The Left-Digit Effect and Stock Selling Behavior

Investors are more likely to sell stocks after a change in the left-digit. This occurs for both price increases and decreases. The likelihood of a stock being sold jumps when the price crosses the left-digit from below, e.g. a stock increasing from £9 to £10, and also increases when the price crosses the left-digit from above, e.g. a stock decreasing from £10 to £9. We interpret this as showing that investor attention is drawn to stocks that change their leftmost digit. Left-digit changes are attention grabbing, causing sale activity. This is similar to the rank effect finding of Hartzmark (2015), whereby either top-ranked or bottom-ranked stocks by return since purchase are those most likely to be sold.

To show our result, we draw a sample of stock × quarters that have increased in value and have gone through a left-digit in a calendar quarter (e.g. Jan - Mar), which we call the Price Increasing Sample. We then draw a sample of stocks that have decreased in value through a left-digit in a calendar quarter, which we call the Price Decreasing Sample.[1] Note, this sample restriction is at the stock × quarter level.

We then draw all investor × stock × days within the Price Increasing Sample and the Price Decreasing Sample, i.e. all observations for investors × days on which the investor held the stock at the beginning of the day. We look at the probability of sale when the stock is just below a left-digit change, e.g. £9, compared with above the left-digit change, e.g. £10. This exercise might compare investor × stock × days drawn from different investors. Therefore, we also conduct estimates that include individual fixed effects, thereby exploiting within-investor variation in the probability of sale either side of the left-digit change.

Figure 3 illustrates the main result. Each panel shows the probability of a stock sale by the leftmost two digits of the stock price. Note, this pools over leftmost digits that are in pence, pounds, hundreds of pounds, and so on. The only information used in the analysis is the leftmost two digits, in integer values. The left-side plots pool all observations by the leftmost two digits and the probability of sale together with a 95% confidence interval. The right-side plots show the probability of sale by leftmost two digits. Panel A shows an increase in the probability of sale when the price crosses the left-digit from below, Panel B shows an increase

[1] We have implemented this sample restriction approximately in this version. In a future version we will implement the sample restriction precisely. We do not expect the results to change when we do this.

in the probability of sale when the price crosses the left-digit from above. Figure 4 and Figure 5 reproduce these plots for subsamples by the price range of the stock, in Panel A up to £1, in Panel B between £1 and £10, and in Panel C between £10 and £100.

Possible queries:

1 Limit orders. We have previously discussed the possibility that the patterns we see might be created by limit orders set at left-digit thresholds, i.e., round numbers. We think this is not the general mechanism at work, because limit orders would create a spike in the probability of sale at the left-digit alone. It would not explain the increased probability of sale at X1, X2, etc.. We think we see higher probability at X1, X2, etc.. because there is a delay between the stock crossing the left-digit and investors logging-in to their accounts. We could examine the role of limit orders more precisely by looking into very fine price data at the penny level.

2 Sample selection. We have previously discussed the possibility that the results might in some way be an artefact of sample selection, given that we are selecting on stock × quarters that pass through a left digit change. We can clarify any concerns around sample selection in two ways.

   A It is true that our sample selection criteria mean that our sample does not uniformly comprise observations across XO - X9. For example, in the price increasing sample the requirement is that the stock has increased in value up to at least X0, but there is no further requirement. This will give us an excess of observations at X0 compared with X1, X2, and so on. We see this is indeed the case in Figure A2 in the histogram. However, this does not bias our results as the y-variable in our analysis is the *probability* of sale. Hence, the XO bin has a larger denominator in the y-variable compared with the other variables. Moreover, our results is that the probability of sales increases between X9 and X0, for which there is only a small increase in density in the histogram.

   B To double-check, we conducted a simulation analysis in which we input the same data but choose stocks to be sold at random. The result in Figure A2 in the right-side plot confirms that this delivers a uniform probability of sale.

EQ: Updating the samples:

The old samples uses only login days to define a price as being part of increasing or decreasing trend:

– Increasing Price sample: We divided the data by quarters and looked at the $FirstLoginPrice$ (the price at the first login day of the quarter), we selected all quarters in which at least in one login day during the quarter (i) the price was larger than $FirstLoginPrice$ & (ii) the first left digit of that day was different than the first left digit of $FirstLoginPrice$.

– Decreasing Price sample: All remaining quarters.

Because the second sample includes stocks that go down or whose price do not move much,I have redefined the samples as follows:

– Increasing Price sample: We divided the data by quarters and looked at the $FirstLoginPrice$ (the price at the first login day of the quarter), we selected all quarters in which at least in one login day during the quarter (i) the price was larger than $FirstLoginPrice$ & (ii) the first left digit of that day was different than the first left digit of $FirstLoginPrice$ & (iii) **in all days of the quarter the price was never smaller than** $FirstLoginPrice$.

– Decreasing Price sample: We divided the data by quarters and looked at the $FirstLoginPrice$ (the price at the first login day of the quarter), we selected all quarters in which at least in one login day during the quarter (i) the price was SMALLER than $FirstLoginPrice$ & (ii) the first left digit of that day was different than the first left digit of $FirstLoginPrice$ & (iii) **in all days of the quarter the price was never LARGER than** $FirstLoginPrice$.

– Stable Price sample: Remaining days, prices were larger or smaller than $FirstLoginPrice$, but they never change the first left digit in comparison with the first left digit of $FirstLoginPrice$

But because we want to study the aggregate market effects of left digit selling, we cannot use the prices on login days to define increasing and decreasing samples (Datastream only has prices and sells but not logins). So here I redefined the samples without making restrictions on whether the investor log in on the first day of the quarter. Recall that above the samples were built looking at the prices on login days during

the quarter relative to the price on the first login day of the quarter. Now we do not look at the first login day, but just at the first day of the quarter, and we compare it with prices on any day—not necessarily login days.

– Increasing Price sample: We divided the data by quarters and looked at the $FirstPrice$ (the price at the first day of the quarter), we selected all quarters in which at least in one day during the quarter (i) the price was larger than $FirstPrice$ & (ii) the first left digit of that day was different than the first left digit of $FirstPrice$ & (iii) **in all days of the quarter the price was never smaller than** $FirstPrice$.

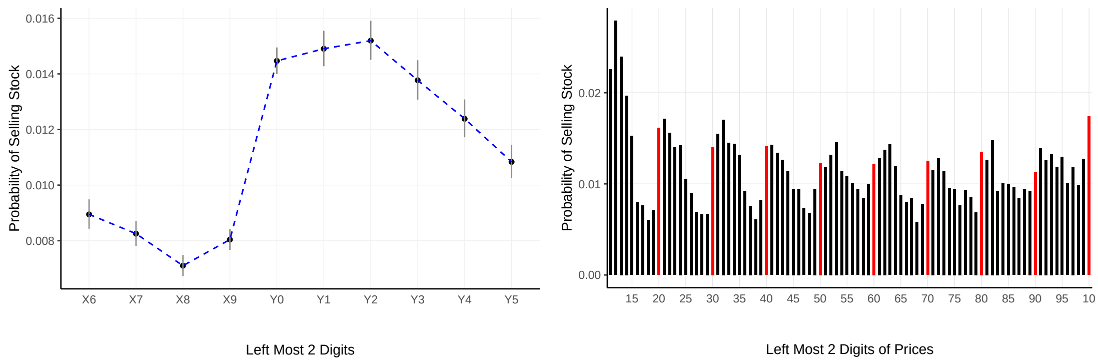
– Decreasing Price sample: We divided the data by quarters and looked at the $FirstPrice$ (the price at the first day of the quarter), we selected all quarters in which at least in one login day during the quarter (i) the price was SMALLER than $FirstPrice$ & (ii) the first left digit of that day was different than the first left digit of $FirstPrice$ & (iii) **in all days of the quarter the price was never LARGER than** $FirstPrice$.

– Stable Price sample: Remaining days, prices were larger or smaller than $FirstPrice$, but they never change the first left digit in comparison with the first left digit of $FirstPrice$.

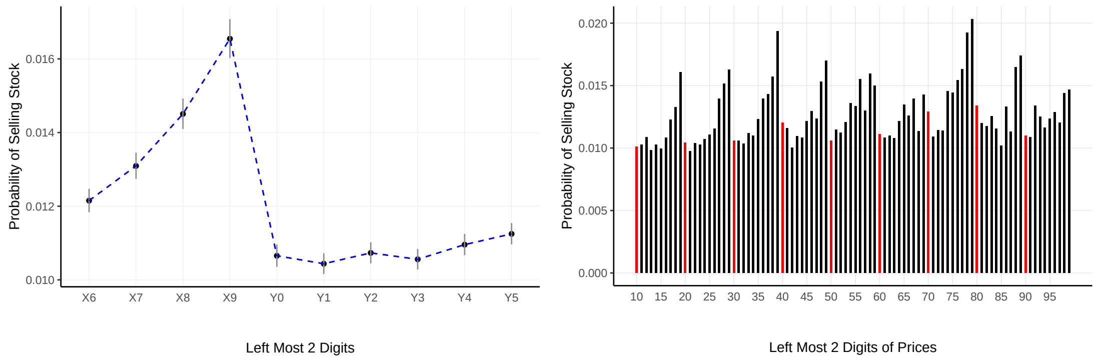
THE PROBLEM IS THAT USING PRICES WITHOUT CONDITIONING ON LOGIN DAYS TO DEFINE THE SAMPLES SHOWS NO EFFECT OF LEFT DIGITS ON SELLING CHOICES. THIS IMPLIES THAT PEOPLE CANNOT REPRODUCE OUR RESULTS UNLESS THEY ALSO HAVE LOGIN DATA. THIS ALSO IMPLIES THAT I CANNOT USE MARKET DATA TO IDENTIFY THE ECONOMIC CONSEQUENCES OF LEFT DIGIT BIAS. HOW BIG THIS PROBLEM IS??

Figure 1: Leftmost Stock Price Digit and Probability of Sale [EQ: Old samples]

(A) Price Increasing



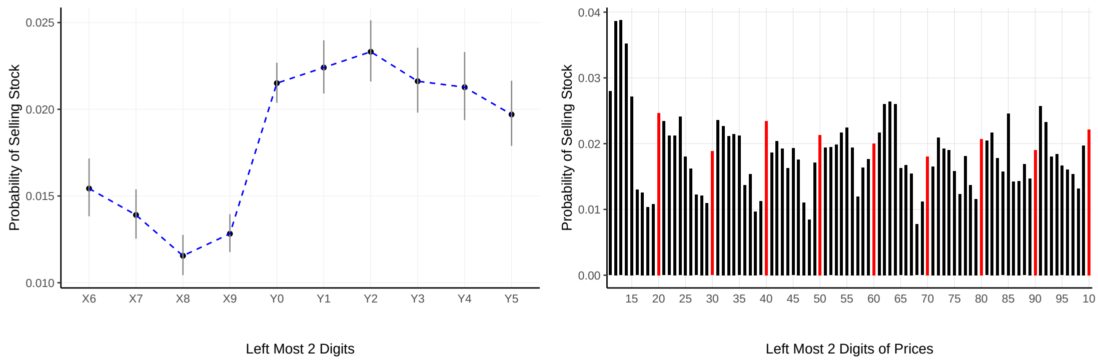
(B) Price Decreasing



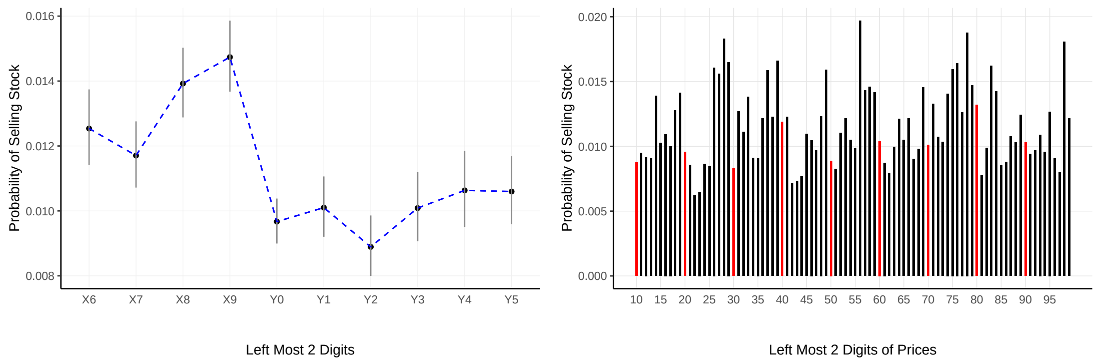
Note: £Y in the X-axes is equivalent to £$X+1$ (e.g., £X9 could include £0.19, £1.9, £19, etc., while £Y0 could include £0.20, £2.0, £20, etc.,).

Figure 2: Leftmost Stock Price Digit and Probability of Sale [EQ: New samples, defining patterns based on prices on login days]

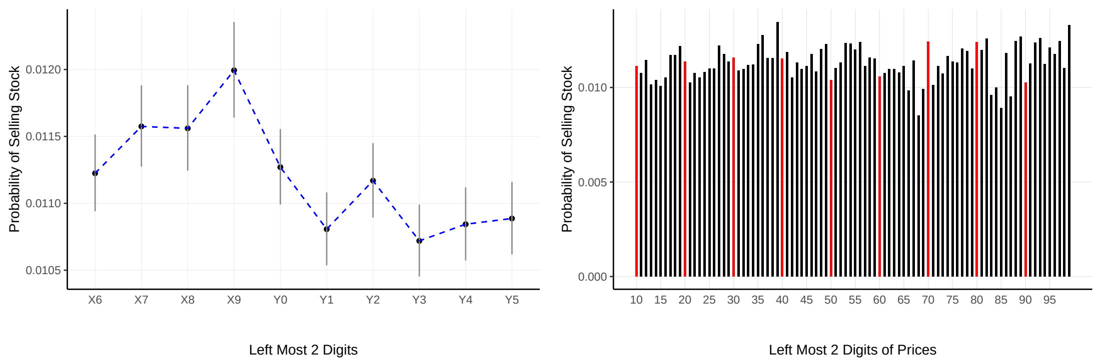
(A) Price Increasing



(B) Price Decreasing



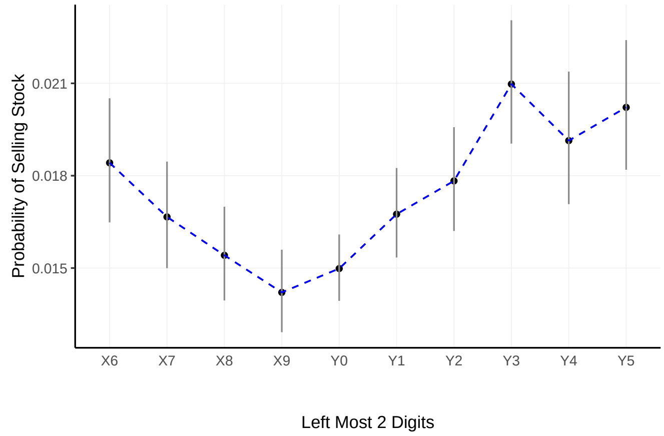
(C) Remaining



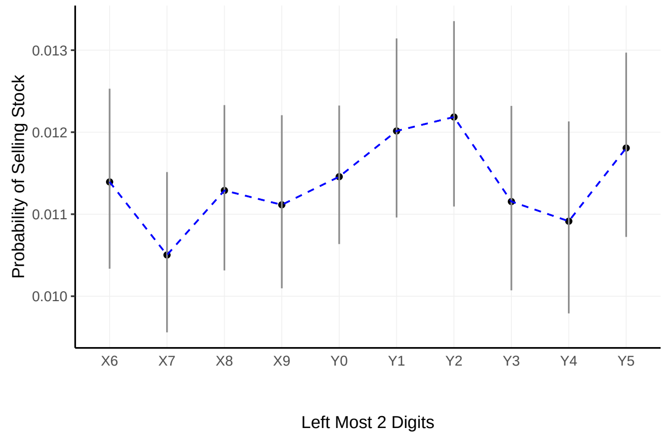
Note: £Y in the X-axes is equivalent to £$X + 1$ (e.g., £X9 could include £0.19, £1.9, £19, etc., while £Y0 could include £0.20, £2.0, £20, etc.,).

Figure 3: Leftmost Stock Price Digit and Probability of Sale [EQ: New samples, defining patterns based on market prices not restricted to login days]

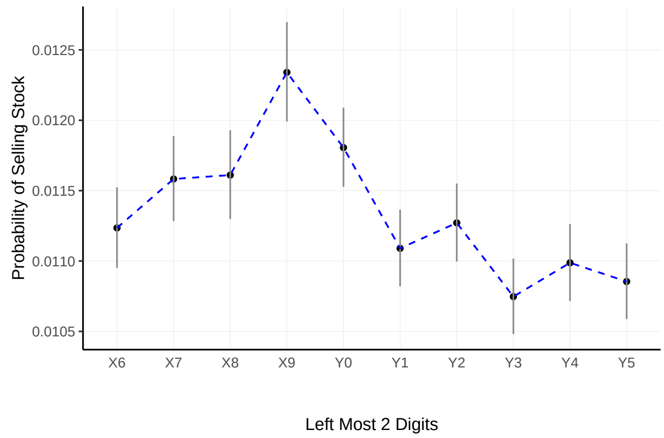
(A) Price Increasing



(B) Price Decreasing



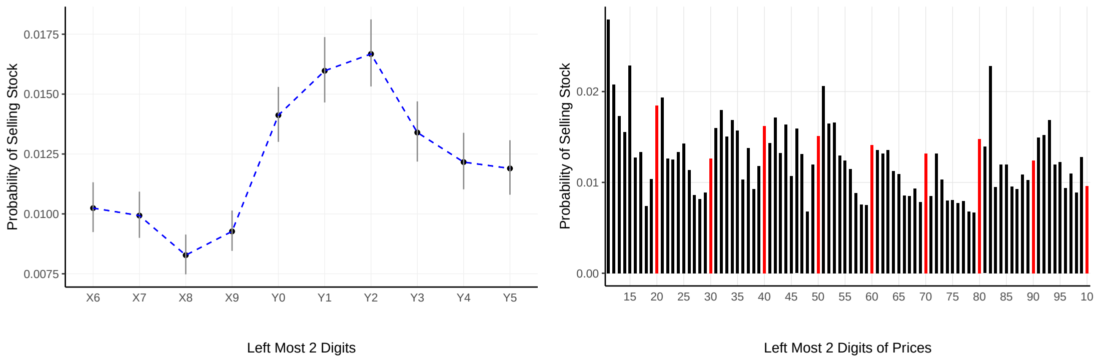
(C) Remaining



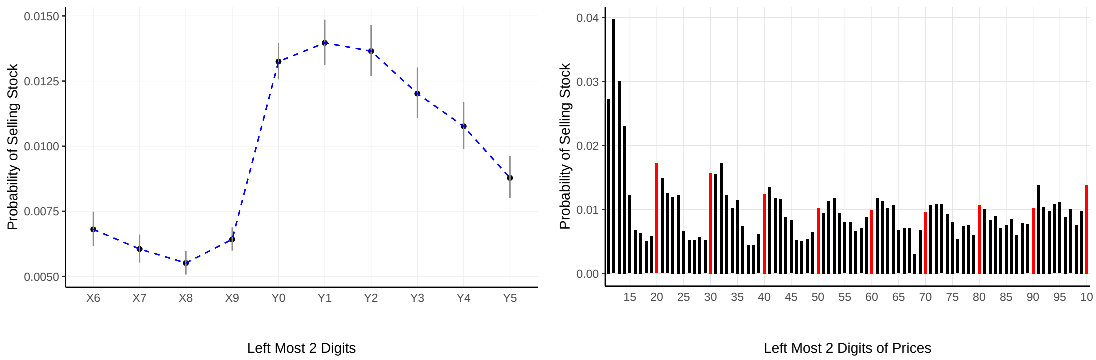
Note: £Y in the X-axes is equivalent to £$X + 1$ (e.g., £X9 could include £0.19, £1.9, £19, etc., while £Y0 could include £0.20, £2.0, £20, etc.,). [EQ: there is some overlap between the remaining sample here and in the one in Figure 2.]

Figure 4: Leftmost Stock Price Digit and Probability of Sale
Prices Increasing Sample by Price Range

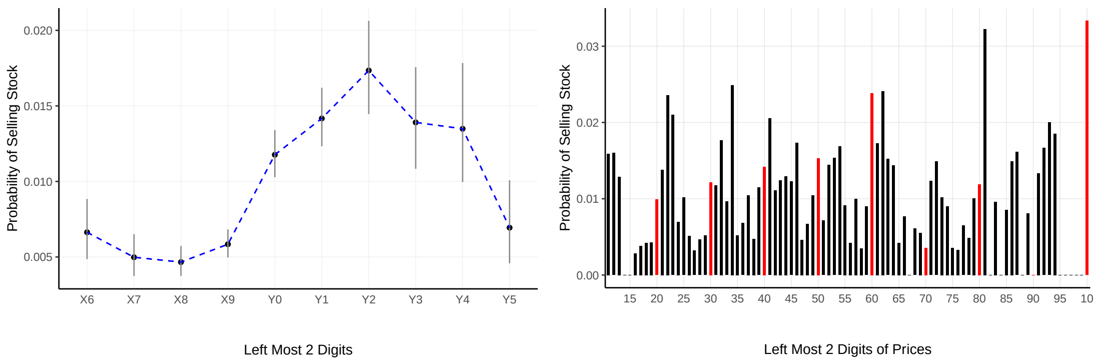
(A) Price = £0.11 to £1.01



(B) Price = £1.01 to £10.1



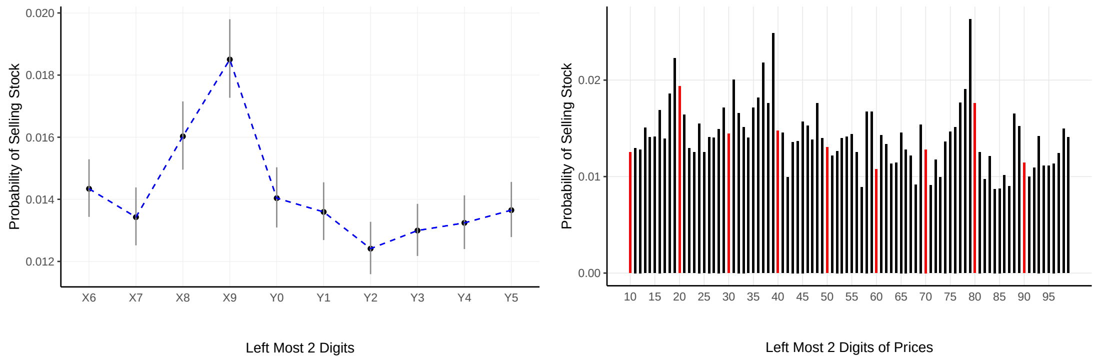
(C) Price = £11 to £101



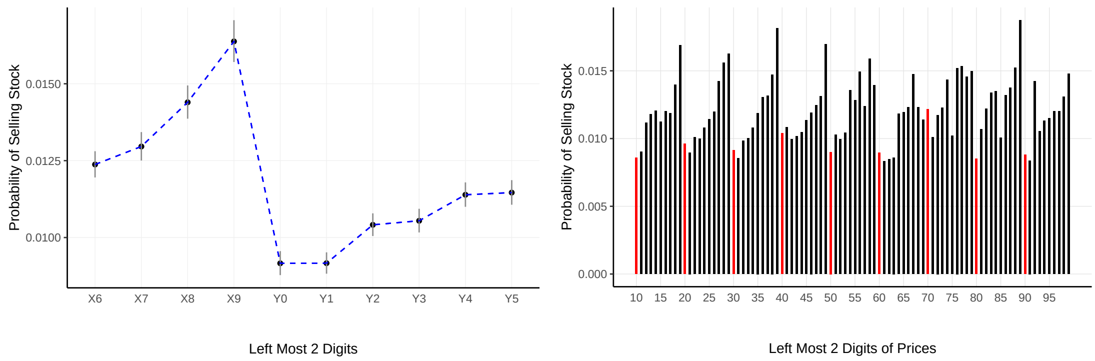
Note: £Y in the X-axes is equivalent to £$X+1$ (e.g., £X9 could include £0.19, £1.9, £19, etc., while £Y0 could include £0.20, £2.0, £20, etc.,).

Figure 5: Leftmost Stock Price Digit and Probability of Sale
Prices Decreasing Sample by Price Range

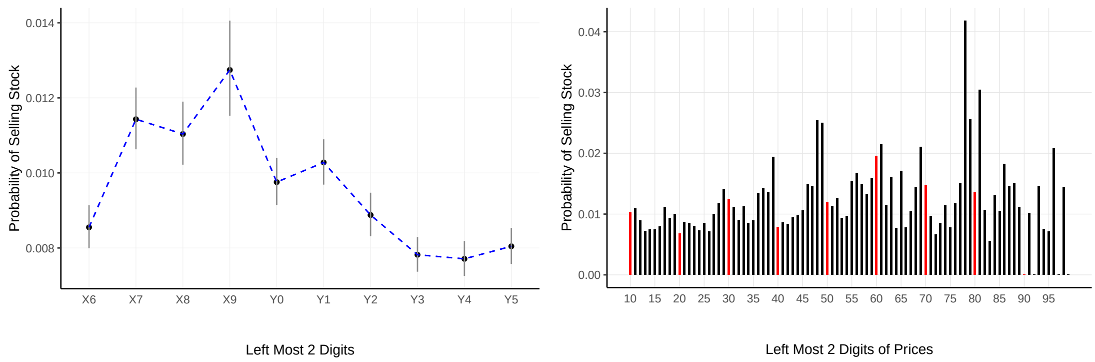
(A) Price = £0.11 to £1.01



(B) Price = £1.01 to £10.1



(C) Price = £11 to £101



Note: £Y in the X-axes is equivalent to £$X + 1$ (e.g., £X9 could include £0.19, £1.9, £19, etc., while £Y0 could include £0.20, £2.0, £20, etc.,).

Table 1: Probability of Sale and Left Digit, Price Increasing Sample

	$Probability\ of\ Sale_{ijt} = 1$				
	(1)	(2)	(3)	(4)	(5)
Above X0 = 1	0.0058***	0.0076***	0.0070***	0.0067***	0.0070***
	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Stock Digits (XO to X5)		-0.0007***	-0.0008***	-0.0008***	-0.0010***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
Stock Digits (X6 to X9)		-0.0003***	-0.0001	-0.0001	0.0001
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
Constant	0.0080***	0.0076***	0.0098***		
	(0.0003)	(0.0003)	(0.0025)		
Day FE	NO	NO	YES	YES	YES
Industry FE	NO	NO	YES	YES	YES
Account FE	NO	NO	NO	YES	YES
Stock FE	NO	NO	NO	NO	YES
Observations	1,517,823	1,517,823	1,517,823	1,517,823	1,517,823
R^2	0.0008	0.0008	0.0022	0.0511	0.0549

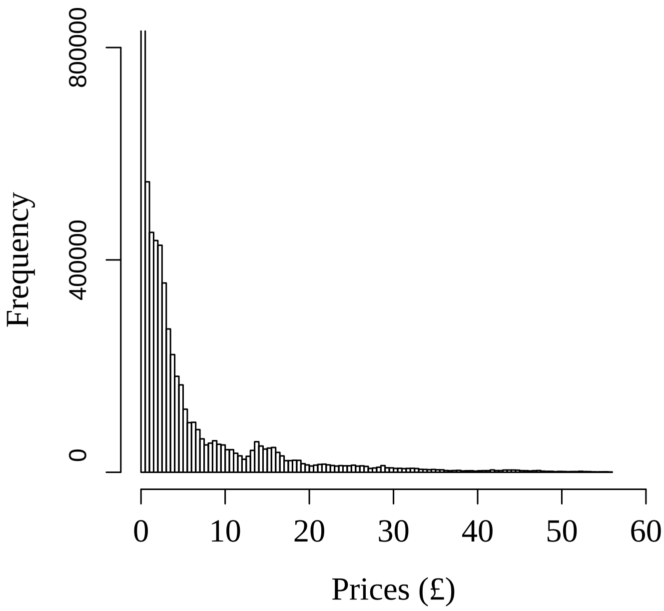
Note: The unit of observation is an investor × stock × day. The samples is restricted to login days. We include only quarters in which the stocks increased in price (regarding the first observation of the quarter) and change the left most digit at least once during the quarter. Only those stocks that have changed the left most digit are included. Regressions fit an intercept for the change in the left most digit at X0 and two slopes for the left (X6 to X9) and right (X0 to X5) values, as described by the raw patterns in **??**. The constant shows the probability to sell the stock at when the second digit is 9 (X9). The second digit over threshold dummy shows the jump in probability when the first digit changes and so the second digit becomes 0 (X0). SE are clustered by account.

Table 2: Probability of Sale and Left Digit, Price Decreasing Sample

	$Probability\ of\ Sale_{ijt} = 1$				
	(1)	(2)	(3)	(4)	(5)
Above X0 = 1 (in Range X0 to X5)	-0.0029***	-0.0057***	-0.0056***	-0.0054***	-0.0057***
	(0.0001)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Stock Digits (XO to X5)		0.0001***	0.0002***	0.0004***	0.0004***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock Digits (X6 to X9)		0.0014***	0.0013***	0.0011***	0.0011***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
Constant	0.0137***	0.0162***	0.0193***		
	(0.0003)	(0.0004)	(0.0019)		
Day FE	NO	NO	YES	YES	YES
Industry FE	NO	NO	YES	YES	YES
Account FE	NO	NO	NO	YES	YES
Stock FE	NO	NO	NO	NO	YES
Observations	4,376,352	4,376,352	4,376,352	4,376,352	4,376,352
R^2	0.0002	0.0002	0.0009	0.0492	0.0526

Note: The unit of observation is an investor × stock × day. The samples is restricted to login days. We include only quarters in which the stocks have not increased in price (regarding the first observation of the quarter) and have not changed the left most digit at least once during the quarter. Regressions fit an intercept for the change in the left most digit at X0 and two slopes for the left (X6 to X9) and right (X0 to X5) values, as described by the raw patterns in **??**. The constant shows the probability to sell the stock at when the second digit is 9 (X9). The second digit over threshold dummy shows the jump in probability when the first digit changes and so the second digit becomes 0 (X0). SE are clustered by account.

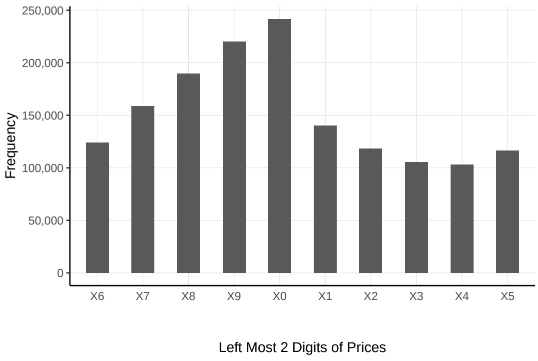
Figure A1: Histogram of Stock Prices

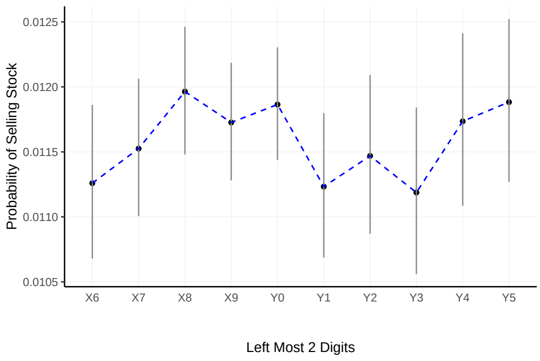


Note: Figure shows the histogram of prices on login days. Outliers in the 99 percentile are excluded.

Figure A2: Sample Selection and Simulation Exercise

(A) Price Increasing Sample

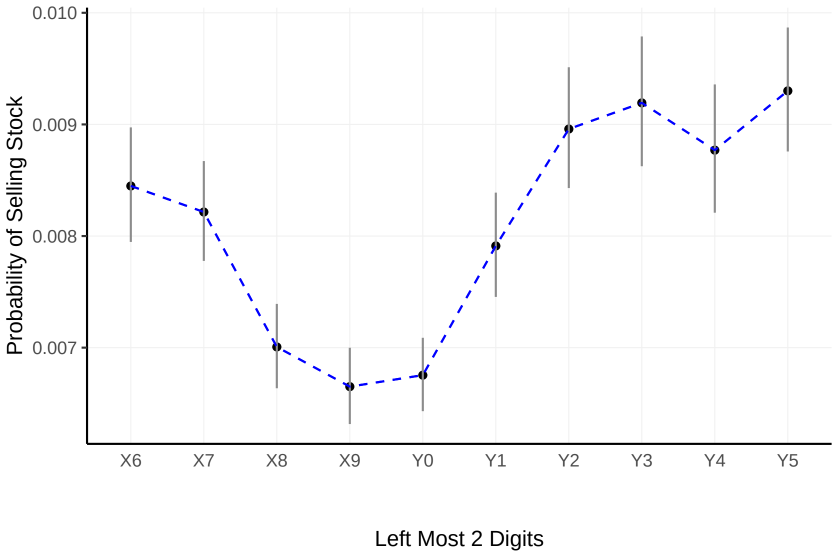




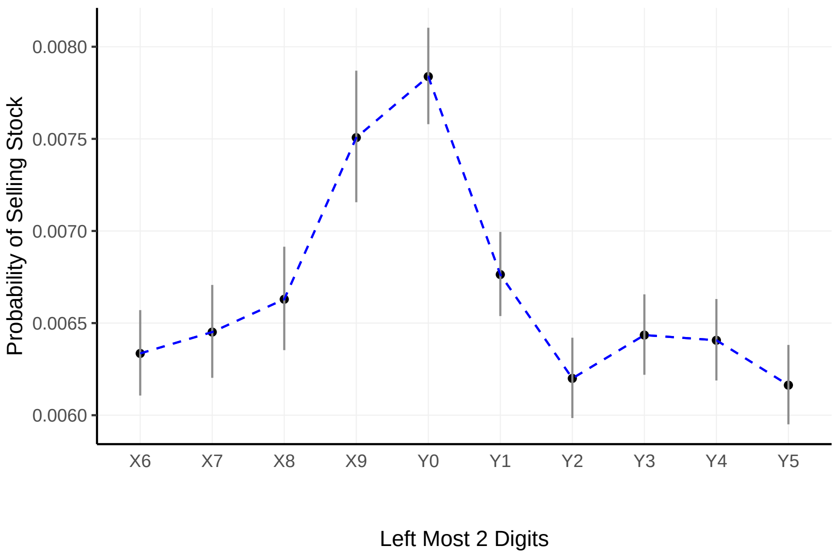
EQ: Right plot looks a bit different because I use a different seed in the simulation.

Figure A3: Probability of Topping-up

(A) Price Increasing Sample



(B) Price Decreasing Sample



Note: Figure shows the probability of topping up (increasing position in an stock) under the same sample selection. £Y in the X-axes is equivalent to £$X + 1$ (e.g., £X9 could include £0.19, £1.9, £19, etc., while £Y0 could include £0.20, £2.0, £20, etc.,).

Table A1: Summary Stats

Panel (A): Baseline Sample

	N	Mean	St. Dev.	Min	Pctl(25)	Median	Pctl(75)	Max
Price on Login Days £	5,894,175	7.090	27.717	0.000	0.938	2.625	6.990	4,495.251
Price on Sell Days £	349,983	6.247	29.101	0.000	0.645	2.211	5.615	4,443.405
Price of Stocks Sold £	68,103	6.451	40.256	0.000	0.624	2.200	5.400	4,443.405

Panel (B): Price Increasing Sample

	N	Mean	St. Dev.	Min	Pctl(25)	Median	Pctl(75)	Max
All Stocks	1,517,823	5.887	31.146	0.000	0.568	2.250	5.992	2,062.035
Stocks with Prices Between £0.11 to £1.01	387,060	0.607	0.246	0.110	0.398	0.655	0.799	1.010
Stocks with Prices Between £1.1 to £10.1	754,649	4.884	2.420	1.100	2.882	4.477	6.745	10.100
Stocks with Prices Between £11 to £101	117,405	33.897	17.368	11.000	20.010	29.580	40.500	100.997

Panel (C): Price Decreasing Sample

	N	Mean	St. Dev.	Min	Pctl(25)	Median	Pctl(75)	Max
All Stocks	4,376,352	7.507	26.412	0.000	1.183	2.650	8.270	4,495.251
Stocks with Prices Between £0.10 to £1.0	611,813	0.491	0.277	0.100	0.226	0.472	0.740	1.000
Stocks with Prices Between £1 to £10	2,461,228	3.230	1.998	1.000	1.750	2.602	4.176	10.000
Stocks with Prices Between £10 to £100	978,415	20.993	11.905	10.000	13.725	16.350	24.450	99.990