

Henryk Gurgul*, Marcin Suder*

Impact of ATM location on its profitability in Malopolskie and Podkarpackie provinces**

1. Introduction

Automated Teller Machines (ATMs) were introduced in Poland in 1990. The first ATM was installed in 1991 in Warsaw at Polish Bank PKO. The most intensive expansion of ATMs since 1999 achieved a rate of growth of about 12% per year. In 2007, the number of ATMs reached more than 10,000; by the end of 2013, the number of ATMs had reached 18,903; in September 2016, there were 22,504 ATMs in Poland; and in March 2017, this number exceeded 23,000. The number of ATMs was growing constantly except for the second quarter of 2010 and first quarter of 2013, when declines were observed. Since 2010, one can observe a slowdown of the increase of ATMs. The rate of growth in this time span was about 1% as compared to the time period from the beginning of 2007 until the beginning of 2010, when the rate of growth was close to 4%. The described changes in the number of ATMs are illustrated in Figure 1.

The dynamic growth of ATMs was a result of bank policy. They tried to find alternative and cheaper ways to distribute cash (withdrawals from ATMs are cheaper than from bank branches). Moreover, the banks were confronted with a growing demand for cash. Some banks were not interested in investing in ATM networks; therefore, they started to cooperate with independent deployers.

The rise in ATM withdrawals and profits from interchange fees (3.50 PLN per withdrawal) seemed to guarantee that this business would be promising and profitable.

* AGH University of Science and Technology, Faculty of Management, Department of Applications of Mathematics in Economics, e-mail: hgurgul@zarz.agh.edu.pl, msuder@agh.edu.pl

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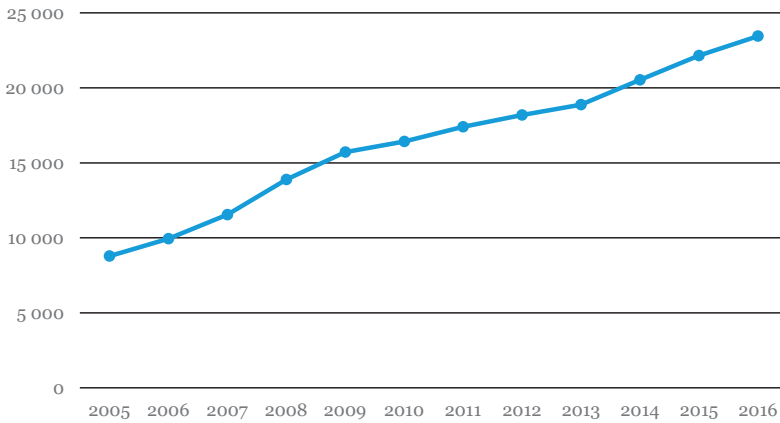


Figure 1. Trend of number of ATMs in Poland from 2005 through 2016

Source: own elaboration on basis of data from National Bank of Poland

Figure 2 demonstrates the scheme of the interaction of different subjects with respect to the charges, service, and functioning of ATM networks. In the scheme, basic charges that are typical for the part of the banking system related to ATMs are presented. **Interchange** charges for withdrawal from foreign ATMs as well as **surcharges** are paid on the basis of transactions. For each withdrawal from an ATM, the owner receives an issued debit card interchange from the bank. However, the bank that issued the charge card can charge a commission in the case of withdrawals from foreign ATMs. It is not common to charge a commission on transactions from one's own ATMs. In some countries (e.g., the U.S.), surcharges demanded by owners of ATMs (banks or independent deployers) from customers withdrawing cash are common.

As just mentioned, the main profits of independent ATM deployers are due to interchange commissions. This depends on the number of withdrawals from the ATMs. However, at the end of the first decade of the 21st century, the positive trend in the development of ATM networks stopped.

First of all, in the beginning of 2010, MasterCard and Visa reduced their interchange commissions by 60%; i.e., the reduced interchange amounted to 1.3 PLN. The profits of the owners of ATM networks essentially declined. During this time, cashless payments started to become popular. More and more shops were offering cashless payments. In 2009, cashless transactions exceeded 50% of the total number of transactions for the first time. These were mostly small transactions. Small transactions (withdrawals) from ATMs are relatively the most profitable.

The reduction of profits due to the interchange and development of terminal payments forced owners of ATMs (mostly independent deployers) to undertake

measures to increase the competitiveness of their ATMs. First of all, they removed ATMs from locations where the number of withdrawals was low and installed them in more profitable places. The negative consequence was lower ATM availability for customers.

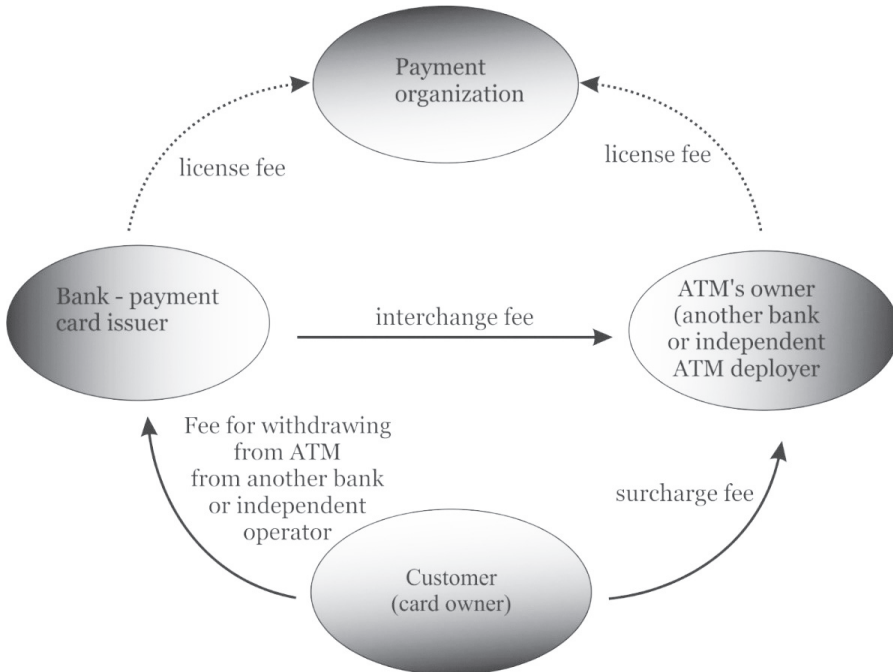


Figure 2. Model of charges in ATM system
Source: Górka (2011)

Another way to increase the profitability of ATMs was the attempt to encourage customers to take out small withdrawals due to promotions or restrictions of a maximal withdrawn sum of money. Some independent deployers issue advertisements during withdrawals from ATMs. This is an additional way to gain extra profits with their ATMs.

As one can see from Figure 1, the development of ATM networks slowed down at the beginning of the second decade of the 21st century. This is also reflected in the number of withdrawals during this period. As is visible in Figure 3 (which illustrates the number of withdrawals during the period of 2005–2016), the number of withdrawals did not increase in 2010 as compared to 2009. This situation occurred for the first time since the installation of the very first ATM in Poland.

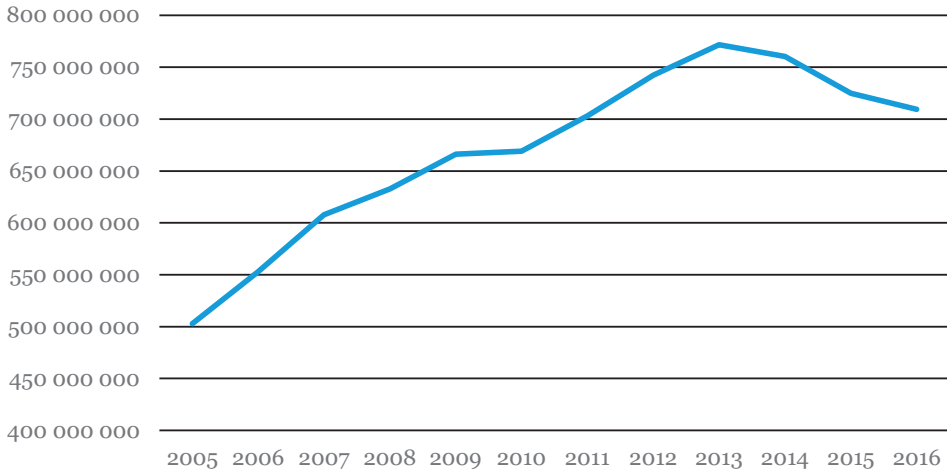


Figure 3. Number of withdrawals from all ATMs during 2005–2016

Source: wwn elaboration on basis of data from National Bank of Poland

However, this negative tendency did not continue with respect to the number of installed ATMs in Poland. The number of ATMs is not the only factor reflected in the development of ATM networks. International comparisons of the development of ATM networks are possible by taking into account the population of an analyzed country. In 2013, there were 5.4 transactions per capita in Poland. An important observation is that we not only saw a growth in ATM numbers through 2013 but also in the number of transactions; e.g., in 2013, the number of transactions per inhabitant of Poland showed a tendency to rise. The number of transactions through 2013 not only tended to rise but also exhibited seasonality. The lowest numbers of transactions were usually in the first quarters of each year.

However, the number of transactions was lower in 2014 than one year earlier (comp. Figure 3). This situation occurred for the first time since the ascendance of ATMs in Poland. This took place in spite of the growing number of ATMs (comp. Fig. 1). The reason for this was the growing number of cashless terminals and cashless payments. The growing availability of cashless terminals in shop service points followed from the considerable reduction of interchange commissions for shops owner and service points in 2014–2015.

The decline in the number of withdrawals from ATMs and growth of the number of ATMs resulted in a decrease in the average number of withdrawals per ATM. During the year 2016, this number amounted to 2500 withdrawals from each ATM monthly.

As follows from a report from June 2014 by the National Bank of Poland, each ATM requires 3000–3500 withdrawals monthly to be considered profitable. One can see that the average ATM is not profitable in Poland.

The problem of the loss of profitability of ATMs in recent years is seldom considered in research publications. The only thorough analyses of this problem are due to Górka (2011), who demonstrates that an analysis of Polish market data shows that reductions in the interchange fees collected from ATM cash withdrawal transactions have directly led to a sharp decline in the profitability of the ATM business for banks and independent ATM deployers. The independent deployers have recently been the main driving force behind the development of the ATM network in Poland. In the case of Poland, the possibility of charging special ATM transaction convenience fees does not necessarily mean that such fees will be charged to consumers. However, they would help stimulate the market. In 2011, interchange fees were low. Górka stressed that this discouraged both banks and independent ATM deployers from investing in the development of the ATM network despite consumer needs.

In Górka and Chodnicka (2012), a method is described to forecast the number of ATMs in Poland in the near future. They forecasted the further dynamic growth of the number of ATM networks in Poland in the future. In addition, Górka (2013) published an extensive contribution concerning an efficiency analysis of payment instruments in Poland. In this contribution, the management of cash and non-cash transactions in Poland and approximation of the costs of particular payment instruments are also considered.

One of the first contributions with respect to the management of ATM networks in Poland is the PhD thesis by Zajączkowski (2013). The author attempted to build a complex model of the functioning of ATM networks, both at bank branches and those owned by independent deployers.

Bjørndal et al. (2004) discussed the cost allocation of ATMs from a mathematical point of view. They considered a situation in which a group of banks would connect their ATMs in a network. The banks' customers may use the ATMs of any bank in the network. The problem studied is that of allocating the total transaction costs arising in the network among the participating banks. The situation is modeled as a cooperative game with transferable utility. The authors proposed two allocations and discussed their relationship to the core and other well-known solution concepts as well as to population monotonicity.

We did not find any contributions concerning the number of withdrawals from particular ATMs from the selected ATM network. To the best of our knowledge, the contribution by Gurgul and Suder (2016) is the only work based on original data of this type. It is concerned with the seasonal and calendar effects for time series of the number of withdrawals in selected ATMs in the Malopolskie and Podkarpackie provinces (comp. Gurgul and Suder, 2016).

The general tendency on the bank market changes (both cash and cashless) is not comfortable for independent ATM deployers. The main reason is the declining number of withdrawals from ATMs and increasing number of cashless transactions. One way to manage this problem is replacing ATMs at non-profitable localizations (where the number of withdrawals is below the level of profitability) to places where the number of withdrawals is greater than 3500 monthly.

In our paper, we try to indicate the types of localizations that may occur to be profitable for owners as well as those that bring losses. An analysis of the deployers who know the number of withdrawals is not difficult; however, scientists' knowledge of these problems with respect to the functioning ATM market is important. A lack of publicly available data about withdrawals does not allow us to conduct a respective analysis. To the best knowledge of the authors, they are not available contributions to this subject.

2. Structure of location of selected ATMs

In our paper, we analyze the number of withdrawals from ATMs managed by one of the largest networks of ATMs in Poland. This data is from ATMs installed in the Malopolskie and Podkarpackie provinces. We analyze the daily number of withdrawals from selected ATMs during the time period of January 2011 to December 2012. The total number of ATMs whose volume of withdrawals was analyzed amounts to 254.

Although the presented data is from the period of 2011–2012, we can draw the conclusion (based on Figure 3) that the overall number of withdrawals from ATMs in Poland during this period does not differ significantly from the number of withdrawals from ATMs in 2016. Assuming that the distribution of withdrawals for the particular locations remained approximately the same as in 2011–2012, we can consider the used data to be representative of the present data.

The goal of this paper is to find the impact of ATM location on the profitability of its functioning. In order to establish whether a certain type of localization has an effect on its profitability, we introduce some categories of locations.

Since our data comes from two provinces, one location criterion is the province in which a given ATM is located. A further type of location introduced by the network of ATMs refers to the type of surrounding where the ATM is placed. The network defined some types of locations. In Table 1 are the defined locations and numbers of ATMs in both provinces in these locations. The only criterion for a given location to be considered in the table are that there are at least two ATMs at this place.

Table 1
Number of ATMs in given types of locations in both provinces

Location type	Malopolskie		Podkarpackie		Total	
	Number	Percent-age	Number	Percent-age	Number	Percent-age
Bakery/Patisserie	6	3.03	0	0	6	2.36
Bank branch	49	24.75	26	46.43	75	29.53
Factory	2	1.01	0	0	2	0.79
Hypermarket	25	12.63	8	14.29	33	12.99
Hotel	3	1.52	0	0	3	1.18
Office building	3	1.52	0	0	3	1.18
On Street	4	2.02	1	1.79	5	1.97
Other	2	1.01	1	1.79	3	1.18
Petrol station	24	12.12	2	3.57	26	10.24
Pharmacy	2	1.01	1	1.79	3	1.18
Residential	2	1.01	0	0	2	0.79
Restaurant	2	1.01	0	0	2	0.79
Service point	3	1.52	0	0	3	1.18
Shop	33	16.67	6	10.71	39	15.35
Shopping center	33	16.67	11	19.64	44	17.32
Transport	3	1.52	0	0	3	1.18
University	2	1.01	0	0	2	0.79
Total	198	77.95	56	22.05	254	100

Source: own elaboration

From Table 1, it is visible that more than 75% of the ATMs under study are located in the Malopolskie province. Taking into account the types of locations, approximately 29% are in bank branches. The next most popular locations are those connected with shopping: shopping centers (17.32%), shops (15.35%), and hypermarkets (12.99%).

The listed types of locations are the main criterion for the clustering of ATMs. However, in the present study, we introduced two additional criteria of the clustering of ATMs.

The first refers to the number of inhabitants in a given locale.

We introduced five categories of place sizes:

- Class I – populations of up to 20,000 (i.e., villages and small towns);
- Class II – populations from 20,001 to 50,000 (i.e., moderately sized towns);
- Class III – populations from 50,001 to 100,000 (i.e., large towns);
- Class IV – populations from 100,001 to 200,000, (i.e., large cities, such as Rzeszow and Tarnow);
- Class V – populations of 200,001 or more (i.e., Krakow).

In Table 2 is the information that 57% of the ATMs were located in Krakow (Class V). The smallest percentage of ATMs (below 4%) was found in places with populations below 20,000.

Table 2
Number of ATMs in given places in both provinces in classes

City-size class	Malopolskie		Podkarpackie		Total	
	Number	Percent-age	Number	Percent-age	Number	Percent-age
I	10	3.94	1	0.39	11	4.33
II	23	9.06	15	5.91	38	14.96
III	9	3.54	14	5.51	23	9.06
IV	9	3.54	26	10.24	35	13.78
V	147	57.87	0	0	147	57.87
Total	198	77.95	56	22.05	254	100

Source: own elaboration

The last clustering of location is based on accessibility to ATMs in the given places. The places were clustered on the basis of the number of inhabitants per one ATM¹.

We introduced four classes of places:

- Class A – fewer than 1000 people per ATM;
- Class B – from 1000 to 1199 people per ATM;
- Class C – from 1200 to 1499 people per ATM;
- Class D – 1500 people or more per ATM.

¹ On the basis of data by the end of 2012.

In Table 3 is the data about the number of ATMs in the different classes of accessibility for both provinces. One can note that more than 61% of the analyzed ATMs were located in places with Accessibility B (i.e., places where there were 1000–1199 inhabitants per ATM). The smallest percentage of ATMs (below 8%) were found in places with the greatest accessibility. In addition, one can see in Table 1 that the deployers whose data was used do not install ATMs in places with the broadest accessibility.

Table 3
Number of ATMs in selected classes of accessibility in both provinces

Availability of ATMs class	Malopolskie		Podkarpackie		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
A	20	7.87	0	0	20	7.87
B	156	61.42	26	10.24	182	71.65
C	10	3.94	19	7.48	29	11.42
D	12	4.72	11	4.33	23	9.06
Total	198	77.95	56	22.05	254	100

Source: own elaboration

The clustering of ATMs according to type of location and size of the place where they are located enables us to test a hypothesis on whether the location of an ATM and the kind of place determines the pattern and number of withdrawals from a given ATM.

3. Impact of location on volume of withdrawals

One of the main problems of ATM network deployers is the selection of the proper locations of its ATMs. The location of an ATM should guarantee a high volume of withdrawals; i.e., more than 3500 withdrawals per month. In order to check whether the selected types of locations have a significant impact on the number of withdrawals from the ATMs located in these places, we calculated descriptive statistics of the average withdrawals from ATMs in selected clusters of locations. In order to better describe the structure of withdrawals, we conducted a more detailed analysis for four ATMs selected from different types of locations.

3.1. Analysis of four selected ATMs

In Table 4, the four locations of the four selected ATMs are described. In Figure 4, the monthly withdrawals from the given ATMs during the period of 2011–2012 are shown.

Table 4
Location of selected ATMs

ATM type	ATM 1	ATM 2	ATM 3	ATM 4
District	Malopolskie	Podkarpackie	Malopolskie	Malopolskie
City	Krakow	Rzeszow	Zakopane	Oswiecim
Location type	shopping center	bank branch	petrol station	restaurant

Source: own elaboration

Analyzing Figure 4, one can notice that the selected ATMs represent different types with respect to the profitability of their functioning. During the whole period at ATM 1 (i.e., 24 months), the volume of withdrawals was considerably greater than 3500. A quite different observation follows from a visual inspection of ATM 2. Here, in all of the months of 2011 and 2012, the number of withdrawals was approximately 2500 (i.e., lower than the level of profitability). In the case of ATM 3, the number of withdrawals was below the line of profitability in only in two of the months. This is the probable result of a smaller number of tourists in Zakopane during the months of March–April and October–November. At ATM 4, a number of withdrawals lower than 3500 occurred 9 times out of the 24 months taken into account. One can notice that the largest monthly fluctuations were at this ATM as well as at ATM 3.

From the perspective of a manager of an ATM network, the size of withdrawal during the selected months is not important; very important, however, is the average number of withdrawals per month during a given period. The number of withdrawals is directly reflected in the level of profitability of the functioning of the ATM under study. In Table 5, the basic statistics regarding the monthly withdrawals for the four selected ATMs are given.

The data from Table 5 indicates that, during the period under study (i.e., the period of 2011–2012), the deployers of ATMs 1 and 3 made a profit because the average number of withdrawals from these ATMs was more than 3500 monthly. In the case of ATM 4, the average number of withdrawals was about 3500, so the

functioning of this ATM was on the boundary of profitability. The functioning of ATM 2 (with an average number of withdrawals of 1100) was not profitable for the deployer.

Table 5
Basic statistics of monthly withdrawals for four selected ATMs

Descriptive statistics	ATM 1	ATM 2	ATM 3	ATM 4
Average	7902.8	1099.3	5185.9	3495.0
Minimum	6515	953	3302	2741
Maximum	9650	1248	9327	4047
Standard deviation	664.0	87.9	1511.4	325.0
Coefficient of variation [%]	8.4	8.0	29.1	9.3

Source: own elaboration

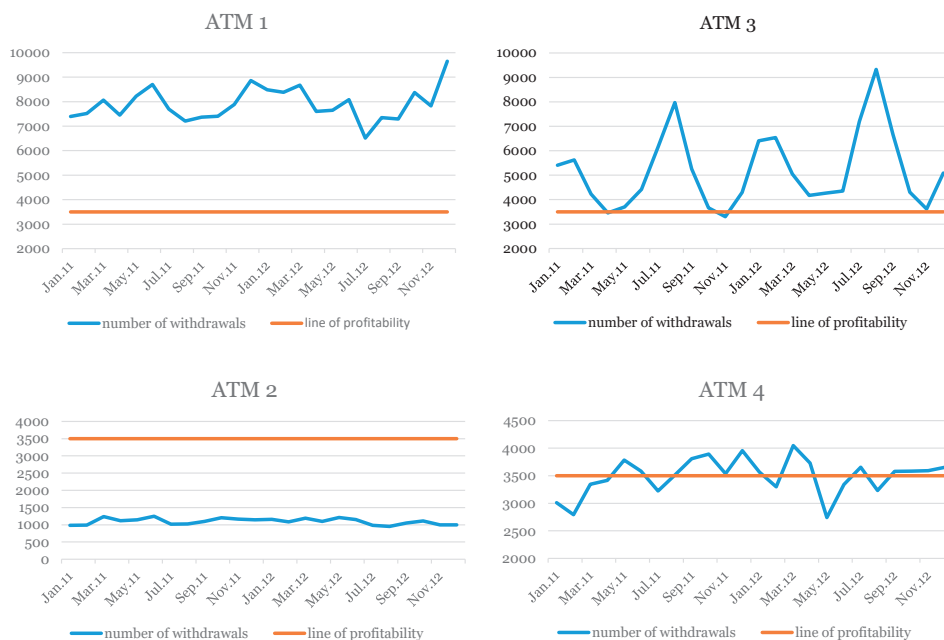


Figure 4. Number of withdrawals from four ATMs

3.2. Analysis of all ATMs in location clusters

The analysis of the number of withdrawals from the four selected ATMs showed that the profitability of the functioning of these ATMs depends strongly on their type of location. In order to verify this hypothesis, all 254 ATMs were analyzed; the results were presented for all ATMs originating from the same types of locations. For three location categories (i.e., type of location, size of place, and availability of ATM), the results for both provinces were presented together and separately. The analysis was based on the monthly averages of withdrawals from the ATMs.

Category “type of location”

In Table 6, the results of the analysis of the number of ATMs in particular types of locations are presented where the average number of withdrawals exceeded 3500. One can notice that all ATMs located in pharmacies, residential areas, and universities in Malopolskie exhibit average numbers of withdrawals above the boundary of profitability. Considerable percentages of ATMs in shopping centers (93.9%), hypermarkets (88%), and bakeries (83.3%) also exhibit withdrawals numbering over 3500 monthly. Profitable locations are also at shops and service points. In these locations, the percentage of profitable ATMs amounts to 70%. In the case of the remaining locations, the number of ATMs with more than 3500 withdrawals was not more than 50%.

The least profitability of the functioning of the exhibited ATMs were located in the “transport” (0%) and bank branch (22.5%) types of location. In Malopolskie, more than 60% of the installed ATMs exhibit an average number of withdrawals of more than 3500. In Podkarpackie, only two location types are profitable: “on the street” (100%) and in hypermarkets (75%). In the first case, it is difficult to draw general conclusions because observations were made on only one ATM. In Podkarpackie, only 17 out of 56 ATMs exhibited average monthly withdrawals of over 3500. Because a considerable number of the ATMs are located in Malopolskie, the total results for both provinces are similar to those of Malopolskie.

Information about the percentage of ATMs that make a profit in a given location can be one of the determinants of “profitability” at a planned location. However, this information may not give the full picture if the average number of withdrawals from ATMs exceeds 3500 (criterion of profitability) or not. Therefore, in Table 7, the main descriptive statistics for ATM withdrawals for all types of locations are presented.

In 13 out of the 17 types of locations in Malopolskie, the average number of withdrawals amounted to 3500 or more. The largest averages (more than 6000 withdrawals monthly) were for residential and shopping center locations. The four locations in Malopolskie with an average number of withdrawals below the level of profitability were bank branches, factories, hotels, and transport.

Table 6
Number of ATMs and percentage for which average number of withdrawals in selected locations is greater than 3500 in dependence of type of location

Location type	Malopolskie			Podkarpackie			Total	
	Number of ATMs	Number of ATMs with averages over 3500	Percentage of ATMs with averages over 3500	Number of ATMs	Number of ATMs with averages over 3500	Percentage of ATMs with averages over 3500	Number of ATMs with averages over 3500	Percentage of ATMs with averages over 3500
Bakery/patisserie	6	5	83.3	0	×	×	6	83.3
Bank branch	49	11	22.5	26	3	11.5	75	18.7
Factory	2	1	50.0	0	×	×	2	50.0
Hypermarket	25	22	88.0	8	6	75.0	33	84.9
Hotel	3	1	33.3	0	×	×	3	33.3
Office building	3	1	33.3	0	×	×	3	33.3
On street	4	2	50.0	1	1	100.0	5	60.0
Other	2	1	50.0	1	0	0.0	3	33.3
Petrol station	24	11	45.8	2	0	0.0	26	42.3
Pharmacy	2	2	100.0	1	0	0.0	3	66.7
Residential	2	2	100.0	0	×	×	2	100.0
Restaurant	2	1	50.0	0	×	×	2	50.0
Service point	3	2	66.7	0	×	×	3	66.7
Shop	33	24	72.7	6	2	33.3	39	66.7
Shopping center	33	31	93.9	11	5	45.5	44	81.8
Transport	3	0	0.0	0	×	×	3	0.0
University	2	2	100.0	0	×	×	2	100.0
Total	198	119	60.1	56	17	30.4	254	53.5

Source: own elaboration

Table 7
Basic statistics for averages of number of withdrawals from ATMs in the same type of location

Location type	Malopolskie			Podkarpackie			Total		
	average age	coefficient of variation [%]	Min. Max.	average age	coefficient of variation [%]	Min. Max.	average age	coefficient of variation [%]	Min. Max.
Bakery/patisserie	4478.1	23.5	3189.1 6032.5	x	x	x	4478.1	23.5	3189.1 6032.5
Bank branch	2451.3	54.6	372.2 6394.9	1874.7	59.6	482.1 4915.8	2251.4	57.2	372.2 6394.9
Factory	3002.4	41.4	2124.3 3880.6	x	x	x	3002.4	41.4	2124.3 3880.6
Hypermarket	5516.1	36.2	2778.8 11531.1	4343.0	37.3	1642.9 6955.6	5231.7	37.4	1642.9 11531.1
Hotel	3293.9	89.2	622.5 6440.9	x	x	x	3293.9	89.2	622.5 6440.9
Office building	3732.8	34.6	2781.8 5201.6	x	x	x	3732.8	34.6	2781.8 5201.6
On street	4559.2	32.3	2798.7 6076.4	6621.0	x	6621.0 6621.0	4971.6	31.6	2798.7 6621.0
Other	4656.5	48.4	3064.5 6248.5	3322.3	x	3322.3 3322.3	4211.8	42.0	3064.5 6248.5
Petrol station	4089.9	47.3	2159.1 9539.7	2902.1	9.7	2703.5 3100.6	3998.6	47.1	2159.1 9539.7
Pharmacy	5573.8	41.9	3921.8 7225.7	2614.2	x	2614.2 2614.2	4587.2	51.8	2614.2 7225.7
Residential	6319.8	5.0	6096.7 6542.9	x	x	x	6319.8	5.0	6096.7 6542.9
Restaurant	3938.7	15.9	3495.0 4382.3	x	x	x	3938.7	15.9	3495.0 4382.3
Service point	4595.4	48.9	2987.5 7163.5	x	x	x	4595.4	48.9	2987.5 7163.5
Shop	4645.6	31.4	2601.2 7779.1	3461.1	26.8	2334.1 4744.7	4463.4	32.4	2334.1 7779.1
Shopping center	6144.7	38.1	2655.2 13224.0	4529.2	44.7	2262.3 8171.2	5740.8	41.0	2262.3 13224.0
Transport	3317.1	8.5	2993.3 3494.6	x	x	x	3317.1	8.5	2993.3 3494.6
University	3961.2	15.3	3534.0 4388.4	x	x	x	3961.2	15.3	3534.0 4388.4
Total	4328.7	49.7	372.2 13224.0	3079.2	59.1	482.1 8171.2	4053.2	52.9	372.2 13224.0

Source: own elaboration

In most cases, we observe moderate values of the coefficient of variability; i.e., for the majority of locations, the differentiation of mean withdrawals is not very high. Therefore, we can assume that the calculated averages can represent all ATMs in a given location. In general, the results from Table 7 for Malopolskie confirm the conclusions from an analysis of the results from Table 6.

Solely for ATMs located in petrol stations, the first analysis indicated that fewer than half of the ATMs in these locations make a profit. Therefore, this location seemed to be not very good. However, the average for the total number of ATMs is considerably greater than 3500. This indicates that the installation of ATMs at petrol stations makes sense (it is profitable). On the basis of the total results for Malopolskie, we draw the conclusion that the installation of ATMs in Malopolskie is profitable, with an average monthly volume (number of withdrawals) of more than 4300.

The results in the analysis of averages for Podkarpackie confirm the results from Table 6. There is only one exception – shopping centers. In this type of location, the number of ATMs that bring profits is below 50%; however, the average number of withdrawals at this location is considerably greater than 3500.

The level of differentiation of the averages for all location is low or moderate. This means that, at a given location, we cannot observe considerable deviations from the average.

To summarize this part of the analysis, one can say that, taking into account all locations with five or more ATMs, only the ATMs at bank branches exhibited volumes below the expected volume (necessary to assure the profitability of ATMs). This is true for both provinces under study.

The most profitable locations (high average of monthly withdrawals) are hypermarkets. For locations with five or fewer ATMs, they were not profitable in factories, hotels, nor transport. However, because of the small sample size, these results cannot be considered as a general rule.

Category “size of place”

Taking into account Table 8, we see that, for Malopolskie in this category of location, the most-profitable location is Krakow (Class V). Nearly two-thirds of the ATMs in Krakow exhibit average monthly numbers of withdrawals over 3500. The results of the profitability assessment of ATMs in small or very small places are similar; the percentage of profitable ATMs is approximately 50%. The lowest percentage of profitable ATMs can be found in large and very large towns. (Categories III and IV). For the Podkarpackie province, the only profitable locations are in very small places; however, this conclusion is made regarding only one ATM, so this conclusion cannot be generalized. The same conclusions can be made from Table 8, taking into account both provinces jointly: most profitable locations are in Krakow and the smallest places.

The conclusions drawn from Table 8 are confirmed by the results in Table 9. The mean number of withdrawals from ATMs in Krakow is over 4600. The deviation from the average is not high; therefore, this number is representative for Krakow. However, one should take into account that there are also ATMs whose functioning is not profitable in Krakow (the minimum of the monthly averages in Krakow amounts to 372.2). Also, for the ATMs in Categories I and II, the average is greater than 3500. In the rest of the cases, none of the averages were greater than the value of profitability (at least 3500 withdrawals monthly). The results in Table 9 for both provinces under study are analogous to Table 8 (the profitability of ATMs installed in Krakow and the smallest places). The profitability of ATMs in small places is close to the boundary of profitability.

Table 8

Number of ATMs and percentage for which average number of withdrawals in selected locations is greater than 3500 in dependence of type of size of place

City-size class	Malopolskie			Podkarpackie			Total		
	Number of ATMs	Number of ATMs with averages over 3500	Percentage of ATMs with averages over 3500	Number of ATMs	Number of ATMs with averages over 3500	Percentage of ATMs with averages over 3500	Number of ATMs	Number of ATMs with averages over 3500	Percentage of ATMs with averages over 3500
I	10	5	50.0	1	1	100.0	11	6	54.5
II	23	12	52.2	15	3	20.0	38	15	39.5
III	9	3	33.3	14	4	28.6	23	7	30.4
IV	9	2	22.2	26	9	34.6	35	11	31.4
V	147	97	66.0	0	x	x	147	97	66.0
Total	198	119	60.1	56	17	30.4	254	136	53.5

Source: own elaboration

Table 9
Basic statistics for average number of withdrawals from ATMs installed in places of same size

City-size class	Malopolskie				Podkarpackie				Total			
	average	coeffi- cient of variation [%]	Min.	Max.	average	coeffi- cient of variation [%]	Min.	Max.	average	coeffi- cient of variation [%]	Min.	Max.
I	3583.9	36.6	1281.1	5201.6	5885.04	×	5885.04	5885.04	3793.1	37.5	1281.1	5885.0
II	4015.8	44.7	1240.3	8409.8	2643.31	62.02	792.75	6471.17	3474.0	53.1	792.8	8409.8
III	2888.6	65.4	1012.7	7019.2	2709.56	47.81	1053.71	4867.96	2779.6	54.5	1012.7	7019.2
IV	2957.3	54.7	623.3	6243.9	3421.82	60.53	482.083	8171.17	3302.4	59.1	482.1	8171.2
V	4600.4	48.3	372.2	13,224.0	×	×	×	×	4600.4	48.3	372.2	13,224.0
Total	4328.7	49.7	372.2	13,224.0	3079.21	59.14	482.083	8171.17	4053.2	52.9	372.2	13,224.0

Source: own elaboration

Category “ATM availability”

An analysis of Table 10 convinces the reader that, among ATMs from the category of Availability B for Malopolskie (i.e., 1000–1200 people per ATM), these are the highest number of ATMs making a profit for ATM network deployers. This observation can follow from the fact that Krakow belongs in this category. In the case of Malopolskie, the least “profitable” ATMs are located in the classes with the highest availability. For the Podkarpackie province in all categories of availability, the percentage of the number of ATMs with an average number of withdrawals of more than 3500 is less than 50%. An analysis of the results for both provinces jointly suggests that ATMs are profitable only in the “very small” and “small place” availabilities.

These conclusions are in line with the data in Table 11. For Malopolskie, ATMs are profitable in Classes A, B, and C. For Podkarpackie, none of the averages were greater than 3500. For all ATMs jointly, we received averages above the level of profitability in the places belonging to Classes A and B.

Recapitulation of analysis for given types of locations

During the analyzed period, only 53.5% of ATMs managed by the ATM network and installed in the given regions made a profit during the period of 2011–2012. The average monthly number of withdrawals was more than 4000; i.e., at least 500 more than the break-even mark. In general, the ATMs installed in Malopolskie are more profitable than those in Podkarpackie.

Summarizing the results of analysis for the remaining location criteria, we can draw a general conclusion that the source of the greatest profits are ATMs located in hypermarkets and shopping centers in Krakow. The sources of deficits are ATMs installed at bank branches in moderate and large places with large and very large availabilities. In order to make the conclusions more precise, the average numbers of withdrawals in the selected types of locations with respect to the size of place and availability of ATMs at a given place are inserted in Tables 12 and 13.

The results in Table 12 confirmed our earlier hypotheses. The installation of ATMs in hypermarkets is profitable regardless of the size of the place. This is the only location in all of the types of places in which the installation of ATMs is always profitable. In the case of shopping centers, the functioning of ATMs in average places is not profitable. In petrol stations, one can expect profits in ATMs installed in the smallest places and in Krakow. For a number of ATMs greater than or equal to five, good results are exhibited by ATMs installed close to bakeries/patisseries in Krakow and ATMs from the “on the street” category. In the last category independent of place, the average number of withdrawals is more than 3500. Not profitable ATMs are due to our criterion functioning at bank branches; this is true independent of size of place.

Table 10
 Number of ATMs and percentage for which average number of withdrawals in selected locations is greater than 3500
 in dependence of class of availability of ATMs in given place

Availability of ATMs class	Malopolskie			Podkarpackie			Total		
	Number of ATMs with average over 3500	Percentage of ATMs with average over 3500	Number of ATMs	Number of ATMs with average over 3500	Percentage of ATMs with average over 3500	Number of ATMs	Number of ATMs with average over 3500	Percentage of ATMs with average over 3500	Number of ATMs
A	20	50.0	0	×	×	20	10	50.0	10
B	156	64.1	26	9	34.6	182	109	59.9	109
C	10	50.0	19	3	15.8	29	8	27.6	8
D	12	33.3	11	5	45.5	23	9	39.1	9
Total	198	60.1	56	17	30.4	254	136	53.5	136

Source: own elaboration

Table 11
Basic statistics for average number of withdrawals from ATMs installed in place from same class of availability

Availability of ATMs class	Malopolskie				Podkarpacie				Total			
	average	coefficient of variation [%]	Min.	Max.	average	coefficient of variation [%]	Min.	Max.	average	coefficient of variation [%]	Min.	Max.
A	3680.8	35.3	1281.1	5762.0	×	×	×	×	3680.8	35.3	1281.1	5762.0
B	4501.7	49.7	372.2	13,224.0	3421.8	60.5	482.1	8171.1	4347.4	51.5	372.2	13,224.0
C	4136.5	57.5	1240.3	8409.8	2568.2	55.9	792.7	6471.1	3109.0	62.0	792.8	8409.8
D	3319.9	48.3	623.3	6243.9	3152.0	54.8	1113.5	5885.0	3239.6	50.3	623.3	6243.9
Total	4328.7	49.7	372.2	13,224.0	3079.2	59.1	482.1	8171.1	4053.2	52.9	372.2	13,224.0

Source: own elaboration

We cannot draw reliable conclusions for the other types of locations because the samples were too small. However, one can say that, taking into account the classes of sizes of places, the most profitable functioning of ATMs is in Krakow.

Table 12

Average number of withdrawals from ATMs installed in place of same size in dependence of type of location

Location type	City size class				
	I	II	III	IV	V
Bakery/patisserie	×	×	×	×	4478.1
Bank branch	1686.27	2041.47	2049.37	1631.27	2698.66
Factory	×	2124.25	×	×	3880.63
Hypermarket	5885.04	4870.69	4210.47	4289.32	5726.05
Hotel	×	×	×	×	3293.89
Office building	4208.31	×	×	×	2781.75
On street	×	5408.83	×	6621	4276.03
Other	×	×	×	3322.33	4656.5
Petrol station	3651.23	3342.22	3100.63	2703.54	4304.84
Pharmacy	×	×	×	2614.17	5573.75
Residential	×	×	×	×	6319.77
Restaurant	×	3495.04	×	×	4382.29
Services point	×	×	×	×	4595.44
Shop	3928.65	4465.22	×	3271.13	4669.99
Shopping center	4961.79	5018.22	3200.9	4984.7	6522.35
Transport	×	3463.21	×	2993.33	3494.63
University	×	×	3534.04	×	4388.42
Total	3793.13	3474.03	2779.63	3302.38	4600.44

Source: own elaboration

Good profits are brought by ATMs installed in the smallest places. The ATMs in small and large places obtained results close to the boundary of profitability. The analysis demonstrated that the installation of ATMs in average places is not profitable.

In Table 13, the results of clusters with respect to the classes of availability of ATMs are inserted. Also, the previous results are confirmed here. For ATMs from Class A, the functioning of ATMs is only unprofitable at bank branches. Quite similar is in the case of places from Class B; here, the relatively low average monthly number of withdrawals was shown at the office building location. For the remaining types of places, one can find “profitable” locations. However, in places with the greatest availability of ATMs, the average number of monthly withdrawals from ATMs is considerably lower as compared to the two other classes.

Table 13

Average number of withdrawals from ATMs installed in place of same size of ATM availability in dependence of type of location

Location type	Availability of ATMs class			
	A	B	C	D
Bakery/patisserie	×	4478.1	×	×
Bank branch	1695.79	2349.5	1991.87	2346.53
Factory	×	3880.63	2124.25	×
Hypermarket	4870.69	5681.92	4102.19	3666.93
Hotel	×	3293.89	×	×
Office building	3215.04	2781.75	×	5201.58
On street	5408.83	4862.27	×	×
Other	×	4211.78	×	×
Petrol station	3514.23	4220.56	×	3100.4
Pharmacy	×	4587.22	×	×
Residential	×	6319.77	×	×
Restaurant	3495.04	4382.29	×	×
Services point	×	4595.44	×	×
Shop	4174.74	4520.11	4311.08	4626.67
Shopping center	4467.13	6064.69	4733.19	4531
Transport	3463.21	3494.63	×	2993.33
University	×	3961.23	×	×
Total	3680.76	4347.42	3109.01	3239.61

Source: own elaboration

4. Conclusions

The main goal of the research was to determine the location factors that impacted the profitability of ATMs installed in the Malopolskie and Podkarpackie provinces during the period of 2011–2012.

The conducted analysis showed that the functioning of the ATM network is much more profitable in Malopolskie than in Podkarpackie. For the category “type of location,” the authors found those locations where the installation of ATMs was statistically profitable. For places with a large number of ATMs (only in this case can the analysis be assumed to be reliable), the functioning of ATMs in hypermarkets, shopping centers, and bakeries is definitely profitable. ATMs in bank branches appeared to be unprofitable; however, it is worth noting that this location is specific and the installation of many ATMs at this location can be justified in spite of the lower number of withdrawals. This assumption may follow from the fact that the costs of an ATM functioning at a bank branch may be lower than those outside the bank. Taking into account the types of places where ATMs are located, the most profitable ATMs are in Krakow as well as the small and smallest places. These are places with very low and low availabilities of ATMs.

The results of the profitability analysis for the particular locations of ATMs and the declining number of withdrawals from ATMs in recent years allow for the conclusion that activity on the market of ATM networks can be less and less profitable in the upcoming years. The decline of profitability mostly concerns main independent network deployers. They cannot introduce additional charges to their customers like bank deployers can. Although the number of ATMs grew from year to year through the end of 2016, the first information by the end of 2017 (comp. Sadowski, 2017) indicated that the number of ATMs in 2017 could decline as compared to 2016.

Most of the measures by independent deployers against further declines of profitability are not advantageous for customers; as a consequence, this may bring forth a negative reputation for the ATM network.

The first measure in the case of non-profitable ATMs is their relocation. However, relocation of ATMs from places with lower profitability to places of higher profitability where there are many withdrawals implies a lower availability of ATMs (the distances to the nearest ATM will be further). A second way is limiting the size of particular withdrawals. Large withdrawals are a source of higher costs and do not generate considerably higher profits. Also, this measure is not welcome by customers and can be a source of the loss of a firm’s reputation. The next measure may be the establishment of additional fees for customers of banks with whom they cooperate. However, this decision may also be a source of decline for customers of ATMs and may be bad for business relationships with banks.

The next way of attaining additional profits may be the emission of advertisements during withdrawals from ATMs. It seems that this way of seeking additional profits may not be so harmful to deployers' relationships with customers as described above. However, according to empirical investigations, customers are not happy with the advertisements because the withdrawals take longer to complete (comp. Molga, 2015)

There is one method of increasing profits that is accepted by the customers of ATMs. This is an increase in the functionality of ATMs. Many ATMs allow withdrawals in foreign currency, top-ups of handy money transfers, and even the ability to apply for credit. More and more popular are the so-called dual-device cash recyclers. A cash recycler is a complex machine that handles a couple of simple but important tasks – accepting and dispensing cash.

It is not easy to assess the effectiveness of the deployers' measures in order to preserve the profitability of ATMs. This will be more visible in the upcoming years.

The obtained results are important for ATM deployers who are planning locations for their ATMs. In addition, our results may inspire a discussion about the future of ATM markets. Moreover, these results may help to find a way to avoid uninstalling ATMs in our country.

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