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The Impact of "Rollover" Contracts on Switching Costs in the UK Voice Market: Evidence from Disaggregate Customer Billing Data

Gregory S. Crawford, Nicola Tosini, and Keith Waehrer[1]

July 2, 2011

Abstract

In February 2008, British Telecommunications (BT) introduced automatically renewing, or "rollover", contracts into the UK market for fixed-voice telephone service. These contracts included a 12-month Minimum Contract Period (MCP) with associated Early Termination Charges (ETCs). Unless customers opted out, at the end of the 12 months they would automatically be rolled over into a new MCP and face new ETCs if they later wished to leave BT. Using a unique, disaggregate, customer billing dataset, we measure the impact of rollover contracts on BT customers' decision to switch to another provider. We find that, controlling for the effects of tenure, broadband purchase, price discounts, and self-selection, rollover households switch after their first MCP 34.8% (54.8%) less than comparable customers on standard plans (fixed-term contracts). These imply rollover contracts induce switching costs on the order of 33.0% of the monthly price of the average BT fixed-voice telephone service. This raises significant concerns about the competitive effects of such contracts in media and telecommunications markets.

[1] Crawford: Department of Economics, University of Warwick, Coventry CV4 7AL, UK, crawford@warwick.ac.uk; Tosini: ESMT Competition Analysis, Schlossplatz 1, 10178 Berlin, Germany, nicola.tosini@esmt.org; Waehrer: Bates White, Suite 600E, 1300 Eye Street NW, Washington, DC, 20005, USA, keith.waehrer@bateswhite.com. Waehrer was visiting ESMT Competition Analysis when this study was prepared. The analysis in this paper formed the basis of a report delivered to the UK Office of Communications (Ofcom) in August 2010 and released in March 2011 titled, "Empirical analysis of BT's automatically renewable contracts (ARCs)." We thank Andrea Coscelli, Chris Taylor, David Pinch, and Jasminder Oberoi at Ofcom for their collaboration and assistance in the production of that report and Agata Lewicka, Heiner Lindenlaub, and Sergey Zykov at ESMT Competition Analysis for their research help.

1 Introduction

On 1 February 2008, British Telecommunications (BT), the largest provider of fixed-voice telephone service in the United Kingdom (UK), introduced an innovative contract offer to its residential customers. Like many of the contracts offered by BT, this one offered a discount (of £2.99, or 21%) on the price of its Unlimited Evening and Weekend Plan during an initial, 12-month Minimum Contract Period (MCP). The innovation was an automatic renewal, or "rollover", clause: unless the customer contacted BT before the end of the contract, the terms of the contract would be automatically renewed for an additional 12 months.[2] In this case, the customer would keep their discount, but would also be subject to a new MCP. This came with a cost: if a customer wished to switch providers during a MCP (either the first or subsequent), she would have to pay Early Termination Charges (ETCs) of £7.50—65% of the contract price—for each month left until the end of the current MCP.

BT soon followed by introducing rollover contracts on all its fixed-voice residential telephone plans and began marketing them heavily. Many customers found these attractive relative to BT's existing fixed-term contracts and standard plans, and a significant portion of both new and existing customers signed up.[3] At the same time, BT began introducing rollover contracts for residential broadband offers.

There are several views in the economics literature on firms' incentives to provide term contracts and their consequences in the marketplace. BT argued that the contracts were efficient: they lowered transactions costs for those customers happy to stay with BT indefinitely and reduced their (BT's) marketing and customer service costs (BT, 2010, 2011). The ETCs associated with term contracts, however, necessarily increase consumers' "switching costs".[4] Switching costs, in general, can introduce a "bargains-then-rip-offs" element into pricing, replacing competition period-by-period with competition for a buyer's "lifecycle requirements" (Farrell and Klemperer (2007)). This need not imply social welfare losses, but can, for example due to consumers that are either myopic or make mistakes. Contractual switching costs, in particular, can also discourage efficient entry by limiting the ability of a potential entrant to attract new consumers (Aghion and Bolton, 1987).

The purpose of this study is to estimate the effect of BT's rollover contracts on its customers' decisions to switch to another provider of fixed voice telephone service. Working closely with staff at the Office of Communications (Ofcom), the UK media and telecommunications regulator, we obtained a unique, disaggregate, customer billing dataset from BT for a random sample of almost 180,000 of its fixed-line voice customers as of 31 December 2008.[5] This data included

[2] About one month before each MCP expired, BT did send its customers a letter reminding them that, if they did not call BT to cancel the contract before the end of the MCP, they would be automatically rolled over into the next MCP.

[3] BT's standard plans were subject to neither contract conditions (MCPs or ETCs) nor discounts. BT's "fixed-term" contract offers were often identical to their rollover offers, except that at the end of the MCP these customers automatically migrated to a standard plan.

[4] In the canonical survey of the literature, Farrell and Klemperer (2007, p.1972) say "A product has classic switching costs if a buyer will purchase it repeatedly and will find it costly to switch from one seller to another [during that series]."

[5] As noted in the acknowledgements, the analysis in this paper formed the basis of a report delivered to Ofcom in August 2010. In light of that report and additional evidence, Ofcom decided to propose an amendment to the "General

information about each household's history with BT as well as their voice plan, contract, price paid (including any discounts), and minimum contract period(s) as of this date and for 15 subsequent months (through 31 March 2010).[6] We augmented this with aggregate market-wide information measuring macroeconomic trends and prices offered by rival providers for similar services. The result was a comprehensive dataset ideal for analysing the effects of contract terms on switching behaviour at the level of the individual household. To our knowledge, ours is one of the first papers to use such detailed, disaggregate, billing data to analyze household switching behaviour in product markets.

We use this data to specify and estimate a recursive bivariate probit model designed to measure the causal effect of rollover contracts on switching behaviour controlling for a host of other factors that might influence switching, including tenure (i.e., how long a customer has been with BT), whether the customer purchases other services from BT (e.g. broadband access), and the effect of any price discounts. Due to the highly disaggregate nature of our data, identification of most of these effects is straightforward. It is most challenging for prices, but we are able to exploit variation in the presence and size of price discounts associated with different rollover offers presented by BT to accurately identify the separate effects of discounts from the other contract terms. We also exploit the timing of households' decisions to account for "self-selection" (or just "selection"), unobserved differences in households' likelihood of switching that might be correlated with their decision to select a rollover contract.

We focus our analysis on measuring the impact of rollover contracts in the months after the initial 12-month MCP, as this is the period for which the terms in rollover contracts differ from BT's existing, fixed-term, contract offers. We find that all of tenure, broadband purchase, and price discounts are statistically and economically important determinants of households' switching behaviour. We further find statistical evidence of self-selection, although its economic effects are tiny. Most important, we find that, controlling for all these effects, households on BT's rollover contracts switch after their first MCP 34.8% less than comparable customers on standard plans and by 54.8% less than comparable customers on BT's fixed-term contracts. These imply rollover contracts induce switching costs on the order of 33.0% of the monthly price of the average BT fixed-voice telephone service. This raises significant concerns about the competitive effects of such contracts both in this market and in media and telecommunications markets more generally.

The analysis in this paper relates to a growing empirical literature measuring the effects of switching costs, often in media and telecommunications markets. The majority of this literature looks at the demand side and tries to measure the welfare consequences of switching costs; recent papers have begun to tackle competitive (supply-side) effects as well. On the demand-side, Crawford and Shum (2005) estimate the effects of uncertainty, learning, and risk aversion (the combination of which induce switching costs) in the market for anti-ulcer drugs, finding eliminating uncertainty reduces market concentration and increases welfare by 8%.[7] Shcherbakov (2007) estimates switching costs in U.S. pay television markets and finds them to be between

Conditions," under which all UK communications providers offer service, that prohibits "opt-out" processes for MCP renewal. See http://stakeholders.ofcom.org.uk/consultations/arcs for more information.

[6] The data were anonymized to protect customer privacy: we observed no customer names or addresses, only a unique household identifier and their postcode as of the sampling date.

[7] Goettler and Clay (2011) similarly find that uncertainty and learning in combination with fixed fees to change tariffs introduce switching costs (and "flat-rate bias") for customers of an online grocer.

$100-200, roughly 3-6 times the monthly cost of the average service. On the supply side, Viard (2007) finds that reduced switching costs make markets more competitive in U.S. long-distance telephone service while Dubé, Hitsch and Rossi (2009) find the opposite: increasing brand loyalty/state-dependent utility (that is, switching costs) in the (differentiated) markets for orange juice and margarine make markets more competitive.

The study most closely related to ours is a recent analysis by Handel (2010) of switching costs and adverse selection in the choice of U.S. health insurance plans. He, too, has access to detailed, disaggregate, customer billing data and observes household choices over time.[8,9] He finds, holding plan prices fixed, that eliminating switching costs would improve consumer choices and increase welfare by 10%. Allowing prices to change, however, exacerbates problems of adverse selection and lowers welfare. The nature of the products being sold, consumer purchase habits, and market structure all appear to be important factors driving the variation in measured effects of switching costs, suggesting accurate modelling of the specific market under study is necessary for obtaining reliable inferences about their magnitudes and effects.

The rest of this report is structured as follows. In Section 2, we describe the detailed customer-level data we collected from BT to measure the impact of rollover contracts on the propensity of their customers to switch to another provider. We make a point of demonstrating the raw patterns in the data that will subsequently identify our causal effects of interest. In Section 3, we introduce the econometric models used to estimate the effect of rollover contracts on switching. We highlight how we control for determinants of switching behaviour other than rollover contracts and specify a model of rollover contract choice designed to control for the self-selection of households into such contracts based on unobserved differences in their willingness to switch. Section 4 presents our results and Section 5 concludes.

[8] Dubé, Hitsch and Rossi (2009) and Dubé, Hitsch, Rossi, and Vitorino (2008) also use disaggregate household panel data, but study choices in frequently purchased consumer products (butter and orange juice) based on market survey panels. While such data are valuable, customer data like that used in this paper and in Handel (2010) are often superior in size and in the baseline information provided about customers.

[9] Even better, the characteristics of his products change frequently over time, so that an option that is attractive in one year may become dominated in the next year. That a large number of his customers continue to enroll in dominated plans (likely due to default bias) provides demonstrable (and quantifiable) evidence of switching costs in his context.

2 Data

The primary dataset used in this paper is detailed customer information provided to us by BT from their internal billing database. It was collected in collaboration with Ofcom and BT under the powers provided Ofcom by Section 135 of the UK Communications Act 2003 ("S135 Data Request"). We also collected price data from BT and other communications providers (CPs) and aggregate macroeconomic variables. We describe each of these datasets in turn.

2.1 Disaggregate BT customer data

2.1.1 Sampling plan

An important aspect of the data collection was the design of the sampling plan. We requested BT to provide customer-level information on a subset of 180,000 customers randomly drawn from the population of individuals that were BT customers on 31 December 2008.[10] We call this date the *sampling date*. We further asked BT to report the product choices of these customers from 1 January 2007 (or when they joined BT, if later) until the end of the observation period, on 31 March 2010 (or when they left BT, if earlier).

This type of sampling is called *stock sampling* as it consists of sampling from the stock of customers at a given point of time.[11] It is common in the economic analysis of duration (or survival) data (Wooldridge, 2002, and Jenkins, 2004). We adopt stock sampling because this scheme is simpler to implement than flow sampling and because many BT customers are long-term customers, the effects on whom we might miss if we were to use flow sampling.

The sampling date was chosen to strike a balance between observing long histories (from the sampling date until the end of the observation period) and having a significant fraction of the population on automatically renewable contracts (which were introduced in February 2008). The sample size was chosen to be large enough to allow us to precisely estimate the effects of interest.

2.1.2 Variables

Before describing the variables collected, we define some relevant terms and concepts:

- The *sampling date* is the date on which BT sampled from their database to provide the data used in this study. It is 31 December 2008;

[10] A BT customer is an individual who both rents a telephone line and purchases calls from BT. This definition does not include individuals that only rent the line from BT and purchase calls from a rival CP.

[11] The primary alternative to stock sampling is *flow sampling* which would sample from customers as they enter the BT customer database over a specified period of time.

- The *observation period* is the time period for which we obtained BT customer data (1 January 2009 to 31 March 2010);

- A customer's *BT start date* is the month in which the individual became a BT customer (e.g., July 2008);

- If a customer leaves BT, her *BT switching date* is the date on which she leaves BT. A customer leaves BT when he or she ceases to rent the line from BT;

- If a customer does not leave BT, her *censoring date* is the latest date for which her customer information is available (e.g., March 2010);

- A BT *promotion* is a particular combination of plan (e.g. Evenings and Weekends), contract (e.g. rollover), price discounts (if any), and additional phone services (if any) to which a customer subscribes at a point in time;[12]

- We refer to the set of promotions featuring a fixed-term or a rollover contract as fixed-term or rollover contracts, respectively;

- We refer to customers on promotions featuring a fixed-term or a rollover contract as fixed-term or rollover customers, respectively;

- The *sampling-date promotion* is the promotion which the customer was on at the sampling date;

- *Previous promotions* and *subsequent promotions* are promotions (if any) that the customer was on previous to and/or following their sampling-date promotion.

We collected three main categories of information from BT: information on dates, information on promotions, and other (aggregate) information.

Date Information:

- BT start date;

- Start date for the sampling-date promotion;

- Switching or censoring date, as appropriate.

Plan information for the sampling-date, previous, and subsequent promotions:

- Plan identifier (UWP, UEWP, UAP);[13]

[12] The use of the word "promotion" suggests limited duration and it is indeed the case that (a) the set of promotions available to new and existing BT customers varies over time; and (b) certain characteristics of a promotion (for example, a discount on the price of a plan) may not be permanent. However, once a customer starts a BT promotion, that customer remains on the same promotion until she moves to a different promotion or she switches away from BT. Promotions that do not have any contracts are called *standard plans* (or *standard contracts*).

- Contract identifier (Standard plan/None, Fixed-term, Rollover);
- Information on prices and ETCs;
- MCP information (None, 12-month fixed-term, 18-month fixed-term, 12-month rollover).

Other Information:

- Subscription to other BT services (i.e., broadband and BT Vision) at the sampling date;
- Customer postcode at the sampling date.

2.1.3 The estimation sample

The raw dataset provided to us by BT had 519,168 observations on 179,957 customers. An observation was a customer-promotion, i.e. the specific BT promotion under which that customer was being provided service for every promotion held by the customer between 1 January 2007 and 31 March 2010 (or the date they left BT). BT also provided a data dictionary that permitted matching the promotion for each customer to a set of characteristics of that promotion, notably plan type, contract type, and any price discounts or additional services included in the promotion.

The matching process was imperfect. Some customers had promotion codes that were not in the data dictionary, some promotion codes in the data dictionary were not associated with any customers, and other promotions were associated with more than one code. Furthermore, as some customers have been with BT since the 1930s, there were many old and/or redundant promotion codes.

In constructing the estimation dataset, we balanced the goals of including as many BT customers as possible in the analysis against the costs of including erroneous and/or tracking down mismatched data. We first excluded customers that were on old, "grandfathered", promotion codes (related to BT Together Local, BT Working Together, etc.) for which it was relatively costly to obtain the associated plan, contract, and price-discount information. This eliminated 18,341, or 10.2%, of the original sample. Further customers were lost due to their dropping BT for calls but keeping it for line rental (10,352, or 5.8%) and due to their having holes or overlaps in their choice history (5,964, or 3.3%). Overall, the estimation sample contains 144,861 customers, or 80.5% of the original BT sample. Appendix 4 describes the data-cleaning process, and its consequences for the estimation sample, in more detail.

2.1.4 Descriptive statistics

While the data report decisions made by customers regarding plan choices at a daily level, BT presents plan prices and ETCs to its customers as a monthly charge. Furthermore, discrete time lends itself more easily to the incorporation of time-varying covariates in the econometric analysis, like the plan/contract a BT customer is on and the price they pay. As such, we

[13] The three most common plans were Unlimited Weekend Plan (UWP), Unlimited Evenings and Weekend Plan (UEWP), and Unlimited Anytime Plan (UAP)

aggregate the data to the level of the month and analyze switching behaviour on a monthly basis. Such aggregation (called "grouping") is common in the analysis of duration data.

We then construct a panel dataset in which an observation corresponds to an individual (a BT customer) in a time period (a month). For every individual in every time period, a binary outcome variable (which we will call $Switch_{it}$) indicates whether an individual has decided to continue with BT into the next month ($Switch_{it}$ = 0) or to leave BT by the end of this month ($Switch_{it}$ = 1). If a customer remains with BT for all 15 months in our sample period, then $Switch_{it}$ will simply be a sequence of 15 zeros. In this case, we say the data are censored and define $censored_{it}$ = *1* for all 15 *t*'s for that *i*. If a customer switched from BT during the sample period, then $Switch_{it}$ will be a sequence of zeros followed by a 1 in the month that they switched. In this case, $censored_{it}$ = *0* for as many time periods as *i* is in the data. This data structure allows us to apply discrete-choice panel data methods to analyze switching, as described in the next section. Excluding a very small number of observations regarding customers on 18-month rollover contracts yielded our estimation dataset of 1,984,270 monthly observations on 144,849 customers.

Table 1 below reports descriptive statistics for the key variables used in our analysis. Unless otherwise noted, sample means and standard deviations are measured in percentages ranging from 0 to 100.

Table 1: Descriptive statistics for the estimation sample

	All observations			Obs. In the first month		
Variable	**Obs.**	**Mean**	**St. Dev.**	**Obs.**	**Mean**	**St. Dev.**
Switch	1,984,270	1.2%	11.1%	144,849	1.2%	10.8%
Time period (1-15)	1,984,270	7.8	4.3			
Censored				144,849	82.9%	37.6%
Tenure at BT (in years)	1,984,270	10.9	10.6	144,849	9.9	10.5
Tenure on promotion (in years)	1,984,270	3.4	4.6	144,849	3.1	4.4
First promotion	1,984,270	34.1%	47.4%	144,849	38.1%	48.6%
Months to end of MCP	1,984,270	1.9	3.3	144,849	1.7	3.1
UWP plan	1,984,270	48.4%	50.0%	144,849	52.5%	49.9%
UEWP plan	1,984,270	38.7%	48.7%	144,849	36.4%	48.1%
UAP plan	1,984,270	12.9%	33.5%	144,849	11.2%	31.5%
Standard contract	1,984,270	65.0%	47.7%	144,849	68.1%	46.6%
Fixed-term contract	1,984,270	3.7%	18.9%	144,849	4.6%	21.0%
Rollover contract	1,984,270	31.2%	46.3%	144,849	27.3%	44.5%
F&F mobile	1,984,270	3.9%	19.4%	144,849	1.6%	12.4%
F&F international	1,984,270	0.2%	4.3%	144,849	0.1%	3.2%
Broadband				144,849	24.5%	43.0%
BT Vision				144,849	2.6%	15.8%

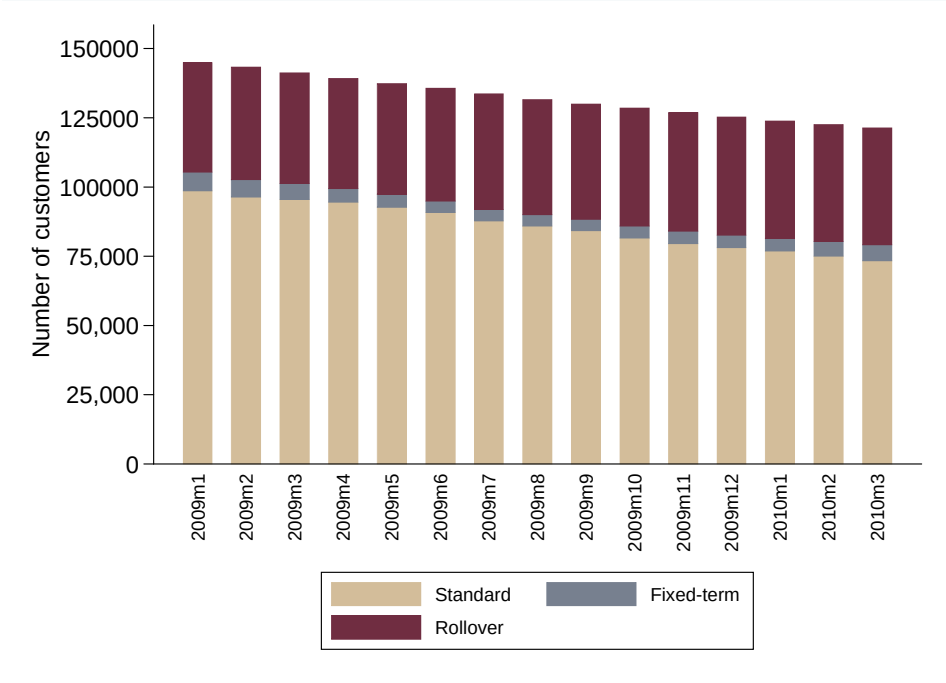
Source: Own calculations based on BT data.

Notes: This table contains descriptive statistics for the sample of data used in our analysis. An observation is a customer-month, i.e. information about a given BT customer in a given month. There are 144,849 customers and as many as 15 months per customer (January 2009 to March 2010). The first group of columns ("All observations") reports descriptive statistics across all customers and months. The second group of columns ("Obs. In the first month") reports descriptive statistics across customers in the first month (January 2009). "Switch" indicates the event of switching away from BT. "Censored" indicates whether a household in the sample is still a BT customer at the end of the observation period. A promotion is defined as a combination of plan, contract, price, and additional phone services (if any). MCP stands for Minimum Contract Period. UWP, UEWP, and UAP are BT calling plans. F&F mobile/F&F international/Broadband/BT Vision are other BT services that customers may be purchasing in addition to fixed voice telephone service. We only observe this at the time of the first month.

The first set of columns in the table reports descriptive statistics across customer-months.[14] The second set of columns reports descriptive statistics across customers in the first month of the observation period (January 2009).

The first row of Table 1 shows that, on average, 1.2% of BT customers switch away in a given month. This corresponds to an annual switching rate of 13.9%.[15] As a result, 82.9% of customers are censored (i.e. still a BT customer at the end of the observation period). Figure 1 below demonstrates the attrition occurring in the sample as customers switch away from BT and also shows the share of the customers that remain that subscribe to a standard, fixed-term, or rollover contract.

Figure 1: Number of customers by contract type and month in the observation period



Source: Own calculations based on BT data.

At the beginning of the sample period, the average customer in the data has been with BT for almost 10 years and has been on their sampling-date promotion (i.e. plan, contract, and price) for just over 3 years. Figure 2 reports other patterns in the data relating to tenure. First, it shows the tenure with BT during the first observation month (Jan 2009) for all the customers in the data. While most customers have been with BT for less than a decade, there are some customers in the database that have been with BT for over 75 years![16] The figure also splits out the contract type for each of these customers. As might be expected, rollover and fixed-term contracts are relatively more common among customers new to BT. That being said, some even

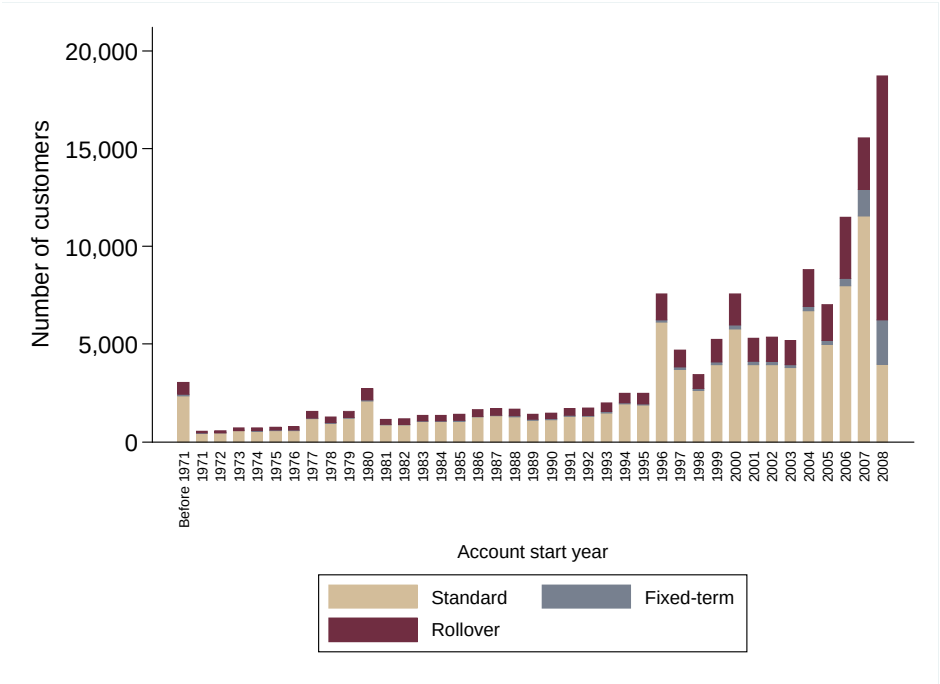
[14] An observation in the full dataset provides information about a given customer in a given month. We therefore call any such observations a customer-month.

[15] Calculated as 1-[(1-Switch)^12] and expressed as a percentage.

[16] These are very few of course. Only ¼ of 1% of households in the sample have been with BT for more than 50 years.

very long-standing BT customers have adopted them. This is consistent with BT's having promoted rollover contracts to both new customers and their existing installed base.

Figure 2: Number of customers by contract type and account start year



Source: Own calculations based on BT data.

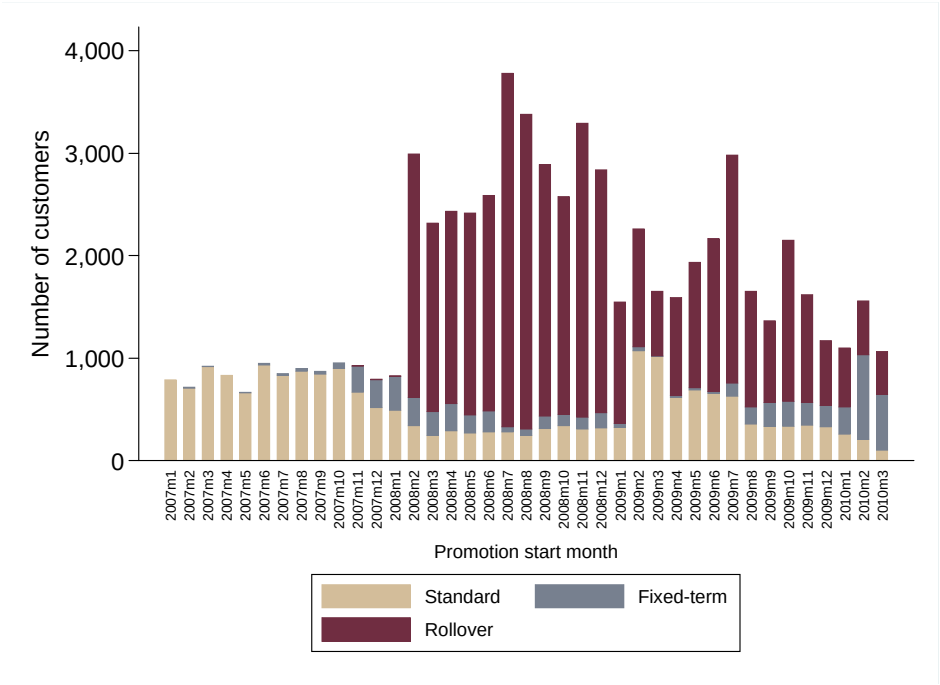
Notes: The number of customers and their distribution over start years by contract types is as of the first observation month (January 2009).

Continuing along the rows of Table 1, we see that the majority of BT customers (52.5%) are on the baseline, Unlimited Weekend minutes (UWP), plan at the beginning of the sample period, with 36.4% on the Unlimited Evening and Weekend minutes (UEWP) and 11.1% on the Unlimited Anytime minutes (UAP) plan.

The majority of BT customers (68.1%) are on a standard (flexible) contract at the beginning of the observation period, with 27.3% on rollover contracts and 4.6% on fixed-term contracts. Comparing to the full sample (and Figure 1), we see that rollover contracts become more prevalent over the sample period. Figure 3 develops this idea more fully. It reports the number of customers on contracts of various types by the first month of their current "promotion" (i.e. plan, contract, and price).[17] The figure shows that fixed-term contracts were first introduced in October 2007 and rollover contracts soon followed in February 2008. The high share of rollover customers from that date also shows BT's emphasis on promoting rollover contracts once they were introduced. Recall our sampling date is December 31, 2008, so the customer numbers drop slightly from January 2009 as all new promotion starts from that date are existing BT customers migrating to new contracts.

[17] We build Figure 3 using the contract held by the household in the final month they are observed in our data.

Figure 3: Number of customers by contract type and promotion start month

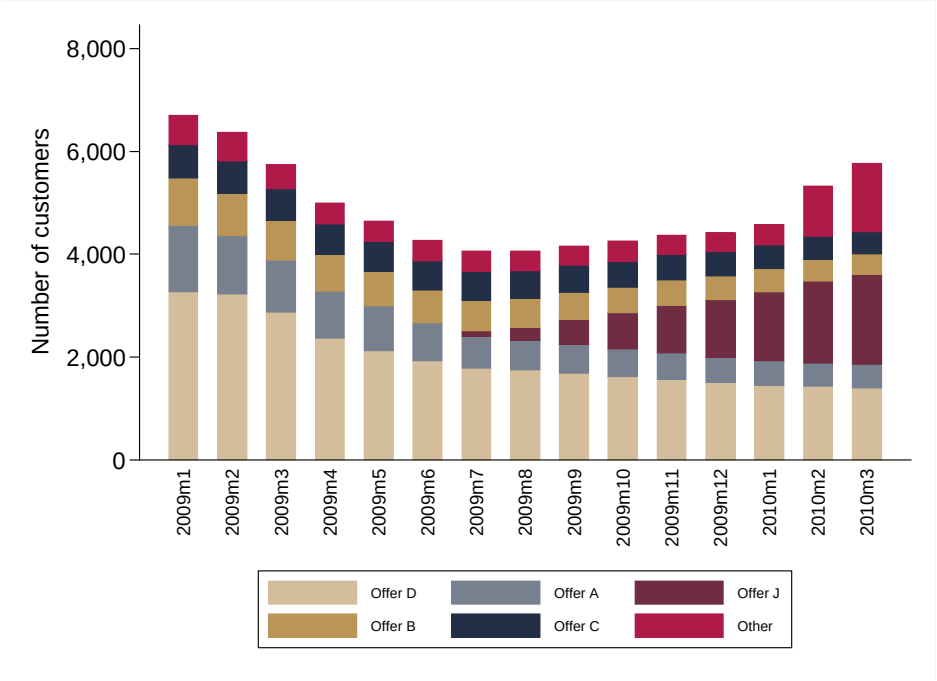


Source: Own calculations based on BT data.

Notes: The number of customers and their distribution over promotion start month by contract types is as of the last observation month (March 2010). Customers whose promotion started before January 2007 are dropped. A promotion is defined as a combination of plan, contract, price, and additional phone services (if any).

While BT offers 3 general types of contracts (standard/none, fixed-term, and rollover), many different promotions (i.e. plan, contract, and price) were offered to households in the data that contained the same type of contract. This is important for the analysis because different promotions had different discounts (and/or discounts that lasted for differing numbers of months within a MCP). This variation provides valuable information to identify the effects of price discounts on switching behaviour.

Figure 4: Number of customers by fixed term-contract promotion and month in the observation period



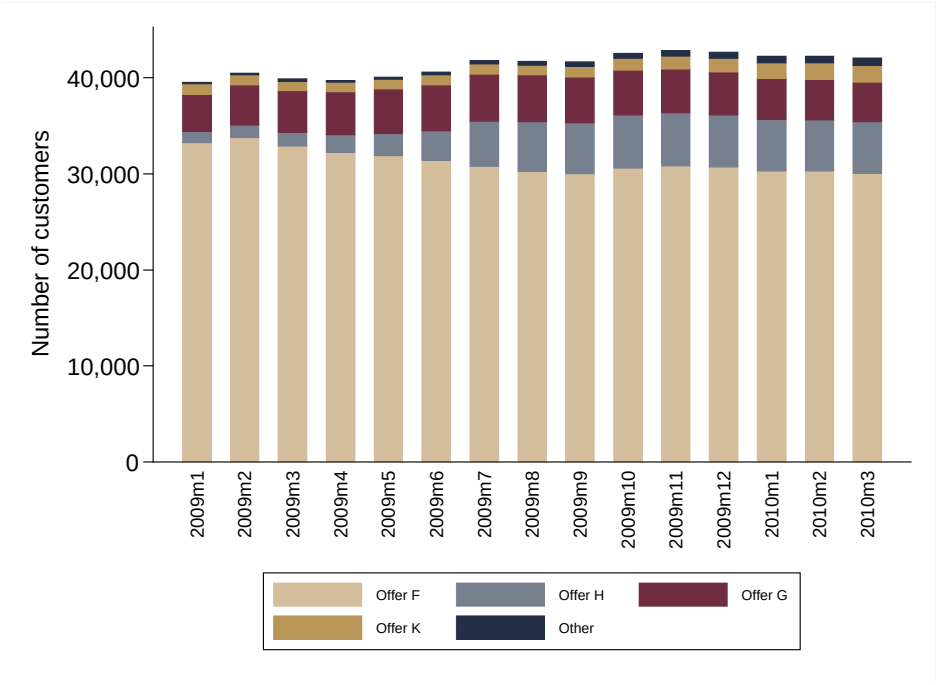
Source: Own calculations based on BT data.

Notes: A promotion is defined as a combination of plan, contract, price, and additional phone services (if any). In this graph we focus on promotions featuring a fixed-term contract. "Offer B" and "Offer A" are promotions on a UEWP plan. "Offer D" and "Offer J" are promotions on a UAP plan. "Offer C" is available on all plan types. See text for details of specific promotions.

Figure 4 and Figure 5 describe the types of promotions BT offered on fixed-term (Figure 4) and rollover (Figure 5) contracts.[18] For example, Figure 4 shows that, at the beginning of the observation period, the most prevalent fixed-term promotion was "Offer D", which is a promotion with a UAP plan, a 12-month MCP, and a price discount on the corresponding standard plan during the first 3 months. "Offer A", the second most popular fixed-term promotion at the beginning of the observation period, is a promotion with a UEWP plan, an 18-month MCP, and a price discount on the corresponding standard plan during the first 12 months. Figure 4 also shows that "Offer J", which was introduced in July 2009, has rapidly gained ground.

[18] In conducting the analysis, we had access to the internal name used by BT for each promotion. They considered this confidential business information, however, so in the paper we simply identify them as "Offer A", "Offer B", etc.

Figure 5: Number of customers by rollover-contract promotion and month in the observation period



Source: Own calculations based on BT data.

Notes: A promotion is defined as a combination of plan, contract, price, and additional phone services (if any). In this graph we focus on promotions featuring a rollover contract. "Offer H" and "Offer F" are promotions on a UEWP plan. "Offer G" is a promotion on a UAP plan. "Offer K" is available on all plan types.

Figure 5 shows that the distribution of customers over rollover promotions is much more concentrated than for fixed-term promotions. By far the most popular rollover promotion is "Offer F", which consists of a UEWP plan at the price of a standard UWP plan (a £2.99 discount) and a 12-month automatically renewable contract.

2.1.5 Switching patterns in the BT data

The extent to which customers on rollover contracts are more or less likely to switch away from BT will be critical to our analysis in this report. As such, we now present the raw patterns in the data that we will later refine, analyze, and interpret with our econometric analysis.

We begin by defining the *timing* of switching. In both the figures and analysis to follow, we define switching in month *t* to mean that month *t* will be a customer's *last* month of service with BT, i.e. they have decided to switch away from BT at the *end* of month *t*.[19]

Figure 6 presents the differences in switching rates by contract types depending on the month someone is in their existing contract.[20] The vast majority of customers (96.5%) on either fixed-

[19] Throughout this report, we refer to switching as switching away from BT, not switching between different promotions (i.e. plans, contracts, and/or prices) within BT (about 1.5% of customer-months involved the latter kind of switching) As we are most concerned with the competitive effects of BT's rollover contracts, we chose not to focus on within-BT switches of plans or contracts.

term or rollover contracts have a 12-month MCP during which they must pay ETCs in order to switch away from BT.[21] Furthermore, the magnitude of the ETC depends on the number of months remaining in their MCP. These effects are evident in the data with reduced (but increasing) switching rates for fixed-term and rollover contract customers relative to standard-contract customers in the first 11 months of their MCP. In the 12th month (i.e. at the end of the 12th month), switching rates for both fixed-term and rollover customers jump as they no longer have to pay an ETC in order to switch. After month 12, the majority of fixed-term contracts are identical to standard contracts:[22] customers pay the undiscounted rate for whatever plan they are on and can leave in any month without paying an ETC. By contrast, rollover contract customers enter a new MCP beginning in month 13 and must again pay ETCs in order to switch. These patterns show up in post-month-13 switching rates: they are broadly similar for standard and fixed-term customers and lower for rollover customers.[23] There is a similar, but smaller, spike in switching for rollover customers ending their second MCP in month 24.

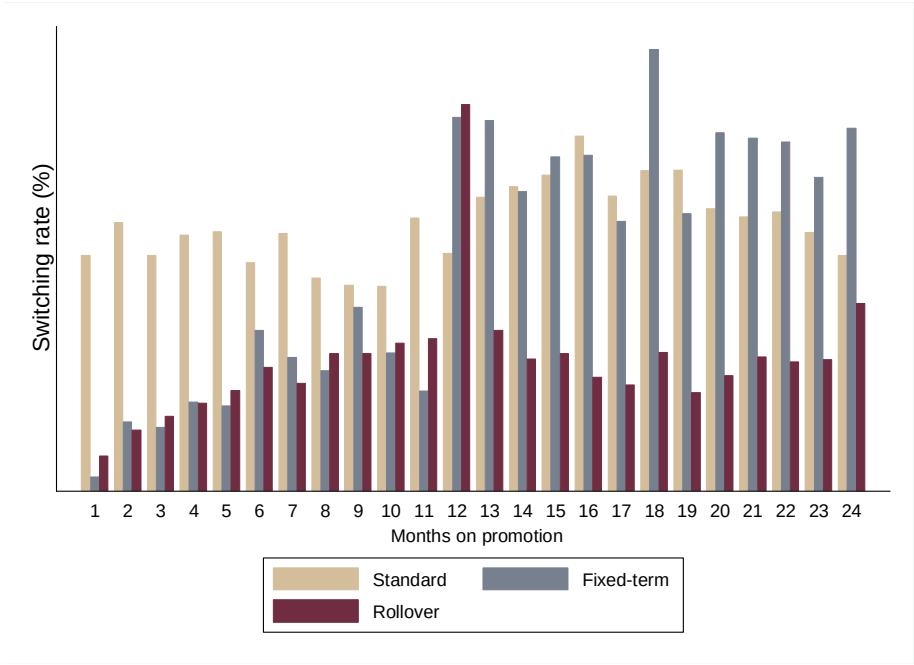
[20] For confidentiality reasons, we are not able to report the units on the y-axis in this figure. We note, however, that across all customers and months in the sample, the average switching rate is 1.2% (cf. Table 1).

[21] The remaining customers have an 18-month MCP.

[22] The other fixed-term contracts have a longer, 18-month, MCP – whose existence is also visible in Figure 6.

[23] While post-month-13 switching rates are lower for customers on rollover compared to fixed-term and standard contracts, they are not as low as for customers on rollover contracts in their first MCP. We hypothesize that this may be due to greater leniency offered by BT on ETCs in MCPs after the first. We further explore this idea in Appendix 2 of the original report, available as part of Annex 7 to Ofcom's consultation.

Figure 6: Switching rates by contract type and tenure on promotion



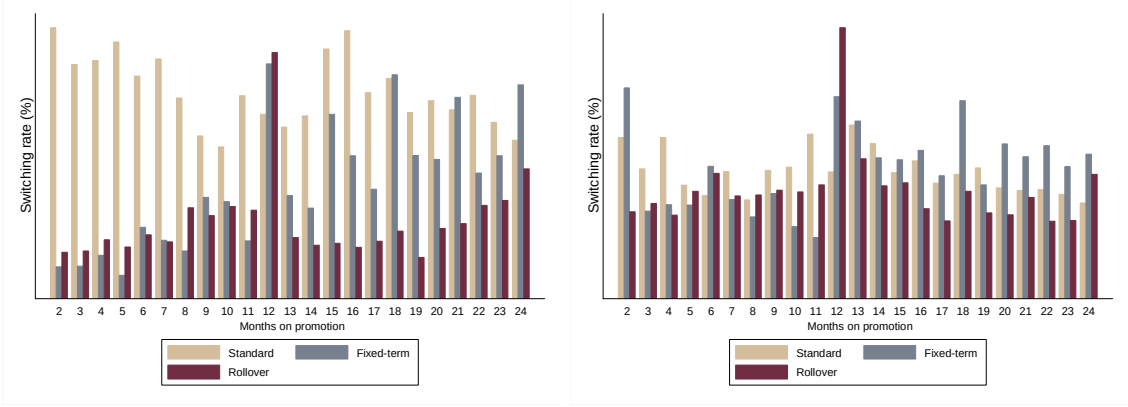
Source: Own calculations based on BT data.

Notes: Switching is defined as the event of switching away from BT. A promotion is defined as a combination of plan, contract, price, and additional phone services (if any). See Appendix 4 of the original report, available as part of Annex 7 to Ofcom's consultation. It is assumed that switches occurring up to 370 days after the promotion start date occurred within the twelfth month on the promotion.

Figure 7 presents the same figure as that above, but split between old (panel above) and new (panel below) customers.[24] While, for confidentiality reasons, we cannot compare the overall level of switching between old and new customers, the figure demonstrates that the impact of rollover contracts is similar: both types of customers switch less when on rollover contracts. Similar patterns obtain across all tenures in the data.

[24] A new customer is defined as one whose BT start date is no more than 15 days earlier than her promotion start date.

Figure 7: Switching rates by contract type and tenure on promotion, for existing and new customers



Source: Own calculations based on BT data.

Notes: The left hand-side graph refers to existing customers, the right hand-side graph to new customers. Switching is defined as the event of switching away from BT. A promotion is defined as a combination of plan, contract, price, and additional phone services (if any). New customers are defined as customers whose account start date is no more than 15 days earlier than their promotion start date. It is assumed that switches occurring up to 370 days after the promotion start date occurred within the twelfth month on the promotion.

2.2 Other (aggregate) data

We augmented the disaggregate BT customer-level data with aggregate data on several other factors thought to influence switching.

The most important of the additional aggregate information were the prices charged by rival CPs for comparable fixed-line products. There are four primary competitors in this market: BT, Virgin Media, TalkTalk (Carphone Warehouse), and Sky.[25] There are two standardized products offered by all major CPs for fixed-line telephony services: Free Evening and Weekend Calls and Free Anytime (UK) Calls. TalkTalk and Virgin used to also offer a Free Weekend Calls product, but Virgin and TalkTalk withdrew this product from the market in August and December 2008, respectively. BT continues to offer an Unlimited Weekend Plan.

Aggregate price data were purchased on our behalf by Ofcom from PurePricing for the observation period of January 2009 until March 2010. Reported were the prices for each of the main CPs (including BT) for each of the fixed-line voice services described above.

Standard plan prices for BT on its own and/or compared to rival CPs changed little over time. As described further in Section 4.1.3 below, we investigated the relative importance of this variation compared to other types of price variation in identifying the effects of price discounts

[25] Ofcom (2009a), Figure 4.1 and page 32.

and found variation in BT's and other CPs' prices are relatively unimportant in determining our results. As such, in the interests of space we omit here a detailed description of this variation.[26]

Finally, aggregate macroeconomic variables (i.e. the unemployment rate) by month and region were provided by the UK's Office for National Statistics.[27]

[26] Interested readers may learn more by examining Section 2.2 in Annex 7 to Ofcom's consultation.

[27] The regions include England's Government Office Regions, Scotland, Wales, and Northern Ireland.

3 Econometric model

3.1 Switching

We analyze the impact of BT's rollover contracts using a discrete-choice panel-data model of consumer switching behaviour. We begin our exposition of the econometric model under the assumption that there is no self-selection of households into rollover contracts. In the next subsection, we generalize the econometric model to account for this possibility.

As described in the data section above, our data consists of 1,984,406 monthly observations on 144,861 BT customers. Let *i* index households and *t* index months. For each household *i* in month *t*, define $Switch_{it}$ = *1* if they switched away from BT by the end of that month (and zero otherwise). The values of $Switch_{it}$ for each household *i* in the dataset are either a sequence of 15 zeros (if they are still with BT at the end of the observation period) or a sequence of zeros followed by a 1 (in the month they left BT).

Let

$$S_{it}^{*} = x_{it}^{'}\beta + \varepsilon_{it} \qquad (1)$$

be the latent utility to household *i* from switching in period *t*. x_{it} and ε_{it} are factors influencing the decision to switch plans; x_{it} are observable and ε_{it} is unobservable. We discuss the key elements of x_{it} in what follows below.

Let

$$Switch_{ijt} = \begin{Bmatrix} 1 & if\ S_{it}^{*} \geq 0 \\ 0 & if\ S_{it}^{*} < 0 \end{Bmatrix}$$

We assume that ε_{it} is distributed as a Standard Normal random variable, implying $P(Switch_{it})$ has the Probit form:

$$P(Switch_{it}) = \Phi(x_{it}^{'}\beta) = \int_{-\infty}^{x_{it}^{'}\beta} \phi(s)ds \qquad (2)$$

where $\phi\ (\Phi)$ is the Standard Normal probability (cumulative) distribution function.

3.1.1 Model specification

Our primary focus is to measure the effect of the introduction of BT's rollover contract on the incidence of households switching away from BT. We write this as

$$P(Switch_{it}) = \Phi(\beta_0 + tenure_{it}\beta_1 + plan_{it}\beta_2 + MCP_{it}\beta_3 + contract_{it}\beta_4 + p_{it}\beta_5 + x_{it}^{'}\beta_6) \quad \textbf{(3)}$$

where $tenure_{it}$ includes various measures of household *i*'s tenure in month *t* (both with BT and on a given promotion), $plan_{it}$ includes dummies for the various plans offered by BT, MCP_{it} includes measures of whether household *i* is in a MCP, $contract_{it}$ includes dummies for the various contracts offered by BT (including, critically, one for rollover contracts), and p_{it} includes measures of relative price differences across plans and providers. X_{it} includes other factors that might influence switching behaviour, including other BT services purchased by household i, time dummies, and macroeconomic variables. The specific identities of the variables included in this equation are further described in Section 44 below.

If we can consistently estimate the parameters in Equation (3), then the parameter on the indicator for rollover contracts (the relevant component of parameter vector β_4) will estimate the causal effect of BT's rollover contracts on the probability a household switches away from BT, controlling for the discount offered on such plans (β_5) and the length of time a household has been on a plan (β_1). Descriptive statistics for the variables included in the model were given in Table 1.

3.2 Self-selection into rollover contracts

It is reasonable to assume that households differ in their willingness to switch from BT in a given month. Indeed this is one of the sources of randomness captured by the random shock, ε_{it}, in (1). It is possible, however, that households that are less likely to switch are also more likely to choose a rollover contract. This might happen because they value the lower price associated with rollover contracts and don't mind that this means higher costs to switching providers. They may be quite happy with BT and are happy to both pay less and stay with them.

In the presence of selection, household *i*'s choice of a rollover contract is (negatively) correlated with their willingness to switch, ε_{it}, and the MLE estimate of β_4 will be inconsistent and biased downward. As this would cause us to overestimate the effect of rollover contracts on switching, it is clearly a cause for concern.

Accommodating discrete right-hand-side endogenous variables (the decision to enrol in/remain on a rollover contract) is challenging when both the dependent variable (switching) and endogenous explanatory variable (rollover) are themselves discrete (e.g., Wooldridge, 2002). Methods commonly used for continuous dependent and/or explanatory variables like Instrumental Variables (IV) estimation are not typically available. One is usually forced to make stronger assumptions and to jointly model both decisions.

We follow that approach here. We jointly estimate a switching equation (Equation (3) above) as well as a "selection equation" estimating household *i*'s choice of a rollover contract in month *t*. Following notation analogous to that above, let

$$R_{it}^{*} = x_{it-1}^{'}\delta_1 + z_{it}^{'}\delta_2 + \eta_{it-1} \quad (4)$$

be the latent utility to household *i* from choosing a rollover contract in period *t*. x_{it-1} (η_{it-1}) are observable (unobservable) factors influencing the decision to select a rollover contract in period t-1 and z_t are observable factors that influence such decisions in period t. We discuss the key elements of x_{it-1} and z_{it} in what follows below.

There is an important difference in the specification of the switching equation (3) and the rollover equation (4) in that the latter includes lagged variables. This difference is due to differences in the timing of decisions in the model. To understand these differences, consider a BT customer in a rollover contract at the beginning of time period *t-1* and let x_{it-1} measure information about their "state" at the beginning of the period (e.g. their plan, their contract, etc.). During period *t-1*, if they decide to stay with BT, they must further decide what plan and contract to select for period *t.* Whether they are in a rollover contract in period *t* clearly depends on x_{it-1}. For example, whether they remain on a rollover contract in February 2009 is strongly influenced by whether January 2009 is the last month of their MCP.

The switching decision, on the other hand, is defined to happen at the *end* of the current month. Thus the switching decision in month *t* depends on period-t state variables, x_{it}, (as in equation (3)) while the rollover decision depends on period *t-1* state variables, x_{it-1}.[28] We include other, period *t* covariates, z_{it}, in the rollover equation to allow for some period-*t* effects on rollover choices (e.g. time dummies).

The goal of the rollover equation is to predict whether a household enters a rollover contract. The difference in timing of the switching and rollover decisions helps us identify candidate instruments that influence the rollover decision but not the switching decision (cf. Wooldridge, 2002). This helps motivate the identification of our causal effects of interest. In practice, any/all of the period-*t* covariates entering the switching equation, x_{it}, could enter (with lags) in the rollover equation. In practice, we include lags of the contract and plan variables and time dummies.[29]

Let

$$Rollover_{it} = \begin{cases} 1 & if\ R_{it}^{*} \geq 0 \\ 0 & if\ R_{it}^{*} < 0 \end{cases}$$

We will assume ε_{it} and η_{it-1} are distributed as a joint normal random variable independent of all the exogenous variables in both models with correlation coefficient ρ. If, as we suspect, unobserved differences in households' willingness to switch from BT are negatively correlated with their choice of rollover contracts, this will result in a statistically significant, negative estimate of ρ.

[28] An alternative notational convention would be to define all states to occur at the beginning of each period. In this case, we would say someone switching in period t would have S_{t+1} = 1 and there would be a similar lagged relationship between outcomes and covariates in both equations.

[29] The qualitative results were largely insensitive to the exact variables included in the rollover equation.

Formally, the model is a recursive bivariate probit (Greene, 2008, Section 23.8.4, page 823; Maddala, 1983, p.123). Following the notation in Greene (2008), the estimating equation is then

$$P(Switch_{it}, Rollover_{it}) = \Phi(X_{1t}\beta + \gamma Rollover_{it}, X_2\delta, \rho)$$

where $X_{1t}\beta + \gamma Rollover_{it}$ are the covariates in the Switching equation (with the Rollover term pulled out), $X_2\delta$ are the covariates in the Rollover (selection) equation, Φ is a standard bivariate normal random variable with the variance of ε_{it} and η_{it-1} each normalized to 1 and ρ measuring their correlation. We estimate it by Maximum Likelihood Estimation (MLE) using Stata, allowing arbitrary serial correlation within individuals over time, so-called "clustered" standard errors.

3.2.1 Discussion

There are a number of assumptions implicit in the econometric model specified in this section that warrant further discussion.

First, note that the model presented here is a simplified version of a more general, dynamic, model that analyzes a household's choice of plans, *j*, among all plans available in the market in month *t*. In such a model, a household switches when the present discounted value of her utility to the new plan, *k*¸ exceeds that of her utility to her existing plan, *j*.[30] Unfortunately, estimating a dynamic model of plan choice requires both more detailed data (especially regarding the providers and plans households leaving BT switch into) as well as significantly more researcher and computation time. Such models are at the frontier of applied micro-econometric research and are beyond the scope of this study. We have included some dynamics by exploiting the differences in timing in the selection and rollover equations. While our model may not allow us to jointly analyze the optimal sequence of household rollover and switching decisions, it is likely to be adequate for measuring the average effect of rollovers on switching.

A second important assumption is that of no persistent unobserved individual heterogeneity, e.g. that the error in the switching equation cannot be written as $\varepsilon_{it} = c_i + \tilde{\varepsilon}_{it}$. Allowing for unobserved heterogeneity is a hallmark of linear panel data estimation (e.g. fixed-effects models), but it is significantly more complicated in a discrete-choice (and thus nonlinear) setting. It is possible to do fixed-effects logit estimation in some settings by conditioning on the set of observations with a given number of outcomes (switches). In our case, however, every household either switches or doesn't (the sum of their binary outcomes over time is either 0 or 1) and, if they do switch, it is always in the last period of the data. Furthermore, as many households do not change contracts in the data, we would have to rely on the much smaller set of BT customers who switch plans within our observation period. Similarly, estimating a random-effects model (e.g. a random-effects probit) either requires making untenable assumptions about the distribution of the random effect (e.g. unobserved tastes, c_i, are independent of the explanatory variables, *including tenure*) or coding an appropriate estimation procedure. Such

[30] This complicated dynamic model could even itself be augmented to account for "behavioural" effects (e.g. context effects, default bias) typically missing from a dynamic utility-maximizing framework.

models are also at the frontier of applied micro-econometric research and also beyond the scope of this study.

Regardless, we feel unobserved heterogeneity in the switching equation is unlikely to bias our results in ways we could predict. The primary bias from any time-persistent unobservables is likely to most be felt by the tenure variables.[31] The tenure variables aren't the focus of our study, however. While bias or inconsistency in any single parameter generally contaminates the estimates of all other parameters, assigning any such "transmitted bias" to our rollover coefficient is difficult. While it is too strong to say unobserved heterogeneity is clearly not a problem, neither is it true to say that it would obviously bias the effects of rollover contracts on switching one way or another.

A final concern is that unmodelled dynamics or unobserved heterogeneity could influence the legitimacy of our self-selection correction. For example, there could exist indexes of unobserved heterogeneity in both rollover and selection equations that are negatively correlated with each other. The tenure variable and lagged contract variables in the switching and rollover equations, respectively, could (unintentionally) capture these effects, muting our estimates of that correlation. In our opinion, this is the area of greatest concern with our proposed modelling framework, and so we conduct a specification test to assess the possibility of such effects after presenting our baseline results.

[31] Unobserved heterogeneity bias makes it difficult to disentangle whether long-time BT customers switch less because they simply like BT (unobserved heterogeneity) or because being with BT in any single period makes them want to switch less in the following period (so-called state dependence).

4 Results

4.1 Specifications

4.1.1 Switching equation

We considered a number of specifications of the switching equation based on the econometric model outlined in the last section. In the final specification below, we included the following variables:

Macroeconomic Variables: As switching can be driven by macroeconomic factors unrelated to the issues analyzed here, we include two controls for macroeconomic effects: (1) The unemployment rate (varying by both region and month) and (2) Month dummies for the 15 months in our sample. We chose not to report these variables due to space constraints.

Tenure: As shown in Figure 2 and Figure 7, customers in the data differ considerably in their tenure with BT and this tenure is strongly (negatively) correlated with switching rates. We include three measures of tenure: (1) log of the household's tenure with BT (in months), (2) log of the household's tenure on their current promotion (i.e., contract, plan, and discount; in months), and (3) whether or not they are a new customer, defined as a customer whose BT start date is no more than 15 days earlier than her promotion start date.

Plan Dummies: As certain plans may be more or less attractive to households (and because when we introduce prices we want to account for differences in the amount of calls services provided), we include plan dummies to measure these effects. The included dummies are two: (1) the Unlimited Evening and Weekend Plan and (2) the Unlimited Anytime Plan. The Unlimited Weekend Plan is the excluded plan.

Other Product Dummies: We were able to obtain information about other BT products being purchased by each BT household at the time of the sampling date. These were BT's Broadband Service and BT Vision (Multi-channel TV service). We include these as households may be less likely to switch if they also subscribe to one of these products due to higher perceived benefits from staying with BT and/or higher perceived switching costs from leaving BT. Furthermore, we include indicators for the additional calls services which, throughout the observation period, are associated with some promotions: these add-on packages for calls to mobile phones and international calls are called Friends & Family Mobile, and Friends & Family International.

Month in initial MCP: Over 96% of customers on fixed-term or rollover contracts sign up for a 12-month Minimum Contract Period. For these customers, we included dummies indicating in which month of their first MCP is each observed month.[32] This will measure the impact of households

[32] Not reported are separate effects for customers on 18-month contracts.

having to pay ETCs in order to switch from BT. As ETCs are higher the more months remaining in a MCP, we expect this effect to be strongest for months early in the MCP. To isolate the effects of MCPs on rollover contracts versus fixed-term contracts, we measure these effects in *just* the first 12 months of a household's contract. After this 12-month period, fixed-term and rollover contracts are very different: the former have no contractual restrictions (but do have higher prices) compared to the latter. After being unable to reject their difference, the Month-in-initial-MCP dummies were constrained to be the same for customers on fixed-term contracts and customers on rollover contracts in their initial MCP.[33]

Fixed-term Contract Dummy (Post-MCP): The Month-in-initial-MCP dummies capture the impact of being in a particular month of the (first) 12-month MCP on switching behaviour for fixed-term customers. After those 12 months, we include a single dummy to measure any subsequent differences in switching behaviour between customers who were originally on a fixed-term contract but no longer face contractual restrictions relative to those households who were never on a term contract.

Rollover Dummy (Post-MCP): The Month-in-initial-MCP dummies also capture the impact of being in a particular month of the first 12-month MCP on household switching behaviour for rollover customers. After those 12 months, we include a single dummy to measure any subsequent differences in switching behaviour between customers who were originally on a rollover contract. As rollover-contract households are the only types of households that face ETCs under their new MCP, we expect their switching rates to be lower than other customers.[34]

Price Difference (Some specifications): In all but our first specification, we also control for price effects. We do so by including, for each household, the difference between the price they pay for their chosen plan (net of any price discount they might benefit from) and the lowest price in the market for that same plan at rival providers TalkTalk and/or Virgin.[35] We expect that the higher is BT's price in the market relative to its rivals, the more likely it is for households to switch. As defined, this variable will also capture changes in the price paid by households for their chosen BT plan as any price discounts are removed due to the expiration of a promotional period. For households on standard and rollover contracts, there is no price change as there either is no discount or the discount is effectively permanent. For households on fixed-term contracts, this will capture the increase in the price for Evenings and Weekend (similarly Anytime) service after the first 3 (similarly 12) months of their MCP. We measure this variable as a percentage of the price of the household's chosen service.[36]

The last two (sets of) variables above are our key explanatory variables. The rollover dummy in particular measures the extent to which customers on rollover contracts are less likely to switch in month 13 onward relative to both standard (un-contracted) and fixed-term customers, *controlling for* the price discount they receive on the service.

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[33] Motivated by the switching patterns we observe in the data, we ignore throughout our analysis the fact that ETCs are applicable not only on special offers, but also during the first 12 months of all new accounts.

[34] Note this post-MCP rollover dummy will measure the impact of both (a) ETCs in subsequent MCPs as well as (b) any direct effect of rollover contracts independent of these ETCs. We discuss this issue in Section 4.2.1 below.

[35] We elected not to include prices for Sky voice service as these are only available to Sky TV customers, implying the price comparison being made by households is not just that for fixed-voice services.

[36] E.g. price difference = 100*(price – min_rivals_price) / price

4.1.2 Rollover (selection) equation

In our final specification, we also accommodate the possibility of self-selection by jointly estimating the switching and rollover equations, (3) and (4). The specification for the switching equation is as above. We included the following variables in the rollover equation:

Lagged Contract/Plan Choices: We include lagged contract and plan dummies to predict the choice of rollover contracts in the current month. The lagged dummies included are (1) Plan type (Evening & Weekend and Anytime plans, Weekend plan omitted), (2) On a fixed-term contract (separately during, and at the end of, and after the end of the MCP), and (3) On a rollover contract (separately during and at the end of each rollover period).

Month Dummies: We include month dummies to capture aggregate trends in subscriptions to rollover contracts, e.g. due to variation in BT's marketing focus and/or expenditure over the sample period.

4.1.3 Identification

The key effect of interest is the impact of rollover contracts on household switching, controlling for tenure, other services purchased by the household, price discounts, and selection. Fundamentally the effect of rollover contracts on switching are identified by the patterns shown in Figure 6 and Figure 7: how often do households on rollover contracts switch *after their MCP* relative to both fixed-term and standard contracts. The data suggested they switch less, a result the econometric analysis confirms.

Of course, customers who have long been with BT (i.e. have longer tenure) in general switch less. We control for that by including the tenure variables described above. The data are rich enough to, in principle, flexibly estimate the impact of rollover contracts for households at each possible tenure (e.g. customers that have been with BT for 0, 1, 2, etc. years). We have done this and found the effect of tenure is well-captured by the log(tenure) specification above and for parsimony simply report those results.

Customers on rollover contracts also receive price discounts. Failing to account for these discounts will tend to attribute a lack of switching to the presence of the rollover contract instead of the lower price being paid by households. We account for this by estimating the effect lower monthly prices have on switching rates, controlling for contract and plan characteristics.

The variation in the data that identifies price effects could, in principle, come from one of three sources. First, it could come from variation over time in the undiscounted standard plan prices offered by BT relative to rival CPs. Second, it could come from variation over time in the level of the discount from standard plan prices for fixed-term plans whose discount varies within the MCP (e.g. one with a discount of 3 months within a 12-month MCP). Finally, it could come from variation in the level of discount across promotions marketed to and accepted by BT customers for fixed-term and/or rollover contracts.

In results not reported here, we explored the relative importance of these sources of variation and found the latter the most important by far. For example, there are two BT promotions ("Offer H" and "Offer K") that, for the UEWP plan, appear to be identical except that the former has a price discount and the latter does not. Customer switching is higher for the plan without

the discount. We rely on all of these sources of price variation in estimation, but it should be understood that the latter is the most important for identification.[37]

Finally we wish to control for selection into rollover contracts based on unobservable differences in willingness to switch that are correlated with tastes for key characteristics of rollover contracts (such as lower prices in exchange for greater restrictions on churn). As further discussed in Section 3.2, the selection model will have power to the extent we have identified instruments that can influence the choice of rollover contracts and not switching. Exogenous variation in the instruments will exogenously "move rollover" and identify the causal effect of rollover contracts on switching. Correlation in the deviations in the predicted from the actual switching and the predicted and actual rollover will then identify the correlation in the unobservables in the two equations.

4.2 Results

Table 2 below presents the results of the switching regressions under three specifications. The first specification measures the effect of rollover contracts on switching behaviour but does not account for either the effects of the price discounts or selection into rollover contracts. This specification is closest in spirit to the patterns presented in the raw data in Section 2.1.5. The second specification includes the price effects described above. The third specification accounts for self-selection into rollover contracts. We present in the table only the results for the switching equation. Results for the Rollover equation are presented in Appendix 1.

The estimates in the table report the marginal effects of the variables at left on the probability of switching away from BT in a given month, measured as a percentage point. The predicted switching rate for the average observation in our dataset (reported in the last set of rows) is slightly below 1.0% per month. This corresponds to something slightly below 11% per year. Estimates that are significant at the 5%, 1%, and 0.1% level are reported with 1, 2, and 3 stars.

As an example of how to read the table, consider the switching rates for the Evening and Weekend plan (denoted UEWP). Switching is an estimated 0.05 percentage points higher on the Evening and Weekend plan than for the Weekend only plan (the excluded category), or 5.3% of the baseline 0.95% switching rate.[38] This is a relatively small effect.

We begin by considering the results of tenure, plan characteristics, other services, and month in the MCP in the baseline specification (Column 1). All are consistent with prior expectation as well as the patterns described in the data section.

Tenure is shown to strongly influence the probability a household switches. Long-standing BT households switch much less. For example, a household who has been with BT for 4 years and

[37] Interested readers may learn more by reading the supplementary report we prepared for Ofcom, available as Annex 8 to Ofcom's consultation.

[38] For consistency, we evaluate the percentage effect of a change in any explanatory variable at the predicted switching probability evaluated at the mean of the data. As can be seen at the bottom of the table, this differs slightly from the average predicted probability in the data.

increases its tenure by 100% (to 8 years) is predicted to switch with a 0.59 percentage-point lower probability, over 60% of the average baseline switching rate. Tenure on a particular promotion (i.e. plan, contract, and price) is also associated with lower switching rates.

Subscribing to another BT service had mixed effects on switching. The largest effect, both economically and statistically, was for the purchase of BT broadband service. Households that were purchasing broadband at the sampling date had a 0.49 percentage point lower switching rate, just over half of the average baseline rate.[39] This is consistent with operators' views that providing bundles of telecommunications services to households may reduce their willingness to switch. The unemployment rate and month dummies (not reported) both influence switching, with higher levels of unemployment associated with greater departures from BT.

The effects of being on a MCP are very strong and consistent with expectation. Being in the first month of an MCP is associated with a 0.89 percentage point reduction in the predicted probability of switching, over 90% of the baseline rate! Moving closer to the end of the MCP increases this likelihood, although it stays significantly below the baseline until the very last month, month 12. Here, in the first month in which households with MCPs can switch without penalty, there is a very large (0.64 percentage point, almost 70% of the baseline) increase in the predicted probability of switching. This demonstrates the importance of MCPs (and the ETCs associated with them) in limiting household switching behaviour.

[39] Of the remaining services analyzed, the effect of F&F Mobile was modest (reducing switching by an estimated 12.7%), while the effects of the others (BT Vision and F&F International) were not statistically different from zero.

Table 2: Main marginal effects in the benchmark regressions

	Switching		
	Probit	**Probit**	**Bivariate probit**
Variable	**Without prices**	**With prices**	**With prices and self-selection**
Log(Tenure at BT)	-0.59***	-0.59***	-0.59***
Log(Tenure on promotion)	-0.18***	-0.18***	-0.17***
Broadband	-0.49***	-0.50***	-0.50***
BT Vision	0.09*	0.09	0.09
F&F mobile	-0.08*	-0.13**	-0.12**
F&F international	0.15	-0.067	-0.061
UEWP	0.05*	0.09***	0.08***
UAP	-0.25***	-0.31***	-0.31***
Initial MCP month 1	-0.89***	-0.86***	-0.79***
Initial MCP month 2	-0.84***	-0.79***	-0.79***
Initial MCP month 3	-0.80***	-0.74***	-0.73***
Initial MCP month 4	-0.75***	-0.68***	-0.67***
Initial MCP month 5	-0.71***	-0.63***	-0.62***
Initial MCP month 6	-0.61***	-0.51***	-0.50***
Initial MCP month 7	-0.65***	-0.56***	-0.55***
Initial MCP month 8	-0.53***	-0.41***	-0.40***
Initial MCP month 9	-0.50***	-0.38***	-0.37***
Initial MCP month 10	-0.47***	-0.33***	-0.32***
Initial MCP month 11	-0.45***	-0.31***	-0.31***
Initial MCP month 12	0.64***	0.99***	1.01***
12-month fixed-term after end of MCP	0.39***	0.41***	0.42***
Rollover in subsequent MCP(s)	-0.49***	-0.34***	-0.33***
Percentage price difference from rivals		0.01***	0.01***
Rho (corr. coeff.)			-0.06***
Average predicted switching	1.25%	1.25%	1.24%
Predicted switching for the average observation	0.95%	0.95%	0.95%

Source: Own calculations based on BT data.

Notes: Reported are the estimated marginal effects for most variables in our Probit switching equation evaluated at the mean of the explanatory variables. Switching means switching fixed voice telephone service away from BT. The first column does not control for price differences or self-selection. The second column includes controls for price differences. The third column controls for self-selection by estimating a bivariate probit of the switching and rollover equations (Equations (3) and (5)). A promotion is a combination of plan, contract, price, and additional phone services (if any). F&F mobile/F&F international/Broadband/BT Vision are dummies for other BT services that customers may be purchasing in addition to fixed voice telephone service. UEWP and UAP are BT calling plan dummies. MCP stands for Minimum Contract Period. Percentage price difference from rivals is the price of the household's chosen service minus the minimum price from Virgin & Talk Talk for the comparable voice service, divided by the price of the chosen service. Included in all specifications but not reported are a constant term, month dummies, unemployment, and variables measuring the effects of 18-month term contracts. Included in the rollover equation in column 3 but not reported here (but see 0) are lagged plan dummies and lagged contract choice variables. Estimates significant at 5%/1%/0.1% levels denoted by 1/2/3 stars. Significance levels determined based on standard errors that allow for arbitrary correlation across months within each customer.

4.2.1 The effects of rollover contracts

Remaining with the results in column 1, we turn to the contract dummies, including our key parameters of interest. We see that households on rollover contracts switch after their first MCP by 0.49 percentage points (51.7%) less than comparable customers on standard contracts. By contrast, households on fixed-term contracts switch 41.2% more than standard-contract customers, implying rollover customers switch 65.8% less than fixed-term customers.[40] This is no doubt due, in part, to the additional ETCs such customers would have to pay compared to either standard or fixed-term customers.

The remaining columns in the table break out the effects of reduced switching by customers on fixed-term and rollover contracts into a portion due to prices and that due to the effects of the contracts themselves.

Column 2 demonstrates that price variation significantly influences switching. It says that a 10 percentage point increase in the monthly price of a fixed-voice service relative to BT's rivals is associated with a 0.11 percentage point increase in the switching rate. Thus the £3 (20.6%) discount on Evening and Weekend Service associated with a rollover contract is predicted to lower the probability of a household switching by an estimated 0.21 percentage points, approximately 22% of the baseline rate.

Note also that accounting for prices has the predicted effect of reducing the magnitude of the Rollover dummy, from -0.49 to -0.34 percentage points. As expected, if we fail to account for the lower prices offered on rollover contracts, we attribute too much to the influence of rollover contracts to the rollover feature (and associated ETCs). That being said, there is still a negative estimated effect of rollover contracts on switching relative to households on standard contracts, by 35.9% relative to standard contracts and by 55.3% relative to fixed-term contracts

The worry is that this effect doesn't only represent the causal effect of rollover contracts but in part captures the self-selection of customers into rollover contracts that are less likely to switch

[40] (-0.49-0.39)/(0.947+0.39)=-0.658.

anyway. The last column of Table 2 addresses this issue by presenting the switching regression results associated with our Bivariate Probit model including a rollover self-selection equation.

The effects of selection are both economically and statistically modest. While we do estimate that there is a statistically significant negative correlation in the unobservable errors in the switching and rollover equations, it is only estimated to be -0.06. As a result, there are few differences in the estimated effects of any of the explanatory variables in column 3 versus column 2. In this, our final specification, households on rollover contracts switch after their first MCP approximately 34.8% less than comparable customers on standard contracts and by 54.8% less than comparable customers on fixed-term contracts.

What do these impacts of rollover contracts on switching imply about switching costs in this market? Because both rollover contracts and percentage price differences between BT and its rivals enter the utility to switching from BT, we can easily quantify the switching cost implied by our estimates. For our preferred specification (Table 2, Column 3), rollover contracts reduce switching by 0.34 percentage points and the percentage price difference for BT products relative to rivals increases switching by 0.01 percentage points at the mean of the explanatory variables.

The switching costs associated with rollover contract can therefore be measured as the percentage price difference for BT relative to its rivals that would make a consumer indifferent to taking a rollover contract. This is just 0.33/0.01 = 33.0%. In other words, a rival would have to offer (in perpetuity) a discount on the price of its fixed line voice service of 33.0% of the BT price in order to overcome the average switching costs imposed on households induced by rollover contracts.[41]

4.2.2 Decomposing the effects of rollover contracts

The effects of rollover contracts presented thus far aggregate two distinct economic effects that each could reduce a household's propensity to switch. First, rollover contracts introduce additional MCPs beyond the first. These bring with them ETCs that naturally reduce switching.

Second, rollover contracts could *themselves* reduce switching, even after controlling for the effects of ETCs. One reason would be that rollover contracts make staying with BT the default option and that household decisions could be influenced by *default bias*.[42] This seems particularly relevant if there is only a short window in which customers must make a decision to switch.[43] Another reason would be that opting out of a rollover contract required customers to contact BT on a special telephone number, where they were sometimes offered "bespoke" retention deals. By making rollover contracts an opt-out process, BT essentially gave itself the

[41] This value is comparable to previous estimates of the size of switching costs in the literature. For example, Dube, Hitsch, and Rossi (2009) estimate switching costs in the margarine and orange juice markets in the range of 15-60% of the purchase price and Shcherbakov (2007) estimates switching costs in the cable and satellite television markets in the range of 32-52% of the annualized expenditure on the service.

[42] Della Vigna (2009) surveys the empirical literature on behavioural biases, including the default bias. Sunstein and Thaler (2008) raised the awareness of behavioural biases in the general public. As discussed earlier, Handel (2010) attributes the estimated switching costs in his study to default bias.

[43] A personal anecdote illustrates such an effect. While recently travelling abroad, one of the authors was called by his energy provider and asked if he wanted to continue service with them. Renewing meant a new 12-month contract with associated ETCs or a switch to a monthly contract with unknown (at the time) prices. Failing to renew meant a lapse in service. The existing contract was set to expire *the next day!* He chose to renew his existing contract.

option to offer customized discounts to those households that had expressed an interest in switching at the moment of their decision.

To separate the effects of rollover contracts into its components due to associated ETCs versus the contracts themselves is both challenging and beside the point. It is challenging because it requires making strong assumptions about the specific form that monetary values of ETCs translate into reduced switching. This may not be constant across months, MCPs, or (unobserved) customer types.[44] It is beside the point because the important market consequence of rollover contracts is the *aggregate* effect they have on market outcomes. It probably doesn't matter to a competitor whether BT's customers switch less due to ETCs or the contracts themselves; what does matter is that they switch less![45]

4.2.3 Robustness of self-selection correction

As we are concerned that we have accurately modelled the effects of self-selection, we considered several alternative specifications of the rollover equation. Variation in the set of lagged covariates had modest effects of the results; in the final specification we included the lagged contract variables as described above.

We also assessed the possibility of bias in our measurement of self-selection due to unobserved heterogeneity in the rollover and/or selection equations. The best test would be to estimate an unrestricted model that allowed for such unobserved heterogeneity and test the significance of this addition. For the computational reasons discussed in Section 3, however, this was not possible.

Instead, we estimated alternative specifications that omitted the tenure variables from the switching equation and lagged contract choice variables from the rollover equation. The hope is that these specifications remove those variables most likely to be picking up any time-persistent unobserved heterogeneity in each equation, allowing those to (re-)enter the error term and be estimated in our bivariate probit specification. The results were encouraging. Not only was the estimated correlation in this specification *not* more negative, it was in fact positive. Indeed, despite the natural increase in the variability of the estimate due to omitting important explanatory factors, large negative values could be rejected.

Figure 7, showing switching rates by month on promotion for both existing and new BT customers, provides further insight into why we may not be finding evidence of self-selection. A reasonable story of self-selection would seem to be that of a loyal BT customer who intends not to switch and is happy to enjoy the price discount offered with a rollover contract. However, such households would also seem more likely to be long-time BT customers, something we can

[44] In supplementary results not presented here, for example, we found that ETCs had a very different effect on switching during households' first MCP compared to subsequent MCPs. While this could in part be due to BT (unobservedly) forgiving ETCs for customers that didn't realize the nature of rollover contracts, it nonetheless poses a difficult interpretation challenge.

[45] In further results not presented here, we explored separately estimating these effects and found that, *controlling for ETCs* (as measured in the first MCP), rollover contracts reduced switching by 0.14 percentage points, 14.7% of the 0.95% predicted switching rate at the mean of the explanatory variables. Based on the estimated effect of percentage price differences in this specification, this implied that the switching costs induced *just* by rollover contracts is 10.8%, i.e. a rival would have to offer (in perpetuity) a discount on the price of its fixed line voice service of 10.8% of the BT price in order to overcome the switching costs imposed on households by rollover contracts, supposing such contracts contained *no* associated ETCs.

see in the data. If this story were right, we would expect to see no effect of rollover contracts on old customers, but strong effects on new customers. Figure 7, however, shows that, if anything, switching rates for customers on rollover relative to standard contracts are more different for existing than new customers, a result confirmed (but not reported) for the full model. For there to be strong effects of self-selection, it must be that customers *of a given tenure with BT* differ in their unobserved willingness to switch that is correlated with their choice of a rollover contract. Put this way, self-selection seems less likely to be an issue, something confirmed in our empirical results.

While not conclusive, the statistical test and analysis above encourage us to conclude that we are not underestimating the amount of self-selection in the market.

5 Conclusions

This paper evaluates the effects of automatically renewable ("rollover") contracts introduced by British Telecommunications (BT) on their customers' willingness to switch suppliers in the UK fixed-voice telephone market. Working closely with Ofcom staff, we obtained detailed customer-level billing data from BT for a random sample of almost 180,000 of their fixed-line voice customers as of 31 December, 2008 and followed their choices for the subsequent 15 months. We augmented this with aggregate market-wide information measuring macroeconomic trends and prices offered by rival providers for similar services, yielding a comprehensive dataset well-suited to analyze the factors influencing household switching from BT. Patterns in the raw data strongly support the conclusion that households on rollover contracts switch less than those on standard and (especially) fixed-term contracts.

We specified an econometric model to analyze the factors influencing these switching patterns. The model was designed to estimate not only the direct, causal, effect of rollover contracts on switching away from BT, but also other factors that might influence switching, especially the price discounts included in such contracts and "self-selection", the possibility that there are unobserved differences in households' likelihood of switching that might be correlated with their decision to select a rollover contract.

We found all of these factors were important determinants of households' switching behaviour. In our preferred specification, we found customers respond strongly to facing ETCs in minimum contract periods (MCPs): they switch 83.4% less than the average baseline switching rate in the first month of a MCP, with the effect smoothly lessening until the last month (when customers can switch without paying ETCs), where it jumps to an estimated 80% greater than baseline. We further found that doubling a household's tenure with BT, offering a 21% price discount like that offered by BT on the most popular rollover contract, and purchasing broadband service from BT was associated with an estimated 62.3%, 21.9%, and 52.8% reduction in switching, respectively. Finally, we found only modest evidence of self-selection: unobservable factors influencing households selection of rollover contracts were found to be negatively correlated with unobservable factors influencing their switching from BT, but the magnitude of this correlation was small (-0.06) and its economic effects were negligible.

Our primary result focused on the effect of rollover contracts on switching. We found, after controlling for the effects of tenure, price discounts, broadband purchase, and self-selection, that customers on BT's rollover contracts switch after their first MCP an estimated 34.8% less than comparable customers on standard contracts and by 54.8% less than comparable customers on BT's fixed-term contracts. These imply rollover contracts induce switching costs on the order of 33.0% of the monthly price of the average BT fixed-voice telephone service.

Two literatures in economics suggest rollover contracts should be viewed with scepticism and concern in light of our results. First, our results suggest that BT's rollover contracts significantly increase switching costs in fixed voice telephony markets. A likely short-run effect is that these switching costs reduce rivals' incentives to attract customers by cutting prices or promoting their own products. Is this effect outweighed by the benefits of more aggressive competition for customers willing to enter such contracts? As they were newly introduced, we weren't able to

analyze this question in the UK market. While they acknowledge that the evidence in the economics literature isn't definitive, Farrell and Klemperer (2007) conclude that it is likely that higher switching costs increase average prices and therefore reduce consumer welfare.

A growing literature analyzing exclusive contracting in product markets provides an additional cause for concern. This literature analyzes the incentives a manufacturer may have to sign exclusive contracts with one or more downstream retailers. When there are economics of scale in manufacturing, such contracts can exclude an efficient entrant.[46] The essential insight is that when any one retailer signs an exclusive deal, it imposes a negative externality on all other retailers by reducing the potential market for (and raising the costs of) the new entrant. This is a kind of coordination failure and it can induce all retailers to sign exclusives when they would jointly prefer to instead buy from the entrant.

The implications of this literature for BT's rollover contracts are analogous. Rollover contracts introduce (rolling, near-) exclusive contracts over a portion of BT's customer base.[47] If, as is likely, there are economies of scale in the provision of either existing or new services, this reduces the likelihood of either new market entry or the introduction of new services by existing rivals, again reducing welfare.

Can rollover contracts be justified on efficiency grounds? The most prominent argument in the economics literature is that exclusive contracts can solve problems of asymmetric information and/or moral hazard,[48] but these are unlikely to be relevant where exclusives are with final customers. Arguments that MCPs help lower signup costs may be credible, but presumably only for the *first* MCP, not on a rolling basis. They clearly could also reduce transactions and marketing costs, but at what cost to the competitive process?

While this paper has exclusively analyzed the impact of BT's rollover contracts on switching in fixed voice telephone markets, the lessons appear to us to be more general. If similar rollover contracts reduce customer switching for access to broadband Internet, energy, or mobile telephone service without providing any additional benefits (e.g. a new mobile handset), the conclusions we draw for fixed voice would equally well apply to those markets. Overall, the evidence in the economic literature provides few efficiency justifications for rollover contracts of the type used by BT and several reasons why they could reduce competition and, by inference, social welfare. They should clearly be a cause for concern for policymakers in all markets where they are used.

[46] E.g., Aghion and Bolton (1987), Rasmusen, Ramseyer, and Wiley (1991), Segal and Whinston (2000). Whinston (2006), Chapter 4 provides a nice introduction to this topic.

[47] Strictly speaking, rollover contracts are not exclusive. Like exclusives, however, they impose a cost on consumers wishing to buy from another provider.

[48] See Whinston (2006), Section 4.5.

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Appendix: Rollover equation

Table 2, in the main body of the study, reports the marginal effects of a set of covariates on the probability of switching, under three alternative specifications. Specifications 1 and 2 are single-equation (Probit) specifications (without and with controlling for prices, respectively) in which only the outcome of switching away from BT is modelled. To address the issue of self-selection into rollover contracts, Specification 3 is a two-equation (Bivariate Probit) specification in which the switching outcome is modelled together with the outcome of choosing a rollover contract.

The marginal effects on the probability of choosing a rollover contract, as emerging from the estimation of the rollover equation in Specification 3, are reported in Table 3.

Table 3: Main marginal effects for the rollover equation

	Switching
	Bivariate probit
Variable	**With prices and self-selection**
Lagged UEWP	9.3***
Lagged UAP	-0.2
Lagged fixed-term	-22.8***
Lagged fixed-term during MCP	-5.2
Lagged fixed-term at end of MCP	25.9***
Lagged rollover during MCP	98.4***
Lagged rollover at end of MCP	77.7***
Average predicted switching	31.24%
Predicted switching for the average observation	23.70%

Source: Own calculations based on BT data.

Table 3 shows in particular (variables "Lagged rollover during MCP" and "Lagged rollover at end of MCP") the impact of state dependence, whereby a customer is more likely to remain on a rollover contract than she is to move to one. Relative to a customer on a standard UWP plan, a customer on a rollover contract and in the middle of an MCP is more likely to "choose" a rollover contract (the default option) by over 4 times (98.4/23.7 = 415%). This effect is attenuated for rollover customers who are at the end of an MCP and therefore they do not have to pay any ETC to move to different contracts.