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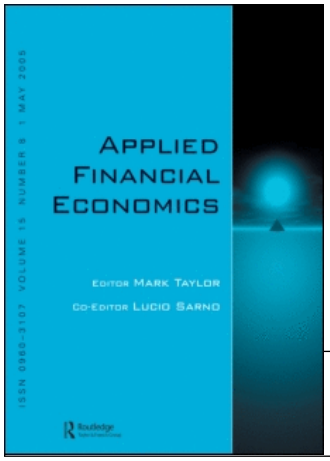

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Is Baumol's 'square root law' still relevant? evidence from micro-level data

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Is Baumol's 'square root law' still relevant? evidence from micro-level data

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The purpose of the article is to test, from micro-level data, the complete general framework of the transaction demand for money *à la* Baumol. Controlling for selection bias, we distinguish two populations who exclusively withdraw cash from either ATM or bank counter, from a sample of French representative individuals. The estimation results show the existence of large economies of scale as well as a positive effect of ATM surcharge and ATM and bank counter density on cash holding. Moreover, contrary to what might be expected, we do not find evidence of the impact of risk on cash holding.

I. Introduction

Following the inventory theoretic approach of the transaction demand for money proposed by Baumol (1952), the optimal amount of cash withdrawals depends on the cost incurred per withdrawal (fixed fee, opportunity cost to withdraw cash) plus foregone interests (which include the value of loss and protection against theft). Given these costs, Baumol shows that the average cash holding is proportional to the square root of the value of transactions and inversely proportional to the square root of interest.

Since this pioneering research, the payment environment has evolved considerably in two important ways. First, a larger variety of innovative payment instruments is available (debit and credit cards, electronic purse, etc.). Second, ATM networks substantially alter the way people obtain cash. Globally, both developments can affect the demand for cash in two opposite ways. On the one hand, innovative payment instruments can lower cash holding since: (i) they accelerate the payment process at point of sale and consequently increase the opportunity cost to withdraw cash,[1] (ii) they embody technologies, which protect holders against

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[1] Recent empirical investigations show that payment cards have considerably reduced the time at check out, compared to checks and that banks have considerably increased the network density of payment card terminals in order to encourage the replacement of cash payments (Klee, 2006). As a result, some people may find costly the distance they have to travel to withdraw cash from ATMs or bank counters, and may prefer to replace cash payments by cards. Recent empirical contributions support this argument and show that in many industrialized countries card payments have become the most important cash substitute (Kiser *et al.*, 2006).

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risks of loss and theft and so decrease the relative value of cash. On the other hand, the development of ATM networks reduces the opportunity cost to withdraw cash and consequently can increase the total amount of cash withdrawal.[2]

Given these contradictory effects of technological innovations on the transaction demand for cash, the objective of this article is to determine whether the Baumol model predictions are still valid. In doing so, we exploit a unique data set, which depicts the weekly cash holding of a representative sample of the French population, and describes their cash payment patterns and consumption behaviors. Our work contributes to the empirical literature on the demand for money by using a direct measure of the determinants of cash holding, rather than proxy variables that can lead to over(under)estimations, and by integrating new explanatory variables such as ATM surcharge and risk. Three previous contributions are close to our research but differ in certain respects. Stix (2004), for instance, estimates the average cash holding from qualitative data on withdrawal frequencies that must be converted into quantitative values. Boeschoten (1998) and Attanasio *et al.* (2002) do not assess the role of the direct cost incurred per withdrawal, which still plays a significant role in inventory theoretic models. Finally, neither of the aforementioned studies assesses the role of the subjective risk on cash withdrawal, which nevertheless seems to have a significant effect on cash holding (Avery *et al.*, 1986).

The remainder of the article is structured as follows. First, we specify the setting of our empirical analysis. We then present the econometric analysis in the second part and in the third part discuss the estimation results. Finally, in the last part we conclude this article.

II. Empirical Implications of Baumol's Model

Following Baumol (1952), in the course of a given period an individual has a pre-determined value of transactions, T. To meet his transactions, the individual has to choose equally spaced withdrawals of cash of an amount C. Each time the individual withdraws cash, he pays a transfer cost (fixed fee) of b (which amounts for each withdrawal to b^*T/C) and supports a cost due to the loss of interest r equivalent over a given period on average to $r^*C/2$ (where $C/2$ is the average cash holding). Consequently, the total cost paid by an individual to use cash over a period is given by $b^*T/C + r^*C/2$. This total cost is minimized when $C = \sqrt{2bT/r}$; the average cash holding is then equal to $M = C/2 = \sqrt{bT/2r}$. From an empirical standpoint, we can interpret the previous framework as $M = f(T, r, b)$ with:

- $f'_T > 0$, $f''_T < 0$. The average cash holding increases with the total value of transactions paid for in cash but at a decreasing rate.
- $f'_r > 0$. The average cash holding decreases with the interest rates. r includes the cost of loss and the value of protection against theft that depends on the subjective risk, R_i, related to the holding and the use of cash.
- $f'_b > 0$; b has two components. The first is the direct charge (fixed fee) related to cash withdrawal (Cw) and the second is related to the cost of the trip to withdraw cash that we can approximate to an opportunity cost to withdraw cash (Co).

  - Cw can be directly assessed by a fee, if any, charged to the consumer. In some countries such as France, a withdrawal at a bank counter or on an ATM of the customer's own bank is free. However, a customer who uses other banks' ATM machines can be charged. Generally, the bank charges a fixed fee on each withdrawal from other banks' ATM machines, above an authorized ceiling (for instance, from the fifth withdrawal per month in France).
  - Co is not directly observable but basically depends on the density of ATM and bank counters and on individual characteristics such as age, income and profession. Thus, Co can be expressed as $Co = g$ (*age, income, density, profession*):

    - g'_{age}?; the expected effect of age on Co is unknown since, on the one hand, the cost of a trip to withdraw cash increases with age but, on the other hand, older people generally work less and hence have much

[2] Increasing the network density of ATM machines has decreased the cost to travel to withdraw cash, compared to bank counters. Now, according to the formal model of Whitesell (1989), a decrease of the costs of withdrawals may positively affect the number of withdrawals and, in turn, the use of cash in transactions.

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more time for shopping and therefore for withdrawing cash.

- $g'_{income} > 0$; Co increases with income since the loss of time is much more valuable for higher incomes.
- $g'_{density} < 0$; Co decreases with the density of ATM and bank counters around individuals since people have a greater access to cash.
- $g'_{profession} < 0$; the impact of some professions such as craftsmen and traders is negative on Co since they directly receive their income in cash and do not need to withdraw any.

– Globally, the transfer cost, b, can be rewritten as follows: $b = Cw + Co$ and $Co = g(Age, Income, Density, Prof)$.

The empirical implications of Baumol's model suggest that cash withdrawals can be made from either ATM or bank counter and that both places are associated with different costs. In particular, the transfer costs incurred by individuals may be different since a cash withdrawal from ATM may imply a surcharge and since the opportunity cost depends to a greater extent on the density of ATMs and bank counters. As a result, the amount of cash withdrawals may be affected by the choice of the place to withdraw and it becomes more appropriate to estimate the amount of cash withdrawal according to the place of withdrawal. More formally, we need to estimate:

$$M_i^{bank} = f^{bank}(T_i, r, R_i, Cw_i^{bank}, g(Age_i, Income_i, Density_i^{bank}, Prof_i)).$$

$$M_i^{atm} = f^{atm}(T_i, r, R_i, Cw_i^{atm}, g(Age_i, Income_i, Density_i^{atm}, Prof_i)).$$

III. Econometric Analysis

Data description

We undertook a survey using a two-stage method from March to May 2005 on a representative sample of the French population aged 18 years and older.[3]

First, we administrated a survey to collect information on individuals. Four specific parts of the questionnaire are valuable for our concern. The first is related to socio-economic characteristics such as gender, age, income and profession. The second part is dedicated to individual cash acquisition; survey participants were asked about their usual weekly cash withdrawals, the frequency of those withdrawals and the usual places of withdrawal (from ATMs and bank counters).[4] The third concerned the evaluation of the risk related to the holding and use of cash. We put the following question to respondents: If you should evaluate the risks (fraud, loss, theft, etc.) related to the holding and use of cash, where do you place it on a scale ranging from 1 to 5 (with 1 the least risky and 5 the most risky)?. Finally, we asked each respondent to note their main recurrent payments and bills paid cash.[5]

Second, we asked each respondent to keep a diary for 1 week in which they reported all information related to daily purchases. A purchase is characterized by six pieces of information such as amount (size of the purchase) and the payment instrument used to settle the transaction (cash, payment card, etc.). Therefore, we know for each individual the total number and value of transactions paid cash.

Before briefly presenting basic descriptive statistics, it is worth noting that information collected on weekly cash acquisition in the first stage is based on individuals' subjective evaluations of their withdrawals, whereas purchases collected in the second stage derive from real observations reported by individuals during a random week; in other words, M_i and T_i do not refer to the same week.

[3] We used the quota method of sampling; individuals from nine regions (defined by the National Institute of Statistics (INSEE)) and living in five categories of urban agglomeration were recruited (fewer than 2000 inhabitants, from 2000 to 20 000 inhabitants, 20 000 to 100 000 inhabitants, more than 100 000 inhabitants, Paris area). The result of the cross-comparison of the area and the agglomeration is represented in the sample in proportion to its demographic weight. The representativeness of the sample was controlled from the following quota variables: 'gender' crossed with 'work status' (employed or not) (in order to avoid an over-representation of 'women' within 'unemployed'); 'age' in five classes; 'socio-professional category' in eight classes by distinguishing 'retired' from 'others'; the 'type of residence' ('individual house' or 'apartment in collective building'). Respondents were directly recruited at their place of abode; they had never participated in a survey before. They agreed not only to answer the questionnaire but also to keep a diary.

[4] The questions are: (1) 'Usually, where do you withdraw cash?' [Bank counters]; [ATMs], [Do not withdraw cash]; (2) 'On average, how many times per week do you withdraw cash from ATMs?' and 'On average, how many times per week do you withdraw cash from bank counters?' [0; 1; 2; ... 7 and +]; (3) 'On average, how much cash do you withdraw from ATM?' and 'On average, how much cash do you withdraw from bank counter?' [in euros].

[5] We questioned people on eight different recurrent bills and payments such as loans (automobile, house, etc.) and public utilities (water, electricity, etc.). People reported for each recurrent bill and payment the periodicity, the average amount paid and the payment instrument used (direct debit, cash, check, etc.).

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Table 1. Statistic description of withdrawals[6]

Place of withdrawal	Number of individuals	Average Amount	SD
Bank counter	123	168	164
ATM	929	83	90

Table 2. Cash holding and payments according to the level of risk

	Individuals (%)		Average of the total cash holding (euros)		Average of the total spending in cash (euros)	
	ATM	Bank counter	ATM	Bank counter	ATM	Bank counter
Risk = 1	40.6	36.2	84.6	141.3	83.3	173.3
Risk = 2	22.8	21.2	84.8	129.4	63.7	199.5
Risk = 3	22.8	19.9	80.9	75.3	73.4	147.1
Risk = 4	4.9	9.2	85.5	41.4	82.5	96.7
Risk = 5	8.9	13.5	79.7	117.4	72.6	151.8
Total of individuals	929	127	929	127	929	127

Briefly, we observe in our sample two different populations, which strictly use either the bank counter (12%) or the ATM (88%) to withdraw cash (Table 1). Out of the 12% of the people who withdraw cash from bank counters, 93% make on average one withdrawal per week. Similarly, among the 88% of the people who withdraw cash from ATMs, 70% make on average one withdrawal per week and 18% make two withdrawals. Interestingly, we note that the weekly average cash holding of people who exclusively use ATMs (83 euros) – number of withdrawals times the average cash withdrawal per week – compared to people who exclusively use bank counters is about twice as high (168 euros).

We also questioned respondents about the risk related to the holding and use of cash. Globally, Table 2 shows that few people consider cash to be a riskier payment instrument. As a result, the level of risk does not seem, at first glance, to significantly influence the total cash holding and the total spending in cash of individuals.

Explanatory variables and econometric relations

The purpose of the article is to estimate the total cash holding, M, of an individual i. In so doing, we use several explanatory variables to explain cash holding.

Before describing the different explanatory variables, we have to point out that, at the time of the survey, interest rates on deposits were legally prohibited in France. We, therefore, assume in the estimation that the role of interest rates on deposits is insignificant.

First, we measure the individual total spending in cash, T_i, as the total value of transactions and bills paid cash during a week. Second, the risk, R_i, associated to the holding and use of cash, is assessed using the subjective answers of respondents described above. In the estimation, we use the natural logarithm of R_i. Third, to capture the effect of the surcharge on ATM withdrawals, we use a dummy variable. We recall that in France the surcharge is applied from a threshold of (five) withdrawals carried out outside the customer's bank ATM network; by contrast, withdrawals from bank counters are free. Fourth, we use two distinct measures of the density related to bank counters and ATMs. On the one hand, we use the number of ATMs over the population in the *département*; on the other, we use a subjective evaluation of the distance in time between the nearest bank counter of the individual's bank network and his living or working place.[7]

[6] We performed a test on the equality of means with unequal variance. The null hypothesis is that the difference is zero. The computed value of t is -5.59. We can reject the null hypothesis at the level of 99.99%.

[7] More precisely, we asked the following question: 'At which distance is the nearest bank counter of your bank network from your residence or your working place? [< 5 min], [From 5 to 15 min], [From 15 to 30 min], [More than 30 min], My bank does not have a bank counter [electronic bank]'. In the estimation, we have considered that the distance was equal to zero for people answering electronic bank to the question. Since the natural logarithm of the distance is used in the estimation, the value 0 has been converted in 0.01.

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The variable takes five values from 0 to 4: 'no distance (electronic bank)', 'from 0 to 5 min', 'from 5 to 15 min', 'from 15 to 30 min' and 'more than 30 min'. We use the natural logarithm of the distance. Fifth, we introduce the natural logarithm of age (Log(Age)) since we expect a decreasing of the marginal effect. Sixth, we distinguish seven categories of *Income*. Seventh, a dummy variable *Profession* captures the individual's occupation: it is equal to one if the individual is a merchant or a craftsman and zero otherwise. Finally, we use some variables to control for other effects such as gender and living area.

Econometric specification

In this section, we present an econometric specification that deals explicitly with the problem of selection bias indicated above. The distribution of respondents across the two places of withdrawal of interest here might take place in a selective way. As a result, we may face a biased estimate of the place of withdrawal effect.

To account for selection bias, we decided to run estimations using a Heckman model.[8] on specific populations who exclusively withdraw cash either from ATM or bank counter. In the first step, a *probit* model is estimated on overall population in order to explain the probability to withdraw cash either from ATM or bank counter (*selection equations*). In the second step, we estimated the amount of cash holding for each individual of both sub-samples. We used the selection bias control factor *rho* as an additional independent variable (*level equations*).

In doing so, we differ from Attanasio *et al*. (2002) who apply the first procedure of the Heckman model to the holding of a bank account. Actually, contrary to the Italian situation, we note that all the individuals in our sample hold a bank account.[9] As a result, the question of the access to a bank account appears to be less relevant for our concern. However, the issue related to the choice of withdrawal and the amount of cash withdrawals seems more significant to our estimation since, we observe for instance that 57 individuals over 123 who exclusively withdraw cash from bank counters hold a card to withdraw cash from ATM.

IV. Estimation Results

As a preliminary remark, it is worth noting that the distinction between both places of cash withdrawal seems to be validated since the costs of withdrawal from bank counter or ATM are different for both populations (Table 3). Moreover, the choice to use a Heckman model in order to account for selection bias also seems appropriate since the correlation between errors terms of the estimations for people who only withdraw cash from ATM is positive and significant (rho = 1.43). On the other hand, it seems that any selection bias occurs for people who withdraw cash from bank counters. As a result, we will hereafter comment on the result estimations from the OLS model for people who withdraw cash from bank counter and from the Heckman model for people who withdraw cash from ATM.

Globally, we observe that all the coefficients have the expected signs even if some are not significant.

First, the natural logarithm of the value of transactions paid cash (T_i) has a positive and significant effect on cash holding. Interestingly, we note that this effect is higher for individuals who withdraw cash from bank counter rather than from ATM even if, technically speaking, we cannot compare the two coefficients. More precisely, we note that a change of 1% of the total value of cash spending induces respectively an increase of about 0.08% and 0.12% of cash holding with people who withdraw cash from ATM and bank counter. Surprisingly, these findings indicate the presence of large economies of scale and contrast significantly with the theoretical transaction elasticity predicted range[10] and with recent empirical works (Attanasio *et al*., 2002; Stix, 2004).[11] Two explanations may be advanced. First, the respondents may overestimate their cash withdrawals. Second, empirical works based on micro-level data such as Attanasio *et al*. (2002) and Stix (2004) may overestimate transaction elasticities by using debatable proxy variables to assess the total consumption paid cash. For instance, Attanasio *et al*. (2004) use the sum of the expenditures on food consumption, entertainment, education, clothes, medical expenses, etc., to the exclusion of expenditures on durable goods. However, since expenditures as a whole are probably paid using

[8] See Heckman (1979).
[9] Out of 1134 individuals, only three did not have a bank account. This observation is in line with previous national statistics (see the website of the French Bank Association for more details: http://www.fbf.fr).
[10] For a recent survey of the literature, see Knell and Stix (2006).
[11] Attanasio *et al*. (2002) find that the transaction elasticity of people with a bank account and an ATM card is equal to 0.35 and people with a bank account but without an ATM card is 0.44. Stix (2004) estimates the transaction elasticity at about 0.6.

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Table 3. Estimation results

	coeff (SE)											
	OLS estimations: cash holding				Estimations with selection bias							
					Selection equations: probability				Level equations: cash holding			
	ATM users		Bank counter users		P(ATM use)		P(Bank use)		ATM users		Bank counter users	
Log (Ti)	0.09***	(0.01)	0.12***	(0.03)	–		–		0.08***	(0.01)	0.12***	(0.03)
Log (age)	0.43***	(0.07)	0.11	(0.21)	−0.02***	(0.002)	0.02***	(0.003)	0.01	(0.08)	−0.06	(0.62)
Sex	0.12**	(0.05)	−0.05	(0.16)	−0.04	(0.07)	0.03	(0.11)	0.09	(0.06)	−0.05	(0.15)
Profession	0.29	(0.2)	1.44**	(0.64)	−0.57***	(0.24)	0.03	(0.39)	0.004	(0.22)	1.45**	(0.60)
Log (Ri)	0.01	(0.04)	−0.02	(0.14)	0.08	(0.06)	−0.0153		0.05	(0.05)	0.005	(0.16)
ATM density	0.26	(0.22)	–		0.77**	(0.37)	−0.83	(0.52)	0.56**	(0.26)	–	
Log (distance bank counter)	–		0.14	(0.19)	0.17**	(0.07)	−0.0264		–		0.17	(0.20)
ATM Surcharge	0.08	(0.05)	–		–		–		0.07*	(0.05)	–	
Living area (category 'rural area' excluded):												
From 2 to 20 000 inhabitants.	−0.03	(0.08)	0.18	(0.24)	0.03	(0.11)	0.36**	(0.15)	−0.05	(0.09)	0.13	(0.29)
From 20 to 100 000 inhabitants.	0.06	(0.08)	0.63**	(0.28)	0.17	(0.11)	−0.03	(0.17)	0.09	(0.09)	0.63**	(0.26)
Up to 100 000 inhabitants.	0.01	(0.07)	0.41*	(0.23)	0.26***	(0.10)	0.08	(0.15)	0.10	(0.08)	0.39*	(0.23)
Paris and urban area	0.11	(0.08)	0.49	(0.3)	0.26**	(0.13)	0.21	(0.19)	0.15	(0.10)	0.45	(0.30)
Level of income (category 'less than 500 €' excluded):												
From 500 to 1000 €	0.07	(0.09)	0.24	(0.23)	0.23**	(0.12)	−0.0416		0.13	(0.10)	0.27	(0.24)
From 1000 to 1500 €	0.08	(0.08)	0.35	(0.24)	0.47***	(0.12)	−0.43***	(0.16)	0.27***	(0.10)	0.41	(0.30)
From 1500 to 2000 €	0.09	(0.09)	0.13	(0.31)	0.71***	(0.14)	−0.63***	(0.20)	0.39***	(0.11)	0.23	(0.44)
From 2000 to 2500 €	0.15	(0.12)	0.38	(0.47)	0.57***	(0.17)	−0.77***	(0.29)	0.40***	(0.14)	0.5	(0.61)
From 2500 to 3000 €	0.13	(0.15)	−0.88	(0.91)	0.62***	(0.23)	−1.26***	(0.48)	0.44**	(0.17)	−0.71	(1.03)
More than 3000 €	0.08	(0.18)	0.25	(0.55)	0.46*	(0.27)	−0.43	(0.36)	0.34*	(0.20)	0.3	(0.54)
Do not know or refusal	0.10	(0.10)	0.34	(0.29)	0.34**	(0.14)	−0.43**	(0.19)	0.25**	(0.12)	0.39	(0.33)
Intercept	1.86***	(0.31)	3.26***	(0.90)	0.36	(0.30)	−1.45***	(0.44)	2.58***	(0.35)	4.17	(3.27)
Athrho	–	–	–	–					1.43***	(0.14)	−0.23	(0.8)
LogLikelihood	–	–			−1770		−512					
Chi square (test of indep. Equations, rho = 0)									29.35***			0.08
Nb. uncensored obs.	927		123		927		123		927		123	

Notes: The natural logarithm of age in used in the level equation but not in the selection equation;
***, ** and * means the coefficient is statistically significant at the 1, 5 and 10% levels, respectively.

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multiple payment instruments such as cash, checks or credit cards, the consumption paid cash may be overestimated and lead to a biased transaction elasticity. Similarly, Stix (2004) uses the average withdrawal amount as a proxy variable of the volume of cash transactions. But, as in Attanasio (2002), this measure may also lead to overestimated cash transactions since a relatively small share of cash withdrawals is used for transaction purposes.[12]

Second, contrary to what might be expected, the subjective measure of risk related to cash has no impact on cash holding even though, we observe that it decreases the probability to withdraw cash from bank counter. This absence of effect may be due to our measurement of cash holding, for risk may affect not necessarily the total cash holding of individuals, but rather the average amount by withdrawal or the frequency of withdrawal. But these effects may be opposed and cancelled: for instance, the risk may induce a decrease of the frequency of withdrawal from the ATM or bank counter and an increase of the average amount by withdrawal. Globally, the total amount of cash holding may not be impacted by the risk.

Third, the surcharge variable which captures the cost of a withdrawal from ATM, incurred by consumers, has a positive effect on cash holding. More precisely, we observe that people, who are charged by a fixed fee over a threshold of withdrawals when they use 'foreign ATM machines', are likely to withdraw higher amounts of cash. This result is interesting since it extends a recent empirical contribution of Gowrisankaran and Krainer (2005) on the Iowa–Minnesota population, which shows that individuals are sensitive to the distance they must travel to use an ATM. The authors find more precisely that if the probability of a consumer using ATM is 50%, then raising the surcharge by just 10 cents would result in the same consumer using the ATM with 46% probability. Hence, our results show that beyond the decreasing of the probability to use ATM machines, the sensitivity of consumers to ATM surcharges causes them to withdraw higher amounts of cash.

Fourth, concerning the impact of the density variable, we observe that when an individual lives in an environment with more ATMs, both the probability to use an ATM and the level of cash withdrawn from ATM are higher. Similarly, we note that the greater the distance from bank counter, the higher will be the probability to withdraw cash from ATM. On the other hand, the density of ATM has no statistically significant effect on the probability to withdraw cash from bank counter even though the coefficient has the expected sign. Finally, we observe that the distance from bank counter does not influence the amount of cash holding from this source.

Fifth, we confirm the intuition according to which people who receive their income in cash have a lower probability to withdraw cash from ATM. Actually, we observe a further effect: these individuals withdraw higher amounts of cash from bank counters probably because they need to make deposits on accounts more often. For these people, there are consequently some economies of scale to withdraw cash from their private account, while they make deposits on their professional account.

Finally, we confirm the existence of an opportunity cost for people with higher incomes. For these people, the probability to withdraw cash respectively from ATM and bank counter increases and decreases. Moreover, we observe that the negative effect of the level of income on the probability to withdraw cash from bank counter is strictly increasing (except for the highest incomes). This observation is also relevant for the cash holding of higher income people who withdraw cash from ATM: except for people who earn more than 3000 euros per month, we note a constant positive effect.

V. Conclusion

In a context of significant innovations in the payment environment (ATM, alternative payment instruments, etc.), the purpose of the article was to test the relevancy of the inventory theoretic models *à la* Baumol, using micro-level data. As Attanasio *et al.* (2002) point out, there is very little evidence from empirical works (partly because data sets containing information on cash holdings are few and far between).

Following Attanasio *et al.* (2002) and Stix (2004), our article provided a new estimation to explain the individual total cash holding from a sample of French representative individuals. Controlling for selection bias, the estimation results

[12] Boeschoten (1992) and Paunonen and Jyrkönen (2002) show that only a relatively small share of cash in circulation is actually used for transactions (11–12%), the major part being hoarded and/or held abroad.

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confirm large economies in scale in cash holding for individuals who exclusively withdraw cash from ATM or bank counter. Finally, our article provides new interesting findings on the impact of ATM surcharges and of subjective risk on cash holding. More precisely, we showed that the presence of a surcharge increases the total individual cash holding whereas the subjective measure of risk related to cash seems to have little impact on cash holding, even though, we observe a decrease of the probability to withdraw cash from bank counter.

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