2006) further, a discrete choice study was undertaken to reveal the willingness to pay of mail recipients for doorstep delivery. Building on these results, we computed welfare and profit implications for various levels of a “delivery flat rate”, a fee that would be charged to receivers’ in case they prefer doorstep delivery to a free P.O. box delivery. Finally, we presented first results from a RPP product sold in Denmark.

We found one essential requirement for a successful implementation of RPP: Receivers need to bear a large implicit cost in case they choose not to be connected to the postal network. If for example mailers were no longer able to reach recipients, mail demand could decline significantly with negative impacts on welfare and industry profits. As to whether or not this would actually be the case and how this could be prevented remains for further research.¹⁴

On the other hand, if postal organizations succeed to exploit the already significant willingness to pay for high-quality delivery services, they will generate a new source of financing the universal service and reduce its burden. Our market survey reveals that the current range of last mile services is rated highly different among recipients. Our results indicate that large sections of the population receive services today to which they do not attach a high value. In the same time, there exists a significant fraction of receivers with a high willingness to pay, which could be enhanced by adequately priced last mile services. We have shown that although the introduction of the RPP is a politically controversial issue, it is a concept with considerable potential in postal delivery that offers the prospect of greater consumer choice and increased efficiency.

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¹⁴ Further, RPP raises some questions in the context of two-sided markets.

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